TRANSACTIONS

OF THE

AMERICAN CLIMATOLOGICAL
AND
CLINICAL ASSOCIATION.

FOR THE YEAR 1914.

VOLUME XXX.

"The object of this Association shall be the Clinical Study of Disease, especially of the Respiratory and Circulatory Organs, and of Climatology and Hydrology."—*Constitution.*

PHILADELPHIA:
PRINTED FOR THE ASSOCIATION.
1914.

OFFICERS OF THE ASSOCIATION.

PRESIDENTS.

JAMES M. ANDERS, M.D., PHILADELPHIA, 1914.
HENRY SEWALL, M.D., DENVER, 1915.

VICE-PRESIDENTS.

LAWRASON BROWN, M.D., SARANAC LAKE, 1914.
WILL HOWARD SWAN, M.D., COLORADO SPRINGS, 1914.
ARTHUR K. STONE, M.D., BOSTON, 1915.
JAMES ALEXANDER MILLER, M.D., NEW YORK, 1915.

SECRETARY AND TREASURER.

GUY HINSDALE, M.D., HOT SPRINGS, VA.

REPRESENTATIVE TO THE EXECUTIVE COMMITTEE OF THE CONGRESS OF AMERICAN PHYSICIANS AND SURGEONS.

THOMAS DARLINGTON, M.D., NEW YORK.

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CHARLES L. MINOR, M.D., ASHEVILLE.
JAMES M. ANDERS, M.D., PHILADELPHIA.

ERRATUM.

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LIST OF OFFICERS.

Presidents.

NAME	YEAR
A. L. Loomis	1884–5
William Pepper	1886
Frank Donaldson	1887
A. L. Loomis	1888
V. Y. Bowditch	1889
Charles Denison	1890
F. I. Knight	1891
W. E. Ford	1892
R. G. Curtin	1893
A. H. Smith	1894
S. E. Solly	1895
J. B. Walker	1896
E. Fletcher Ingals	1897
E. O. Otis	1898
Beverley Robinson	1899
Abraham Jacobi	1900
Robert H. Babcock	1901
Samuel A. Fisk	1902
Norman Bridge	1903
James C. Wilson	1904
W. F. R. Phillips	1905
E. L. Shurly	1906
Thomas Darlington	1907
Thomas D. Coleman	1908
Charles E. Quimby	1909
Edward R. Baldwin	1910
John Winters Brannan	1911
Alexander D. Blackader	1912
Charles L. Minor	1913
James M. Anders	1914
Henry Sewall	1915

Vice-Presidents.

NAME	YEAR
F. I. Knight, W. H. Geddings	1884-5
Frank Donaldson, Beverley Robinson	1886
V. Y. Bowditch, R. G. Curtin	1887
A. Y. P. Garnett, J. T. Whittaker	1888
J. R. Leaming, E. T. Bruen	1889
A. L. Gihon, H. B. Baker	1890
E. L. Trudeau, T. S. Hopkins	1891
E. Fletcher Ingals, Beverley Robinson	1892
A. H. Smith, E. O. Otis	1893
I. Hull Platt, E. L. Trudeau	1894
John H. Musser, G. R. Butler	1895
Charles E. Quimby, James A. Hart	1896
S. A. Fisk, John C. Munro	1897
Beverley Robinson, C. F. McGahan	1898
James A. Hart, R. C. Newton	1899
R. H. Babcock, J. W. Brannan	1900
Albert C. Peale, S. W. Langmaid	1901
Norman Bridge, W. F. R. Phillips	1902
James C. Wilson, H. S. Orme	1903
Thomas Darlington, Thomas D. Coleman	1904
S. G. Bonney, S. D. Risley	1905
A. D. Blackader, Henry Sewall	1906
Frank Fremont-Smith, C. L. Minor	1907
Judson Daland, Charles Fox Gardiner	1908
E. R. Baldwin, C. E. Edson	1909
James M. Anders, H. Longstreet Taylor	1910
Will Howard Swan, John H. Lowman	1911
Herbert Maxon King, Carroll E. Edson	1912
James M. Anders, C. D. Alton	1913
Lawrason Brown, Will Howard Swan	1914
Arthur K. Stone, James Alex. Miller	1915

Secretaries and Treasurers.

James B. Walker	1884–95
Guy Hinsdale	1895

LIST OF MEMBERS.

Honorary Members.

ELECTED

1888. Abbot, Griffith E., Leominster, Mass.
1914. Fox, R. Fortescue, Devonshire Place, W., London.
1914. Garnett, A. S., Hot Springs, Arkansas.
1914. Gros, Edmund L., 23, Ave. du Bois de Boulogne, Paris, France.
1902. McBride, James H., Pasadena, Cal.
1914. Philip, Sir Robert W., Charlotte Square, Edinburgh, Scotland.
O. M. Reed, Boardman, Alhambra, Cal.
O. M. Robinson, Beverley, 42, West 37th Street, New York.
O. M. Schauffler, Edward W., Kansas City, Missouri.
1911. Stupart, Prof. R. F., Director, Dominion Meteorological Service, Toronto, Canada.
1898. Sunderland, Septimus, 11, Cavendish Place, Cavendish Square, W., London.
1885. Trudeau, Edward L., Saranac Lake, New York.
O. M. Tyndale, J. Hilgard, Richards Block, Lincoln, Nebraska.
1897. Weber, Sir Hermann, 10, Grosvenor Street, W., London, England.
1907. Williams, Leonard L. B., 123, Harley Street, London, W.

Corresponding Members.

1912. Carpenter, Ford A., Weather Bureau, Los Angeles, Cal.
1898. Eyre, G. G., Claremont, Cape Town, South Africa.
1910. Forbes, Mr. N. Hay, F.R.C.S., Church Stretton, England.
1911. Grenfell, Wilfred, C.M.G., St. Anthony, Newfoundland.

O. M., Original Member.

ELECTED

1912. HENDERSON, YANDELL, 440, Prospect Street, New Haven, Conn.

1910. LAMB, GEORGE, Indian Medical Service, Parel, Bombay, India.

1908. LISTON, W. GLEN, D.P.H., Capt., Indian Medical Service, Parel, Bombay Bacteriological Laboratory, Bombay, India.

1910. ROGERS, LIEUT.-COLONEL SIR LEONARD, C.I.E., F.R.C.S., School of Medicine, Calcutta, India.

1904. SANDWITH, FLEMING MANT, 31, Cavendish Square, W., London.

1902. WEBER, F. PARKES, 19, Harley Street, W., London.

1907. WELLMANN, F. CREIGHTON, Tulane University, 1551, Canal Street, New Orleans, La.

1914. WOOD, NEVILLE, 42, Elvaston Place, Queen's Gate, London.

ACTIVE MEMBERS.

1914. ALSEVER, WILLIAM D., S° Salina Street, Syracuse, New York.

1897. ALTON, CHARLES D., 1310, Asylum Avenue, Hartford, Conn.

1899. ANDERS, JAMES M., 1605, Walnut Street, Philadelphia.

1890. ANDERSON, B. P., 106, N. Cascade Avenue, Colorado Springs, Col.

1900. ARNOLD, HORACE D., 520, Commonwealth Avenue, Boston.

1893. BABCOCK, R. H. 311, Belden Avenue, Chicago.

1898. BALDWIN, EDWARD R., Saranac Lake, N.Y.

1901. BARLOW, W. JARVIS, Security Building, Los Angeles, Cal.

1907. BARNES, HARRY LEE, Wallum Lake, R.I.

1902. BERGTOLD, WILLIAM H., 1159, Race Street, Denver, Col.

1906. BILLINGS, JOHN S., Jun., 149, Centre Street, New York City.

1897. BLACKADER, ALEXANDER D., 236, Mountain Street, Montreal, Canada.

1914. BLUE, RUPERT, Surgeon-General, U.S. Public Health Service, Washington, D.C.

1895. BOARDMAN, W. S., 63, Mt. Vernon Street, Boston.

ELECTED

1897. Bonney, S. G., Stedman Building, Denver, Col.

1885. Bowditch, V. Y., 506, Beacon Street, Boston.

1901. Bracken, Henry Martyn, 1010, Fourth Street, S.E., Minneapolis, Minn.

1891. Brannan, John W., 48, West 51st Street, New York City.

1894. Bridge, Norman, Temple Auditorium, Los Angeles, Cal.

1903. Brown, Lawrason, 104, Main Street, Saranac Lake, N.Y.

1903. Brown, Philip King, ~~350, Post Street~~, San Francisco, Cal. 516 Sutter St

1897. Brown, Sanger, Reliance Building, Chicago.

1907. Browning, Charles C., Story Bldg., Los Angeles, Cal.

1909. Bushnell, George E., U.S.A., Fort Bayard, New Mexico.

1886. Butler, G. R., 226, Gates Avenue, Brooklyn.

1914. Byers, John Roddick, Ste. Agathe, P.Q., Canada.

1896. Campbell, W. A., 424, N. Nevada Ave., Colorado Springs, Col.

1910. Carrington, P. M., U.S.M.H. and P.H. Service, San Diego, Cal.

1898. Casselberry, W. E., 15, East Washington Street, Chicago, Ill.

1906. Claytor, Thomas A., 1826, R. Street, N.W., Washington, D.C.

1901. Cobb, J. O., U.S.P.H. Service, Marine Hospital, Chicago.

1894. Coleman, Thomas D., 505, Greene St., Augusta, Ga.

1901. Collins, Charles Farnham, 50, West 55th Street, New York City.

1889. Coolidge, A., jun., 613, Beacon Street, Boston.

1910. Crane, Bayard T., Rutland, Mass.

1907. Da Costa, John C., jun., 264, South 15th Street, Philadelphia.

1892. Daland, Judson, 317, South 18th Street, Philadelphia.

1890. Darlington, Thomas, 27, Washington Square North, New York City.

1907. Darnall, Wm. Edgar, 1704, Pacific Ave., Atlantic City.

ELECTED

1897. DAVIS, N. S., 7, West Madison Street, Chicago.
1910. DIXON, SAMUEL G., Harrisburg, Penn.
1905. DUNN, WILLIAM LEROY, Asheville, N.C.

1897. EDSON, CARROLL E., 517 Majestic Bldg. ~~McPhee Building~~, Denver, Col.
1903. ELLIOTT, J. H., 11, Spadina Road, Toronto, Canada.
1892. ELSNER, H. L., Fayette Park, Syracuse, N.Y.

1912. FARRAND, LIVINGSTON, Boulder, Colorado.
1910. FLOYD, CLEAVELAND, 1398, Beacon Street, Boston, Mass.
1885. FORD, WILLIS E., 266, Genesee Street, Utica, N.Y.
1911. FULTON, FRANK TAYLOR, 36, Prospect Street, Providence, R.I.

1896. GARDINER, C. FOX, 818, North Cascade Avenue, Colorado Springs, Col.
1892. GIBSON, WILLIAM M., 260, Genesee Street, Utica, N.Y.
1909. GRIFFIN, WALTER ALDEN, Sharon, Mass.

1907. HALL, J. N., 452, Metropolitan Building, Denver, Col.
1912. HAMMAN, LOUIS, 714, Park Avenue, Baltimore.
1893. HANCE, I. H., Lakewood, N.J.
1891. HART, JAMES A., P.O. Box 144, Geneva, N.Y.
1912. HASTINGS, THOMAS W., 172, East 71st Street, New York.
1912. HATFIELD, CHARLES J., 2008, Walnut Street, Philadelphia.
1914. HAWES, JOHN B., 2nd, 29, Gloucester Street, Boston, Mass.
1896. HEFFRON, JOHN L., 582, South Salina Street, Syracuse, N.Y.
1912. HEWLETT, A. WALTER, 1835, Cambridge Road, Ann Arbor, Michigan.
1893. HINSDALE, GUY, Hot Springs, Va.
1902. HOAGLAND, HENRY W., 818, North Nevada Avenue, Colorado Springs, Col.
1914. HOLDEN, G. WALTER, St. Agnes Memorial Sanatorium, Denver, Colorado.
1905. HUDDLESTON, JOHN H., 145, West 78th Street, New York.

O. M. INGALS, E. FLETCHER, Monroe Buildings, 104, Michigan Avenue, Chicago.

ELECTED

1889. JACOBI, A., 19, East 47th Street, New York.
1888. JAYNE, W. A., 416, McPhee Building, Denver, Col.
1901. JENNINGS, CHARLES GODWIN, 457, Jefferson Street, Detroit, Michigan.

1910. KAHLO, GEORGE D., White Sulphur Springs, West Virginia.
1904. KING, HERBERT MAXON, Liberty, New York.
1907. KINGHORN, HUGH M., 14, Church Street, Saranac Lake, N.Y.
1899. KLEBS, ARNOLD C., c/o J. M. Forbes and Co., Sears Bldg., Boston.
1903. KYLE, D. BRADEN, 1517, Walnut Street, Philadelphia.

1910. LANDIS, H. R. M., 11, South 21st Street, Philadelphia.
1914. LEE, ROGER I., Harvard University, Cambridge, Mass.
1914. LICHTY, JOHN A., 4634, Fifth Avenue, Pittsburg, Pa.
1909. LOCKE, EDWIN ALLEN, 311, Beacon Street, Boston, Mass.
1913. LORD, FREDERICK T., 305, Beacon Street, Boston.
1904. LOWMAN, JOHN H., 1807, Prospect Ave., S.E., Cleveland, O.
1907. LYMAN, DAVID RUSSELL, Wallingford, Conn.

1906. MANGES, MORRIS, 72, East 79th Street, New York.
1910. MARCY, ALEXANDER, Riverton, N.J.
1902. MARVEL, PHILIP, 1616, Pacific Avenue, Atlantic City, N.J.
1887. MAYS, THOMAS J., 1829, Spruce Street, Philadelphia.
1905. MILLER, JAMES ALEXANDER, 18, West 51st Street, New York.
1909. MINER, CHARLES H., 115, South Franklin Street, Wilkesbarre, Pa.
1909. MINER, STANLEY G., 58, Cadillac Square, Detroit, Mich.
1899. MINOR, CHARLES L., Asheville, N.C.
1909. MORGAN, JAMES DUDLEY, 919, Fifteenth Street, N.W., Washington, D.C.

1895. NEWTON, R. C., 42, Church Street, Montclair, N.J.
1907. NICHOLS, ESTES, 655, Congress Street, Portland, Maine.

ELECTED

1907. Nichols, John B., 1321, Rhode Island Ave., N.W., Washington, D.C.

1912. Norris, George W., 1530, Locust Street, Philadelphia.

1888. Otis, E. O., 381, Beacon Street, Boston.

1913. Parfitt, C. D., Gravenhurst, Ontario, Canada.

1912. Paterson, Robert Childs, ~~Ste. Agathe des Monts, Province of Quebec,~~ Canada. Saranac Lake.

1906. Perkins, Jay, 125, Waterman Street, Providence, R.I.

1895. Phillips, W. F. R., Mobile, Alabama.

1887. Platt, Walter B., 802, Cathedral Street, Baltimore.

1902. Pottenger, F. M., 1100, Title Insurance Building, Los Angeles, Cal.

1905. Pratt, Joseph H., 317, Marlborough Street, Boston.

1914. Probst, Charles O., 185, State Street, Columbus, Ohio.

1905. Pryor, John H., 26, Linwood Ave., Buffalo, N.Y.

1891. Quimby, Charles E., 278, West 86th St., New York.

1885. Rice, C. C., 123, East 19th Street, New York.

1901. Richardson, Charles W., 1317, Connecticut Avenue, Washington, D.C.

1904. Richer, A. J., Ste. Agathe des Monts, Province of Quebec, Canada.

1890. Robinson, W. D., 2012, Mt. Vernon St., Philadelphia.

1902. Rochester, Delancey, 469, Franklin Street, Buffalo, N.Y.

1892. Roe, John O., 44, South Clinton St., Rochester, N.Y.

1890. Rogers, E. J. A., 222, Colfax Avenue, Denver, Col.

1905. Schauffler, William Gray, 400, Madison Ave., Lakewood, N.J.

1901. Sewall, Henry, 1360, Vine Street, Denver, Col.

1910. Shurly, B. R., 32, Adams Avenue W., Detroit, Mich.

1890. Smith, A. Alexander, 18, West 51st St., New York.

1887. Smith, Frank Fremont, 1808, Massachusetts Ave., Washington, D.C.

1911. Steiner, Walter R., 4, Trinity Street, Hartford, Conn.

1909. Stevens, Martin L., Asheville, N.C.

ELECTED

1904. Stone, Arthur K., 44, Fairfield St., Boston, Mass.
1910. Swan, John M., 457, Park Avenue, Rochester, N.Y.
1901. Swan, Will Howard, 1440, North Nevada Avenue, Colorado Springs, Col.

1892. Taylor, H. Longstreet, 75, Lowry Arcade, St. Paul, Minn.
1907. Taylor, J. Gurney, 514, Goldsmith Building, Milwaukee, Wisconsin.
1896. Taylor, J. Madison, 1504, Pine Street, Philadelphia.
1910. Thomas, John D., 1726, M. Street, N.W., Washington.

1897. Whitcomb, H. H., 622, Dekalb St., Norristown, Pa.
1911. White, William Charles, Bedford Ave. and Wandless St., Pittsburg, Pa.
1898. Whitney, Herbert B., 320, Temple Court, Denver, Col.
1898. Williams, Harold, 528, Beacon Street, Boston.
1885. Williams, H. F., 416, Grand Avenue, Brooklyn.
1911. Williams, Linsly R., 882, Park Avenue, New York City.
1910. Wilson, Gordon, 4, East Preston St., Baltimore.
O. M. Wilson, James C., 1509, Walnut Street, Philadelphia.
1913. Wood, Nathaniel K., 309, Beacon Street, Boston.

Total, 135 Active Members.

MINUTES.

THERE were present during the Sessions :—

J. M. Anders,
H. D. Arnold,
J. W. Brannan,
C. G. Browning,
T. D. Coleman,
T. Darlington,
W. E. Darnall,
W. L. Dunn,
C. E. Edson,
C. Floyd,
C. F. Gardiner,
J. N. Hall,
L. Hamman,
I. H. Hance,
J. A. Hart,
G. Hinsdale,
C. G. Jennings,
H. M. King,
H. M. Kinghorn,
H. R. M. Landis,
D. R. Lyman,
J. McBride,
P. Marvel,
J. A. Miller,
C. L. Minor,
J. D. Morgan,
R. C. Newton,
E. Nichols,
G. W. Norris,
E. O. Otis,
R. C. Paterson,
Jay Perkins,
F. M. Pottenger,
C. W. Richardson,
W. D. Robinson,
D. Rochester,
W. G. Schauffler,
B. R. Shurly,
M. L. Stevens,
A. K. Stone,
J. M. Swan,
J. G. Taylor,
J. M. Taylor,
J. D. Thomas,
H. H. Whitcomb,
G. Wilson,
J. C. Wilson,
N. K. Wood.

The following sent excuses: E. R. Baldwin, W. S. Boardman, S. G. Bonney, V. Y. Bowditch, J. Daland, J. H. Elliott, H. L. Eisner, J. L. Heffron, A. Jacobi, W. A.

Jayne, G. D. Kahlo, C. H. Miner, J. H. Pratt, W. F. R. Phillips, C. E. Quimby, A. J. Richer, A. A. Smith, W. R. Steiner.

First Session, Friday Morning, June 19, 1914.

The thirty-first Annual Meeting of the American Climatological Association was held at the Hotel Chelsea, Atlantic City, N.J., on June 19 and 20, 1914.

The meeting was called to order at 10.15 A.M.; the President, Dr. James M. Anders, of Philadelphia, in the chair, called on Rev. Henry Morse Mellin to open the session with prayer. After an address of welcome by Mayor William Riddle, Dr. Philip Marvel, Chairman of the Committee of Arrangements, invited the members and accompanying ladies to an informal tea at his house on the following afternoon.

The President's address was then delivered by Dr. James M. Anders, of Philadelphia.

In the absence of Dr. A. Alexander Smith, of New York City, the Secretary read the memorial of the late Dr. Egbert Le Fevre, of New York.

In the absence of Professor R. F. Stupart, of Toronto, the Secretary read his contribution on "The Climate of South-western Alberta." The scientific programme, as represented in the volume herewith published, occupied the succeeding sessions.

The first business session was called to order at 12.30 P.M. by the President immediately after the adjournment of the Scientific Session.

The calling of the roll was omitted, as the members present had all registered.

The minutes of the previous meeting were not read, having been published in the Transactions.

Dr. Hinsdale then read the minutes of the Council meetings held in Philadelphia, and presented the minutes of the Council Meeting held on Friday morning, June 19, 1914.

The report of the Secretary was read by Dr. Hinsdale.

It was moved and seconded that the Secretary's report be accepted. Carried.

The Treasurer's report was then called for.

Dr. Hinsdale : The Treasurer's report shows a balance in the treasury of $132.83, with vouchers ready for the Auditing Committee.

It was moved and seconded that the Treasurer's report be received and referred to the Auditing Committee. Carried.

Drs. Rochester, Robinson, and Minor were appointed.

The report of the Council on recommendations for membership showed that twelve names received approval.

The following were appointed on the Nominating Committee : Drs. Otis, Darlington, Pottenger, Richardson, and Gardiner. Adjourned.

Second Business Session, Saturday, June 20, 1914.

The meeting was called to order by Dr. Anders at 12.40 P.M.

Dr. Rochester : Chairman,—I have to report that the Auditing Committee went over the records and vouchers of the Treasurer and have found them correct. They have, accordingly, signed a statement to that effect.

It was moved and seconded that the report of the Auditing Committee be received. Carried.

Dr. Otis : Chairman,—The Nominating Committee has the honour to present the following report : It recommends for election as President Dr. Henry Sewall, of Denver, Col.; Vice-Presidents, Drs. A. K. Stone, of Boston, Mass., and J. A. Miller, of New York City; Secretary and Treasurer, Dr. Guy Hinsdale, of Hot Springs, Va.; Member of the Council, Dr. James M. Anders, of Philadelphia, Pa.; Delegate to the Congress of Physicians and Surgeons, Dr. Thomas Darlington, of New York City; and alternate, Dr. Lawrason Brown, of Saranac Lake, N.Y. It also recommends that the next Annual Meeting shall be held at San Francisco, Cal.

It was moved and seconded that the recommendations of the Nominating Committee be adopted. Carried.

It was moved and seconded that the President be directed to cast a ballot for the election of the officers named by the Nominating Committee. Carried.

The Chairman reported that he had cast a ballot for the officers, whose names were read. The next business was the election of new members. The Chairman appointed Dr. Norris, Dr. Paterson, and Dr. Hamman as tellers.

Dr. Paterson reported that those on the list of honorary members had all been elected unanimously. The report of the tellers on the active list is as follows. Those elected are: Drs. William D. Alsever, Syracuse, N.Y.; Rupert Blue, Washington, D.C.; John R. Byers, Ste. Agathe des Monts, P.Q., Can.; John B. Hawes, 2d, Boston, Mass.; G. Walter Holden, Denver, Col.; Roger I. Lee, Boston, Mass.; John A. Lichty, Pittsburg, Pa.; and Charles O. Probst, Columbus, O.

The resolutions introduced by the Committee appointed to consider the President's address last year were then discussed.

The first resolution was discussed by Dr. Minor, Dr. Otis, Dr. Stone, Dr. Edson, Dr. Rochester, Dr. J. M. Swan, Dr. Darlington, Dr. Anders, Dr. Hinsdale, Dr. Arnold.

The resolution was then adopted by which Article I of the Constitution was changed so as to read: "This Society shall be known as the American Climatological and Clinical Association."

It was moved and seconded that the Association adopt the second resolution, viz.: "That Article II be changed so as to read: 'The object of this Association shall be the clinical study of diseases, especially those of the respiratory and circulatory organs, and of climatology and hydrology.'"

On Dr. Minor's suggestion, the Association considered the resolution amended as follows: "That Article II be changed so as to read: 'The object of this Association shall be the clinical study of disease, especially of the respiratory and circulatory organs, and of climatology and hydrology.'"

This amendment was seconded and carried. It was then moved and seconded that the motion as amended be adopted. Carried.

The next resolution was: "That Article III be amended by adding, after the last sentence: 'Candidates for membership shall, at the discretion of the Council, present a paper to the Association showing clinical study of merit.'" [It was moved and seconded that it be adopted. Carried.]

Dr. Hinsdale: According to the will of the late Dr. Charles Denison, a member of this Association, there is a provision for a prize essay. The will also provides that one of the members of the Committee to award this prize shall be appointed by this Association, and another by the Medical Society of Colorado. It is in order to make this appointment now. [It was moved and seconded that the President appoint a member of this Committee. Carried.] Dr. C. E. Edson, of Denver, was appointed.

Adjourned at 1.25 P.M.

EGBERT LE FEVRE, M.D., LL.D.

Born October 28, 1858. Died March 30, 1914.

MEMORIAL.

DR. EGBERT LE FEVRE.

Dr. Egbert Le Fevre died March 30, 1914, of scarlet fever, after four days' illness.

Dr. Le Fevre was born October 28, 1858, in Raritan, New Jersey. He was graduated from Rutger's College in 1880, and from the New York University Medical College in 1883. He became interne at Bellevue Hospital the same year. In 1885, when nearing the completion of his interne service, he developed a tuberculous process in the lung with active hæmorrhage, from which he apparently recovered, after a few months' stay in the country, and never had any recurrence.

Dr. Le Fevre was of French Huguenot ancestors, both on the paternal and maternal sides. His father was Rev. James L. Le Fevre, D.D., a clergyman of honourable standing and career in New Jersey, and his mother, whose maiden name was Cornelia Bevier Hasbrouck, came of a well-known family in New York State.

Dr. Le Fevre's father, who died on May 6, 1914, was born in New Paltz in 1828. His first ancestor in America was Simon L., who emigrated from France in 1663, and was one of the twelve at that time to purchase a large tract of land of many thousand acres from the Indians on the banks of the Wallkill River, in Ulster County, N.Y., and established a "palatinate" which they called New Paltz, and over which they and their descendants ruled for more than a hundred years.

Dr. Le Fevre spent a portion of the years 1886 and 1887 in study abroad, and on his return began the practice of medicine in New York City. He began his career as a teacher in 1888, when he was appointed Clinical Lecturer in the Practice of Medicine in the Medical Department of the New York University; from 1890 to 1895 the Professor of Clinical Medicine; from 1895 to 1898 he was Adjunct Professor of Medicine; then in 1898 occurred the consolidation of the Bellevue Hospital Medical College and the New York University Medical College under the name of the New York University and Bellevue Hospital Medical College, in which institution he became Professor of Clinical Medicine and Associate Professor of Therapeutics and Materia Medica.

In 1903 he became Professor of Therapeutics and Materia Medica and Clinical Medicine, and in the same year was made Dean of the Faculty, which positions he held at the time of his death.

Rutger's College conferred on him the degree of A.M. in 1884, the honorary degree of Sc.D. in 1903. The New York University conferred the degree of LL.D. on him in 1911.

Dr. Le Fevre was a Fellow of the New York Academy of Medicine and a Fellow of the American Medical Association, member of the New York Pathological Society and the National Association for the Study and Prevention of Tuberculosis. He was also a member of the City Club, the New York Athletic Club, the Automobile Club of America, and the Thousand Island Yacht Club. From 1895 to 1898 he was Visiting Physician to New York City Hospital. Since 1898 up to the time of his death he was Visiting Physician to Bellevue Hospital and Consulting Physician to a number of hospitals in New York City and vicinity.

Dr. Le Fevre was a man of large stature, being 6 ft. 4 in. tall, broad in proportion, and weighed at the time of his death 220 lb. He was a man of most genial personality. By his learning and acute perception he gained the respect of all who knew him, and by his kindly thoughtfulness and justice secured the affection and esteem of his students and colleagues.

His enormous capacity for hard work was a marvel to his associates and a constant stimulus to them. His ability as an administrator was unique. He was an acute diagnostician and his advice as a consultant was wise and helpful. He was an inspiring and excellent teacher. He

ALBERT CHARLES PEALE, M.D.

Born April 1, 1849. Died December 5, 1914.

was not only interested in medical education, but this interest was extended to all educational matters. His unselfish devotion to the care and health of medical students was a pronounced feature of his life.

He was married on December 12, 1889, to Mrs. Helen D. Hasbrouck Trotter, but left no children.

Dr. Le Fevre was elected a member of this Association in 1899.

A. A. S.

ALBERT CHARLES PEALE, M.D.

Albert Charles Peale, geologist and paleobotanist, son of Charles W. and Harriet (Friel) Peale, was born in Heckscherville, Pennsylvania, April 1, 1849, and died in Philadelphia, December 5, 1914. On December 23, 1875, he married Emily, daughter of Rev. George F. Wiswell. He was educated as a physician, taking the degree of M.D. in the University of Pennsylvania in 1871, but evidencing a predilection for the natural sciences he devoted his life to geology and kindred subjects. As mineralogist and geologist he was connected with the United States Geological and Geographical Survey of the Territories from 1871 to 1879, and was a geologist in the United States Geological Survey from 1883 to 1898, when he was placed in charge of the paleobotanical collections of the National Museum. During his connection with the Museum he prepared for exhibition a geological section, on a scale of two miles to the inch, entirely across the American continent from North Carolina in the east to San Francisco in the west, compiling this work by means of the various actual surveys that had been made and reducing them all to a common standard.

Dr. Peale was the first geologist to prepare for publication a manuscript for the present geological folio series. His studies of the thermal springs of the Yellowstone region, coupled with his medical training, led to his interest in mineral waters, on which subject he was for many years a recognized authority.

Although quiet and unassuming, Dr. Peale was broad in his tastes, as evidenced by his affiliation with the American Chemical Society, the National Geographical Society, the Academy of Natural Sciences of Philadelphia, the Philosophical and Geological Societies of Washington, the Washington Academy of Sciences, the Chemical Society of Washington, the American Climatological and Clinical Association (of which he became a member in 1887, contributing several valuable papers to the *Transactions*), the Society of Colonial Wars and the Sons of the American Revolution.

As a field geologist, Dr. Peale's writings were published mainly in the Annual Reports of the Hayden Survey, with the exception of the Three Forks Folio of Montana, which formed No. 24 of the Geological Atlas of the United States. His most important contribution was his Monograph on the Thermal Springs of the Yellowstone National Park, which filled nearly 400 pages of the Twelfth Annual Report of the Hayden Survey for 1878.

Among his other publications are "The Classification of American Mineral Waters," *Transactions of the American Climatological Association*, 1887; "Mineral Springs of the United States," 1886; "The Natural Mineral Waters of the United States," 1895; "Classification of Mineral Waters," 1902; Biographical Sketches of Charles Willson Peale and of Titian R. Peale, 1905; "The Stratigraphic Position and Age of the Judith River Formation," 1912; and a number of geological reports and papers.*

Dr. Samuel A. Fisk, President of this Association in 1902, died at his home in Boston, January 18, 1915. A memorial will be read at the next Annual Meeting.

The Association has also lost by death, on February 2, 1915, Dr. Samuel W. Langmaid, who was elected a member in 1887.

* The Association is indebted to Dr. R. Rathbun, Assistant Secretary of the Smithsonian Institution, Washington, for this notice of Dr. Peale.

CONSTITUTION AND BYE-LAWS.

CONSTITUTION.

Article I.—Name.

This Society shall be known as the American Climatological and Clinical Association.

Article II.—Object.

The object of this Association shall be the Clinical Study of *Disease, especially of the Respiratory and Circulatory Organs, and of Climatology and Hydrology.*

Article III.—Membership.

Section 1.—This Association shall consist of *active, corresponding*, and *honorary* members, the former not to exceed 150 and the latter not to exceed twenty (20).

Section 2.—Names of candidates for active membership, whose applications shall have been endorsed by *three* (3) active members, shall be sent to the Secretary at or before the annual meeting at the second business session of which they shall be read and then lie over until the next annual meeting, when such as are approved by the Council shall be balloted on. Three (3) black balls shall be sufficient to reject a candidate. The Council shall have power to nominate active members.

Candidates for membership shall, at the discretion of the Council, present a paper to the Association showing clinical study of merit.

Section 3.—The power of nominating honorary and corresponding members shall be vested in the Council. The election shall be conducted in the same manner as that for active members. Honorary members shall enjoy all the privileges, but shall not be allowed to hold any office or cast any vote.

Section 4.—Any member of the Association absent from the meetings, in person or by contributed paper, for three (3) consecutive years, without sufficient cause, shall be dropped from the list of members by vote of the Council.

Article IV.—Officers.

Section 1.—The officers of this Association shall consist of a *President*, two *Vice-Presidents*, a *Secretary and Treasurer*, who, with five other members, shall constitute the *Council* of the Association.

Section 2.—*Nominations.* The officers, including the Council, shall be nominated by a committee of five (5) members, which committee shall be nominated by the President at the first session of each annual meeting and shall report at the business meeting.

Section 3.—*Elections.* The election of officers shall take place at the business meeting. A majority of votes cast shall constitute an election.

Section 4.—The President, Vice-Presidents, Secretary and Treasurer shall enter upon their duties at the close of the annual meeting at which they are elected, and shall hold office until the close of the next annual meeting, or until their successors are elected.

Section 5.—Members of the Council, other than the President. Vice-Presidents, Secretary and Treasurer, shall hold office for five (5) years.

Section 6.—*Vacancies.* Any vacancy occurring among the officers of the Association during the year may be filled by the Council.

Article V.—Duties of Officers.

President and Vice-Presidents.

The President and Vice-Presidents shall discharge the duties usually devolving upon such officers. The President shall be *ex-officio* Chairman of the Council.

Secretary and Treasurer.

As Secretary, he shall attend and keep a record of all the meetings of the Association and of the Council, of which latter he shall be *ex-officio* Clerk. At each annual meeting he shall announce the names of all who have ceased to be members since the last report. He shall superintend the publication of the Transactions, under the direction of the Council. He shall notify candidates of their election to membership. He shall send a preliminary notification of the annual meeting two (2) months previous thereto, and the programme for the annual meeting at least two (2) weeks previous to its assembly, to all the members of the Association. He shall also send notification of the meetings of the Council to the members thereof. At each annual meeting of the Association he shall read the minutes of the previous meeting and of all the meetings of the Council that have been held during the current year.

As Treasurer, he shall receive all moneys due, and pay all debts therewith. He shall render an account thereof at the annual meeting, at which time an auditing committee shall be appointed to report.

Article VI.—Council.

The Council shall meet as often as the interests of the Association may require.

Four (4) members shall constitute a quorum.

It shall have the management of the affairs of the Association, subject to the action of the Association at its annual meetings.

It shall consider the claims of candidates recommended to it for admission to membership.

It shall not have the power to make the Association liable for any debts exceeding in total one hundred dollars ($100), in the course of any one year, unless specially authorised by a vote of the Association.

It shall have the entire control of the publications of the Association, with the power to reject such papers or discussions as it may deem best.

It shall have power to nominate active members at the annual meeting.

The Council shall have power to invite any gentleman, not a member, to read a paper at the annual meeting, on any subject within the scope of the objects of this Association.

The Council shall determine questions by vote, or—if demanded—by ballot, the President having a casting vote.

The Council shall constitute a Board of Trial for all offences against the Constitution and Bye-laws, or for unbecoming conduct, and shall have the sole power of moving the expulsion of any member.

The President, or any two members, may call a meeting, notice of which will be transmitted to every member two (2) weeks previous to the meeting.

Article VII.—Papers.

Section 1.—The titles of all papers to be read at any annual meeting shall be forwarded to the Secretary not later than one (1) month before the first day of the meeting, in order to appear on the printed programme.

Section 2.—No paper shall be read before the Association which has already been printed or been read before another body.

Article VIII.—Quorum.

A quorum for business purposes shall be ten (10) members.

Article IX.—Amendments.

This Constitution may be amended by a four-fifths ($\frac{4}{5}$) vote of all the members present at an annual meeting, provided that notice of the proposed amendment has been printed in the notification of the meeting at which the vote is to be taken.

BYE-LAWS.

(1) Meetings of the Association shall be held annually.

(2) The time and place of the meetings shall be determined by the Council.

(3) The dues of active members shall consist of an annual assessment not to exceed seven and a half ($7.50) dollars. Members in arrears shall not be entitled to vote. Those in arrears for two (2) years may be dropped from membership by recommendation of the Council.

(4) Order of business meeting.

First day:—

Calling the roll of members.
Minutes of previous meeting.
Secretary's and Treasurer's reports.
Appointment of auditing committee.
Appointment of nominating committee.
Report of Council on recommendations for membership.

Second day, Morning session:—

Reports of nominating committee and auditing committee
Election of officers.
Election of members.
Report of committee on health resorts.
Miscellaneous business.
Adjournment of business meeting.

PRESIDENT'S ADDRESS.

By J. M. ANDERS, M.D., LL.D.
PHILADELPHIA.

As your presiding officer for the current year, it becomes my first and pleasing duty to make grateful acknowledgment of the signal honour which you have bestowed upon me in my election to the Presidency of this Association. The traditions of the American Climatological Association are highly creditable, and its record for scientific achievement is equally noteworthy. It is a recognized fact that the massed and combined intelligence of a large body of professional men is seldom wrong. On the other hand, the presentation of the views of an individual member often fails to be convincing as contrasted with the instinct of either a people or profession.

Somewhat akin to the latter fact, in a sense, is the accepted evolutionary principle which aims to perpetuate the species regardless of the individual.

> "So careful of the type it seems;
> So careless of the single life."

Despite the general acceptance of the foregoing principles, there are certain problems which, it seems to me, demand attention in this address. Guided by considerable thought and preparation, your presiding officer can at least claim that what he is about to present was seriously worked out in advance.

In the first place, the climate of America—a climate of great variety—ought not to fail of interest among the members of this Association. There is a sense shared by conservative, scientific master spirits, by the medical profession at large, and the general public with regard to climate, that it has both health-giving and health-destroying properties, according to its organization, as well as special characteristics at different seasons, and in different localities.

Few persons can easily give up their inherited belief that some connection—manifestly not a feeble one—exists between climate and the public health. It remains for future scientific investigation and study to establish between the two with greater precision the relationships actually existing. Here it must be recollected that certain propounded facts bearing upon the issue in question rest on the most authoritative opinion, and others on the indisputable results of experimental observation.

The unique records of absolute heat and cold, as well as aridity, enjoyed by this country are particularly noteworthy. While this does not imply that ours is either the hottest, coldest, or driest weather in the world, these peculiarities of the American climate, together with its simple, easily determinable character and luxuriousness, should nevertheless cause us to find great attraction in its study.

It is not only the legitimate function of this body to investigate the various meteorologic elements and conditions as affecting the state of the climate, both local and general, but also to study such questions as the influence of special climates and particularly the seasons of the year, as predisposing factors in the causation of disease, as well as the therapeutic uses of the different weathers to be found in the United States and Canada. It is especially desirable to investigate further into the modifications of climate and weather in small localities, since these are often of first-rate importance, where they occur, as aids in the treatment of certain diseases.

It would be both profitable and interesting to draw comparisons between our own climate and that of other countries. For example, John Burroughs tells us that an American resident in England is reported as saying that the English have an atmosphere, but no climate, and then adds: "We certainly have a climate, a two-edged one, that cuts both ways, threatening us with sunstroke on the one hand, and frost-stroke on the other, but we have no atmosphere to speak of in New York and New England, except now and then during the dog-days, or the fitful and uncertain Indian summer." He continues: "An atmosphere, the quality of tone and mellowness in the near distance, is the product of a more humid climate. Hence, as we go south from New York, the atmospheric effects become more rich and varied, until on reaching the Potomac you find an atmosphere and a climate." Here, "The days are more brooding and the nights more enchanting"; here Walt Whitman saw the full moon

"Pour down night's nimbus floods."

This Association should likewise keep the medical profession in constant attention of hydrotherapy—a subject which has been too scantily considered by its members in the past. Climatology and hydrology should together form a definite branch of the future work—contributions and discussions—of our organization, and each one of us should be willing and eager to assume an individual share of the task.

I have vaunted with fair warrant, I trust, the importance of maintaining a lively interest in climate which is a quite definite organization capable of exerting a potent racial influence and "as full of its own vitality as any living creature," and an increased interest in hydrology since nothing more regular is known to us in the abundance and diversity of our therapeutic armamentarium than the manifold therapeutic uses of water.

It is precisely along these lines that the proceedings of our Society mark, and should continue to mark, a fundamental contrast with those of other national bodies, and give to it its most distinctive character, as well as much of its prestige. The purpose and effect of an unbroken continuance of such a course is to further strengthen the individuality of this Association. While typifying in the main the views here expressed in its deliberations in the past, the American Climatological Association has been steadily and potently winning its way in the medical profession of the United States and Canada. At no previous period has the medical profession as a whole been so deeply imbued with the importance of giving serious attention to the various physical methods of the treatment of disease as at the present day. Moreover, it may be safely assumed that the founders of this Association clearly recognized the true relationship of medicine to the public health, and as a national organization we should not desire to ignore sociologic and sanitary problems in so far as they are affected by hygiene, climate and hydrology. In regard to many public questions affecting the health and welfare of the profession and laity alike, this Association should in future make a creditable showing.

Granted the recognition of the true place and importance of both climatology and hydrology, and other physical means of treatment, in the proceedings of this organization, I am not averse to calling upon these two subjects to share an extension of the more purely clinical portion of our programme. This Association can readily adapt itself to a broadening and quickening of its field of endeavour, can, and I feel strongly that it should, widen its boundaries.

As my distinguished predecessor, Dr. Minor, pertinently said in his President's Address: "Climatology, even with the powerful addition of diseases of the lungs and heart, no longer, I believe, offers a sufficient field for the activities of the Society." After referring to the growing feeling among our members in favour of widening our borders he continued: "We must remove the restrictions set upon us by our name and by a clause in our constitution, and must feel ourselves free to study all subjects within the realm of clinical medicine."

"Only so can we hope to keep up with the march of modern medical progress; only so draw to ourselves each year the best of those eager workers who are growing up everywhere in our country and with whom lies the future; only so can we keep up the honourable reputation and position which is ours; only so can we make our future worthy of our past."

While enlarging the scope of the clinical subjects to be embraced, however, let us not lose sight of climatology and hydrotherapy, and their near and remote connections with practical medicine—the elements in which this Society originated, and have in the main resided.

In my view, any medical society that combines in its scope a practical interest in, and the advancement of, an abstract science, with clinical subjects, has a clear advantage over one that confines its work and activities to clinical medicine alone. If in the shaping of the future policy of this Association the views here advanced be respected, it is my firm belief that it will continue to gain in force, influence and general usefulness, in answer to the needs of a great profession and the public alike.

May I suggest that an effort be made to add to our membership an increasing number of medical and non-medical men who have special knowledge of the subjects of climatology and hydrology, as well as other recognized physical means of treatment, whether from their purely scientific or practical relations? I would further respectfully suggest that one of the sessions of the annual meetings of this Association be devoted exclusively and regularly to these branches of our art. Devotees, whether or not members of the American Climatological Association, should be invited to participate in the deliberations of these scientific sessions.

The speaker feels strongly that the vital interests of this Society would also be promoted by the creation of a committee on scientific programme whose chief function would be to provide the annual programme for the scientific session, and it should consist of three members, two of whom should be the President and Secretary and Treasurer, while the remaining member should be appointed by the outgoing President, and should be chosen with sole reference to his fitness and reputation as a climatologist.

Thus would this Association continue to maintain a most desirable departure from the regular course of things medical with their monotonous regularity of results, and thus would it continue to fulfil the hopes, aims and purposes of its distinguished founders.

I am quite sure that this slight degree of reorganization would make for greater efficiency, and I write thus with the purpose of bringing about an adamantine position of this Association in favour of a continuance of effort in the systematic manner suggested above to advance, however slowly and gradually, climatology and hydrology. On the other hand, progress is out of the question where mere chance plays a large part in future advancement.

It is my earnest hope that we shall never be forced to make the humiliating admission that the principal motive of the Society failed of being fulfilled. Thanks to the persistent researches made by scientists, we have the assured means of enlightening the medical profession, with the great possibility of actual gain to the members thereof, as well as of conferring a public benefit. Moreover, the labours of our membership along these lines in future will make for the advancement of the healing art, and furnish a logical, definite outlet for their energies.

One day not far distant it is to be hoped the scattered fragments of knowledge which have emanated from this body bearing upon climatology and hydrotherapy will serve as a framework into which more exact facts on the subject may be fitted. Possessed, as I trust we are, with the genius of patience, let us continue to gather interesting facts and data, continue our researches, leaving to a future generation, if you please, their co-ordination. We may feel assured that the results of future investigations into the subject will present a picture easy of analysis, rather than a mere confused mass of facts.

The responsibilities and the vows of the founders of this Association, few of whom are left, have descended to others —to us. The standards they imposed were pre-eminently true, and their single-mindedness then should carry conviction now and in the days to come. While expanding our activities until we secure all that is worth having in clinical medicine, let us never disregard an instinctive and natural sense of obligation to our distinguished predecessors, but hold fast our high purpose amid all the vicissitudes of time and place.

We need to remember that medicine embraces not only one, but all of the physical sciences, and that the grouping of climatology, as well as hydrotherapy, with clinical medicine is quite appropriate since they are kindred sciences.

Moreover, the public will in future demand physicians of broad culture and scientific attainments, and it is rapidly providing its own protection against any lowering either of the intellectual or ethical plane. Finally, the science of medicine must ever strive to rid itself of vague, loose, unsystematized knowledge, the while it works toward a more and more comprehensive system—the *scientia scientiarum*.

> "A little learning is a dangerous thing,
> Drink deep, or taste not the Pierian spring."

THE CLIMATE OF SOUTH-WESTERN ALBERTA.

By R. F. STUPART.

TORONTO, CANADA.

Director, Dominion Meteorological Service.

BANFF is situated in latitude 51°10′, on the Bow River, at an altitude of 4,542 ft., well within the Rocky Mountains, and at a distance of ninety miles from the city of Calgary, which is on the prairies at an altitude of 3,389 ft., and also on the Bow River.

A fully equipped meteorological observing station was established at Calgary in 1883. A temperature and precipitation station was established at Banff in 1890, and raised to a first-class station in 1894, and in 1904 an observatory with self-recording instruments was placed on Sulphur Mountain, Banff, at an altitude of 8,030 ft., and four miles distant from the village station; the difference between the two stations being 3,500 ft.

Comparisons between mountain and plain stations, no natter where situated, are interesting, but in Alberta parücularly so, since the climate of the whole province possesses many strongly marked, distinctive features. It is a region where some of the most potent and opposite factors which control weather conditions meet in conflict.

The crest of the Rocky Mountains forms the western boundary of Alberta at an altitude averaging nearly 10,000 ft., and lying some thirty miles from the foot hills bordering those high tablelands which, in the early days of settlement, were considered as ranching lands *par excellence,* and have since become important for mixed farming. Between the crest of the Rockies and the outer coast of the continent the distance is less than five hundred miles—within which are other mountain ranges with a general altitude of 10,000 ft. and isolated peaks of a greater height. Where else can be found a country where dominating climatic influences are more varied? In geographical position quite within the zone of the low areas of the middle latitudes; the vast Pacific only five hundred miles distant to the west with high mountain ranges between—a situation most favourable for the Chinook effect. A continental region to the eastward and northward, and extending to the Arctic regions, whence, at times in winter come cold waves with exceedingly low temperature, while at other times southerly winds blowing with considerable strength bring temperatures normal to a much lower latitude.

If abrupt and at times great temperature changes are detrimental to health, Alberta must be ranked as an undesirable country from the health standpoint, unless it can be shown that a high altitude, a dry atmosphere and much sunshine offset any deleterious influences, and this will probably be proven to be the case.

The writer has spent many short periods in Southern Alberta and can attest to the peculiarly exhilarating effect of the air, whether it be warm or frosty; and it is certain that the older residents of the country are invariably enthusiastic in their praise of the country and its climate.

A feature of the Alberta climate, both on the prairies and in the mountains, in common with that of other inland places at a considerable altitude, is the large daily range in temperature, which is, of course, most marked in the summer months, when it reaches 28° or 30° F., and ensures most perfect sleeping conditions as the nights are always cool.

At Banff the mean annual temperature as determined from readings of maximum and minimum thermometer during twenty years' observations is 35·5° F., just 2·5° lower than the Calgary normal, and 10° higher than the mean derived from the records at the mountain observatory.

The seasonal mean temperatures are: Winter 16·3°, nearly the same as Montreal; spring 34·9°, summer 54·3°, and autumn 36·6°. The winter normal is a fraction of a degree higher than that of Calgary, but all the other seasons are cooler.

There are points about this winter difference between Banff and Calgary which are exceedingly interesting. A severe winter on the prairies is less severe in the mountains, and to such an extent is this true that with a zero mean temperature for a winter month at Calgary, the corresponding temperature not only at Banff, but also on the top of Sulphur Mountain, is higher than at the prairie station. An example of this occurred in February, 1904, when the mean at Calgary was −1°, at Banff 6°, and at Sulphur Mountain 4·5°; and again in January, 1907, Calgary gave −7°, and Banff and Sulphur Mountain each −4°.

On the other hand, winters mild on the prairie are colder in the mountains: *e.g.*, January, 1908, when Calgary mean was 26°, Banff 19°, and Sulphur Mountain 9°; and January, 1910, Calgary 21°, Banff 15°, and Sulphur Mountain 7°.

As will be surmised from these figures, the Chinook is less pronounced at Banff than on the prairies, and in marked instances of it at Calgary when the temperature rises perhaps 15° above freezing on the prairie, it is but a few degrees above 32° at Banff.

BANFF.

MEAN VALUES, TWENTY YEARS 1894-1913 INCLUSIVE.

Months	Temperature						Precipitation			Average number of days	Wind		Average. Number of days		
	Mean				Absolute		Average								
	Temp.	Max.	Min.	Range	Max.	Min.	Rainfall	Snowfall	Total	Measurable rain and snow	Prevailing direction	Mean velocity	Clear	Part cloudy	Cloudy
							Inches	Inches	Inches						
January ...	13·4°	22·3°	4·5°	17·8°	49·7°	−48·2°	0·02	13·3	1·35	9	S.W.	5	11	13	7
February ..	16·2	26·6	5·8	20·8	49·2	−48·8	0·04	8·0	0·84	9	S.W.	5	9	12	7
March ...	23·0	34·5	11·6	22·9	59·7	−32·9	0·13	12·1	1·34	11	S.W.	4	9	12	10
April ...	36·5	47·4	25 6	21·8	73·1	−13·7	0·34	7·1	1·05	11	S.W.	4	8	13	9
May ...	45·1	57·5	32·8	24·7	81·4	12·1	1·64	5·5	2·19	14	S.W.	3	5	15	11
June ...	51·7	64·8	38·6	26·2	87·7	24·8	2·83	1·2	2·95	17	S.W.	4	6	13	11
July	56·8	71·3	42·3	29·0	90·5	27·8	2·51	—	2·51	14	S.W.	3	11	14	6
August ...	54·4	68·3	40·5	27·8	89·0	27·0	2·50	0·1	2·51	15	S.W.	3	11	12	8
September ...	46·7	58·3	35·1	23·2	79·8	13·5	1·41	2·0	1·61	11	S.W.	4	8	12	10
October ...	38·7	48·2	29·2	19·0	70·8	−3·3	0·67	4·7	1·14	10	S.W.	4	10	14	7
November ...	24·3	31·6	17·0	14·6	57·4	−40·8	0·31	15·0	1·81	10	S.W.	5	8	13	9
December ...	19·3	26·5	12·1	14·4	49·5	−33·7	0·11	9·4	1·05	9	S.W.	5	10	14	7
Year ...	35·5	46·4	24·6	21·8	90·5	−48·8	12·51	78·4	20·35	140	S.W.	4	106	157	102

CALGARY.

Mean Values, Twenty Years 1894-1913 Inclusive.

Months	Temperature						Precipitation			Average number of days	Wind		Average number of days		
	Mean				Absolute		Average								
	Temp.	Max.	Min.	Range	Max.	Min.	Rainfall	Snowfall	Total	Measurable rain and snow	Prevailing direction	Mean velocity	Clear	Part cloudy	Cloudy
							Inches	Inches	Inches						
January ...	12·6°	22·8°	2·4°	20·4°	58°	−48°	0·01	4·0	0·41	2	W	8	12	14	5
February ...	15·7	26·0	5·4	20·6	76	−49	0·00	5·1	0·51	3	W	8	10	12	6
March ...	23·9	35·2	12·7	22·5	75	−34	0·06	7·3	0·79	6	W	9	8	14	9
April ...	40·3	53·3	27·2	26·1	84	−14	0·29	5·0	0·79	5	W	10	9	12	9
May ...	48·8	61·8	35·8	26·0	90	12	2·31	5·0	2·81	10	W	11	8	11	12
June... ...	56·0	67·9	44·0	23·9	94	26	3·65	0·7	3·72	13	W	10	8	11	11
July ..	60·5	74·3	46·7	27·6	95	29	2·62	0·0	2·62	11	W	8	14	10	7
August ...	58·2	71·8	44·6	27·2	95	28	3·09	0·2	3·11	10	W	8	12	10	9
September ...	49·9	62·8	37·1	25·7	89	15	1·19	2·4	1·43	8	W	9	9	12	9
October ...	43·0	56·6	29·5	27·1	85	−8	2·85	2·7	3·12	4	W	7	12	13	6
November ...	25·6	35·6	15·6	20·0	70	−31	0·01	7·2	0·73	2	W	7	12	12	6
December ..	21·6	31·0	12·3	18·7	60	−39	0·00	3·6	0·36	3	W	8	11	12	8
Year ...	38·0	49·9	26·1	23·8	95	−49	16·08	43·2	20·40	77	W	9	125	143	97

The village being completely surrounded by high mountains, strong winds are infrequent.

Periods of extremely cold weather occur at intervals, but it is only in very occasional years that these periods are at all frequent, and it is rather remarkable that in but three winters in thirty years has more than one of the winter months had a very wide departure from normal temperature. Minima of $-20°$ occur from time to time in most winters, but $-30°$ is exceptional and $-40°$ is seldom reached.

The winter sets in early and the end of October usually sees a light snow covering, while November is a month without much thawing and frequent snowfalls. It is not until April that spring can be said to open, and even that month and May have a few light snowfalls, and flurries occasionally occur in both early June and September. The total aggregate snowfall averages 78 in.

The summers are very delightful, the mean maxima for the three months being 65°, 71°, and 68° respectively, and the minima 39°, 42° and 41°, indicating warm days and cool nights, and during this season overcast days are infrequent and the rainfall is approximately the same as on the prairies, namely, about 8 in., which occurs chiefly in thunderstorms.

The writer is strongly of the opinion that the claims of Banff as a summer sanatorium are distinctly good, and the winter is not so severe; but that even the coldest months may be altogether desirable for many pulmonary complaints. Certainly as a pleasure resort it may be ranked with any of the places in Europe to which people flock for ski-ing, tobogganing and skating.

DISCUSSION.

Dr. Carroll E. Edson (Denver, Col): I feel much indebted to Professor Stupart for his interesting paper, with the details of these climatic conditions. It is of particular interest to me to have meteorological statistics in regard to Alberta presented so clearly and concisely, because I had occasion, about two years ago, to consider the desirability of Calgary as a place of residence and business for one of my patients, who had made a working recovery from extensive tuberculosis in Colorado, and whose business made it necessary for him to live in Calgary. I had considerable doubt as to the feasibility of this for this particular patient, owing to the fact that the winter there is so long and so cold and to the necessity of his going to work. I endeavoured, at that time, to get a picture of the climatic conditions in Calgary from such statistics of the weather bureaux of the Province of Ontario as I could obtain. The clinical result in this case has far exceeded my expectations. My patient has been in constant correspondence with me, and he says that while the winter was long and the working days were short, a great deal of work having to be done by artificial light, the dryness of the air made the cold much less depressing than he had expected it would be. The cold is such that sleeping out during the winter is altogether impossible, the thermometer being below zero a great part of the time. The people shut their houses up tightly, getting their ventilation a little at a time. They open the door a crack, changing the air to about a foot from the door, which they then shut up again and let that air get warm. Then they open the door a little once more, and repeat the process. The climate, however, has been quite endurable to my patient, and he has maintained his working health in every way, in spite of the long winter and the short hours of sunshine. The climate is entirely comparable to that of Colorado, as the place lies in the same relative position to the mountains that Colorado does. The only difference that he has noted is the diminished amount of sunshine, owing to the short hours of daylight in the winter. That was a bad feature, but the dryness of the air, the slight precipitation, &c., he has found to make an exceedingly comfortable climate—surprisingly so—in which to live.

Dr. Anders: We will proceed to the next paper, if there is no further discussion: "Prolonged Subnormal (Clinical) Temperatures in Tuberculosis," by Dr. A. K. Stone, of Boston, Mass.

Dr. Stone read his paper (see p. 66).

HOUSING AND ITS RELATION TO CLIMATE AND HEALTH.

By ESTES NICHOLS, M.D.
PORTLAND, MAINE.

In census terms, a dwelling is any building in which one or more persons reside, and a family is a household or group of persons, whether related by blood or not, who share a common abode.

Housing and its relation to national vitality and health is a problem closely related to climate, and a matter in which each one of us should take an active interest.

One of our national characteristics has been the spreading of the population of our cities upward instead of outward, and another characteristic is known as "The call of the city." Americans, as a people, are not willing to exchange the amusements of the city for the quiet and repose of the country. As an example, New York has set the pace for both of these characteristics. In the borough of Manhattan the census figures show an increase from 23 persons on an average to a dwelling in 1900 to 30·9 in 1910. This surely means house overcrowding as well as land overcrowding. What is true of New York is true of most of our cities, and even in many of our towns and villages.

While land overcrowding is not very common, yet house overcrowding is very common, due partly to an improper understanding of sanitary laws, and the national characteristic of the drifting of our people to town and city centres.

If we can change this American tendency and succeed in spreading the population outward instead of upward, many of our housing problems will be solved. This must come through city planning schemes, which means the intelligent directing of the growth of our cities outward, where there is plenty of space, fresh air and sunlight, and where there is at least no land overcrowding.

Household sky-scrapers are more common and taller in America than in any other country. This intensive use of city land has resulted in the building of homes one on top of the other many stories high, with many small rooms that can only be compared to prison cells or Pullman berths in size, and frequently in which mothers cannot give birth to a child, because there is no room for the doctor to work.

These houses with many rooms, looking out on nothing but walls and shut-in courts, filled with stagnant air and odours, giving no aid to ventilation, and where direct sunlight never enters, must be an unnatural, unhealthy, and unwise method of housing our people.

Each of us knows the relation of improper housing to tuberculosis, typhoid, and the other infectious diseases, and each one of us knows the relation of improper housing to infant mortality and vice. If it can be shown that there is a co-relation between tuberculosis, typhoid, alcoholism, syphilis, insanity, infant mortality, and overcrowding in insanitary dwellings in our large cities, is it not a question whether our public money should not be expended in solving the housing problem, rather than expending large sums on sanatoriums and homes for the feeble-minded and insane hospitals?

Should not our studies in climatology be directed toward city planning, especially as to housing and ventilation, play-grounds, and breathing-spaces for the masses, rather than to some specific climate for the wealthy health resorters, many of whom desire only a place in which to play?

Is it not our duty to guide and shape a national tendency toward a saner city planning and better housing scheme as an American characteristic, especially in showing the manufacturers and business men that good houses mean more efficient workers; the family head that better houses mean a better chance for his family; and the social worker that better homes mean fewer social problems?

We all understand that the working class is our most useful class of people, and also that they are housed in the poorest manner. Is it not the business of towns and municipal governments to see that the houses in which the working people live are sanitary in their construction, and so built in relation to each other that they may get the best climatic effect, viz., that every room must be easily ventilated, and that they must have not only light but sunlight?

Is it not their duty to prevent overcrowding? For it has been shown by sanitary experts that infant mortality is very much greater in overcrowded houses, and while children under 5 years equal only one-ninth of the population, yet they furnish one-third of all of the deaths. Infant mortality varies uniformly with housing conditions, but the most pitiful victim of our present housing condition is not the child who dies, but the child who lives under these conditions.

Is it not the duty of our health officials to see that the population of our large cities, when they are twice as large as they are at present, are spread out over more than double their present area, rather than pushing them up in the air to double their present height?

The spreading of our cities outward, of course, means the solving of many problems, especially transportation facilities, as well as sewerage problems; yet I believe there is no other country in the world so well prepared to meet these problems as our own.

Is not the most frequent cause of our winter epidemics of infectious diseases due to overcrowding caused by the pouring into our cities of labourers from the country when the ground freezes in early winter, and who hire rooms in the sections of towns and cities where the housing conditions are the poorest?

These epidemics have frequently been ascribed to the blowing of dust from the uncovered frozen streets. I have often wondered whether the fifty-seven varieties of New England weather are responsible for many of the ailments to which it is credited; or are they due to improper housing and room overcrowding? If they are due to the latter, why should not the Boards of Health have the power to correct these conditions as a preventive measure even as our infectious diseases are quarantined to prevent them from spreading? Instead of this, workmen and others are told not to spit, and various other advice, which is considered the proper way of preventing these diseases.

Is it any wonder that the wealthy leave their homes at this time of the year and go to health resorts to escape their home climate? How long would the health resorts remain as such if they should take along the housing conditions with which they are surrounded at home? Let us be frank with ourselves and consider whether health, after all, is so much a matter of climate as it is a method of living, especially housing.

Will any climate endure the housing conditions of most of our towns and cities, and if the advantages of our health resorts, viz., light, air, flowers, and bathing facilities, pay a good dividend in wealth, why should we not apply some of these principles to our cities? Surely they would pay a good dividend in health return.

How often we see a journalistic controversy as to the comparative size of two cities, while really the need of every great city is not to grow larger but to grow smaller, or in other words, to spread the people of our metropolitan districts over double the present area. Let us hope the future growth of our cities will be a centrifugal and not a centripetal movement.

The massing of a great number of people in a small area may benefit the hotels, theatres, and department stores, but it injures everybody else. It may be a gold mine for them, but why other people should boast about our big cities is a mystery under the present conditions of housing. Is not our present system of apartment homes placing a premium on the rearing of children, for many of them are manifestly unsuitable places for children, and landlords will not admit people with children in the ones that are suitable?

At one time houses were used for babies to be born in, to be reared in, to be comfortable and healthy in, but are not apartment houses doing more to destroy the idea of permanency in the American homes than any other one thing? Without children you cannot make a home, and without a home what have you got on which to base a family life?

Is climate responsible for the conditions of housing which the reader has mentioned? Are not our housing conditions due to the energy and enterprise of our business men who are unguided and untaught concerning the relation of housing to climate and health? Can any climate rise above its housing conditions?

I offer no theories to be applied to the building of houses, as all theories are pretty apt to be overthrown by each succeeding year. I only offer the one fact which has been so well established, and that is, the vital necessity of plenty of room, as well as plenty of light and air, even to the remotest part of our dwellings. Any plan that will prevent house overcrowding and land overcrowding must surely prevent air overcrowding and sunlight overcrowding, both of which are so necessary in the fight for the health of the American people.

DISCUSSION.

Dr. Darlington: It is difficult to determine how much is due to overcrowding and how much to other causes. There is no question but that overcrowding does lessen resistance to disease. My own investigations have shown that there is more typhoid in houses where the windows are shut than in others exposed to the same infection, on account of the lessened resistance to the disease produced in that way. Sometimes we find this condition in the outskirts of cities, as well as in the more thickly settled portions of the cities, because the latter are better cleansed. Dr. Bowditch, many years ago, found tuberculosis largely connected with soil contamination. That is a point that we sometimes forget. In a neighbourhood where I lived, where the soil was much polluted from privy vaults, the people had very little resistance to disease. This was due, undoubtedly, not to bacteria, but to the formation of gases in the soil and in houses where they do not have electric lights. Sickness commences at about the time the children go to school and when the people begin to close their windows. Is it due to closed windows, or to contact of the children in school? It is hard to say. As to the distribution of population, 65 per cent. of all immigrants stay in New York City. They will overcrowd and they will not wash. How much disease among them is due to poor food, how much to dirt, how much to the foods being kept in the houses without ice, how much to fatigue, and how much to a lack of enough food, it is hard to say. It is all based on lessened resistance to disease. I have been watching the girls that live in the east district of New York and go to the restaurants in New York for their lunches. Is the illness due to overcrowding, or because they do not have proper luncheons? Many of them are underfed. Is the disease in these cases, then, due to lack of resistance, poor food, or overcrowding? It is hard to say whether it is due to lack of keeping windows open. They certainly air their beds. They keep their windows up, and the fire-escapes are filled with bedding. Everyone breaks the law forbidding the obstruction of fire-escapes.*

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* Dr. Darlington showed some lantern slides illustrating remarks on the "Prophylactic Value of Water Supplies and Baths, with Special Reference to Industry."

Dr. Landis : During the past few years I have been preparing for the Phipps Institute an investigation on housing conditions in Philadelphia, taking in one block almost all Jewish, one block with Italians and Jews, and two or three blocks with a negro population. The data are being worked up at the present time. It is rather interesting to note what has been emphasized before, by those who have studied the relationship between the slums and bad housing conditions. I think that we have to remember that the people have as much to do as the houses with the making of the result. I am not sure that they do not have more to do with it. Some of the charts bring this out clearly, where we used two—one relating to the houses, and the other to the families and their hygiene. A house rated at 100 per cent., and containing everything that it should have to be a healthy dwelling, may have the hygiene of the people in it rated at zero. For instance, a tenement rated at 100 per cent. may have five families in it; and of these the hygiene would run from zero to 100 per cent. We have all sorts of living conditions among these people. Further, it is also interesting to note that the people have very little discrimination in regard to the type of house suited for the neighbourhood that it is going to occupy. We have some people who pay as much rent for a house that is unfit to live in as they would for a house that is good in every respect. Moreover, there are racial characteristics to be considered. The Italians are more cleanly than the Russian Jewish population, although there is a tendency among them to overcrowding. I am firmly convinced that any improvement in the slums would have to be as much through educating the people how to use hygienic means in their houses as through providing them with proper houses.

Dr. David R. Lyman (Wallingford, Conn.) : I think that one of the most important things, not only in tuberculosis, but also in all questions of health, is the housing problem. Dr. Nichols has brought out the tendency of the city to grow up, instead of out, as a great determining factor in producing conditions of bad health. There is no question that to have people living in small tenements or single tenements outside the town would, if such a condition could be brought about, not only tend to prevent disease, but also tend to keep patients well after going back to work. There would also be better living conditions for the children and less danger of spreading disease through personal contact; but there is likewise the question that Dr. Landis has just mentioned, that of the personal hygiene of the people in the houses, which is much more important than the houses themselves. As we have been telling people with tuberculosis, the main thing is the life that they live rather than the place where they live. It is the same with housing conditions in general—the important thing is the use that is made of the housing conditions we have. People can get along better in good tenements in the cities than when living under poorer conditions in the country. In Connecticut our death-rate from tuberculosis is falling faster in the cities than in the country. Some of the worst house infections from tuberculosis that I have come across have been in the rural parts of the State, where the houses are kept closed up, with no light and air admitted, and the people all live together in the kitchen. We find family after family with tuberculosis running through it. Although they have every natural advantage, they do not know how to use their advantages. The essential thing is to teach the people to use the advantages that they have. Then we can try to get them to go outside of the cities; but, as Dr. Darlington says, the man who can get them to do it would solve a great problem.

Dr. Robert C. Paterson (Ste. Agathe des Monts, Province of Quebec, Canada): One important question in connection with this paper is how, if the people leave the tenements in the cities and go into the outlying districts, we shall provide them with proper sanitary conveniences. The question of the disposal of sewage is very important as the houses become more scattered. The question of supplying the people with proper drinking water and water for household use is also important. As the houses become more scattered, the expense for both becomes much greater. Living in the country, as I do, where there is plenty of land, you would think that the question of the spread of disease should be easily controlled, but I am almost ashamed to say that in the mountains north of Montreal, where we send people for their health, we find that the death-rate from tuberculosis is as high as anywhere else on the Continent, if not higher. This is due to the fact that although the people living there can get plenty of fresh air, they will not use it. Their health is undermined by the food that they eat, and by their shutting up their houses in winter and getting no ventilation at all, and also by the fact that their slops and dish-water are thrown out of the back door, making the ground surrounding their houses absolutely polluted. It is this air that the children breathe, and here the children play.

Dr. E. O. Otis (Boston, Mass.): One of the most densely congested districts in Boston was occupied some years ago almost exclusively by the Irish, and the mortality from tuberculosis there was then as high, if not higher, as in any other crowded portion of the city. The Irish in this district have been almost entirely displaced by the Russian Jews and Italians, and there has been a most striking fall in the mortality from tuberculosis since this change has taken place. Dr. Stone can probably give the exact percentages in some statistics that he has published with reference to this change.

Dr. Robinson: I think it is wise to note the easiest means to an end, and it is probably best now to be most active in dealing with conditions as they exist, rather than trying to change the population to other places of environment. In our Pennsylvania Society for the Prevention of Tuberculosis in Philadelphia we have accomplished a great deal with open-air school life, obtaining important results in the physical state of the children. The lesson has been taught so well that there is a great desire on the part of the children to be admitted to these schools. Some years ago I was attending physician of our State Penitentiary. The tuberculosis part of the death-rate was 68 per cent. After establishing modern methods of prevention and treatment, the tuberculosis death-rate was reduced to one-fourth of what it had been. As you know, Mr. President, some years ago a Committee on Infant Mortality was created by our County Medical Society. Two thousand physicians compose the society's membership. It was an active committee, and the result of its work was the Baby Saving Show, which was so wonderfully successful as to have had over 100,000 people in attendance. On account of this success we have had small baby saving shows at intervals ever since, in public places throughout the city; and we have had 150,000 people of the kind we wanted to reach visit these shows and receive instruction. We now have, on the plaza of the City Hall, a building containing such a show, which is there for the summer. Since the activities of this Committee began, and as the result of these and of those of the present Child Federation, the death-rate in infants under 2 years of age has been reduced 22 per cent. during the past two years. These lessons go home, unquestionably. The efforts that we are making are to have non-medical people understand medical things better. We have learned that it is always necessary to convince the class above the class that we would reach. Education must first be accepted by this higher class, and the lower class then accepts it almost altogether by a process of percolation. That we have found to be the case in all our efforts at improvement; and just here I must introduce the thought of a duty that might be taken up by this society. Our County Medical Society inaugurated twelve committees, of five men each, on which the best men were elected to serve. These committees were for the purpose of educating the non-medical public on matters that they ought to be acquainted with to some extent. Among the various works undertaken has been the preparation of a half-page of reading matter to be printed in our best daily paper once a week. These articles are unsigned, except by the name of the County Society and that of the Committee. These lessons have been wonderfully successful. They have brought requests for a re-publication from all over the country. While this is an initiative effort and is not yet at its possible best, I feel confident that it will live and grow. This society might inaugurate some method by which the non-medical public could receive more definite knowledge on matters such as are discussed here to-day and are the object of this meeting.

Dr. Nathaniel K. Wood (Boston, Mass.): The papers of Dr. Nichols and Dr. Darlington are most interesting and suggestive.

Our Government, civic, State and Federal, cannot spend money, energy, and brains to better advantage than in similar efforts to solve these important problems of hygiene. This is definitely Government work, and no less important than the building of sanatoria to cure people after they have become sick. The Federal Government has set the best example of prophylaxis in the way it has stamped out yellow fever and malaria at Panama. If it had not done this, the Panama Canal would not to-day be nearing completion years earlier than was anticipated and at a cost to the Government of millions less than had been estimated. Those of you who have seen somewhat of the country conditions as found in the outlying districts will appreciate the handicap that some of the superstitions of these people are to progress in hygiene. For instance, in some parts of Maine it is believed that a child born in cold weather should not be allowed to go out of doors until their second summer, so that children born in October and November do not go out for nineteen or twenty months, whereas, if they had been born in any large city they would benefit by having fresh air at an early age. In going a distance of five miles in an automobile in such a section of Maine I did not come to a single country house with the windows open. Finally, I saw one, and became curious to find out who was living there. I inquired, and found that it was a summer visitor from Massachusetts.

Dr. GUY HINSDALE (Hot Springs, Va.) : The question has often been asked : Why is the air so pure in the country? The answer that has been given to this is that the poor country people have all the bad air shut up in their houses.

Dr. JAY PERKINS (Providence, R.I.) : As Dr. Darlington says, so many elements enter into our city life that it is hard to tell which is responsible for bad health. In order to get at that point, we purpose to go outside of the crowded sections and find a place where certain elements are eliminated. We have found an excellent illustration. The wife of a prominent physician started a fresh-air school for the sake of her own children, and took a few others in. The demand for admission gradually increased, and it is now so great that seventy-five are registered for next year. These children come from good homes, where everything is as good as the best of our people have it. The conditions in that school are practically the same as those in any of the regular good private schools, the only difference being in the question of air. The children are in the open air a great part of the time. In winter they have fresh air, but are not absolutely in the open air. This change alone, without change in diet or home conditions, has been a wonderful source of change in the children themselves, who have all become stronger and healthier. I wish also to say to the last speaker (not Dr. Hinsdale, but Dr. Wood) that I was also born and brought up in Maine, and spent my summers there frequently, but I have never seen such conditions as he mentioned, although my home was in the country.

Dr. Wood: I made the same statement that I have made here at a meeting in Maine, and two physicians afterwards told me that they had found the same prejudice of which I have spoken.

Dr. Nichols (closing): Education is another word for prevention, of course; but I wonder whether the question of housing and how to live is not a most important part of this education. Now as to the question of expense. Of course, sewerage is a great problem. It is usually pretty easy to get water, but sewerage and transportation facilities are the great problems to be solved. When we consider the expense now involved in maintaining hospitals for infectious diseases, insane hospitals, and homes for the feeble-minded, however, it is a question which will be the most expensive in the long run. I should like to ask Dr. Wood to what portion of Maine he went. I am not a native of Maine, but I have been all over the State as Chief Inspector of the State Board of Health, and I wonder in what part of Maine such conditions exist.

Dr. Wood: North Haven and Rockland, near Bar Harbour.

Dr. Nichols: I should like also to know the names of physicians who have seen these conditions. I will say, to partly corroborate Dr. Wood's statement, that the fishermen along the coast have a great many superstitions. I have never happened to hear this particular one, although it may be present. I did not mean to convey in my paper the idea that the housing problem is confined to cities. Very many instances of buildings with room overcrowding are found in the country, as in the city, and the result works out even worse in the country than in the city.

A SKETCH OF THE ORIGIN OF AUSCULTATION AND PERCUSSION AND OF THE STATE OF CLINICAL MEDICINE IN THE TIME OF AUENBRUGGER AND LAËNNEC.

By RICHARD COLE NEWTON, M.D.
MONTCLAIR, NEW JERSEY.

It is related of a Margrave of Baden that he fell ill in Heidelberg some time about the middle of the seventeenth century and summoned his physician-in-ordinary, who, accompánied by two distinguished consultants, proceeded to render what aid he could to the titled sufferer. After due deliberation it was determined to place a plaster over the patient's heart, when a dispute arose as to whether the human heart lies in the middle of the chest, as Galen had taught, or upon the left side. To settle this controversy a pig was brought in and its chest opened before the eyes of the noble patient, who, perceiving that the animal's heart lay on the left side of its chest, concluded that his own was also on the left side (Baas, "History of Medicine," p. 556). This led him to dismiss his family physician, and incidentally to disregard the teachings of Galen; an act requiring no inconsiderable courage in a layman or a physician two or three centuries ago. The simple device of applying the ear to the chest to determine the location of the heart never seemed to have occurred to these disputants, any more than it occurred to the learned savants, in the incident related by Chisholm, to weigh the vessel and the fish separately and together, instead of spending hours in bitter controversy over the question whether a vessel of water would gain weight or not by putting a fish into it. The conclusion arrived at was that a live fish would not increase the weight of the vessel, but a dead one would. As Karsner (Lecture on "Rise of Experimental Medicine," March, 1913) observes, this was philosophy; and this method of settling scientific and medical problems was strictly in accord with the teachings of master minds that devised the philosophical myths that ruled the medical world for centuries. A long while afterwards some sceptic actually settled the question to his own satisfaction by weighing the vessel under the different conditions specified. This was science.

Laënnec says that it is very singular that the passage in Hippocrates' works, in which he states that by applying his ear to the chest wall he could tell whether if it contained fluid, this was pus or water, "seems never to have engaged the attention of physicians, and there is no evidence that his experiment has ever been repeated until the present (*i.e.*, Laënnec's) time"—a period of over 2,000 years. "Yet," he continues, "I had myself read this passage of Hippocrates many years before I entertained the idea of medical auscultation." He then points out that it is remarkable that the great Hippocrates himself did not pursue this method of research further, and adds, rather sententiously: "Yet nothing is of more common occurrence. It is not given to any man to comprehend all the relations and all the consequences of the most simple fact; and we know that Nature's secrets are more frequently betrayed by fortuitous circumstances than obtained by the force of our scientific efforts" ("Diseases of the Chest," p. 29, Forbes's translation).

Whether Hippocrates really practised percussion or not seems quite doubtful; although Elliott claims that he did ("Outlines of Greek and Roman Medical History," 1914, p. 20). It appears also that he did paracentesis for fluid in the chest, and recognized the fact that the fluid should be gradually withdrawn to prevent syncope. Baas asserts ("History of Medicine," p. 644) that the Salernian physicians practised auscultation in the diagnosis of tympanites and ascites, but adds that "a diagnosis of the diseases of the great viscera had never been attempted in this way until finally Auenbrugger independently brought to light an ingenious use of the ear," which made possible a diagnosis of diseases of the chest and abdomen entirely unattainable before his time.

Auenbrugger was a nobleman of Auenbrugg, Germany. He was born in Graz, in Styria, in 1722, and died in 1809. He studied the humanities and philosophy in his native city, and medicine in Vienna, where, after graduation, he practised medicine for several years. In 1751 he was placed in charge of the Spanish Military Hospital and the Hospital of the Holy Trinity in Vienna, where, for a time at least, he laboured gratuitously, devoting himself assiduously to clinical study and observation. He was quite a musician and a friend of the arts. His musical ear quite probably was a great aid to him in devising the scheme of auscultation, which has brought him posthumous fame. He practised it for seven years in the Spanish Hospital before publishing the results of his labour in 1761. The style of percussion that he practised was mediate, no pleximeter being used. He struck the chest gently with the points of the fingers brought together and stretched out straight and then flexed, the patient holding his breath; a muffled sound or one of higher pitch than usual indicating the presumable site of disease. He insisted that either the percussor should wear gloves or that the chest should be covered with at least one thickness of cloth. This proviso was probably necessary in mediate percussion (Garrison, p. 282). This great discovery, which seems simple enough to us, was slighted and opposed by de Haen, Sprengel, and others of Auenbrugger's contemporaries. The two named were, of course, eminent men, and the former especially prided himself upon his diagnostic acumen. In 1803, forty years after Auenbrugger had published his "Novum Inventum," Sprengel wrote: "It is scarcely credible that he (Auenbrugger) could have diagnosed any disease of the lungs and thorax by means of the resonance." And for that matter a well-known medical writer who died in 1861, who produced the standard translation of the works of Hippocrates and other learned and valuable medical works, is said never to have admitted the possibility of detecting the sounds of the fœtal heart by auscultation. In 1803 the great Frenchman, Corvisart, revived Auenbrugger's forgotten and neglected theory by translating the original treatise and commending it highly to his students, after he had himself tested it by practice for a number of years. He is said to have become Napoleon's regular medical adviser, partly because he practised percussion, which struck the Emperor as a method of diagnosis of a careful and painstaking man. Corvisart's generous treatment of Auenbrugger shows his honourable and high-minded nature. After translating the treatise on percussion he gave all the credit for its introduction to Auenbrugger, although he might easily have claimed it for himself. He says with fine feeling that he would not sacrifice the name of Auenbrugger to personal vanity. His words were: "It is he and the beautiful invention which belongs to him that I wish to recall to life" (Garrison, p. 283). Of Auenbrugger, Garrison says that "He is indeed a noble example of the substantial worth and charm of old-fashioned German character at its very best," Laënnec was descended from a respectable family in the little city of Quimper, in Bretagne. He was born in February, 1781, and he died of consumption in 1826. His early education was neglected owing to poverty and other causes, although his uncle, who had charge of him, was "one of the first physicians of Nantes, and a man in every way distinguished" (Baas, p. 1012). Instead of sending the boy to school he took his nephew to camps and hospitals, where this feeble lad laid the foundation for his future brilliant career as a clinician. In fact, the schools in France were closed for a long time during the Reign of Terror, and yet young Laënnec, like other brilliant men in history, seemed rather benefited than otherwise by this lack of routine schooling. At 19 he went to Paris, where he so amply made up for lost time in his education that he acquired sufficient mastery of Latin and Greek to be able to write well in both languages: as Baas says, "A rare qualification in a modern Frenchman." His medical studies also received the most zealous attention. After having published a number of valuable medical papers, he made in the year 1815, in the Société de l'Ecole, his first experiments with the stethoscope. His original instrument was a block of wood about 10 in. long and 4 in. in diameter with a central canal, and at the thoracic end an obturator upon which Laënnec laid great stress. According to his own account ("Diseases of the Chest," p. 6) he had been in the habit of making use of immediate auscultation "for a long time in obscure cases, and where it was practicable." Hence, we see that both auscultation and percussion, one or both, had been practised at least occasionally for thirty or forty years before Laënnec discovered the stethoscope. This happened accidentally in 1816, when he "was consulted by a young woman labouring under the general symptoms of diseased heart, and in whose case percussion and the application of the hand (to the chest wall) were of little avail on account of the great degree of fatness. The other method " (immediate auscultation) " just mentioned being rendered inadmissible by the age and sex of the patient," he " rolled a quire of paper into a kind of cylinder " and used it as a stethoscope. The result pleased him so greatly that from that moment he imagined that this instrument might furnish means for enabling us to ascertain the character, not only of the action of the heart, but of every species of sound produced by the motion of all the thoracic viscera. He found upon trial that " the hollow cylinder is essential for exploration of the voice," while a solid one is best for examination of the heart. After various experiments he concluded that wood was the best material out of which to make these stethoscopes. I can remember seeing our honoured ex-President, Dr. Beverly Robinson, use a small billet of wood for a stethoscope, which resembled the sawn-off top of a bed post. This was thirty-five years ago, when he was a visiting physician and I was an interne in the old City Hospital in New York. I presume that Dr. Robinson, who had studied in Paris, had brought this instrument from there.

However, the limits of this paper will preclude a study of the various styles of stethoscopes; a field which has been well covered by Dr. D. S. Lamb, in a paper read before the Medical Society of the District of Columbia, April, 1910.

In the pursuit of his studies, in wise counsel and sound instruction Laënnec had the advantage of studying under Corvisart, and was a contemporary of Louis, Pinel, Andral, Parry, Rayer, Ricord, Bretonneau and Bouillaud, a truly extraordinary galaxy of brilliant internists, who were quick to seize upon and exploit Laënnec's great invention. These men, together with Dupuytren, Larrey and Cuvier, probably touched the high-water mark of the French influence in medicine, and gave an impulse to the development of correct diagnostic methods and the careful study of pathological anatomy which is even now felt in the advance of medicine. America was especially fortunate, because such men as Holmes, Gerhard, the Jacksons, the Shattucks, and other American physicians were pupils of the great Louis and of Laënnec and Corvisart, being students in Paris in the period just mentioned. Garrison says ("History of Medicine," p. 343): "The strong stand which Louis took in favour of facts and figures as against the sterile theorizing of the past appealed especially to the keen, practical common sense of these Northern physicians."

Had Auenbrugger been as fortunately placed in Vienna as Laënnec was in Paris, he probably would not have died feeling that his long years of labour in the Spanish Hospital, carried on, as he himself said, *inter labores et tædia,* had gone for naught.

As we have seen, it was the noble-minded Corvisart that introduced Auenbrugger to his own countrymen. And it was a pupil in Corvisart's clinic named Bayle, who is said to have been the first person who studied the heart's action by applying his ear to the bare chest wall.

It is stated that Corvisart himself never did this, although he admitted that he had heard the pulsations of the heart several times by listening very close to the chest: just how close we are not informed.

It all seems wonderful to us. The slow development of natural scientific medicine is hardly comprehensible to our modern intelligence and practical way of looking at things; but we must remember that there was really nothing scientific about mediæval medicine. It was a curious jumble of metaphysics, superstition, and dogma learned by rote and supported by "authority." There were practically no dissections for over 1,000 years after Galen; in fact, this great medical light was obliged to do his dissecting on animals, and, in justice to his memory, some of the anatomical mistakes in his writings must be acknowledged to be the unavoidable consequences of this fact.

Galen is said to have considered himself extremely fortunate in having seen and studied a human skeleton. Baas says that the University of Vienna did not acquire a skeleton until 1658. Strasburg, in 1671, obtained a skeleton of a man, and several years later one of a woman.

About 1725 the great Haller was obliged to flee for his life from Leyden because he had been engaged in grave robbing to secure material for dissection. It might be said that Paracelsus was the Luther of medicine. When he declared, in the early part of the sixteenth century, that all diseases are parasitical, he started the movement which finally brought about the emancipation of the human mind from the idea that all disease was either a divine or a diabolic visitation. It was, however, over two centuries after this before instruments of precision began to be used in the study of the human body in health and disease, and about the same time the belief in the sacredness or accursedness of the human corpse had become sufficiently modified so that dissections might be more commonly made; and, finally, so that practical anatomy could be insisted upon as a part of the regular course of study for the degree of doctor of medicine.

Boerhaave was using a clinical thermometer in the first quarter of the eighteenth century, and was the first to use a magnifying lens in studying the eye. John Floyer (1649-1734) was the first man to count a pulse by the use of the minute watch. This was a watch which ran for exactly one minute, with which Floyer made many observations on the human pulse in health and disease. He was followed in this study by Haller. Floyer tabulated his results; but his work was neglected or vitiated by a revival of the old Galenic doctrine of "specific pulses," *i.e.*, "a special pulse for every disease." However, Louis also adopted the minute watch to count pulses, and by his great influence succeeded in rendering it popular.

All these mechanical aids to diagnosis were at first scoffed at and derided and finally furiously adopted. Skoda, in Vienna, studied every case that came along with the most minute refinement of physical diagnosis, without apparently caring a fig for the patient's welfare.

After Floyer, according to Weir Mitchell, "observation went minutely mad (furnishing) a whole Lilliput of symptoms, an exasperating waste of human intelligence"—another illustration of the fact, so wisely stated by Hecker, that "physicians seem to be condemned to the fate of rarely discovering the golden *via media* of truth between the by-paths of error."

This cursory review of the introduction into clinical medicine of auscultation and percussion is to my mind most refreshing; inasmuch as it gives us at least a glimpse of a widespread and substantial advance in the development of the healing art, whose great importance we can scarcely overestimate. One very obvious benefit is that this method of study has done a great deal to shake the nonsense and superstition out of medicine by making us observe and investigate the human body in its most minute details, and also as a complete organism. It has advanced the practical side of physiology and therapeutics and paved the way for its own great successor in the advance of medical knowledge, which now holds the stage and promises great things for the future; I refer, of course, to bacteriology and the study of natural and acquired immunity—in short, preventive medicine and prophylaxis. It is a pleasant aspect of a rational and sensible movement in medicine which is of the greatest import, and offers a delightful contrast to the speculative, involved, and often ridiculous systems of the pedants and philosophers who have tried to measure our art with the tiny yardsticks of their own restricted intellects, and have succeeded about as well as the theologians and scholiasts have succeeded in measuring the infinite.

DISCUSSION.

Dr. OTIS : We are all exceedingly interested in the lives of Auenbrugger and Laënnec. At a meeting of the Association in 1898 it was my privilege to present a paper upon the same subject. Auenbrugger's "Novum Inventum" is still a sound and accurate treatise on percussion. The reason that his discovery was lost to the medical world for forty or fifty years and then rediscovered, while that of Laënnec was immediately taken up was that Auenbrugger had no teaching clinic and students to spread his discovery, whereas Laënnec had. Auenbrugger died of pneumonia, and it is said that in his last illness he remarked, looking up at the clock, "when it strikes two the end will come," and it did. Another incident related of him is that he kept his little hand-lantern always in readiness, by the light of which he not infrequently went alone to visit his patients, even to the remotest suburbs. Both Auenbrugger and Laënnec were musical. Auenbrugger was devoted to symphony music, and Laënnec was a player on the flute. There is at Quimper, in Brittany, a monument to Laënnec. Whether there is one to Auenbrugger at Vienna I do not know. Laënnec was most extraordinarily industrious. During his first three years at La Charité he drew up a minute history of nearly 400 cases of disease.

Dr. EDSON : I wish to add a few words to Dr. Newton's interesting paper, and this in testimony to Laënnec's uncle, Dr. William F. Laënnec. It is not generally appreciated how much the world owes to this uncle for his recognition of the ability of Laënnec, and his faithful, persistent support of his nephew. Laënnec's father was one of those impossible men, vastly self-conceited, absolutely selfish, and very neglectful of his children. His mother died when he was a mere lad, and his uncle supported and brought him up as one of his own children. During his early days in studying medicine his father contributed during one eighteen months only 40 fr. for his support. Laënnec's letters from Paris as a medical student are heartrending. He says in one : "Father, can't you send me at least some shirts? I have but two, and they are absolutely ragged. I cannot appear for my next examination unless I have clothing to wear." His father would reply : "You are sure to acquire fame; study, write, and above all, practise a good address : that is the secret of success. Can you not use your influence with the professors to get me a job in the Civil Service ? " Laënnec was but half fed all through his medical course in Paris. How much his early death from phthisis may have been advanced by these privations and hardships we cannot tell. Some of his letters bring tears as you read them. His uncle, firmly believing in the boy's ability neglected no means, labour, or self-sacrifice to get money to keep his nephew going, although he had a family of his own to bring up and educate, writing constantly to the father : " You must support the boy now. He has the making of a great man, and it is a terrible responsibility you will take in not assuring him of adequate support during these few years of preparation." In his early days Laënnec showed a tendency to inherit some of his father's traits, and his uncle's influence in drilling these out of the boy was worth everything to him. The world owes a debt of gratitude to the persistent faith, belief, support and self-sacrifice of this uncle, who is now forgotten, whose work was that of a medical drudge at Nantes, where he took a position as military surgeon for the pay it gave him which he might contribute to the support of this brilliant nephew.

Dr. JAMES DUDLEY MORGAN (Washington, D.C.) : Sir William Thomas, when the work of Auenbrugger was called to his attention, and later that of Laënnec, stated that it was very remarkable that he had not himself practised these particular devices of percussion and auscultation, as he had frequently, in trying to find out whether a wall was made of brick or timber, so as to get a good hold for a nail, sounded the wall to find if it was solid or hollow. Sir John Forbes, also an Englishman, said that it was three years before any particular notice was taken in the medical journals of the work of Laënnec. The work of Auenbrugger was put somewhat into oblivion by the fact that his preceptors, who were authors of practices of medicine, made no reference to his work. As has been said, it was Corvisart who translated the work of Auenbrugger, and gave him full credit, having used it on the First Consul, Napoleon Bonaparte ; in that way Laënnec was brought into prominence with the French nobility. Laënnec gave the name " the stethoscope " to his instrument. He used one piece, monaural. It was about 1 ft. long, and was in two parts, for convenience in carrying and getting closer to the patient ; it was funnel-shaped when intended for use on the chest, but when it was used for the heart an obturator was inserted, so as to get in between the ribs and enable the examiner to hear better ; there was a small opening in the obturator, which was inserted in the funnel-shaped part of the stethoscope. It is interesting to us, as clinicians and men dealing with tuberculosis, that Laënnec's mother died of tuberculosis, when he was quite young, of which disease Laënnec, when scarcely aged 50, died.

Dr. HINSDALE : It is a strange thing that Laënnec, who named this instrument the stethoscope, should have used this word. The term stethophone has been used with reference to the instrument, and would seem more appropriate.

Dr. NEWTON (closing) : I do not think that there is anything more to say. There were a number of practitioners who used auscultation before Laënnec's work came out, so that the matter was not entirely in one man's mind. So far as we know, however, no one thought of a stethoscope before Laënnec did. Its great usefulness was at once recognized, no doubt because a number of men had been thinking about it.

PERCUSSION OF THE LUNGS.

BY NATHANIEL K. WOOD, M.D.
BOSTON.

(1) AN EFFORT TO STANDARDIZE THE DEGREES OF DULNESS.

WHILE studying physical diagnosis as a student, one of the very hard things for me to understand was percussion. As I talk to students in the medical schools now I am told by them that percussion is one of the hard things for them to learn, and that it means the least to them of the physical signs. It has interested me to study why this is so, especially as I have come to regard percussion as a distinctly definite and valuable sign. This is so much true that instead of correcting my dulness by what I learn from auscultation, as I once did, I now correct my auscultation by what I learn from percussion.

My studies have led me to recognize that the standards of clinicians for the various degrees of dulness, 1, 2, 3, 4 line dulness, impaired resonance,definite dulness, very marked dulness and flatness, are so individual, so lax and so diversified that they amount to no standard at all; certainly not a standard that can be grasped by an inteliigent student. It is a common occurrence for a physician to percuss a chest which shows nothing but 2 or 3 line dulness, and to have him call the 2 line dulness normal resonance and, in consequence, call the 3 line dulness only 1. In this way serious pathological conditions are overlooked. The following instance, which illustrates my point well, impressed me distinctly, as it was furnished by one of the leading hospitals of Boston and by one of the good instructors of physical diagnosis in the Harvard Medical School. This physician examined a well-built, muscular young man, a light-weight wrestler, who had lost practically no weight, looked perfectly well, and complained only of hoarseness. The examination, signed and written by the doctor, stated that " the chest was normal throughout, lungs show no disease." I examined the patient the next day at the Boston Consumptive Hospital and found 3 and 2 line dulness throughout both chests and fine crackling râles with cough throughout. The larynx showed miliary tuberculosis, and the sputum contained numerous tubercle bacilli. I think that the first clinician failed to recognize this very serious condition because he had no fixed standard of dulness.

Two years ago I began to study the pitch of the various notes of percussion in an effort to establish for myself some definite standard. I made a frequent practice therefore of whistling the pitch of the notes as I percussed the lungs. I soon learned that the variation between normal resonance and flatness was a range of over two octaves. This winter I have carried the investigation further. With an assistant, who has no medical training, I plotted out on the piano the notes which corresponded to what I had come to consider my personal standard of 1, 2, 3, 4 line dulness.

In each instance I took at least six patients and did not tell my assistant what note I expected to find. At first she hummed the note, found it upon the piano, then freed our minds of the note by playing chords. I next hummed or whistled the note and she found that note upon the piano. A comparison of our two notes showed that we never differed more than a half-tone. Later we concluded that an easier and more accurate method was to strike middle C and then work up or down the scale until both of us agreed that the note upon the piano corresponded with the percussion note.

In this way we examined six cases for each note. We also came back to the same case two or three times after examining others to determine how well we would agree with our former notes. When I percussed the same individual in the same place we always agreed with our previous findings. Not only did we agree upon the note previously found in a particular case, but the notes for the different degrees of dulness were the same in a variety of individuals. This proved that the problem was purely a matter of pitch and not one of individual variations.

I determined in this manner that normal resonance is F or F sharp below middle C; 1 line dulness A below middle C to middle C; 2 line dulness E flat to F above middle C; 3 line dulness B flat to intermediate C; 4 line dulness E to F above intermediate C. Thus it will be seen that there is an interval of an octave between normal resonance and 2 line dulness, and an interval of another octave between 2 line dulness and 4 line dulness or flatness.

Has this any practical value, or is it simply an interesting thing theoretically and musically, requiring a specially trained ear to detect these changes of pitch? I think that it does not need a specially trained ear; that it is of distinct practical value, and can be acquired readily by anyone who has had these differences pointed out to him. If it is not practical, then percussion as a physical sign is not practical. The discussion of this point, however, brings me to the second part of my paper.

(2) The Advantages of Percussing from Base to Apex over the Opposite Method.

To percuss well, the stroke upon the pleximeter must be sharp and quick. A rapid recovery is essential. The motion may be best illustrated by saying that it should be made exactly as a woodpecker uses his head in boring a tree. All the motion should come in the wrist and none in the arm. This secures a crisp note. The pleximeter may be held flat, or raised so that only the end of the finger touches the chest. In the latter position a distinctly smaller area is percussed at one time. The note, consequently, is less disguised by the surrounding normal or semi-normal tissue. It is essential, moreover, to remember in a disease like tuberculosis that normal lung is always in intimate contact with abnormal. This change from a flat to finger-tip pleximeter does not alter the pitch of the pathological note. It only makes the note much more evident.

Of far greater importance than the proper manner in which to use the plexor and pleximeter, however, is the direction in which the chest is percussed. It should be percussed upwards and not downwards, from the base of the lungs to the apex and not from the apex to the base, as has been taught so universally. This is so important that I wish to state my reasons for it carefully.

(*a*) It is much easier for the ear to pick up a higher note from a lower that it is to do the reverse.

(*b*) It requires a much lighter stroke to bring out the normal note than the pathological.

(*c*) It is the rational plan to work from the normal as a standard towards the pathological. The reverse leads to faulty standards.

(*d*) The apices, as is well known, are most frequently affected and more rarely give a normal note. To start at the apex, therefore, is usually to commence with a pathological note. This prejudices the further examination. With downward percussion, the higher note merges into the lower too imperceptibly to do accurate work. This is so for two reasons: First, as I have already said, the mind becomes prejudiced in favour of a pathological note, and consequently does not attempt to make fine distinctions; secondly, a heavier stroke is required for the pathological note, and when the more resonant is reached the percussion is continued too heavily to detect what should be readily appreciated differences in the force of stroke necessary to bring out a good note. In this way the examiner deprives himself of a very important guide to collect accurate data.

The best place, therefore, to start the percussion of the lungs is the left lower front, as this is most often normal. From there work upwards to the apex, and record the various notes without percussing the opposite side. Then percuss upwards on the right side and finally from side to side and alter your first findings if necessary. The comparative note between similar areas of the two lungs is often misleading, as both may be pathological. This comparison, therefore, should only be used later to correct first impressions and to detect or confirm fine gradations. In doing the backs follow the same order, left lower to apex, right lower to apex, then from side to side. If this order is followed I am sure that interesting observations will follow as regards the usual progress of a disease like tuberculosis and the relative frequency between incipient cases and chronic ones of long standing with marked reparative ability.

I am absolutely convinced that a fine ear for percussion can be trained only by this upward method. I have been much impressed by the rapidity with which students appreciate the difference between the two modes, and the readiness with which they acquire a standard of dulness as a result of it.

I said that I considered that a musical standard is practical and can be taught easily to the non-musical. I should like to prove that these statements are true. In the first place, I have had no difficulty in teaching such a standard to quite a wide range of students, good, fair and poor.

How then can this be taught the non-musical man? In the first place, the mind must be entirely freed from all preconceived ideas as to what pathological process underlies the varying degrees of dulness; what stage of the disease is indicated, and what bearing the dulness has upon the prognosis. I am sure that I am correct when I say that many men to-day consider that 3 line dulness over all of both chests means a hopeless condition of the lungs. This very attitude of mind prevents them from making what should be an accurate scientific record of what they find. One of the chief reasons why I have so little difficulty with students is because their minds are open. I have several times been told by older men that the patient whom I was examining was too well to have such extensive dulness as I claimed. I am convinced that, until a more uniform standard of dulness is adopted we are in no position to discuss the pathology of 1, 2, 3, 4 line dulness, when applied to such a disease as tuberculosis. At present such terms are as much of a hindrance as a help in the diagnosis and prognosis of chest cases.

In the second place, and in teaching students this occupies the first consideration, when resistance is felt under the pleximeter finger, the note is close to B below intermediate C, or 3 line dulness. As we are all accustomed to this feeling of resistance under the finger when percussing, we have here not only an easy guide to any man, but also an accurate one. This observation depends upon the muscle sense of the fingers of the physician and not upon his ears. Until you feel this resistance you have, therefore, to decide only between normal resonance and 2 line dulness.

Now the differences between normal resonance and 2 line dulness can be detected readily by the muscle sense also. Here, however, it is the muscle sense of the plexor rather than that of the pleximeter. There is a very definite difference between the gentle tap which is sufficient to bring out the normal note and the decided stroke necessary to make the note of 2 line dulness loud enough to carry any distance at all. The physician who trains himself to start with very light percussion will quickly learn to appreciate these differences. That is why the examination should begin with that part of the chest which is most likely to be normal.

Although I have placed stress upon the muscle sense of the pleximeter in detecting 3 line dulness, and upon the plexor in detecting 2 line dulness, in both instances the muscle sense of both hands comes into play. As we measure the resistance under the pleximeter, we naturally measure the force of the plexor stroke. On the other hand, as we measure the lightness of the stroke of normal resonance in the plexor wrist, at the same time we measure the force of the stroke upon the pleximeter. This, then, is as much a matter of training the muscle sense of the fingers and hands as it is of making use of a well-trained musical ear.

I wish to repeat, however, that one of the great barriers to acquiring this skill is the preconceived ideas which we have as to what the underlying pathological condition must be for a given degree of dulness. I am free to confess that my physical examination occasionally makes it hard for some of my patients to enter the State sanatoria. That is because more attention is attracted by my lines of dulness than by my report of symptoms.

Conclusions.

(1) Present methods of percussion are of little value, because, far from having any universal standard of dulness, there is not, in most instances, even an individual standard.

(2) To a field in which there is no accurate standard I bring some standard, to me one that is definite and easily acquired.

(3) Normal resonance is F to F sharp below middle C; 1 line dulness or impaired resonance is A below middle C to middle C; 2 line dulness or definite dulness is E flat to F above middle C; 3 line dulness or very marked dulness is B flat below intermediate C to intermediate C; 4 line dulness or flatness is E to F above intermediate C.

(4) No intelligent idea of diagnosis, prognosis, nor of the underlying pathological condition can be formed by percussion without some such definite standard.

(5) This standard can be acquired readily by the ear and by the muscle sense of both hands, measured by the force of the plexor blow and the resistance under the pleximeter.

(6) Upward percussion is an absolute essential of correct work. The old method of downward percussion should be discarded and no longer taught to medical students.

DISCUSSION.

Dr. Rochester: I have been very much interested in Dr. Wood's paper, as I have always insisted that we could learn more about early involvement of the lung by percussion than by auscultation, following the teachings of the eldest Austin Flint, who insisted that pitch was the thing that we must pay attention to above all others. His method of percussion struck me as one that all should follow, if possible; and his distinctions between different grades of pitch were exceedingly interesting. Dr. Wood's statement that we should percuss from below upwards seems to me rational. I have never done it, but I think that we should first get the clear note from the under part, and get acquainted with the sound of that. It is a wise suggestion. Another thing that I want to say is that I am not a musical man; but I have trained my ear to recognize differences of pitch over the lung quite accurately.

Dr. Minor: In view of the fact that percussion is usually the least satisfactorily carried out of all the elements of physical diagnosis, I am glad to hear a paper like this. We have had relatively too few such papers on physical diagnosis. At the same time, it strikes me that the great difficulty with Dr. Wood's suggestion is to have a sufficiently musical training to carry out the method. I have a good ear, and I train it carefully; but these musical terms are Greek to me. To get a piano in the examining room would be difficult. That adds a complication to the teaching that, I think, would be difficult to overcome; although I heartily agree that we need some definite standard of comparison for pitch.

With regard to the other point that Dr. Wood brings out, as to percussing from below upward, I am glad to see Dr. Wood stress this point on which I have long insisted. In all cases in which the note puzzles me, I go from below upwards, because it is easier to recognize altered tones by running from the normal lung with its lower, longer note up to the higher, shorter note of the apex. Finally, may I say that I am glad our new members are bringing before us such useful papers on physical diagnosis.

Dr. OTIS: I am reminded by Dr. Rochester's remarks of an incident mentioned by a physician in connection with a case that he was examining. The patient was a musician, and the doctor asked him to sing the note which he struck in percussion, which he did. I have been convinced for a long time that a musical ear in the examiner is a great help in obtaining the best results from percussion. If a patient is musical I say, "What is the difference between these two notes?" percussing the two sides; and I often get a very accurate reply from them. It has been my custom, in my classes at the medical school, to advise my students to continue their music, if they sing or play on any instrument; or if not, to take every occasion to listen to good music. We all know that the three great masters of auscultation and percussion, Flint, Auenbrugger, and Laënnec, were all musical. It is an exceedingly admirable paper of Dr. Wood's, and he has brought us many most valuable suggestions.

Dr. MINOR: Why could you not use a whistle with varying notes, instead of a piano? The latter is not always easy to get at. I should like to know how Dr. Wood uses the piano, and whether he has one in his teaching room, also whether he could not use another instrument in its place, one that would not be so bulky? You cannot carry a piano around, and you might want to write down on the diagram the sounds that you hear when examining patients at their homes. I think you should have a smaller instrument—perhaps some tuning-forks specially mounted.

Dr. WOOD (closing): Dr. Rochester and Dr. Minor have spoken of percussion from below upwards. I have not seen that mentioned in the literature. In writing the paper, I had students in mind, and the best way to teach them methods of percussion. That is why I have emphasized upward percussion. I play the notes on the piano. This is the normal resonance. (Plays F and F sharp below middle C.) One line dulness is A below middle C. (Plays the note.) Two line dulness is E flat and F above middle C. Three lines dulness is B flat below intermediate C. (Playing the notes on the piano.) Four line dulness or flatness is E and F above intermediate C, away up here.

When I went out to Cambridge, I would take the Harvard students and get them to find the note of their chest on the piano. I would get the note myself beforehand in some cases, and not tell them what note I expected them to find. One of these students was absolutely non-musical, but agreed with me about the note. My idea is to feel the definite resistance with the pleximeter. When you feel it, you have this note, intermediate C, and not this one, F below middle C. (Plays first the high note, and then the low one.) In making the examinations, I first examined the patients in my office without a piano, and marked the diagram of the chest with the various lines of dulness. Then I took the cases to my assistant, who went over them with the piano. Those that I had marked three-line dulness always gave this note. (Plays B flat below intermediate C.)

Dr. MINOR : Still, you must trust to your memory. For scientific accuracy, you want to record the pitch immediately. To do this, you would have to have with you your piano, under your arm.

Dr. WOOD : That is true.

SOME UNSOLVED AND DEBATABLE PROBLEMS IN TUBERCULOSIS.

By EDWARD O. OTIS, M.D.
BOSTON.

"Die Tuberculose hat uns lange Zeiten hindurch immer wieder Rätsel zu lösen gegeben," says a recent writer. And it is to some of these problems upon which there exist conflicting and perhaps erroneous opinions, or for which we have, as yet, found no satisfactory solution, that I wish to call your attention for a few moments and invite discussion.

First I wish to refer to the undue emphasis placed upon the detection of physical signs in the early diagnosis propaganda. The general practitioner has now for many years been lectured in season and out of season upon the supreme importance of the early diagnosis of tuberculosis, and he has been unmercifully berated for his dereliction in neglecting to do this—many times justly, and sometimes, I believe, unjustly. He has become so sensitive under the censure that in my experience I find him making a diagnosis of clinical tuberculosis, not infrequently, upon indefinite physical signs, without giving due weight to the more important evidence of clinical symptoms. It seems to him more direct and scientific to base the diagnosis upon the physical findings rather than upon a painstaking investigation of the history and general symptoms, or at least the former occupies the foreground while the latter is relegated to the second place. The distinction between clinical active tuberculosis and local infiltration without symptoms does not seem to be always clearly comprehended—not even perhaps by the tuberculosis dispensary physician himself, or even the teacher. The presence of certain physical signs, definite or indefinite, with no symptoms of bacterial toxæmia are interpreted to mean active tuberculosis, and the patient exhibiting such signs is accordingly removed from his family and employment and consigned to a sanatorium, where there is at least some risk that he may receive a new and active infection, whereas the individual was in no way ill, and probably never would have developed any active clinical tuberculosis.

"If a patient feels perfectly fit and well," says Patterson, "and his breathing capacity only is impaired, we could hardly say that he is *ill* with consumption. What really matters to the patient are the products of the bacteria entering into the general circulation." Drs. Gelien and Hamman* have, it seems to me, very justly estimated the relation between the physical signs and symptoms in making the early diagnosis when they say that "the early diagnosis of pulmonary tuberculosis is more a matter of clinical experience and judgment than of unusual skill in eliciting slight abnormalities in pulmonary physical signs." "It seems to us," they continue, "that in attempting to improve the diagnostic acumen of the general practitioner towards pulmonary tuberculosis more emphasis should be laid upon the observation of symptoms than upon the pulmonary examination. To carry out the former is within the reach of all, while to do well the latter will be a goal unattained by most of them." Has not the tendency been to insist too strenuously upon the detection of physical signs, often slight and

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* "The Subsequent History of One Thousand Patients who received Tuberculin Tests," *Johns Hopkins Hospital Bulletin*, June, 1913, xxiv, No. 268.

indefinite, to the neglect of a careful observation and interpretation of symptoms, thereby, on the one hand, causing unnecessary anxiety and the disturbance of social and business relations by instituting uncalled for treatment; and, on the other hand, neglecting treatment because the physical examination was negative, although the symptoms of active tuberculosis were obvious?

Since writing the above a very suggestive article upon "The Responsibility for the Failure to Diagnose Tuberculosis in its Early Stages" has appeared in the *Journal of the American Medical Association* for April 18, 1914, by Dr. Ralph S. Lavenson, which seems to confirm my contention that undue emphasis is placed upon the detection of physical signs in the early diagnosis of tuberculosis. Dr. Lavenson investigated fifty-four instances in which the diagnosis had been made by the general practitioner "only after from three months to as long as five years after the patient had first sought a physician presenting symptoms suggestive of, and undoubtedly referable to, a tuberculous pulmonary infection." In 52·7 per cent. of the cases a physical examination *alone* was made, and depending upon the result *alone* of this physical examination the diagnosis was not made, although tuberculosis existed, as subsequent events proved.

Second: Marriage and tuberculosis.

Under what conditions, if any, shall a man or woman who is tuberculous (one or the other), or who has suffered from tuberculosis, marry and have children? To state the question in detail: Shall a man or a woman with arrested tuberculosis marry and have children, both as regards danger to themselves and a predisposition to tuberculosis in their offspring? Shall a man who is tuberculous but whose disease is in a quiescent state, and who still maintains good resistance and retains his working ability, marry and have children, provided his wife is healthy? Shall a woman who has only evidence of anatomical tuberculosis with no symptoms marry and have children? Various and conflicting answers have been made to these questions. You are doubtless familiar with the oft-asserted solemn asseveration of a prominent phthiso-therapeutist that a tuberculous husband and wife should be taught "not to procreate a race predisposed to tuberculosis." It seems to me that this is too sweeping a statement without modifications. How do we know that the children will be predisposed to tuberculosis? The recently published experiment of Brooks* would appear to offer substantial proof to the contrary, reasoning from analogy. In this experiment tuberculous cows were bred to tuberculous bulls, and at birth the calves were immediately taken from their mothers and fed upon modified pasteurized milk. Of more than 200 calves thus born not one became tuberculous, and there was some evidence which seemed to indicate that animals thus born were rather more resistant to tuberculosis than animals born of non-tuberculous parents. Why should we not expect that children born under similar conditions and treated in the same way would show the same results?

Why should not a tuberculous husband, if his disease is quiescent and the balance between the infection and the resistance is evenly maintained, have children if his wife is healthy? And still more so if his disease is arrested? And yet I recall a pathetic instance of the latter case when the wife, though healthy, refrained from bearing children for fear of the possible inherited predisposition on the side of the husband. Our American Anglo-Saxon race is so rapidly diminishing at the present time that one should be extremely cautious, it seems to me, in advising further race

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* "An Experimental Study of Heredity in Bovine Tuberculosis," *Proc. Soc. Exper. Biol. and Med.*, 1914, xi, 50.

suicide—"the unpardonable sin for which there is no atonement," says Colonel Roosevelt—unless from very definite and clearly determined reasons. I would even go further and say that it were better to take some risks with so much to gain in the preservation of a valuable family. For example, some married people, I am sure, would be willing to shorten their own lives if by so doing they could continue their name and family. I do not suppose there is much difference of opinion as to sanctioning the marriage and child-bearing of a woman who has obtained and maintained an arrest of her disease for a number of years, or of opposing the marriage of a woman who is still actively tuberculous or who has only an apparent arrest. When the husband is actively tuberculous, but not in the advanced stage, and his wife is healthy, it seems to me it is a question for him alone to decide whether he should have children; and if the child is at once removed from the father I do not believe the predisposition bugaboo need cause anxiety.

Third: The question of rest and exercise.

After the acute symptoms have subsided—for everybody agrees that absolute rest should be maintained during the fever period—when and how much exercise, if any, should be advised? Here opinions and practice vary somewhat. Dettweiler and Pratt seem to have proved pretty conclusively that continued rest during the whole period of treatment produces excellent results. Can we show better results and fewer relapses from exercise, however carefully graduated and supervised? Again, is there any definite proof that so-called "breathing gymnastics" are, at least, of any material benefit in the "cure," and is there not an element of danger in their employment? E. Kuhn, of Berlin, has recently published a long and elaborate argument in favour of breathing exercise by means of his "Lungensaugmaske," and adduces much theoretical and experimental evidence of its value. He considers that auto-inoculation is produced not by general bodily exercise, as held by Wright and Paterson, but by the increased lung movement induced by the "Körperbewegung," and hence his conclusion is that breathing gymnastics is the essential element in the production of auto-inoculation. On the other hand, we are familiar with the not infrequent brilliant results attained by the complete immobilization of the lung through artificial pneumothorax, and in laryngeal tuberculosis from long-continued absolute rest. It is fair, however, to state that Kuhn also advises artificial pneumothorax even in cases not far advanced or with cavities. Where mobilization of the lung cannot be practised without rise of temperature, Paterson's method of graduated exercise has become very popular and been widely adopted; not always, however, with the same discrimination that he exercised. One must bear in mind that Paterson's cases were in the first place carefully selected for him at the Brompton Hospital before being sent to Frimley; and, further, that either Paterson himself or a trained superintendent constantly supervised the work. "Uncontrolled doses" (of exercise), says Paterson, "are in the last degree dangerous." "Treatment by means of exercise," he continues, "is not of universal application; it can only be used in the case of a patient who fulfils two rather onerous conditions. In the first place he must be afebrile and quite free from all constitutional symptoms; and, secondly, he must have attained the position of an ordinary person in the house, by being able to remain up all day fully dressed, and to walk up and down stairs." Upon how definite a scientific basis Paterson's theory of auto-inoculation stands seems still to be somewhat uncertain. At all events it is well to remember that continued rest has produced, and does produce, excellent results, and exercise at any stage of the game has its dangers, particularly when lacking the Paterson skill in application and supervision. I recognize, however, that there are psychic conditions in the course of the treatment which may warrant a recourse to exercise even if some risk is incurred.

Fourth: Have we been over-doing, or applying without proper discrimination, the open-air exposure in the treatment of tuberculosis?

It would seem to be rank heresy even to suggest such a thing; but do we always sufficiently individualize our patients in the application of extreme open-air methods? I refer more particularly to the more northern latitudes. Take, in the first place, the far-advanced incurable cases, for even they have, not infrequently, been subjected to this treatment. What is gained by doing this and rendering their last days more wretched, when a warm ward or room —well ventilated, of course—would render their existence more comfortable? "I have seen a good many of them," said a patient in our Municipal Consumptive Hospital, to me not long ago, "put out of doors, but they all go below [to the dead house] just the same."

With regard to the earlier, so-called "curable" cases, not all, it seems to me, are suitable for the rigorous out-door system in our northern climate. Some never become accustomed to the life, and suffer genuine distress under the constant exposure to the cold; and it is, at least, a debatable question whether the excessive demands made upon the heat-producing forces of the body do not lower the resistance more than the open-air exposure raises it. They are like old people in their sluggishness of purpose. Is it not conceivable that with some individuals we would produce better results by less strenuous insistence upon out-door exposure, provided, of course, we furnish pure air in well-ventilated wards or rooms?

Or again: Are all patients equally adapted to the open-air treatment in our cold northern latitudes? Would not some do better in warmer climates, where the heat demands upon the organism are less, and where the out-door life could be enjoyed, not endured? A considerable number of persons, as we know, have a real antipathy to cold. Winter weather is to them a time of discomfort, if not of suffering. They dread cold as others do heat. They never can grow so accustomed to cold exposure as to render it anything more than a very uncomfortable experience. Even if their heat-producing centres did more or less adequately finally respond to the demands made upon them by the cold, the process would be long and painful. If, after trial, this was found to be the case, could we not obtain quicker and better results, or, at least, equally good results, under more agreeable conditions if we sent our patients, with this idiosyncrasy as regards cold, to a warmer climate for the open-air treatment, when a choice of climates was permissible from other considerations—to such a climate, for example, as that of New Mexico, Southern California, or the Pine Belt of the South? We say that "tuberculosis can be cured in any climate," and then in the same breath we say, "but a cold climate is more favourable." But is it so for every case?

Fifth, and finally: The problem of prevention in the case of a person suffering from more or less advanced tuberculosis, but who maintains indefinitely an equilibrium between his infection and his resistance, and who, in consequence, is able to be active in the community and perform his business and social duties. He maintains his normal weight, and, for the most part, his strength; but he is constantly emitting tubercle bacilli. From business or social considerations he naturally desires to conceal his condition, and hence does not exercise all the precautions which he knows, and which we prescribe for an actively tuberculous individual. If of the well-to-do class he goes into society, he dines out, he is brought into intimate association with many people in professional or business relations. Or if of the working class, he lives with his family and is intimately associated with his fellow working men in shop or factory; he, too, that he may hold his job, desires to conceal his condition. I have in mind the case of a professional man in the higher ranks of society, who looks well, and is able to attend to his duties. From his love of music and acquaintance with musicians he goes more or less into society. He is suffering, however, from advanced tuberculosis, and his sputum always contains tubercle bacilli. Such cases must be a menace to those with whom they are brought into intimate association. They will probably never obtain an arrest, and feeling well as they do, or from other prohibitive circumstances, will not take the "cure," or have tried and abandoned it. What are we to do with them from the standpoint of prevention? We cannot compel isolation, and if it were possible, somebody would, in many cases, have to provide indefinitely for the support of the family. So long, however, as they remain in active life they desire to conceal their condition, and hence cannot, or do not, take all the necessary precautions to render themselves innocuous to others. This is one of the many problems in the prevention of tuberculosis which we have not yet solved.*

DISCUSSION.

Dr. MINOR: I should like to discuss a part of what Dr. Otis said. especially in regard to the question of marriage. I agree with him that there has been too much said about the harm of the marriage of the tuberculous. That view is subject to modification according to the

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* Dr. Charles L. Minor, of Asheville, North Carolina, read a paper entitled "The Question of Rest or Exercise in the Treatment of Pulmonary Tuberculosis." No manuscript was furnished for the TRANSACTIONS. These two papers were discussed together.

kind of case, but I am satisfied that we have been too strict in our opinion on that subject. The psychic effect upon the patients who want to marry, especially young patients, of hope deferred, of being unable to marry whom they wish, is often the very worst possible. In deciding about the advisability of marrying you must consider the effect on the man, the woman, the child, and the community. The community does not suffer, I believe, because the properly handled tuberculous man can propagate a perfectly healthy child; and so can the tuberculous woman, although with greater difficulty. The separation of the child from the mother after birth will make the child grow up free from tuberculosis, although it may have some weakness; and history shows that the world would have been worse off if the tuberculous had always been prevented from marrying, because the offspring of tuberculous marriages have often been brilliant and useful people who have accomplished much good. The eugenists and many of the clergy would prevent the marriage of the tuberculous from a lack of sufficient knowledge of this disease. I think that the circumstances in each individual case should be carefully considered before deciding the question. I have in carefully studied cases allowed marriage, even in the case of tuberculous women, and these women have brought forth healthy children, nor have they during or just after pregnancy gone into acute tuberculosis, which I have often dreaded, and I think that the world is better off and that they are better off from my having allowed a marriage to take place in these cases.

Dr. ROCHESTER: With regard to the marriage of tuberculous people, I think that if we allow them to marry they should be thoroughly instructed concerning the dangers to be encountered. With tuberculous men it is not so serious a question, but I feel strongly about the marriage of tuberculous women. I think that, as a rule, they should not marry and bear children, and I believe that we lose less by forbidding such marriages absolutely than we gain by letting these people marry. Some could marry and bear children without danger to themselves or their children; but, as a rule, they should not do so. We must not consider simply the individual, but the whole problem of the prevention of tuberculosis. It seems to me that the tuberculous women should not be allowed to marry. I want to put that very decidedly. Another thing that I want to speak of in connection with the paper of Dr. Otis relates to his first proposition: "The undue emphasis placed upon physical signs in the early diagnosis propaganda." I think that he is perfectly right, in most cases, that undue emphasis has been placed on physical signs, in cases where they have not been found; but I think that in most cases they have not been found because the physicians who made the examination have not been able to find them, although, with care, they could have done so. The increased frequency of pulse is valuable, but has been omitted largely because we have placed such undue emphasis upon changes in temperature. I believe that the pulse should be considered decidedly—not simply its frequency, but also its character in other respects—in the diagnosis of tuberculosis. Then, too, the presence or absence of cough and such things should be considered, as well as the X-ray examination. A great deal can be learned from the X-ray, and especially the fluoroscopic findings. Regarding exercise and rest, I do not think that I can add anything to what Dr. Minor has said. I consider his views perfectly sound.

Dr. GARDINER : I should also like to speak regarding the paper of Dr. Otis and the question of marriage among the tuberculous. I have had rather an unusual experience in observing the results of such marriages, as I live at Colorado Springs, where we have a large population of persons whose parents were tuberculous before their birth. We have not, however, in studying the children and adults of such unions, seen the amount of tuberculosis among them that one would logically expect; in fact, the exact contrary has proved to be the case. The reason for this is either that the climate has some specific effect in causing immunity to the dangers of tubercular infection, or that the parents, having suffered from tuberculosis themselves, are keenly alive to the dangers of its transmission and therefore take extra precautions with their offspring to see that they have plenty of fresh air and good food. It is a fact that the climate which allows of a life in the open air and encourages children playing out every day in the air would build up a physique better able to withstand infection. There are, I think, other men from Colorado here who can corroborate from their observations what I have said, that marriage among the tuberculous is not always a danger to the offspring in a favourable climate and when proper precautions are taken, although I should not care to be reported as advocating marriages among the tuberculous.

Dr. JAMES A. MILLER (New York City) : I think that the opinions regarding this whole subject brought up by these papers vary considerably according to the point of view of the medical man, whether he is in a sanatorium or a health resort, or has to do with the problems in a large city, and involving, as they do, the early recognition of cases and their management after returning from health resorts. Dr. Otis has touched on some of the most important problems confronting us, and I wish to state my belief that he is right in his contention concerning the over-emphasis put upon the significance of slight physical signs, particularly in our large cities, where, after all, the early diagnosis of tuberculosis is most important, and where the responsibility on the physician is the greatest in this respect. It is our experience in New York, and is becoming more and more the general opinion of those who see most of these cases, that we have registered as tuberculous cases probably hundreds or perhaps thousands of cases in which such a diagnosis is unwarranted from the clinical point of view. There are two bases for this diagnosis. One is the frequent slight variation in physical signs from the normal without any other clinical symptoms of tuberculosis; and the other, the undue and absolutely unwarranted reliance put by many physicians on the tuberculin skin test. We have any number of cases in which the diagnosis has rested solely on the finding of a few crackling râles at one apex in a person who has come to seek advice for another condition. We find among general practitioners, as the result of our insistence upon their responsibility, a fear that they may not find tuberculosis when it is present. I think that we have overdone the thing a little bit. We frequently find that doctors—particularly in our clinics, where the younger men are working—will make a diagnosis of tuberculosis upon insufficient evidence, because they feel afraid that someone else will come along and say that they have not found the disease although it was present. We find that less than 20 per cent. of those cases registered in our clinics in New York have positive sputum. It seems to me that, while not an adequate test, yet, when one considers that it includes all stages of the disease, this small percentage indicates a possibly faulty basis for the positive diagnosis. The second point that I wish to speak of is the question of rest and exercise. I feel in accord with everything that Dr. Minor has said. I believe that it is true, from the standpoint of the resort physician, and that a discriminating physician who watches the cases carefully and has them under control can give more exercise with good results. I also feel, however, very strongly, that his statement that more harm is being done by too much rest than by too much exercise, if put into the hands of general practitioners, may be exceedingly dangerous, and I believe that we should be careful before giving too strongly our approval to the statements regarding the advantages of exercise and the disadvantages of rest. It seems to me that the hardest thing is to get the patients to appreciate what rest is. When we speak of a course of rest treatment for a week or two and then allowing exercise, the line is being drawn too finely. Until a patient has been trained to relax physically and mentally we have not given him a proper course of rest treatment. After that the treatment can be varied. When the patients go back home they usually tend to overdo, unless they have been imbued with the knowledge of what the principles of rest and exercise are, and they are sure to do more than the most careful physician can prevent. Speaking from that point of view, I would say that I think we ought to be very careful before we subscribe, as a whole, to Dr. Minor's point of view, and that in large cities, where the temptations to overdo are so great, we will often get along better by sticking more closely to the rest idea rather than by emphasizing the advantages of exercise.

Dr. Herbert M. King (New York): Regarding the matter of diagnosis, which Dr. Otis brought out, I think that almost everyone who has had any experience in endeavouring to diagnose early tuberculosis will agree with him that in the discussion of the subject an undue emphasis has been laid on physical signs, and far from sufficient attention paid to the history and a careful inquiry into the habits, environmental conditions, occupation, &c., prior to the present illness, in the examination. With regard to marriage, I would say that this is a very amusing as well as interesting subject. It would be more interesting still if our conclusions had any effect, but I have found, in some years' experience, that my advice is never followed unless it happens to be the kind of advice that the patient wants, especially when it is offered concerning a matter affecting the laws of affinity. Unless we can contrive some means in this great free government to institute something more effective in the way of paternalism for controlling the laws of affinity I doubt whether it is going to do much good to attempt to stem this current of marriage among the tuberculous. I do not think that anyone will disagree with the opinion that open tuberculosis cases should be advised not to marry, especially women; but I do not believe that it makes very much difference what our opinion may be, as, however it may be expressed, if it is contrary to the patient's inclinations it will scarcely be followed. The main interest to me in this discussion is the question of therapeutic exercise. I could talk a week on it; the difficulty is to say what I want to about it in five minutes. I do not agree with Dr. Miller. I do not see how anyone who did not want to could misunderstand Dr. Minor's clear statement regarding exercise. No one considers rest for only a week in a case of tuberculosis. Most of us would rather advise rest for three months. The incipient case is an unknown quantity. We all recognize that fact. Dr. Paterson rarely got incipient cases. All were taken from Brompton Hospital, where they had had a longer or shorter period of complete immobilization. In the advanced, the long-standing case, where tuberculosis has existed for a period of years, we always have in the history data that form a good criterion of the patient's ability to stand exercise. I agree with Dr. Minor that walking is the standard exercise, and that all other exercises must be related more or less to the effort expended in walking on a level. The number of patients passing through a sanatorium who are eligible for higher grades of exercise than walking is comparatively small. I think that we have, perhaps, the reputation of using exercise as a therapeutic measure in our institution, and we are often misquoted as to the character of patients placed on exercise and the way that we prescribe the exercise. Those present at the meeting of the National Association last month, who heard the paper of my associate, Dr. Mills, will recall his statement that of practically 900 male patients discharged during a given period only one-third were eligible for treatment by means of therapeutic exercise, and only two-thirds of this one-third really received this form of treatment. In these cases we found, making comparisons as well as we could with cases that had gone through the institution prior to the introduction of this therapy, that in the incipient and moderately advanced cases our results were just about the same in these exercise cases as in the rest cases. In the far-advanced cases, those that proved after experience to be eligible for treatment in this way did much better than the corresponding group that did not receive this form of treatment. It is a valuable therapeutic measure when properly and judiciously employed. Of course, it should be employed only by one familiar with it, like any other specific remedy; and I must think that this is most accurately done at present in an institution by the physician who lives with his patients—in other words, the institutional physician. This treatment serves several purposes. The chief, perhaps, is that by determining the patient's ability to exercise, it determines his capacity for earning his living when he leaves the sanatorium. If he can do five hours' hard manual labour in the institution we know that we can discharge the patient, even with a few râles in his chest and tubercle bacilli in his sputum, and that he will be able to earn his living. It would, however, be criminal neglect to fail to instruct him how not to overdo. Of course, we cannot put brains or intelligence into his head, and a great many patients will overdo however they may be advised.

Dr. William L. Dunn (Asheville, N.C.): It seems to me that it would be unfortunate if it should go out that this Association looks with indifference upon the marriage of the tuberculous. As Dr. King has said, they do not listen to our advice any way; but if the impression were to go out that it met with the approval of an association of this kind, that fact would be an enormous lever for these people to use as an excuse for carrying out their wishes. As to the question of rest and exercise, it seems to me that the patient who is under the physician's care until he returns to his activities should always receive, before he leaves the sanatorium, enough exercise to make the sum total of his exertions equal or exceed the amount demanded after his return to his calling. These patients must return to their original work, in the majority of cases. It is folly to think that they can hope in the later years of their lives to take up an entirely new kind of work. They cannot do it. It is much easier and safer for these people to return to their original occupations. I think that this should be taken into consideration in giving them exercise. What is walking, for instance, going to do in preparing a man to drive sledges? We must consider what the patient has to do and select exercise that will fit him to do it. He must have enough exercise to be able to take up a reasonable amount of work when he does go back. I believe that in the early cases we are prone to make the mistake of thinking that a few weeks of rest will do. It is my impression that the early cases, of all cases, should err, if anything, on the side of extreme caution in taking up exercise. They should be rested, perhaps, beyond the limit. I feel that way myself, because the results in an early case are so different from those in a later case. It is not a mere patching up, but giving results that will last the patient all his life, and it is important to obtain these results when they can be obtained easily. It is more important to rest such patients two months than in the case of later stages of the disease, even though they only need two weeks of rest. Such a patient is not to be discharged as a resting patient, but if he gets a thorough rest-cure at the beginning, and that is followed by the work-cure, he is much more apt to get what is coming to him. The early case usually does not get the attention that the possibilities of his case demand.

Dr. F. M. Pottenger (Los Angeles, Cal.): This whole discussion shows one thing, that absolute instruction cannot be given on any point. The whole subject of the handling of the tuberculous can be summed up by saying that it must be left to the intelligent physician to apply what seems best to the individual patient. This thing of laying down a set rule to fit every case will fail. The question of marriage depends on many things, not the least of which is the social status of the patient. One must give different advice in one case from that given in another. Those working in home cities see things differently from those working at health resorts. Our problems in the west are somewhat different from yours in the east. You emphasize the prevention more than the cure, and we emphasize the cure, because our communities receive so many patients who demand treatment, and because native tuberculosis is not as yet so great a factor with us. Regarding the question of marriage, we must remember that every tuberculous patient has the same desires as other people. Starting with this fact we can moralize and philosophize all we wish. We must recognize the strong desires for home and parenthood, and must sometimes yield in cases in which we may not want to do so, and would not on strictly philosophical grounds. With regard to physical grounds, in the talks that I give to general practitioners I tell them that they should not depend on the physical signs unless they have constant experience in examining the chest; but that if they would take a careful clinical history and then observe the patient daily for a week they should be able to make the diagnosis of probable tuberculosis in nearly every active case. The examination of a chest for early tuberculosis is not simple. It is a difficult proposition, and those who are not working at it constantly are bound to be misled if they depend solely on physical signs. As to what Dr. Miller said about a positive diagnosis being made so often in those who apply to the New York Health Board, I do not think that this will hold good in private practice, particularly in the case of the upper classes. I find that only a small percentage of those in my institution had had the diagnosis made in the incipient stage—less than 5 per cent. They do not have the chance to have the diagnosis made early that the poor have. They do not go to the specialist in the clinic, but to the general practitioner. The general practitioner fears to find that the patients have tuberculosis, and dreads to tell them when he does find out. The patients want to go on with their business, and their physician yields. Those who could get well, because they can afford to have the proper treatment, are not benefiting by early diagnosis and early treatment as they should. With regard to rest and exercise. I think that one of the best things that we can do at first is to put all patients to bed. I put every patient that comes to me in bed for at least a week. By doing this I have shown him that we are going to change things. The first day he tires of it, the second likewise, but at the end of a week he sees the advantage and is ready to co-operate with me. If I let him do what he wishes at first I fail to secure his co-operation. I keep patients in bed more than I used to. One should prepare his patients, before they leave his care, for what they are going to do afterwards. If we are obliged to produce the best results possible in five or six months, when we should take a year or two, we can spend most of this time most profitably in rest treatment; but, before the patients leave, if at all consistent with the patients' condition, we must give them graduated exercises short of the limit of their endurance. I like to have my patients when possible, depending on their general condition, walk five or six miles a day before returning to work, then they do not lose so much when they take up their work.

Dr. Louis Hamman (Baltimore, Md.): I have been much interested in one question that Dr. Otis spoke of, and that is the undue emphasis put on slight apical abnormalities in the physical signs. Some years ago we collected the statistics of patients showing slight apical abnormalities, and we found that, five or six years afterwards, very few of them, although they had lived under the ordinary conditions of life, had developed active tuberculosis. I have been impressed by the frequency with which we find abnormal apical signs in healthy individuals. During the past winter I selected fifty students and young physicians and made a careful physical examination in each case. Dr. Baetjer then took X-ray pictures, and we compared our results. We were surprised to find how many of these robust young men showed apical abnormalities in both examinations. In four or five the physical signs were so obviously altered that if they had had any symptoms of tuberculous infection we would not have hesitated to make a diagnosis of active pulmonary tuberculosis. Of course, it must be emphasized that the question of the importance of the physical signs depends on who makes the examination, and it is necessary to state that in speaking of these slight physical signs we refer to examinations by men with considerable experience in making pulmonary diagnoses. They would not be emphasized by men not engaged particularly in pulmonary work. This over-emphasis has led to two errors. One is an over-estimation of the curability of pulmonary tuberculosis. Patients who have these slight abnormalities figure largely in the favourable results reported from sanatoria. The second error is the impression that if medical skill were sufficiently developed all cases of pulmonary tuberculosis could be discovered in the early stages, and if then properly treated the later stages could be prevented. I think that this view does not correspond with the clinical facts, for in 40 to 50 per cent. of the cases we are justified in saying that they never have an early stage. The disease begins acutely and the patient goes abruptly from a state of perfect health to an advanced stage of the disease.

Dr. GORDON WILSON: Regarding Dr. Otis's first point, I would say that he really discussed two things: the diagnosis of the disease, and the diagnosis of the need of treatment. Some persons having positive reactions have latent tuberculosis and do not require treatment; but, nevertheless, they have disease.

Dr. OTIS (closing): I wish to express my gratitude to the gentlemen who have been kind enough to discuss my paper, and to say, regarding the patient of Dr. Darlington who lost five children from tuberculosis and wished she had died at the operation, that probably if the children had been removed from their mother immediately after birth they would have lived.

Dr. DARLINGTON: Would she have been any happier in that case?

Dr. MINOR (closing): I was surprised at what my friend Dr. Miller said. He began by admitting the truth of what I had said, and then stated that he was afraid of it. I am sure that in his heart he is never afraid of the truth. I realize how cautiously we must talk to the general practitioner, and how plainly and carefully we must explain things to our patients in order to make them understand our meaning; but I feel that the English language is capable of expressing fine shades of meaning, and that we can thus make clear what we are driving at. Since Dr. Miller admits the truth of what I said, I believe that I have the ability in the use of English to make myself understood, but when I publish the paper I shall be very careful of my language, so that those who read it may understand what I wish to say. Dr. Dunn put the matter very clearly. He said that the treatment was a rest-cure plus a work-cure. That is exactly it. What I tried to point out was how to weave the two together and get satisfactory results. Regarding Dr. Otis's point, I would say that I have no doubt that slight physical signs indicate the existence of tuberculosis, although it may not be treatable tuberculosis. That is unquestionably the case. The gentleman who combined X-ray with coincident physical examinations showed that these persons had latent cases of tuberculosis, but which did not need or justify treatment. I hope he spoke to them in such a way as not to scare them to death, but they were tuberculous just the same. They had a tuberculous condition, but not necessarily tuberculous disease.

SUBNORMAL TEMPERATURE IN TUBERCULOSIS.

By ARTHUR K. STONE, M.D.
BOSTON.

The occurrence of persistent subnormal temperatures in tuberculosis cases has attracted my attention for a long time, and I have been in the habit of calling the attention of my students to the fact that at a certain period of the disease, usually succeeding the active febrile stage, there is often a period when the temperature curve shows marked excursions in the subnormal, the temperature at no time rising above 98·6° F., and rarely fully reaching that point. The patients during this period of subnormal temperature are usually improving and making distinct gains, but it takes very little to give them exacerbations of real febrile temperature, lasting for a few hours to a few days. This period of subnormal temperature may last for weeks, the curve becoming less and less irregular if the improvement continues, and finally becoming a continuous straight line at 98·6° F. Until this latter condition is found, I do not allow my patients much more latitude in their movements than I do while in an active febrile stage. Incidentally, I do not like the term subfebrile, often used to denote a range of temperature from normal or 99° to 100° F. In talking to patients, we may feel justified in stating that such ranges are of little importance. If, however, they persist, I believe that they are of the greatest importance, and that it is our duty to find a cause. It may be the part of good practice in a very few cases to ignore such a temperature and to smash the thermometer, and say that no attention is to be paid to slight changes in the body temperature; but I feel that we must be very, very sure that such a procedure is correct, and that we are not deceiving ourselves, as well as our patients, when we say that subfebrile temperatures are of no consequence. To my mind, when there is a constant variation of the temperature from the normal, it means that there is a pathological process going on in the body which we may not be able to account for; that, however, is our ignorance, and not because the patient is in a truly normal condition.

The persistent subnormal temperature has become to me a part of the regular course of a case of tuberculosis that is on the whole progressing favourably. It does not have prognostic value, as a patient may from this stage again become febrile; although, on the whole, the tendency is, under favourable conditions, for the temperature curve to become a practically straight line.

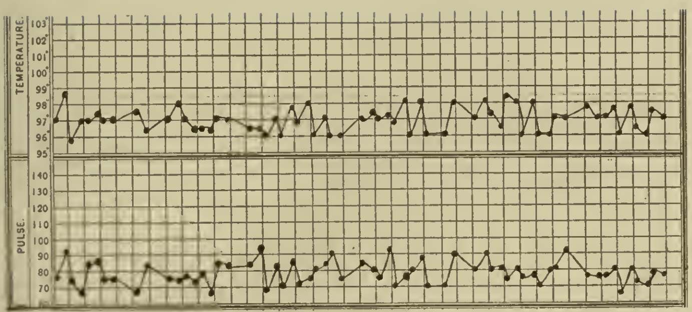
Mild tuberculosis infections frequently show a rapid change from a febrile condition to this subnormal condition. This is graphically exemplified in some charts in a short paper recently (1913) published by Rundle, of England, demonstrating the beneficial effects of tuberculin when the temperature becomes subnormal and remains so, although he calls it "practically normal."

One finds the same condition occurring in tuberculous pleurisy. The fluid is withdrawn or spontaneously disappears; the fever disappears, and is replaced by this subnormal condition. All told, I have come to consider this persistent subnormal temperature so constant an accompaniment of tuberculosis becoming quiescent that it may be considered of diagnostic importance.

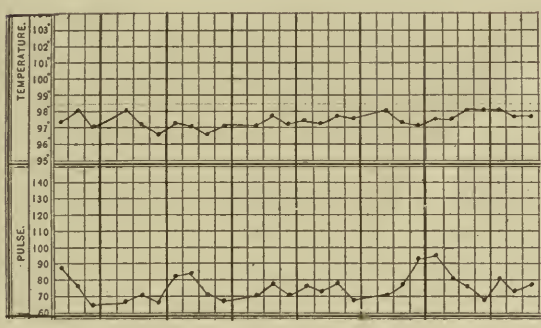
During the past year it has become impressed upon me that these facts which I knew so well were not generally appreciated. I was asked by house officers to explain subnormal temperatures, and received looks of incredulity when I replied that it meant tuberculosis. They rejoined that they thought from their reading that sick cases of tuberculosis always had fever.

Later, a patient whom I saw in consultation gave me the following history: She was an over-worked mother. She had had a "cold" in the spring, which had persisted. For a month or two she had had persistent fever, often over 100° F. Her physician had not been able to demonstrate bacilli or any definite lesion in the lung. After a time the cough had become less, and she had a persistent subnormal temperature, and all the time felt so tired and worn out that she could keep about with difficulty. She had been told that, because of the subnormal temperature, she could not have tuberculosis. Not having tuberculosis she had not stopped and rested, neither had the physician insisted upon rest, as he would have had he made this diagnosis. There was little in the lungs on which to render a diagnosis, but the picture, to my mind, was typical of a mild infection overcome by fair climatic surroundings, with the consequent depressed, physical condition and the manifestation of subnormal temperature which was persisting and calling loudly for further rest to enable the cure to become complete. The persistence of the temperature in the subnormal, to my mind, was the typical thing to be expected, and not the condition to make the case perplexing.

The books on tuberculosis, I find, practically do not mention persistent subnormal temperature as a common symptom to be found in the course of the disease. Pottenger, of course, has made note of the fact. He says (p. 54): "There are types of temperature which persistently remain below normal, 97° to 99° F. [He gives temperature



MORNING AND EVENING CHART.



THREE-HOUR CHART.
Note low pulse rate.

(To face page 68.)

charts to illustrate.] Such cases seem to do well, and, in my experience, I have been unable to account for the condition." Also, in his paper on the "Study of Fever in Tuberculosis," read at Los Angeles in 1911, he states: "The continuously subnormal temperature we associate with both chronic fibroid tuberculosis and chronic tuberculosis of the ulcerative type during the state of quiescence." [Charts.]

These were all the references to subnormal temperature that I had found until Hawes's book, "Early Pulmonary Tuberculosis," appeared, in which he calls attention to the importance of a subnormal temperature combined with a high pulse-rate as very suggestive of a probable diagnosis of tuberculosis. I entirely agree with him that a rapid pulse and the low temperature usually go hand in hand, although a number of my charts show a much lower range for the pulse-rate than he suggests as the usual.

Practically all writers have noted that persons with tuberculosis may have a normal temperature while disclosing signs of activity on physical examination. Also, all have noted the fact that morning subnormal temperatures are common, but they assert that by afternoon the temperature rises to 100° F. or more. In Klebs's handbook Minor points to the diagnostic importance of the persistence of subnormal morning temperature in early cases. Incidentally he has some charts where there are persistent subnormal temperatures, or broken only by occasional rises above normal. Pottenger calls attention to the fact that many persons unfamiliar with the details of the care of tuberculosis patients are frequently alarmed at low subnormal morning temperatures, citing the case of the surgeon who felt he had saved his patients from desperate collapse because he had found a morning temperature of 96° F.

With all of these observations I fully agree, and, further, I wish to emphasize that the continuance of a subnormal temperature, lasting over weeks, is not at all an infrequent condition in the course of improvement in a patient with tuberculosis.

To make sure of the number of cases that occur, I have been over the records of the House of the Good Samaritan since 1907. During that time we have had 378 cases of tuberculosis, many of them being brought there at the very end of life. Many had had steadily progressing disease, and only a few were in a really early stage, or, in spite of advanced progress on entrance, became arrested. Of the 378 cases treated, I found that fifty-eight of them, for two to four weeks at a time, and some several months, ran a subnormal temperature.

At the day camp at the House of the Good Samaritan the patients were for the most part early cases; a large proportion, however, having well-marked signs and bacilli of tuberculosis present. I looked over the first hundred cases treated and found that forty-one had periods of subnormal temperature, several of them showing the condition for several months at a time, others for periods of a couple of weeks broken by periods of fever, for a few days to a week, and again returning to a subnormal range.

The question may be asked: What is a normal temperature, and what do we mean by fever and by subnormal temperature? Is there not a variation in temperature in health that is greater than what we are accustomed to consider as the normal variation? Personally, I do not believe so. The physiologists tell us that there is some variation in temperature in the healthy person. This diurnal swing is usually considered to be confined to about 1° C., being lowest during the early morning hours and highest in the late afternoon. The temperature is stated also to be affected by food and, at times, by exercise.

In order to be sure that the temperatures of patients were persistently subnormal when so appearing on a daily morning and evening chart, I have from time to time had a number of cases tested by having the temperatures verified, by having them taken at three hourly intervals, and later at two hourly intervals, to conform to the strictest requirements which I have found set forth as desirable.

Many times, when I have seen subnormal temperatures registered, I have requested the head nurse to look into the methods of the nurses recording the temperatures, and have been assured that the observations recorded were correct. The subnormal temperatures were found equally in the heat of summer and the cold of winter. On the whole, I am quite sure that so far as the observations go, the maximum subnormal are correct; that the minimum may be occasionally lower than recorded I am not so sure.

Blake's observations on Marathon runners make it seem improbable that the irregularities in temperature which are reported could have been observed in truly normal persons. These Marathon runners showed at the end of their great exercise a rectal temperature of from normal to 99·2° F., and rarely more. My speculation is that many of the so-called normal individuals who have shown marked irregularities of temperature would, on careful examination, have been found to have had tuberculous lesions or some other pathological process which would have accounted for their unstable heat regulation.

However, subsequent investigations shall decide in such cases, for the practical clinical man, when there is no special condition leading to a persistent rise in temperature or to a persistent subnormal temperature. Either of these conditions observed over a long period of time makes the diagnosis of tuberculosis probable.

It has surprised me, since I have been interested in this matter, how few of the conditions where there is general depression were accompanied by subnormal temperature. The most marked, persistent, subnormal temperatures are in my experience, found in mitral disease of the heart, especially stenosis with moderate failure of compensation.

Renal cases of severe enough type to require hospital treatment often show this condition. Cancer in its later stages may or may not; and, in my experience, tired women, and those whom we sometimes call neurasthenics, rarely show the subnormal even during the periods of prolonged rest.

Of the other forms of tuberculosis, tuberculous peritonitis may or may not have subnormal temperature. In the cases I have followed I have not been impressed with its frequency as a special sign to be depended upon in diagnosis.

Cases of bronchiectasis and fibroid phthisis, and cavity formation after non-tubercular infections, all of these interfering with the action of the lung, can give rise to prolonged subnormal conditions; but these are not the cases where this range of temperature comes into active play as a help in diagnosis.

Dr. B. G. R. Williams (of Paris, Ill.) has reported that he had observed a form of "grip" where there was a persistence of temperature of from 94° to 97° F., with marked depression. In the cases usually called "grip" or "influenza," my general experience has been that the return to normal has been moderately rapid. In correspondence with Dr. Williams, he states that he has not noticed so far that the cases in which he has noted sub-normal temperature have developed active tuberculosis.

It goes without saying that in doubtful cases everything must be taken into consideration when one sees his patient and makes his diagnosis. Cardiac and renal conditions must not be allowed to escape notice, and must be surely eliminated before the subnormal temperature alone assumes special importance; and then it must be borne in mind that there is the possibility that convalescence from various bacterial infections may be found to have periods of subnormal temperature which must make us careful in our diagnosis, although, personally, I do not believe that they enter into consideration to any great extent. And I say this, in spite of the statement in Krehl's "Clinical Pathology" that subnormal temperatures are more common than is generally supposed. They are often seen during convalescence from infectious diseases; and in such instances they are generally due to a diminished production of heat with an inefficient heat regulation.

DISCUSSION.

Dr. Minor: All of us, I am sure, are interested in the study of this question of subnormal temperatures in tuberculosis, and in considering it, it struck me that there is, after all, one common causation for these cases, a lowered activity of metabolism. More specifically, there are three things which this subnormal temperature really expresses. The first is inherent weakness in the patient. Extremely weak patients with low vitality usually run, in my experience, a subnormal temperature. The second is over-exertion on the part of the patient. Over-exertion when the patient is well enough for exercise not to produce a rise of temperature thereby is commonly followed by a fall of temperature; and I consider a marked fall after exercise a good indication for a limitation of the amount of exercise. The third thing is very cold weather. Besides the chilling of the face and cheeks caused by extreme cold, these patients very often run a low temperature in cold weather. The temperatures of a whole houseful of patients will all run low during cold weather, just as they will run higher during the hot weather. Then I might mention as a possible cause carelessly taken temperatures, the nurse either leaving the thermometer in the patient's mouth for too short a time or looking at it carelessly, or even taking the temperature out of doors. Broadly speaking, I have always considered a low temperature not as a dangerous prognostic sign, but as a sign that the patient needed further vitalization—either more food or whatever measures would tend to build up the vitality and resistance. Such subnormal temperatures have a distinct prognostic value, although not a very important one, in the indication of lowered vitality. There is one time, however, when prognostically it has great importance, and that is the subnormal temperature which so often appears in formerly febrile cases which are doing badly. This comes from an excessive lowering of the metabolism of the patient *ante-mortem*, and has, of course, the very worst prognostic significance. I am glad that Dr. Stone has brought out the fact that the average medical student does not recognize the diagnostic value of these subnormal temperature readings. In 1908, in a paper that I read before this Society, I expressed the view, now more generally recognized than then, that there is distinct diagnostic value in subnormal readings without any hypernormals accompanying them. In regard to the treatment, I would refer to the excellent effect of whisky in half-ounce doses in cases of subnormal temperature in tuberculosis, although, of course, the real cure of persistent subnormal temperature lies in more food and more control of the vitality.

Dr. George W. Norris (Philadelphia): A class of cases to which Dr. Stone did not allude is that in which we frequently see an early morning subnormal temperature; cases, that is, of essential or constitutional low tension. These patients have a systolic pressure lower than 110 and a diastolic pressure lower than normal, often associated with visceroptosis, either entire or partial. There is a difference of opinion as to whether this class of individuals really constitute a definite pathological condition, or whether we are dealing with an ulterior condition, such as latent tuberculosis. There is also a great difference of opinion as to the value of blood-pressure readings in tuberculous subjects. The Germans hold that they are of very little value, whereas a great many French physicians think that hypotension is a valuable sign in the diagnosis of tuberculosis. Unquestionably, there is a group of individuals with hypotension who have a lack of resistance, and who represent a constitutionally inferior type of individual. There is a low blood-pressure, and also a low morning temperature—often as low as 97° F. Just what these cases are due to we do not know. It has been suggested that there is an unfitness of the whole system that maintains normal blood-pressure. I think that we cannot afford to ignore this class of individuals. They are common. They are poorly nourished, because of visceroptosis, and we may in them suspect tuberculosis, if we do not bear in mind that these cases often occur in patients who do not have tuberculosis at all.

Dr. C. F. Gardiner: I think we should use more care regarding the thermometers that are used in taking the temperature of the tuberculous invalid. Many of our thermometers will be found to be inaccurate. I took occasion, some years ago, to examine all the thermometers used by my patients, and found at least 40 per cent. of them incorrect, and in many instances a great deal of apprehension was caused by this inaccuracy. Also, family characteristics, it seems to me, should be considered. Occasionally we come upon these unusual cases. I remember very well in my practice some years ago, examining a patient who ran an afternoon temperature of 101° F., and he had been told by several prominent physicians that such a continued temperature for months must indicate tuberculosis. A constant loss of flesh from worry seemed to substantiate this fact. I found, however, by accident, that this temperature was due to a family trait, the mother of the patient having a temperature in the afternoon of 100° F., and was a fine specimen of a healthy woman, never having been ill in any way, but apparently the slightest exertion or excitement would elevate the temperature. The patient in this case made a perfect recovery and gained his flesh when told about this family tendency.

Dr. GORDON WILSON (Baltimore, Md.): I have been studying the cases of broken compensation which so constantly show subnormal temperature, and have found in them the diastolic pressure to be low. As the diastolic pressure comes up, the temperature comes up to normal also. In tubercular cases I have found it the same. The diastolic pressure may be below 70, and as the diastolic pressure comes up to normal so does the temperature.

Dr. JAMES A. MILLER (New York City): I think that it would be well to go slowly with regard to drawing definite conclusions from temperature observations. That point has already been brought out in the discussion. Many conditions may give a prolonged low temperature, just as many give an abnormally high temperature. We need some more careful observations of the normal temperature under varying conditions of life. In connection with Dr. Lee, of Columbia University, I have had an opportunity to study variations of temperature accurately observed. In conjunction with the New York State Ventilation Commission, we have installed constant-reading thermometers, which can be worn rectally over a long period of time. They are connected with an electric galvanometer, to record the temperature. We are using these in persons subjected to various conditions of environment, atmosphere, exercise, &c. We feel that it is important to really get more accurate information from observations of this character rather than to rely on less accurate observations of both rectal and mouth temperatures. Until we have studied the whole question of the possibility of variations in temperature under normal conditions we should be very careful in drawing definite conclusions from the temperature range alone.

Dr. CLEAVELAND FLOYD (Boston, Mass.): I want to refer to the statement made regarding the value of taking rectal and mouth temperatures at the same time. I have seen some striking results from this method. In a number of patients, who were taking graduated exercises, I have gotten almost invariably a subnormal temperature following exercise when taken by mouth. The rectal temperature would start at three or four degrees above and gradually decline toward normal; then, following rest, the subnormal mouth temperature would rise to normal, and the rectal temperature would come down to normal, the two coming together. In this way we could get a pretty accurate idea of the reaction of the patient to exercise.

Dr. EDSON: I agree with Dr. Stone in considering that there is much of clinical importance in the temperature to be considered in the management of our cases of tuberculosis. The fundamental basis of the normal physiology of temperature, and its pathologic disturbance, is not wholly worked out, and until this has been done we should be careful in drawing conclusions. Nevertheless, in the clinical care of patients, temperature curves such as Dr. Stone has called attention to are important; and many physicians do not appreciate sufficiently the attention that should be given to the indications offered by the temperature. It has seemed to me that there are clinically two types of subnormal temperature: one which is perhaps most closely described by the title of Dr. Stone's paper, "Continuous Subnormal Temperature," in which the daily range is very slight, being a little subnormal—97.5° to 98° F., in the morning and 98° to 98.2° F. in the afternoon. This, especially if it be a rectal temperature, is a valuable sign. The other type of case is one in which, while the afternoon temperature is but slightly above normal—possibly 99° F.—the morning temperature is found to be very low—97° F.—so that the daily variation of temperature is marked, amounting to, perhaps, two degrees. This type corresponds to those of the ordinary reaction, with a normal morning temperature, and an afternoon temperature of 100° F. It is in this type that the clinical resistance is particularly low, and in which rest in bed is fully as important as if the afternoon temperature were 100° or 101° F. It is in this type, I think, that the blood-pressure tends to be of the low, diastolic type. As the patients improve the blood-pressure rises, and the afternoon temperatures fall with a return of the morning temperature to a more nearly normal elevation.

Dr. MINOR: May I say a word more regarding what Dr. Gardiner has said? I had six dozen clinical thermometers with nearly perfect certificates from the makers. Suspecting their accuracy, I sent them to the Government Bureau of Standards at Washington and had them tested, and one-sixth of the number were rejected for errors of more than $\frac{2}{10}$° F. Therefore, it is important to insist that all clinical thermometers be tested at Washington, and not at the factories of their makers. Regarding the figures that Dr. Edson quoted, I would say that Wünderlich, who is the great authority on medical thermometry, sets the range of normal temperature between 97.8° F. in the morning and 99.2° F. in the afternoon. The latter cannot be called a temperature except in exceptional cases.

Dr. W. D. ROBINSON (Philadelphia, Pa.): I think that it would be wise for us to be sure that there is no pathological process in the lower bowel when the temperature is taken by the rectum. It is possible to have a low-grade pathological process there which will influence the temperature; therefore it is important to see that this is not the case.

Dr. STONE (closing the discussion): I simply want to emphasize the fact that subnormal temperatures are very common in the course of tuberculosis. The cause I do not know. It may be due to lowered metabolism, whatever that is, as Dr. Minor says. I asked Professor Benedict, of the Carnegie Laboratory, at Washington, and he said that he knew nothing about it. I shall be glad to get absolute data from Dr. Miller and his work. The gentleman from Illinois (?) in his case of grippe, agreed with Dr. Minor in saying that whisky was the only thing that brought up the temperature.

THE POTTERY INDUSTRY AND ITS RELATION TO TUBERCULOSIS.

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THAT there is a growing interest in regard to the effect which occupation may have on the health of the working men and women of this country is evidenced by the numerous laws relating to industrial hygiene which are being introduced yearly in the various State Legislatures. If, however, we except the successful crusades which have been waged against lead and phosphorus poisoning, most of the remedial legislation has been directed towards the minimizing of accidents, and very little has been done towards correcting evils which have a remote rather than an immediate evil effect on the health of the worker.

Within the past year or so twenty-one potters employed in the several manufacturing establishments at Trenton, New Jersey, have been sent to the White Haven Sanatorium by the local Union of the National Brotherhood of Operative Potters. My interest in the occupation was aroused, partly because a number of these men were assigned to my service, and partly because of the fact that, as a group, the manifestations of their disease differed somewhat from those encountered in other patients, who had much less involvement of the lungs.

Etiology.—The manufacture of pottery in the United States is largely centralized in two places, namely, Trenton, New Jersey, at which place the manufacture of sanitary ware is the chief product, and East Liverpool, Ohio, where the major part of the output is confined to white ware. These two cities represented 41 per cent. of the total value of pottery products for the United States in 1909.

The total number of people employed in the pottery industry of this country is about 16,000, and approximately 5,000 of this number live in Trenton, New Jersey. (Mortality Statistics, Tenth Annual Report, Census, 1909.)

The term "potter" is a very comprehensive one, and is ordinarily understood to mean any workman employed in a pottery. It is to be borne in mind, however, that the occupation is one "having many departments, between several of which no common characteristics can be said to exist. This holds true of the two principal departments, viz., (1) the making of articles from potter's clay, and (2) their ornamentation by painting and gilding." (Arlidge, "Hygiene and Diseases of Occupation," 1892.)

A brief description of the process of the manufacture of earthenware is essential to a correct understanding of the risks to which the working men are exposed.

The initial process consists in mixing the clay with ground flint and water. This is very dusty work, but requires only a few men. Formerly the mixing was done by hand; at the present time machinery is almost universally employed. After the mixing process is completed the resulting product, known as "slip," is passed through sieves, at high pressure, in order to expel as much of the water as possible.

The wet clay is then ready to be shaped into various articles, such as plates, cups, pitchers, &c., and sanitary ware. The men employed in the fashioning of articles by hand are known as pressers. Those making flat articles, such as plates, are known as jigger-men. The pressers are more skilled, as they fashion the hollow-ware, such as cups, pitchers, &c., by hand, while the jigger-men make plates and other flat ware by machine. Both are exposed to the dust which arises from the lumps of wet clay which fall about them, and eventually become dried out and pulverized. Most of the sanitary ware is made from moulds composed of plaster of Paris; the dust from the latter being added to the clay dust.

After the various articles have been made from the wet clay they are set aside to dry out. The surfaces of the articles when dry are always more or less rough and uneven to the touch, and this roughness is removed by placing the hollow-ware on a lathe and the flat objects on a rapidly revolving disk, and rubbing them with tow and flannel. This completes the work of the pressers and jigger-men, and is known as "towing." After the required smoothness is obtained the ware is ready for the kiln.

The first firing is known as "biscuiting." The ware to be fired is placed in large thick-walled vessels, much the shape of a large cheese, and made of coarse clay. These vessels are known as "saggers." Into these the ware to be fired is placed, the different pieces being separated from each other and packed about with ground flint dust. This dust is pure white, very gritty to the feel, and when inhaled is very irritating. Because of its irritating qualities, manufacturers have tried, at different times, various substitutes. Nothing, however, has as yet been discovered which can replace the flint, for the reason that all the materials tried contain impurities. These impurities, by reason of the high temperature to which the ware is subjected in the kiln (1,800° F. to 2,000° F.), are driven into the ware and thus ruin it, because the stains cannot be removed or concealed.

After the ware to be fired is placed in the "saggers" the latter are placed in the kiln and are built up tier upon tier until the kiln is filled. In addition to exposure to the flint dust the men who handle the "saggers" are exposed to alternating heat and cold from passing from the outside to the interior of the ovens, if recently heated. In addition there may be some sulphur fumes.

In the absence of precautions a tremendous amount of dust is present in the air of the workrooms. Lemaistre (quoted by Oliver in "Dangerous Trades"), from an analysis of the air in the Limoges potteries, found the air in some of the workshops to be composed of earthy particles, fragments of granite, flint, particles of dried glaze, soot and wood charcoal. The atmosphere in which the porcelain makers generally worked was found to contain 640,000,000 particles of dust to the cubic metre.

After the first firing or biscuiting the ware is ready to be glazed, and, in the case of articles which are ornamented, to be painted or imprinted by coloured transfers. The ware is then ready for a second firing, which is carried out as in the first instance.

The final process consists in chipping off the uneven projections on the under side of the plates, cups, &c. The ware is then sorted, and is ready to be packed in barrels as required for shipment.

While the question of lead poisoning does not belong properly to the subject matter of this paper, some mention of it is necessary for a complete understanding of the subject. After the first firing the fired clay or biscuited ware is dipped into a liquid mixture containing lead (15 per cent.). This process is known as glazing, and the men who perform the work are called "dippers." In carrying out this process the worker has both hands and forearms immersed in the liquid almost constantly throughout the working day.

After the ware has been dipped in the glazing fluid it is set aside in a drying room until it dries, usually a matter of twenty-four hours. During this time a certain amount of the liquid drips off and rapidly dries.

For many years it was thought that the dippers were poisoned by the lead because of having their hands and arms immersed in the glazing fluid. It is now known that there is no absorption through the skin, but that the real danger lies in the swallowing of dust containing lead. So long as the glazing material is in a liquid state or the dried material is not broken up into fine dust, there seems to be no danger, if, in addition, the workman is cleanly about his person.

Although lead poisoning is still unduly prevalent among the English potters it seems to have been eliminated entirely among the American workmen. This has been accomplished by the simplest of precautions. Not only is the dipper cleanly as to his personal habits, but in addition two rooms are used for the freshly glazed ware which is being dried. Before a room which has contained the freshly glazed ware is used a second time it is flushed out with a hose, and, furthermore, no one is allowed to walk about in the room and break up the dried glazing material on the floor.

Several of the dippers to whom I talked had been employed in this branch of the work for over twenty years without any ill-effects. From them I also learned that in former years it was the belief among the workmen exposed to the danger of lead that poisoning could be prevented if they got sufficiently drunk every Saturday night to bring on vomiting. This they thought eliminated any lead that might have accumulated during the week.

The following table shows the different departments in which the twenty-one workers were employed :—

Presser	8
Dishmaker (" jigger-man ")	4
Kilnman	3
Dipper	1
Foreman (formerly mouldmaker)	1
Labourer	2
Unknown	2
Total	21

In addition to the working environment other etiological factors undoubtedly play a part in producing ill-health among these workers. In former times the bad hygienic conditions prevalent among the English potters unquestionably had a strong determining influence in the production of disease. The marked reduction in both the mortality and morbidity rates among English potters is probably due in part to improved living conditions. Arlidge (paper presented at the Social Congress, Leeds, October, 1871), the leading authority on the diseases met with in potters, in a paper contributed nearly fifty years ago, ascribed much of the high incidence of respiratory diseases among the potters of North Staffordshire, England, to the damp climate, unhealthy shops and habitations, defective sewage disposal and drainage, improper diet and vicious habits.

G. Calvert Holland (" Diseases of the Lungs from Mechanical Causes "), in a monograph on the respiratory diseases encountered among the employees of the various cutlery establishments at Sheffield, England, also emphasizes the influence of poverty, drinking and poor sanitation. In his opinion there is a distinct relation between intelligence and the duration of life. In other words, the workman with intelligence enough to protect himself during the actual conduct of his work, and who, in addition, will observe the ordinary rules of hygienic living at home, will counteract the risks of his employment much better than the careless or ignorant workman.

In this connection I might mention that in a recent visit to the Trenton potteries I saw several men who had contracted tuberculosis from two to three years ago. After their return from the sanatorium, with their disease arrested, they had returned to the pottery and had continued well. This could probably be ascribed to two causes: first, they took the best of care of themselves outside of working hours; and, secondly, they were extremely clean in the performance of their work.

While I have no personal knowledge of the home hygiene of the workers I had under observation, it is somewhat significant that eight of the twenty-one admitted the excessive use of alcohol.

The relationship which exists between wages and ill-health is one of the burning questions of the day, and there are not a few who believe that an adequate wage will eliminate much of the ill-health associated with many industries. In regard to this industry, however, such is not the case. The employees most exposed to the dust are, as a rule, skilled workers who command a good wage. Of the twenty-one men included in this report, seventeen were skilled workers capable of making from twenty-five to forty dollars per week prior to the onset of ill-health.

The Secretary of the Potters' Union at Trenton informed me that so far as could be judged from reports from other unions throughout the country, there existed at the present time among the 16,000 potters from 115 to 120 cases of tuberculosis.

Pathology.—The pathological changes induced by dust of various kinds depends to some extent on the intensity of the irritation set up. Exposure to almost any kind of dust, even for a short time, is apt to irritate the respiratory tract and produce coughing. This may become a true bronchitis if the exposure is sufficiently long. Between simple irritation, as the result of a brief exposure, and extensive tissue changes, as the result of prolonged exposure, varying degrees of pathological alteration may occur.

The histological changes which occur in the lungs from prolonged exposure to coal dust have been studied by Wainwright and Nichols (*American Journal of Medical Sciences*, 1905, vol. cxxx). Inasmuch as the prolonged inhalation of any form of inorganic dust tends towards the same end, namely, the production of pulmonary fibrosis, the changes described by these authors, as occurring in anthracosis, are applicable to other forms of dust.

Clay and flint both contain very hard, sharp, angular particles of silex, which when drawn into the respiratory tract during inhalation are not dissolved by the bronchial secretions, but are deposited in the alveoli and smallest bronchi. For a varying length of time the inhaled dust is arrested in its advance partly by the mucous secretion in the bronchial tubes and partly by the ciliated epithelium lining the tubes. Sooner or later, however, these defensive forces weaken, and finally the dust passes into the lymph channels, and also along the finer bronchi, until it reaches the parenchyma of the lungs. As a foreign substance it then sets up a chronic inflammatory process.

Wainwright and Nichols describe the changes which the deposit of coal dust produces as follows: (1) In the case of those who have worked in the coal mines but a few months some of the epithelial cells lining the alveoli become swollen and contain particles of coal dust. Sometimes a few larger desquamated cells containing much pigment are found in the alveoli lying loose with some detritus and free dust particles. Even in this early stage dust particles are seen in the walls of the air vesicles and around the small bronchi. In this first stage there is no evidence of connective tissue proliferation.

(2) In those who have worked in the mines for several years the swollen epithelial cells containing dust particles are much more numerous. The alveoli also contain more detritus consisting of swollen, dust-bearing epithelial cells, free dust and some leucocytes. At this time evidences of connective tissue proliferation become apparent. The pigment in the walls of the air vesicles becomes more marked and collects particularly in the connective tissue septa between the lobules, where it is in such large masses as to be easily seen by the naked eye in the microscopic sections. These masses are especially well seen in the septa that run in from the pleura. In places considerable sized black triangles are seen with their bases on the pleura, showing where some septum has been completely filled up with dust. With this deposit there occurs an increase in the connective tissue of the alveolar septa. The inter-lobular septa thicken, as does also the peribronchial connective tissue, as here also the dust tends to collect. [The gradual evolution of the process is apparent from a study of a potter's lung made by Wilson Fox ("Diseases of the Lungs and Pleura," 1891, p. 494). In the specimen described by him there were numerous round granulations varying in size from a pea to a millet seed, almost entirely composed of deeply pigmented fibrous tissue. Some of the older granulations were entirely converted into fibrous tissue having a concentric arrangement, but solid in the centre, the pigment being also more or less concentrically arranged. In others, apparently more recent, there was a central part strongly resembling a bronchiole surrounded by a concentrically arranged fibrous tissue, between which, and possibly contained in fusiform cells, there was abundant black pigment in a finely granular form. The tendency of the dust to collect in masses at individual points is especially noticeable in the lungs of porcelain makers. According to Oliver ("Dangerous

Trades "), small chalk-like masses are often found in the lungs, and to the uninitiated may be confounded with cretaceous tubercles.]

In this second stage the bronchial and mediastinal lymph nodes become enlarged. As a result of exposure to almost any dust the bronchial lymph nodes are black, and in the case of coal miners, intensely so. The nodes in the lesser omentum are also frequently pigmented from dust swollen in the saliva. The connective tissue changes in this stage are hardly ever sufficient to give signs of consolidation.

(3) It has long been recognized that the progress of the respiratory disorders incident to the inhalation of irritant dust may be arrested if the individual will seek some other employment. The reason for this is apparent from the observations of Wainwright and Nichols. They found that in the case of individuals who had formerly been miners, but who for many years had not followed that occupation, the lungs no longer showed signs of irritation. The swollen epithelium had subsided and again become normal, and neither the cells nor the alveoli contained dust. The deposits of dust in the alveolar walls, the septa and the peribronchial tissue, however, still remained, as did also the connective tissue thickening.

The gross changes are briefly as follows: The first change noted is in the upper respiratory tract and occurs in the form of a pharyngitis which commonly persists; ten of the twenty-one cases reported in this paper had congestion of the pharyngeal mucosa. At this stage there may be some cough of a dry, hacking character. This is often the result of a tracheitis. Gradually the process extends downwards, producing a bronchitis which sooner or later becomes chronic in nature. At this stage the lung begins to show the evidence of fibroid changes. Furthermore, as the result of the chronic bronchitis varying degrees of emphysema develop, and we have the condition commonly known as miner's or potter's asthma.

As the fibrosis increases there is added to the picture dilatation of the bronchi. The dilatation of the bronchi is rarely sacular, but, as a rule, cylindrical, and the bronchi are pretty generally involved. The dilatation of the bronchi results partly as the result of the loss of elasticity in the bronchial wall and partly as the result of the chronic inflammatory condition of the bronchial mucosa which tends to weaken the wall. The bronchi, having lost their elasticity and, in addition, being weakened, are therefore apt to dilate to a greater or lesser extent from the strain put upon them by the cough.

The fibroid changes which occur as the result of dust are bilateral and fairly evenly distributed throughout both lungs. Partly because of this, and partly because of the associated emphysema, the marked chest deformity which characterizes unilateral massive fibrosis does not occur.

According to Oliver, the dust is apt to attack first the posterior and inferior portions of the lungs rather than the apices.

The relationship which exists between the inhalation of dust and tuberculosis is an interesting one, and the belief that dust has a strong predisposing effect in producing pulmonary tuberculosis is pretty generally accepted. Mortality returns for years have shown that the death-rate among potters is excessive from respiratory disorders, particularly tuberculosis. Hoffman (*Bulletin of the Bureau of Labour,* No. 79, November, 1908) states that the experience of the Prudential Insurance Company for the years 1897 to 1906 shows that out of 384 deaths among potters, 127, or 33·1 per cent., were from tuberculosis, and that the rate was excessive from all ages. In addition, there were fifty-seven deaths from respiratory disorders other than consumption.

The Tenth Annual Report of the United States Census records 136 deaths among potters, of which forty-seven were due to pulmonary tuberculosis, a percentage of 28·9. In Trenton, New Jersey, for the year 1911 there were fifty-eight deaths among potters from all causes, and of this number twenty, or 34·4 per cent., were due to pulmonary tuberculosis.

At first sight these figures seem to point conclusively to the fact that the death-rate from tuberculosis is excessive among potters. When we recall, however, the changes which are produced in the lung by reason of the inhalation of inorganic dust, it is evident that the process is in the beginning a non-tuberculous fibrosis of the lungs. Furthermore, it is well known that the symptoms and physical signs produced by such changes are somewhat similar to those met with in tuberculosis. It seems quite likely, therefore, that in not a few instances it has been assumed that the process was tuberculous, and death was ascribed to this cause, without an examination of the sputum having been made to determine the true nature of the disorder. Tatham (Oliver's "Dangerous Trades"), in commenting on this aspect of the question, states that: "Potters succumb to non-tubercular disease of the lungs much more rapidly than they do to tubercular phthisis, and it is certain that much of the so-called potters' phthisis ought properly to be termed cirrhosis of the lung. Deaths from this affection should never be included under the head of phthisis, which term is now restricted by universal consent to the tubercular malady of that name." One of the patients whom I had under observation was of this type. He had extensive pulmonary damage and all the symptoms of tuberculosis, and yet a number of sputum examinations were negative.

On the other hand it is to be borne in mind that the cause of death in cases of this type is not infrequently given as being due to chronic bronchitis, emphysema, pleurisy, &c. This might possibly equalize the error.

There is still another factor to be considered, namely, the effect of an antecedent fibrosis of the lungs. It is well known that the stimulation of connective tissue growth is the way in which Nature overcomes tuberculosis. Therefore, anything which stimulates such a growth in the lungs should aid in preventing the tubercle bacilli from getting a foothold, or in overcoming or retarding their growth if they become established in the pulmonary tissue. This is the view held by Wainwright and Nichols, who found that true tuberculosis was not a frequent finding among coal miners, but that extensive fibroid changes in the lungs, as the result of coal dust, was exceedingly common. The protecting influence, in their opinion, was the fibroid tissue and not the coal dust itself; the latter having been held by some to have germicidal qualities.

While potters are not freed from the danger of becoming tuberculous by reason of the fibrosis which is produced incidental to the inhalation of clay and flint dust, it seems reasonably certain that the fibrosis does tend to retard the progress of the tuberculous infection. Thus it has long been recognized that the age period at which potters succumb to the disease is far beyond the average, and, in addition, so far as my observation goes, the disease seems to be much less severe than the same amount of damage produced in other classes of patients.

Most of the available statistics on the subject support this view. Thus the English mortality statistics for the three years ending 1902 (Supplement to the Sixty-fifth Annual Report of the Registrar-General) states that the mortality of potters between the ages of 20 to 35 falls below that of occupied and retired males generally. At every other age period, however, it shows an excess which amounts to no less than 74 per cent. at ages 45 to 55 years, and to 66 per cent. at ages 55 to 65 years. The principal excess falls under the head of respiratory diseases. The following tables serve to indicate this point :—

(I) Proportionate mortality from consumption among potters, 1897 to 1906, compared with that of all males in the registration area of the United States, 1900 to 1906, by age groups. (Experience of Prudential Insurance Company, Hoffman, *Bulletin of the Bureau of Labour*, No. 79, November, 1908.)

Age at death	Death of potters, 1897 to 1906, due to		Percentage of deaths due to tuberculosis among	
	All causes	Tuberculosis	Potters	Males in registration area, 1900-1906
15 to 24 years ...	46	11	23·9	27·8
25 to 34 ,, ...	68	36	52·9	31·3
35 to 44 ,, ...	84	37	44·0	23·6
45 to 54 ,, ...	78	22	28·2	15·0
55 to 64 ,, ..	72	14	19·4	8·1
65 years or over ...	36	7	19·4	2·7
Total ..	384	127	33·1	

(II) From the Annual Report of the New Jersey State Board of Health for the year 1911 :—

Age	Number of deaths from tuberculosis among potters
15 to 20 years	1
20 to 30 ,, ...	5
30 to 40 ,, ...	4
40 to 50 ,, ...	4
50 to 60 ,, ...	4
60 to 70 ,, ...	2
Total ...	20

(III) Ages of patients included in present Report :—

15 to 19 years	1
20 to 24 ,, ...	1
25 to 29 ,, ...	5
30 to 34 ,, ...	1
35 to 39 ,, ...	4
40 to 44 ,, ...	5
45 to 49 ,, ...	1
50 to 54 ,, ...	3
Total ...	21

If we consider the length of time the men have been employed in the trade, it is evident that the tuberculous infection is engrafted on the fibroid process very late, or, in view of what has already been pointed out, that the tuberculous process, if an early manifestation, has been kept in abeyance. The tuberculosis finally gains the upper hand, because the general resistance has been reduced by the primary trouble, plus certain habits of the individual to which we have previously alluded, namely, poor sanitation and dissipation.

The following table indicates the length of time the twenty-one cases I have had under observation worked in the trade :—

Under 10 years	10-19	20-29	30-39	Over 40 years
2	8	6	3	2

From this it is seen that only two worked at the trade for less than ten years. The length of time the men worked in the pottery ranged from two to forty-two years, and the average for the twenty-one was twenty-one and seven-tenths years.

Symptoms and Physical Signs.—Pulmonary disease as the result of inhaling irritating dust may manifest itself in three forms : (1) as ordinary tuberculosis, either acute or chronic; (2) as a general fibrosis of the lungs; and (3) a mixed form in which a tuberculous process is engrafted sooner or later upon the fibroid condition.

When tuberculosis occurs in a potter who has but recently entered the trade, or who at least has not followed the trade for a time sufficiently long to produce fibrosis of the lungs, the symptoms and course of the disease differ in no particular from those encountered under ordinary circumstances.

Fibrosis of the lungs is sometimes referred to either as fibroid phthisis, or when the cause of the fibrosis is due to dust, as pneumoconiosis. The latter term, which is general, may be modified still further by indicating the character of the dust, as chalicosis when due to flint dust, anthracosis when due to coal dust, &c. Among the working men themselves such names as miner's asthma, grinder's rot, potter's rot or potter's asthma, are prevalent.

Fibrosis of the lungs is always slow in developing. As has already been indicated in the pathology of the process, it is a chronic inflammatory reaction taking place around many minute foci of dust, and which, as time goes on, tend to coalesce and involve larger and larger areas of pulmonary tissue.

In the beginning little or no inconvenience is experienced from the inhalation of dust. The first thing to be noticed is a slight irritation in, and a desire to clear, the throat. Next a slight cough develops, which may occur in the morning only. Later some blackish viscid mucus appears after the cough. As the process advances the cough and expectoration become more and more marked. Examination of the lungs at this stage will show the evidences of chronic bronchitis, and some emphysema. Physical signs indicative of consolidation are rarely met with at this time, although they may occur.

At some period, rarely less than ten years, and not infrequently more than twenty, of continuous employment, the worker begins to experience some tightness in the chest, the breathing gets shorter and shorter, and finally the disturbed lung function becomes so pronounced as to render the victim less and less capable of exertion. In spite of this condition, however, the general health may be but little impaired, and unless the dyspnœa be too great, the patient may not be compelled to cease work.

By this time the fibroid changes in the lungs have become extensive, although the physical signs may indicate nothing more than a diffuse chronic bronchitis. There is quite likely to be added to the picture, however, evidences of bronchiectasis. Cavity signs may be present, commonly in the region of the angle of the scapula, and when they are a diagnosis of tuberculosis is usually made. Marked clubbing of the fingers and the expectoration of large quantities of sputum, sometimes of a foul odour, are also strongly suggestive of bronchiectasis.

The distinguishing feature of general fibrosis of the lungs is the contrast between the extensive pulmonary lesions and the absence of marked constitutional symptoms. "Herein fibroid phthisis presents a well-marked difference from pulmonary tuberculosis; and even if, as we have said, the disease becomes complicated with tubercle, yet the rate of progress may be determined rather by the character of the primary than of the secondary disease, though usually the supervention of tubercle hastens the sufferer into a more rapid consumption." ("Report of British Departmental Committee on Compensation for Industrial Diseases," 1906, p. 13.)

With one exception the cases I have observed belonged to the class in which tuberculosis was apparently engrafted upon a fibroid process. The initial symptoms in these patients were apparently trivial, and the duration of their disease, as given by the patients themselves, was as follows :—

Under 1 year	9
1 to 2 years	9
4 to 5 ,, ...	3
Total ...	21

Contrasted with the length of time they were ill, it is interesting to note the stage of the disease as judged from the signs indicative of pulmonary damage :—

Incipient	1
Moderately advanced	3
Advanced	16
Non-tuberculous	1
Total	21

During the time they were under observation (from two weeks to six months and longer) fever was absent in four; in fourteen the temperature did not exceed 100° F., and in three temperature range was above 100° F. Tubercle bacilli were found in fifteen; in five the sputum was negative, but only one of these had repeated examinations. The remaining four had but a single specimen examined, and for this reason one cannot be certain that they were not actually tuberculous. One case had no sputum.

Dyspnœa was pronounced in fourteen of the twenty-one.

Loss of weight had occurred in all but one.

Marked clubbing of the fingers and curving of the nails were noted in ten of the twenty-one.

Finally, it is to be noted that, with two or three exceptions, these patients did not impress one as being very ill, even those who had slight persistent fever every afternoon.

Prevention.—As has already been stated, the improvements which have been made in the process of pottery manufacture have led to a reduction in both the morbidity and mortality rates of those following this occupation. This is especially true in regard to lead poisoning, which has practically disappeared among American potters.

The dust problem, however, has not as yet been completely solved. The dust which is most feared by the potters themselves is the flint dust used in packing the clay ware for firing, and entering to a slight extent into the composition of the raw material. The danger from this source could be greatly minimized if the "saggers" were packed and unpacked under exhaust hoods, which would remove the dust that is stirred up in this process. In addition, there should be devised some better method of delivering the flint dust from the storehouse. As it is, the dust is carried by the workmen in uncovered boxes and small amounts are apt to be spilled in transit.

"Towing," or the removal of the rough surfaces from the dried clay ware, could also be rendered safer if the work were performed under an exhaust hood. Oliver states that the dust difficulty in this process "can to a large extent be got over by finishing the ware in the 'green' condition." In some of the French potteries the slightly moist ware is smoothed with paper before being heated.

The most difficult problem is to prevent the accumulation of the dust which comes from the small fragments of wet clay thrown off in the process of fashioning the various articles. At the present time the major portion is removed by sweeping out the rooms after work hours. Oliver contends that much can be done by means of improved ventilation, and that in addition to open windows, fans and strong aspirating draughts must be provided.

It is not to be forgotten that the workman himself has a very important part to play in the prevention of disease incident to this occupation. Not a little of the danger from the dust could be eliminated if the workmen made frequent changes of their working clothes. As a rule, the men wear their working garb for an indefinite period, and as a result the meshes of their aprons and shirts become filled with the clay. The movements incident to their work are constantly releasing some of this fine, impervious dust, and in this way much is inhaled which ordinary cleanliness would prevent. A covering for the head could also be used to advantage.

My own observations have led me to believe that more care could be exercised on the part of the workman in the disposal of the fragments of clay which are thrown off in the fashioning of the various utensils. Too much of it is allowed to fall on the floor about the work bench, and as a result is walked upon and quickly pulverized into dust.

Face masks have been repeatedly advocated, but have never been particularly successful for the reason that the workmen are averse to using them.

Because of the fact that the respiratory disorders of potters are extremely slow in their evolution, and because it is known that removal from the occupation will check the progress of the trouble, the individuals who follow this trade, especially those working in the dusty departments, should be subject to frequent medical inspections. A compulsory medical examination three or four times a year would undoubtedly result in detecting many cases which otherwise would pass into the terminal stages of potter's asthma or tuberculosis.

Finally, the life of the workman outside of his hours of employment plays a part which cannot be ignored in estimating the various factors which bring about ill-health.

In this occupation, as in many others, it is well to remember that in the badly ventilated state of one factory compared with another, the home life and surroundings of the workpeople, poverty, heredity, age and sex, are to be found conditions that favour the production of ill-health, and therefore not to be ignored. Usually it is a gradual deterioration of health that is produced. There is nothing of the nature of an acute illness in industrial disease comparable with an accident, except possibly anthrax. (Oliver's "Dangerous Trades.")

DISCUSSION.

Dr. B. R. SHURLY (Detroit, Mich.): I should like to ask whether the potters use any protection, or whether the use of it has been advocated.

Dr. ANDERS: I have seen a great many cases of so-called miner's asthma in which the sequence of events, pathologically speaking, was as Dr. Landis has stated, and in one instance, at least, the condition went on to actual cavity formation; yet no tubercle bacilli were found in the sputum. No matter how extensive the lesions present, the diagnosis of tuberculosis cannot be made without the presence of the tubercle bacillus in the sputum.

Dr. LANDIS (closing): Face masks have been advocated, and have been repeatedly advised, but they have never been successful, because it was hard to get the men to wear them.

THE COMPARATIVE VALUES OF THE VON PIRQUET AND THE SUBCUTANEOUS TUBERCULIN TESTS IN THE DIAGNOSIS OF PULMONARY TUBERCULOSIS IN THE ADULT.

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When a normal animal is inoculated with a certain definite quantity of an extract of a bacterium it can readily withstand any effects of such inoculation. If a similar quantity is injected into an animal previously infected with the same bacterium, dangerous symptoms will appear, and if the dose be large enough, death will likely follow. This is called an aggressin experiment.

If a number of tuberculous guinea-pigs and a number of normal ones as controls are injected with varying doses of tuberculin, after twenty-four hours some of the tuberculous animals will be dead, others will be very ill, while the normal guinea-pigs will remain perfectly active. Just as in the first experiment (the aggressin experiment) we have a bacterial product which possesses slight toxic qualities and which has so increased the virulence of the infection already existing that a slowly progressing disease is transformed into an actute one and terminates in the death of the animal.

When the term "tuberculin" is used, the writer always has in mind Koch's old or original tuberculin.

The experiment described above with the tuberculous guinea-pigs has its analogy in the employment of tuberculin in man. In order to avoid dangerous symptoms far smaller doses are used in man.

If two individuals, one of whom is tuberculous and the other healthy, be injected with the same amount of old tuberculin, say 0·001 c.c., the healthy person will remain perfectly normal while the tuberculous person will show a typical group of symptoms which are classified as:—

(1) General reaction.

(2) Focal reaction.

(3) Local reaction.

The general reaction in its typical form resembles an attack of grip and consists of fever, headache, nausea, cough, malaise. Pains in the limbs and in the small of the back are very frequently present. Increase of temperature is the most constant and the most important symptom and without an increase of temperature one is not justified to say with certainty that a general reaction has occurred. The other manifestations may be very mild or even absent.

The focal reaction shows evidences of a fresh inflammatory process in suspicious or old tuberculous foci. In lupus, laryngeal and iris tuberculosis this inflammatory reaction can be distinctly seen. In pulmonary tuberculosis vague physical signs may become definite; sometimes when obscure physical signs may be present over a small area, a focal reaction may show râles over an increased area, and signs of disease may even be found where they were absent before the reaction. It is, therefore, of great importance to make a careful examination of the lungs both before and during a tuberculin reaction. Pains in the chest may also be present.

The local reaction occurs at the point of inoculation, and the skin around the site of the injection becomes swollen, red and painful. This occurs although the skin be thoroughly disinfected and although the needle be sterile. It is absent in non-tuberculous individuals, and is thus not due to dirt infection. It is not always present during a tuberculin reaction.

The general and the focal reactions are the most constant and most important of the three types of reaction. The general reaction is the most important in practice, and the presence of fever is the most important symptom, and is, in fact, the one symptom which must be present to make the diagnosis certain. The presence of fever is the guiding symptom.

Inasmuch as fever is the important guiding symptom, *no patient with fever should be given a subcutaneous test.* Different writers have different ideas with regard to the amount of temperature which can be allowed for a patient to have a tuberculin test. For instance, some writers think that no patient should be given a subcutaneous test with a temperature above normal; others with a temperature above 99° F., others with a temperature above 99·5° F., and still others with a temperature a little higher, but not beyond 100° F. The writer does not employ this test when the temperature rises above 99·5° F. in the mouth.

The quantity of tuberculin to be injected is also of great importance. In the records of cases which will be described in this paper no patient received a subcutaneous dose of more than 10 mg. of old tuberculin. Doses beyond 10 mg. should be avoided, as the specificity of the reaction is limited quantitatively. Small doses of tuberculin will give a rise of temperature only in tuberculous persons, but large doses may give the same rise in healthy persons. Too large doses may produce in tuberculous persons a general reaction which may be very severe and injurious.

The Tuberculin Test in Man.

The conviction that pulmonary tuberculosis in its earlier stages is curable, and that it is specially necessary to recognize it with certainty in its incipiency is steadily gaining ground. I am firmly convinced that tuberculin is an indispensable aid to diagnosis.

The conditions for its diagnostic use on man are very favourable, for it is not necessary to gain a diagnosis by a single injection, and, therefore, we need not give so large a dose or produce so strong a reaction as we do on animals. If one adopts the method given below one will never expose a patient to danger.

By the end of the year 1900 Koch had performed in his hospital 2,890 tuberculin test injections, and by adding the other cases personally observed by him elsewhere he had a total of more than 3,000. This is the material from which he derived his experience of the diagnostic value of tuberculin. He found that the cases were quite exceptional in which, owing to indistinct reactions, a sure diagnosis was impossible. As a rule he succeeded either in obtaining distinct reactions, or in ascertaining their absolute non-occurrence. Where a reaction occurred he felt he could conclude with certainty that there was a tuberculous focus.

He found the test of special value in judging of catarrh of the apex of a lung without tubercle bacilli in the sputum, especially when influenza was prevalent; because, at such a time, cases pretty often occur which, to the clinician, exactly resemble incipient tuberculosis, but which are not due to tuberculous disease. Among his numerous patients with catarrh of the apex of the lung there were almost 15 per cent. in whom no reaction took place, and in all the cases that could be observed long enough the further course of the disease confirmed his opinion that they were not cases of tuberculosis. Of his pleurisy cases 73·2 per cent. reacted to the test.

He expressly states that he never saw any harmful effect of tuberculin when it was used in the way he describes.

The physician frequently meets cases in which he strongly suspects tuberculosis in the lungs, but in which he cannot obtain positive evidence of its presence. He may have made repeated careful examinations of the chest with the patient stripped to the skin, and have failed to find definite evidence of disease, or there may be slight physical signs, but not sufficient to convict the patient. Expectoration may be present, but may not contain tubercle bacilli, or there may be no expectoration. Yet the patient may have active symptoms of pulmonary tuberculosis, such as a recent hæmoptysis, a persistent and distressing cough, a dry pleurisy, a recent pleurisy with effusion, continued cough and expectoration without physical signs, localized râles in one or several places in the lungs combined with some other symptom, or other symptoms of early tuberculosis. In spite of the most careful examination, and in spite of the employment of other means of help besides physical diagnosis, it is often impossible to determine with certainty whether tuberculosis exists or not. There are also a group of cases that have well-marked physical signs, and in which the physician is certain that tuberculosis is present, but which do not have tubercle bacilli in the sputum. In order to satisfy the relations or friends of the patient, or to convince another physician, the tuberculin test is resorted to. For all such doubtful cases we possess in tuberculin, which at present represents our most delicate test for tuberculosis, a welcome means of help for the sure diagnosis of incipient tuberculosis. It is our final court of appeal. By it the possibility is offered of gaining a distinction between non-tuberculous and tuberculous conditions. I wish to emphasize the fact that the tuberculin test should not be used until we have exhausted all other means of help, and have failed to reach a definite conclusion. By a careful employment of this means of help a harmful result is almost impossible.

Method of giving the Tuberculin Test.

The method of giving the tuberculin test employed by almost all clinicians is that of Koch, with, perhaps, slight modifications. The patient's temperature is observed every two hours for two or three days to ascertain whether the temperature is below 98·6° F. (37° C.). Koch insisted that patients whose temperatures were above 98·6° F. (37° C.) were unsuited for the diagnostic application of tuberculin, and ought not under any circumstances to be subjected to the tuberculin test. In practice, however, this is a low limit, and the writer allows a limit up to 99·5° F. (37·5° C.). Beyond this point patients should probably not be given the test. Marcus Beck considers that fever patients, that is, patients with erratic temperatures or temperatures over 38° C. (100·4° F.), should not be injected. Lawrason Brown says: "Tuberculin should not be used when a patient's oral temperature reaches 100° F. (37·8° C.) at any time of the day." The objection of Koch and others to the use of tuberculin on patients who have not an absolutely normal temperature has not been upheld in the writer's experience.

If a patient is found suitable he receives an injection of tuberculin under the skin of the back in the evening. With nervous patients it is often advisable to give a preliminary dose of physiological salt solution. The forearm and upper arm are sometimes used as sites for the injection but are not so suitable as the back. The first injection is usually ½ mg., but with stout, robust patients 1 mg. may be used. The solutions are made up with 0·5 per cent. phenol in 0·85 per cent. sodium chloride, and should always be used fresh, and should not be made longer than three days before the injection. They should be excluded from light and kept in a cool place. The temperature should be taken every two hours throughout the day till the whole test is complete. If there is no rise of temperature at all, as a result of the first injection, the second dose of 2 mg. is given if $\frac{1}{2}$ mg. was the former dose, or 3 mg. if 1 mg. was the first dose. The second injection is given either two or three days after the first. If there is a slight rise of temperature—only two or three fifths of a degree F., or less than 0·5° C.—the dose may be repeated, or a slightly larger one may be given as soon as the temperature has returned to its normal level. It very often happens that when slight fever follows a dose of tuberculin, and that when the same dose is repeated, a stronger reaction and a higher temperature will result. Koch regarded this as specially characteristic of the effect of tuberculin, and considered it as an infallible sign of the presence of tuberculosis.

Should there be no reaction from 2 mg., the next dose of 5 mg. is given two or three days after the last dose. If no reaction from 5 mg., the next dose of 8 mg. is given; and, finally, the maximum dose of 10 mg. Each dose is given after an interval of two or three days. When one suspects tuberculosis, and the first dose of 10 mg. has failed to cause a reaction, it is well for safety's sake to repeat 10 mg. If no reaction then occurred, Koch felt justified in assuming that the case was not one of fresh or progressive tuberculosis demanding special treatment. If one adopts this method one will never expose a patient to danger, nor even expose him to any serious discomfort. With children the first dose should be $^{1}/_{20}$ mg., and the maximum dose 5 mg.

Considerable diversity of opinion exists as to the maximum dose of tuberculin that should be given for the test. Practically all clinicians agree that not more than 10 mg. should be used. I wish to add my conviction to that of Koch, Bandelier, Marcus Beck, and others, that it is necessary to reach 10 mg. of old tuberculin before a tuberculin test is complete, provided no reaction has occurred previous to that dose.

Description of a Reaction.

Most clinicians consider an increase of temperature of 0·9° F. (0·5° C.) over the previous maximal normal temperature as a reaction. I am more and more convinced that definite though small rises of temperature following test doses of tuberculin are frequently indicative of tuberculin reactions. These small rises of temperature may be less than 0·9° F., and yet may be positive indications of a tuberculin reaction. They should not be considered as negative but as doubtful reactions. The same or slightly higher dose should then be given. My experience has also been that this dose repeated does not always give a strong reaction, but that sometimes no fever results, and that the following higher dose may be necessary to produce the reaction. Care should be taken so that the difference between successive doses should not be too slight, since otherwise a gradual accustoming to the substance may occur; on the other hand the difference between the successive doses should not be too large, in order to avoid too strong reactions. With adults at 10 mg., and with children at 5 mg., if no increase of temperature occurs up to 0·9° F. (0·5° C.) the reaction is considered negative.

In interpreting the result of the reaction one must exclude rises of temperature due to other causes such as influenza, &c. There are also persons, especially hysterical ones, in whom an injection of any substance is apt to produce a rise of temperature. With such persons a preliminary injection of physiological salt solution should be given, and thus overcome this suspicion of error.

Indications.

The diagnostic use of tuberculin when used subcutaneously is indicated when we are dealing with patients who present clinical symptoms or clinically suspicious symptoms of tuberculosis, but who are free from the presence of tubercle bacilli in the sputum, and who are free from fever.

Contra-indications.

Patients with a temperature of over 99·5° F. (37·5° C.) should probably not be given the tuberculin test. Other contra-indications are hæmorrhages or hæmaturia which occurred a short time before. With epilepsy, marked cardiac or renal disease, arteriosclerosis, diabetes, and similar conditions, the tuberculin test should be given only under the strictest indications and with great care. It should not be given when there are extensive physical signs, great dyspnœa, meningitis, night sweats; very slight nephritis is not usually a contra-indication, though judgment is necessary in such cases. When there has been a recent attack of fever or a recent hæmoptysis it is advisable to wait several months before giving the test.

Significance of a General Reaction.

A positive general reaction, that is, when the patient reacts with fever and its accompaniments, means that the patient is infected with tuberculosis, but it does not throw any light upon the site, or the extent, or the prognosis of the infection. The focal reaction, that is, the reaction at the site of the disease, allows the diagnosis of the position of the lesion.

Management of a Patient during a Tuberculin Test.

As mentioned above, a two-hour temperature should be taken for at least three days before the test is begun, and then every two hours throughout the whole course of the test. It is advisable to keep the patient absolutely at rest throughout the whole test. By this I mean he should take no exercise whatever. Should there be a temperature of over 99·5° F. (37·5° C.) following a tuberculin injection, he should go to bed and remain there till it again becomes normal. With a well-marked reaction accompanied by moderately high or high fever he should be put on a liquid diet, preferably a broth diet, till the fever has subsided, and should be kept in bed for several days after the temperature has again reached normal. The local soreness at the seat of injection usually needs no attention. I have never seen any harmful effect from it, and it usually passes off in a few days.

Description of a Reaction.

When the dose of tuberculin is given at night and a reaction occurs, the symptoms usually begin about from eight to twelve hours later. They frequently, however, begin either sooner or later than this. I have known tuberculin reactions to begin within a few hours, and the patient to pass a very restless night; and, on the other hand, they sometimes occur as late as the second or third day. These latter are called delayed reactions, and the physician should be on the watch for them, as otherwise he may overlook a very definite tuberculin reaction.

Typical reactions consist of a definite rise of temperature to at least 1° F. (0·56° C.), accompanied by pain, tenderness, redness, and swelling at the site of the injection, headache and malaise. He feels as though he had a definite attack of grippe. There may also be an increased tendency to cough, increased expectoration, some oppression in the chest, pleurisy, and, at times, severe nausea and vomiting. I regard the rise in temperature as the essential symptom in a tuberculin reaction. It, however, must be a typical rise. That is to say, it must increase gradually, come to its maximum, remain there for a longer or shorter time, and then decline. I do not consider a sudden flurry of temperature as a reaction. The whole reaction is usually over within two or three days, but it sometimes lasts even a week or longer. I have never seen the fever keep up indefinitely. Physicians should not be alarmed at a prolonged reaction. The patient should be kept in bed during the fever, and for several days after it has ceased.

The degree of reaction, that is whether it be mild, moderate or strong, is no criterion of the extent of disease. This fact applies also to the test on animals, and has been thoroughly demonstrated by veterinarians. Animals may react violently to a dose of tuberculin, and at autopsy show only a small focus, while other animals may react mildly and show extensive disease. We have not similar opportunities to establish this fact on man, but clinicians do not consider that the reaction gives any evidence of the extent of the disease.

A patient is usually disturbed according to the grade of the reaction. In mild reactions there is often no other disturbances of the general condition except headache and loss of appetite. In moderate and strong reactions there is headache, pain in the back, pains in the joints and limbs, thirst, loss of appetite, often pain in the chest and stitches in the sides, and a fast pulse.

Local reactions are of great interest. In a considerable number of cases, especially when strong reactions occur, a change can be determined in the diseased parts of the lungs. If one auscultates at the height of the reaction, one very often finds small moist rales over an area where previously there was only abnormal breathing. One may also detect râles over areas where there were no signs of disease whatever. Sometimes increased cough and expectoration occur, and tubercle bacilli are sometimes found when they had previously been absent. The demonstration of tubercle bacilli is usually very seldom.

The reaction fever forms a measure for the judgment of the reaction.

(1) Weak reactions—an increase up to 100·4° F. (38° C.).

(2) Moderately strong reactions—an increase of temperature of over 100·4° F. (38° C.) up to 101·6° F. (38·67° C.).

(3) Strong reactions—temperatures above 101·6° F. (38·67° C.).

In a weak tuberculin reaction a local reaction in the diseased part of the lung is usually not evident.

In moderately strong reactions the local reaction in the diseased part of the lung can very frequently be determined.

In strong reactions the local reaction in the diseased part of the lungs is usually well marked, the expectoration may be increased, and it sometimes happens that tubercle bacilli are found in the expectoration.

Deviations may occur from these three normal types of reactions. Sometimes with high temperatures the general condition is only slightly disturbed, and on the other hand it is very considerably disturbed with low temperatures.

Dangers of a Tuberculin Test.

The great objections to the use of the tuberculin test are that it may cause either tuberculosis, or a spread of the disease to other organs, or that it may rouse a latent tuberculous focus into activity. These objections are absolutely without foundation. It is impossible for Koch's old tuberculin to produce tuberculosis, because it does not contain tubercle bacilli. In preparing it, the broth cultures containing the bacilli are first thoroughly boiled, and then passed through a Pasteur filter, and the filtrate is then evaporated to one-tenth of its original volume at 212° F. (100° C.). I mention this because many physicians believe that Koch's old tuberculin contains live tubercle bacilli. During the last sixteen years I have used tuberculin for diagnosis and treatment on between 100 and 200 patients, and have given many thousand injections of it. I have never seen any evidence of spread of the disease, nor have I seen any latent focus roused to activity. This is also evidenced by the thousands of injections given in Koch's Institute in Berlin without any harmful after-effect, where subsequently a large number of the earlier injected patients were investigated, and no such spread could be established in a single case.

A. Moeller, Germany, has not observed harmful effects, either at the time of or after injection in the thousands of injections given by him at Belzig Sanåtorium. I also mention B. Fränkel's words with regard to Koch's doses. "I consider it as established that the careful employment of tuberculin doses to tuberculous persons is accompanied by no danger." Petruschky also says, "In that stage of the disease in which there is still no material for the bacteriological diagnosis, the diagnostic tuberculin injection affords a means of help free from danger to establish the diagnosis." Petruschky also particularly affirms that he has never seen any harmful effects whatever from the tuberculin test. So also in Weicker's Sanitarium at Görbersdorf no case has occurred in which a harmful effect has followed a test injection of tuberculin.

This question of the danger of tuberculin injections has also been raised by the veterinarians and answered entirely negatively. Bang, of Copenhagen, who perhaps possesses the greatest experience with the tuberculin test on cattle, says, "An acute outbreak of the tuberculosis as a result of the tuberculin is only by way of exception, and only to be feared in such cases in which an acute miliary tuberculosis often occurs without tuberculin injection." In like manner, A. Eber also says, "There can be no doubt that neither the subcutaneous employment of tuberculin, nor the action which this substance has on the bodies of healthy or tuberculous animals (except those high-grade tuberculous and cachectic animals) produce dangers which could hinder the most extensive use of tuberculin in the struggle against tuberculosis in cattle." In 3,000 test cases Nocard saw a spread of the disease only in three, and those three were exceptionally advanced. Veranus Moore, who has had a large experience in New York State, speaks just as emphatically. He says, "There is no evidence that in cattle tuberculin excites a latent tubercle into activity, or that it tends to make the disease worse. It is used the world over, and as yet no authenticated report of injury caused by its use has been recorded."

These facts sufficiently prove that there can be no discussion of a harmful effect from a suitable employment of the tuberculin test. I wish, however, to emphasize the fact that tuberculin must be suitably employed in order to be free from danger. It has always seemed to me that the harmful and sometimes fatal results following tuberculin injections have been due to one of two causes: first, that the dose was not properly measured and that a dose very much too large was given; and secondly, that the injections were made on unsuitable cases. It would seem advisable therefore that no physician should give a dose of tuberculin unless he is thoroughly competent to measure his doses or has someone measure them for him who is competent, and secondly, that he should be thoroughly acquainted with the whole subject of the tuberculin test.

Meissen, of Hohenhonnef, objects to the use of tuberculin on account of the liability of hæmorrhage to occur after an injection. My experience has been absolutely contrary to this, as I do not remember a single hæmorrhage to have occurred as a result of a tuberculin test injection. On the other hand, I have repeatedly seen cases that have had hæmorrhages before the tuberculin treatment was begun to be free from hæmorrhages afterwards.

Marcus Beck also, with his enormous experience, states that he never remembers to have observed hæmoptysis as a result of a tuberculin reaction. To avoid any possibility of hæmorrhage, however, we should try and avoid strong reactions. The question naturally arises, should all persons, either healthy or otherwise, who have reacted to a tuberculin test, have to undergo treatment? From our knowledge of the great frequency of latent tuberculosis in apparently healthy persons, it is evident that a large number of such persons would react if given a tuberculin test. It should not for a moment be considered necessary to put such persons under treatment, if by chance they took the test and reacted. When, however, the physician is consulted by a patient with either subjective or objective symptoms of an active tuberculosis, and he reacts to a tuberculin test, the patient should be put under treatment. The presence of symptoms is the necessary condition to put a patient under treatment.

Cutaneous Reaction.

The cutaneous tuberculin reaction was first used by von Pirquet, who found that by the scarification of the skin and the application of Koch's old tuberculin, tuberculous children would develop a papule at this site, while this reaction would be absent in non-tuberculous children.

The Technique of the Cutaneous Reaction.

"The patient's forearm on the inner side is cleansed with ether; two drops of the pure undiluted old tuberculin are placed upon the skin about 10 cm. apart, and then the skin is scarified first between the two drops for the purposes of a control, and next within each of these drops. (A boring scarifier devised for this works very easily.) Finally a piece of cotton is placed upon each of these drops and allowed to remain there for ten minutes, after which the cotton is removed. A dressing is not necessary." In practice it is found to be of advantage to have the control scarification on the opposite forearm.

Interpretations of the Reaction.

The so-called "traumatic reaction" is produced by the scarification and consists of a small wheel with a rose-coloured margin around each point of scarification. This reaction passes away after several hours and leaves only a small scab surrounded by a red rim.

The "specific reaction" is seen only on the points where the tuberculin has been applied and consists of a red, indurated papule, which rapidly extends in size and elevation, measuring 10 mm. to 30 mm. in diameter. The papule may be round or have irregular margins. Tuberculous children show small, irregularly raised follicular infiltrations around the specific reaction. This is called the "scrofulous reaction." It may appear within three hours, but usually appears within twenty-four hours. It reaches its maximum within forty-eight hours. It is occasionally delayed and may not fully develop until the third or fourth day. Then it begins to fade. Frequently a small spot of pigment remains. General and focal reactions seldom occur, though I have seen quite extensive redness and swelling of the arm with moderate fever.

Comparative Results between the Subcutaneous and the von Pirquet Tuberculin Tests.

In analysing this series of twenty-one cases it is seen that they all presented clinical symptoms or clinically suspicious symptoms of pulmonary tuberculosis and that they were all devoid of the presence of tubercle bacilli in the sputum, and that they all had either a normal temperature or had very slight temperature—not over 99·5° F.

The von Pirquet tuberculin test was always used first, and within four or five days it was followed by the subcutaneous tuberculin test. All of the twenty-one cases reacted to the subcutaneous test = 100 per cent. Seventeen of the twenty-one cases reacted to the von Pirquet tuberculin test = 80·95 per cent. The extraordinary value of the subcutaneous tuberculin test is thus seen in that it revealed the presence of tuberculosis in 100 per cent. of the cases of this series. The great value of the von Pirquet tuberculin test is also seen in that it revealed a tuberculosis in 81 per cent. of this series. Not only is the subcutaneous test the more delicate test to reveal a tuberculosis but it will sometimes reveal where the tuberculous focus is located by causing a focal reaction (that is, a reaction at the site of the disease). For instance, in several cases of this series there were only suspicious areas of disease in the lungs. During the subcutaneous reaction these areas showed well-marked signs of tuberculosis and the extent of the lesions could sometimes be determined. This point was investigated in twenty cases which were clinically suspected cases of pulmonary tuberculosis. In thirteen of these cases (*i.e.*, = 65 per cent.) there was no increase in the physical signs in the lungs, and in seven (*i.e.*, = 35 per cent.) the physical signs were definitely increased during the subcutaneous test. In eighteen cases of tuberculosis in which there was a definite von Pirquet skin reaction there was a constitutional disturbance in three (*i.e.*, in 11·1 per cent.). This was evidenced by a slight increase of temperature. This disturbance was very mild and passed off quickly.

Specificity of the Tuberculin Reactions.

The essential point of the practical application of biological reactions is the specificity of the reaction. There is probably no single absolutely specific reaction. These reactions are therefore only relatively specific. It is not possible to draw an exact line between the specific and non-specific biological reactions. In all biological reactions there will be a doubtful zone in which it will be impossible to say definitely whether a reaction does or does not occur. As a general rule, one can say that the smaller the quantity of antigen that is required and the stronger the resulting reaction, the more probable is the biological specificity.

It is well known that a large number of persons have received a tuberculous infection at some time during life. These persons may be in sound health and yet have a latent tuberculous focus. The clinical consideration of tuberculosis does not deal with these harmless latent foci which in many cases are practically healed. What the physician desires to know is whether or not a group of symptoms in a patient is of a tuberculous nature or not. It is therefore not the latent and inactive, but the active form of tuberculosis that is to be diagnosed. It is therefore important to remember that when a person in sound health, without any clinical symptoms that suggest tuberculosis, reacts to a tuberculin test, this only means that there is a tuberculous focus somewhere in his system, but that he does not require any treatment for it.

From the results obtained in my series it is seen that the von Pirquet cutaneous reaction is less specific in the adult than the subcutaneous test. In children, however, the von Pirquet reaction is the one of choice.

Von Pirquet makes some interesting observations on this point. (*Vide* Julius Citron, "Immunity.")

"Out of 747 children in Escherich's Clinic in Vienna upon whom the reaction was tried there were: Clinically tuberculous 130, out of which 113 (87 per cent.) showed a positive reaction; clinically non-tuberculous 512, out of which 104 (20 per cent.) showed a positive reaction; doubtful 115, out of which 56 (48·6 per cent.) showed a positive reaction.

Almost all of the tuberculous children who did not react were cachectic.

As for the positive reaction in non-tuberculous cases the age of the child in large part explains the great differences found.

Whereas healthy infants up to the sixth month almost never give a positive reaction, healthy children of

1	to	2	years	react in	2	per cent.	of cases
2	,,	4	,,	,,	13	,,	,,
4	,,	6	,,	,,	17	,,	,,
6	,,	10	,,	,,	35	,,	,,
10	,,	14	,,	,,	55	,,	,,

In adults one meets with a positive von Pirquet's reaction in more than 70 per cent. of all cases. Von Pirquet explains this by the presence of latent tuberculosis.

In young children von Pirquet's method should be the one of choice. It is entirely harmless, is easily applied, and it possesses a high diagnostic value.

Koch's subcutaneous tuberculin reaction is specific, because one rarely gets a negative reaction in an active tuberculous process. A positive subcutaneous reaction is of importance only in cases which are clinically suspicious of tuberculosis. In these cases a positive reaction probably points to an active tuberculous focus. This statement, however, requires careful consideration and judgment.

In the series of cases which I present it is seen that in the adult the subcutaneous tuberculin test is the most reliable and is the one of choice, as all (100 per cent.) of the clinically suspected cases of tuberculosis reacted to it. The von Pirquet test, though not so accurate, is of very great importance, as 81 per cent. of the cases reacted positively.

Case 1.—A woman, aged 43, who had a morning cough for several years; no expectoration. Five months previous to the test she had right dry pleurisy accompanied by a temperature of 101° to 102° F. for several days. The temperature then ran to 99·4° to 99·6° F. for several months. At the time of the tuberculin tests there was dulness and prolonged expiration at the right apex to the second rib and an occasional fine moist râle on cough in the first interspace. There were also some fine dry râles at the base of the left lung behind. She had no expectoration and therefore no tubercle bacilli in sputum. Her temperature was normal for some time previous to the tests. There was no increase in the physical signs in the lungs during the subcutaneous test.

Case 2.—A young man, aged 20, who complained of severe cough which had lasted six months. He never had expectoration, no hæmorrhages, no sweats, no loss of weight, but he felt constantly tired. His temperature was normal. There was prolonged expiration at the right apex and dulness at the left apex, but no râles in either lung. There were no tubercle bacilli in the sputum. There was no increase in the physical signs in the lungs during the subcutaneous test.

Case 3.—A young married woman, aged 28, who had severe cough and profuse expectoration and occasional hæmorrhages from the lung after exertion. Her illness followed a pneumonia of the right lung. She had no temperature. There were no tubercle bacilli in the sputum. She reacted positively to both the von Pirquet and the subcutaneous tuberculin tests. An X-ray picture revealed a tuberculous deposit in the right lung. Her case was later diagnosed as bronchiectasis. There was no increase in the physical signs in the lungs during the subcutaneous test, though cough and expctoration became increased.

Case 4.—A young married woman, aged 27, who was under treatment for suspected tuberculous peritonitis. The lungs were practically free from signs of tuberculosis. Her temperature would occasionally reach 99° F. There was no increase of physical signs in the lungs during the subcutaneous test.

Case 5.—A man, aged 42, who complained of cough, expectoration and shortness of breath. He was very subject to colds which would be followed by cough and expectoration which would persist for a considerable time. There were no tubercle bacilli in sputum. There were dulness and fine râles at both apices, both front and back. His temperature was normal.

Case 6.—A young married woman, aged 28, who complained of cough which had lasted for four months. She had had four attacks of dry pleurisy within four months and had had slight and almost constant temperature. There was no expectoration and no tubercle bacilli. There was dulness and prolonged expiration at the apex of the right lung with occasional faint fine râles to the third rib. There was also dulness and prolonged expiration at the apex of the left lung and some fine râles at the base of the left lung posteriorly. Her temperature usually reached 99° F. daily. There was no increase in the physical signs during the subcutaneous test.

Case 7.—A young man, aged 25, who complained of slight cough and slight expectoration. He had a pleurisy with effusion eight months previous to the tuberculin tests.

No.	Name and age	Subcutaneous Tuberculin Test. Number of doses necessary to give a reaction	Reaction at — mgm. O.T.	Maximum temperature of reaction	von Pirquet Cutaneous Test.
1	Miss H. G. A., 43	Slight reaction at $\frac{1}{2}$, 2, 5 mgm. and marked reaction at 8 and 10 mgm.	Reacted at $\frac{1}{2}$ mgm. to 99·4°; at 2 mgm. to 99·5°; at 5 mgm. to 99·8°; at 8 mgm. to 100·2°	100·2° F.; after 8 mgm. ...	No reaction. There was no temperature and no constitutional disturbance during the skin test.
2	Mr. B. C., 20 ...	One	$\frac{1}{2}$ mgm.	100·2° F. ...	Reaction. Very severe reaction with diffuse redness and swelling of the arm. The swelling and redness extended about 6 in. long and 3 in. wide. He also had severe constitutional symptoms and temperature to 100·6° F.
3	Mrs. G., 28 ...	No reaction at 1 mgm. Slight reaction at 3 and 5 mgm. Strong reaction at 9 mgm.	Reacted at 3 mgm. to 99·6°; at 5 mgm. to 99·6°; at 9 mgm. to 100·6°	100·6° F. ...	Reaction. No temperature and no constitutional disturbance during the skin test.
4	Miss H. H., 27 ...	One	1 mgm.	100·3° F. ...	Reaction. Severe reaction with diffuse redness and swelling of the arm and soreness of the glands of the axilla. This was also accompanied by a temperature of 99·6° F.
5	Mr. D. A. N., 42	He failed to react at $\frac{1}{2}$ mgm.; reacted at 2 mgm.	2 mgm.	100·8° F. ...	Reaction. Localized to sites of application of old tuberculin. No constitutional disturbance and no fever.
6	Miss C. M., 28 ...	Reaction at $\frac{1}{2}$ and 2 mgm.	Reacted at $\frac{1}{2}$ mgm. to 99·8°; at 2 mgm. to 101·4°	101·4° F. ...	Reaction. Localized to sites of application of tuberculin; no constitutional disturbance and no fever.

7	L. M. S., 25 ...	Slight reaction at ½ and 2 mgm.; strong reaction at 5 mgm.	Reacted to 99° at ½ mgm.; at 2 mgm. to 99·6°; and at 5 mgm. to 101·4°	101·4° F. ...	Reaction. Localized to sites of application of tuberculin; no constitutional disturbance and no fever.
8	Miss J. S., 26 ...	Slight reaction at ½ mgm.; stronger at 2 mgm., and very strong at 4 mgm.	Reacted at ½ mgm. to 99·6°; at 2 mgm. to 100·3°; at 4 mgm. to 102·2°	102·2° F. ...	Reaction. Localized to sites of application of tuberculin; no constitutional reaction and no fever.
9	Mrs. H. W., 28 ...	One	1 mgm.	101·6° F. ...	Reaction. Localized to sites of application of tuberculin; no constitutional reaction and no fever.
10	P. D., 29... ...	There was no reaction at 1 mgm., but well-marked reaction at 3 mgm.	3 mgm.	100·5° F. ...	Reaction. Confined to sites of tests; no constitutional disturbance and no fever.
11	Mrs. C., 28 ...	There was no reaction at 1 mgm. She reacted to 99° F. at 3 mgm. and to 100·8° F. at 6 mgm.	Reacted at 3 and 6 mgm.	100·8° F. ...	Reaction. Confined to sites of tests; no constitutional disturbance and no fever.
12	Miss E. A. C., 38	One	1 mgm.	99·6° F. ...	Reaction. Confined to sites of tests; no constitutional disturbance and no fever.
13	Miss A. F., 30 ...	There was no reaction from 1 or from 3 mgm. Slight reaction to 99·3° F. at 6 mgm. and reaction to 100·3° F. at 10 mgm.	6 and 10 mgm. ...	100·3° F. ...	No reaction; no constitutional disturbance.
14	Mrs. W. H., 45 ...	One	1 mgm.	100·4° F. ...	Reaction. There is no record in this case as to whether there was any constitutional disturbance.
15	Miss E. H., 29 ...	One	1 mgm.	100·4° F. ...	Reaction. No constitutional disturbance and no fever. The reaction was confined to the sites of the test.

	Subcutaneous Tuberculin Test.				von Pirquet Cutaneous Test.
No.	Name and age	Number of doses necessary to give a reaction	Reaction at — mgm. O.T.	Maximum temperature of reaction	
16	Mr. A. K., 24 ...	One	1 mgm.	100·1° F. ...	Reaction. Confined to sites of tests; no constitutional disturbance and no fever.
17	Mr. A. L., 39 ...	There was no reaction from 1 mgm. At 3 mgm. there was reaction to 101·4° F.	3 mgm.	101·4° F. ...	Reaction which was confined to sites of the tests; no constitutional disturbance and no fever.
18	Mr. G. McG., 24...	He failed to react to ½ mgm. He reacted mildly to 99·4° F. at 2 mgm., and strongly to 101·8°F. at 5 mgm.	2 and 5 mgm. ...	101·8° F. ...	Reaction which was confined to sites of the tests; no constitutional disturbance and no fever.
19	Mr. F. S., 23 ...	He had a slight reaction with 1 mgm. to 99·4° F. and a strong reaction with 4 mgm. to 102·8° F.	1 and 4 mgm. ...	Reacted to 99·4°F. with 1 mgm. and 102·8° with 4 mgm.	No reaction; no constitutional disturbance and no fever.
20	Miss E. S., 18 ...	One. She reacted mildly at ½ mgm., and more strongly at 1 mgm.	½ and 1 mgm. ...	Reacted to 99·4°F. with ½ mgm. and to 99·9° with 1 mgm.	Reaction which was confined to the sites of the tests. Slight constitutional disturbance with slight fever to 99·4° F.
21	Miss M. W., 19 ...	Two	3 mgm.	99·7° F. ...	Suspicious reaction, but not a definite reaction. There was no constitutional disturbance and no fever.

Since the pleurisy he had not felt in good health. There were no tubercle bacilli in sputum. There was a fine pleuritic rub at the apex of the right lung posteriorly. There was some flattening of the left chest with diminished breath sounds over the lower part, and some fine râles at the left apex, both front and back. There was no increase in the physical signs during the subcutaneous test. His temperature was normal previous to the test.

Case 8.—A young unmarried woman, aged 26, who complained of night and morning cough and slight expectoration, occasional night sweats, and also constant feeling of fatigue. These symptoms were present off and on for some years. Her temperature rose each day to 99° or 99·3° F. The physical examination of the lungs showed dulness to the second rib, interrupted inspiration and a dry pleuritic rub below the right breast. In the left lung there were fine râles at the third costal cartilage and some fine râles below the spine of the scapula. There were no tubercle bacilli in sputum. There was no increase in the physical signs in the lungs during the subcutaneous test.

Case 9.—A young married woman, aged 28, who complained of a recent hæmoptysis, also of hæmoptysis five months previously; also of a double pleurisy with effusion five years before. She had no cough, but slight morning expectoration. Previous to the test her temperature rose daily to 99·2° F. There were no tubercle bacilli in the sputum. There was dulness and prolonged expiration and indistinct fine râles at the right apex, front and back. There was no increase in the physical signs during the subcutaneous test.

Case 10.—A young man, aged 29, who complained of a constant feeling of fatigue and of a severe night and morning cough for six weeks. He had no expectoration and therefore no tubercle bacilli in sputum. There were some fine râles at the fourth left costal cartilage and over the left axilla. Both the anterior and posterior cervical lymphatic glands were enlarged. He had no temperature. There was well-marked increase in the physical signs, both in the lungs and in the glands during the subcutaneous test.

Case 11.—A young married woman, aged 28, who complained of severe cough and profuse expectoration. There were no tubercle bacilli in her sputum. The illness had lasted six weeks and began with a pneumonia of the right lung. She lost 30 lb. and had night sweats and great weakness. Her temperature was normal. The sputum was occasionally blood-tinged. The examination of the chest showed (right lung), dulness to the second rib and over the axilla. Over the axilla there was blowing breathing with whispering pectoriloquy and bronchophony and moderately fine râles. Over the lower half of the right lung posteriorly there was dulness with whispering pectoriloquy and bronchophony and moderately fine râles. There were also moderately fine râles at the apex of the right lung posteriorly. During the subcutaneous tuberculin reaction the physical signs were intensified and the râles became louder and larger. Her temperature was normal previous to the tests.

Case 12.—An unmarried woman, aged 38, who complained of cough, expectoration and weakness, all of which had lasted some months. The expectoration did not contain tubercle bacilli. She had occasional attacks of fever. Eight years previously she had a dry pleurisy. There was dulness at the right apex and prolonged expiration, and fine pleuritic-like râles at the top of the lung, both front and back. There was slightly deficient expansion of the left chest with dulness and prolonged expiration at the apex. Posteriorly there were some fine dry râles from the apex to one-third along the margin of the scapula. During the subcutaneous tuberculin reaction the physical signs in the lungs were markedly increased. Previous to the tests her temperature was normal.

Case 13.—A young unmarried woman, aged 30, who complained of constant fatigue. She had no cough and no expectoration. She had a normal temperature. There were no pains in the chest. She was nursing her mother who had advanced pulmonary tuberculosis. There was slight dulness at the left apex to the second rib and there were very dry pleuritic-like râles at the left apex, both front and back. The physical signs in the left lung were accentuated during the subcutaneous tuberculin reaction.

Case 14.—A married woman, aged 45, who complained of constant extreme exhaustion for five years. She had constant slight temperature each afternoon to 99·5° F. for one month. At the time of the test this temperature never rose higher than 99·2° F. in the afternoon. She had pain under the left scapula for one year. There was no cough, no expectoration, and no loss of weight. One year previously she had severe night sweats. There was dulness to the second rib right side, otherwise the lungs were normal. During the subcutaneous tuberculin reaction there was heard a fine pleuritic rub under the right breast. There was also prolonged breathing and impaired resonance at the apices of both lungs. There was tenderness over one of the anterior cervical glands.

Case 15.—A young unmarried woman, aged 29, who complained of feeling constantly fatigued. On several occasions she had a chill which was followed by two or three weeks of temperature between 99° F. and 100° F. She had no cough, no expectoration, and no sweats. There was dulness and prolonged expiration at the apex of the right lung and a fine pleuritic-like rub under the right breast, and also some fine râles at the posterior base of the right lung. There was also a fine pleuritic-like rub below the left breast. There was no increase of the physical signs during the subcutaneous tuberculin test. At the time of the tests her temperature rose each day to 99° F. or 99·4° F.

Case 16.—A young man, aged 24, who complained of cough and expectoration which had lasted two months. There were no tubercle bacilli in the sputum. He had lost 20 lb. in weight. He suffered from occasional sharp pains below the right breast. There were no definite physical signs of disease in the lungs. His temperature was constantly normal or below normal. During the subcutaneous tuberculin reaction there was no definite increase in the physical signs in the lungs.

Case 17.—A man, aged 38, who complained of feeling unwell for several months. He had occasional chills accompanied by fever which reached 100° F. and which then persisted between 99° F. and 100° F. for several weeks. He also had a cough which had lasted three months. There was no expectoration, and no pains in the chest. At the time of the tests his temperature was normal. Up to four years previous to the tests he suffered from frequent severe colds accompanied by cough which was rather persistent. There was dulness and prolonged expiration at the apices of both lungs and doubtful fine râles at the apices posteriorly. During the subcutaneous tuberculin test there was no definite increase in intensity of the physical signs in the lungs. At the time of the tests his temperature was normal.

Case 18.—A young man, aged 24, who complained of cough and slight expectoration, both of which had lasted for three months. There were no tubercle bacilli in the sputum. One year previously he had a cough which lasted six months. His temperature was normal at the time of the tests. He tired more easily than usual. There was dulness but no râles at the apices of both lungs and fine râles at the base of the left lung posteriorly. The posterior cervical lymphatic glands of the left side were enlarged. During the subcutaneous tuberculin test there was marked increase in the physical signs and fine râles were heard over the axilla and outer part of the left chest, and over the base of the left chest posteriorly. There was also increased tendency to cough and expectorate.

Case 19.—A young man, aged 23, who complained of sharp pain in the right chest; cough for one week; constant fatigue; a recent slight hæmoptysis; a constant clearing of the throat. His temperature reached 99° F. almost daily. There were no tubercle bacilli in the expectoration. There was dulness and prolonged expiration at the top of both lungs, but no râles in either lung. During the subcutaneous tuberculin reaction there was no increase of signs in the chest.

Case 20.—A young girl, aged 18, who complained of cough, loss of weight, slight chills, constant feeling of fatigue. She had previously had severe coughs which would last for several months. There was no expectoration. For one week her temperature ran daily to 101° F. It then gradually sank to about normal, and at the time of the tests it was normal. There was prominence of the right clavicle and slight flattening of the right chest, also dulness to the second rib and a fine dry pleurisy rub from the nipple over the base of the chest. There was prominence of the left clavicle and dulness to the second rib, and a moist râle occasionally heard in the middle of the left chest. During the subcutaneous tuberculin reaction there was no increase in the physical signs in the chest.

Case 21.—A young girl, aged 19, who complained of cough which had lasted for fourteen years and of expectoration which had lasted for three years. One or two years previously she had dry pleurisy in both lungs. There were no tubercle bacilli in her sputum and her temperature was normal. There were moderately fine râles at the base of the right lung posteriorly. There was dulness and moderately fine râles over the base of the left lung posteriorly. During the subcutaneous tuberculin test the physical signs in the lungs were intensified.

BIBLIOGRAPHY.

[1] EBER, A. "Tuberkulinprobe und Tuberkulosebekämpfung beim Rinde."

[2] BANG. "Die Verwendung des Tuberkulins in dem Kampfe gegen die Tuberkulose des Rindviehs," *Deutsche Zeitsch. f. Tiermed. u. vergl. Pathol.*, 1895-96, Bd. 22, Heft. 1.

[3] NOCARD. *Transactions of the British Congress on Tuberculosis*, 1901, vol. iii-iv.

[4] KOCH, ROBERT. "On the Agglutination of Tubercle Bacilli and the Application of this Agglutination," *Transactions of the British Congress on Tuberculosis*, 1901, vol. iii-iv, pp. 93-94.

[5] MOELLER, A., and KAYSERLING, A. "Uber die diagnostische und therapeutische Verwendung des Tuberculins," *Zeitsch. f. Tub. u. Heilst.*, July, 1902.

[6] BROWN, LAWRASON. *Boston Med. and Surg. Journ.*, 1908, July 23.

[7] BECK, MARCUS. "Uber die diagnostische Bedeutung des Koch-schen Tuberkulins," *Deutsche med. Wockenschr.*, 1899, March 2.

[8] MOORE, VERANUS. "Bovine Tuberculosis," *Cornell University Bulletin*, 250.

[9] FRANKEL, B. "Das Tuberkulin und die Fruhdiagnose der Tuberkulose," *Berlin. klin. Wochenschr.*, 1900, No. 12.

[10] Petruschky. "Vortrage zur Tuberkulosebekämpfung," Leipzig, 1900.

[11] Cornet, C. "Die latenten Herde der Tuberkulose und die Tuberkulindiagnostik im Lichte neuer Forschung," *Berlin. klin. Wochenschr.*, 1904, No. 14-15.

[12] Brown, Lawrason. "Osler's Modern Medicine," vol. iii, p. 341.

[13] Citron, Julius. "Immunity," published by Blakiston, Son and Co., Philadelphia.

[The discussion on this paper will be found combined with that of Dr. Rochester on p. 275.]

THE ADVANTAGES OF STATE CONTROL OVER COUNTY INSTITUTIONS FOR THE CARE OF CONSUMPTIVES.

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In the work of caring for the consumptive in county institutions, many questions of policy arise, both in handling the funds and in the management of the institutions, in order to obtain the best results for the taxpayers who have supplied the money, which have to be answered by those officers of the State to whom have been entrusted the public funds appropriated for this purpose.

The community which says "It is a good thing to have a sanatorium for our consumptive poor; come, let us build one," and having built the institution entrusts it to the nearest physician without regard to his special fitness for the work, often becomes so dissatisfied with the results obtained that its members lose all faith in the sanatorium idea. The reason for their disappointment is not far to seek. The institutional care of a consumptive to be successful is a highly specialized branch of the practice of medicine and cannot be acquired by the reading of many books. Every step in the location, planning, construction and management of these institutions should be in the hands of experts and should not be left indiscriminately to the country authorities, or to the local profession, without the control of a board with State-wide responsibility.

The duties of this board should not cease with the building operations, but should continue throughout the life of the sanatorium. Their powers should in some way be greater than an advisory board, and they should be able to see that their suggestions are put into effect. If this is not the case, an institution that has been properly launched can soon deteriorate to the level of the ordinary poor farm, and the patients suffer for the want of proper discipline, food and medical attention.

The Minnesota law was drawn up very carefully by a committee appointed by the State Board of Health, of which the writer was a member. That committee attempted to draw a law which should avoid the dangers above enumerated. It entrusted the duties of supervision to a commission, already existing in the State, whose powers had been previously entirely advisory and confined to the State Sanatorium for Consumptives. It is the duty of this commission, when a county or group of counties levies a tax for the construction of a sanatorium, to assist the local commission in the selection of a site, in the preparation of the plans and specifications, and in the erection of the proposed sanatorium. The superintendent of the new institution must be approved by the commission. The manner in which the institution is conducted is subject to scrutiny every month. The suggestions of the State Commission can be enforced because the State of Minnesota pays half of the bills for the site, construction and equipment up to $50,000.00, and after the institution is open the State pays on the order of the commission $5.00 a week for each charity case cared for. In this way uniformity in the general plan of the buildings, in the care and treatment of the patients, and in the records of the institutions is secured.

The county institutions are required to admit any resident of the county if he has pulmonary tuberculosis in any stage. The examining physicians of the State Sanatorium for Consumptives—at least one examiner is located in each county—will determine whether or not the patient has tuberculosis. The county institutions are particularly intended to care for the advanced cases, and the law provides that advanced cases shall always be given preference over others on the waiting list. The incipient cases can be cared for at the State Sanatorium, which is designated as a place where incipient cases only shall be treated. For that reason the smaller the district served by any county institution the better, because the friends of the patient will not have to travel so far to see him, which would not be the case if many counties joined together and the institution took patients from a large territory. The institutions should be near the patient's home. To keep the institution full any vacant beds are at the service of neighbouring counties at a price sufficient to pay for the cost of maintenance.

The lack of uniformity in the conduct of county institutions in most States, especially since there are not a large number of men to be had who have had the advantages of training in sanatoria for the care of consumptives, is greatly deplored. We who are interested in the success of the anti-tuberculosis work should stand shoulder to shoulder in the demand that every institution must be under the supervision of competent men, even if it is not possible to put an expert superintendent into all of the smaller institutions. Some county institutions in the United States are so organized that no good can come of them, and the cause is sure to suffer if they are to go on and others are to be opened. There is too much laxness in the passing of anti-tuberculosis legislation that has not been carefully considered from all points of view before it is brought before the legislature. A concrete example is the following extract from the pen of Dr. J. H. Gifford, of Fall River ("Evolution of Policy concerning Tuberculosis Hospitals," *The Modern Hospital,* February, 1914):—

"The State Legislature of 1911 passed a law requiring each city having a population of 10,000 or over to construct and maintain a local tuberculosis hospital toward the support of which, after its approval, the State agreed to pay practically the same amount that it expends in the support of the State tuberculosis hospitals already built. The cost of building these hospitals equals the whole expense of maintenance for about one and one-half years, so that the State practically sacrificed the full control of these hospitals to this cost of construction, which represents the State's share of the maintenance for three years. A feature of this law is that it gives no specification as to capacity, or location, or material, or equipment, or standard of management of such a hospital. It simply conditions the State support on the approval of the hospital by the State Board of Trustees of Tuberculosis Hospitals."

Dr. Gifford describes the predicament of Fall River, which city built its hospital but failed to get the approval of the State Board of Trustees of Tuberculosis Hospitals, although their taxes go to pay for the Tuberculosis Hospital of Boston and the other cities of Massachusetts that have built institutions.

The Minnesota County Sanatorium Law, chapter 500, Laws of 1913, is a sample of the best legislation to be found in the United States on this topic. Its practical application and the way it is working out is most gratifying. One year after it was approved practically one-third of the counties of Minnesota had taken action, and, before long, there will be a sanatorium for advanced cases of consumption near every Minnesota home.

THE DIFFERENTIAL DIAGNOSIS OF MILD THYROID TOXÆMIA AND INCIPIENT PULMONARY TUBERCULOSIS.

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Certain cases of mild thyroid toxæmia with cough and chronic pyrexia bear so close a resemblance to incipient pulmonary tuberculosis that a differential diagnosis may require a very close analysis of all the clinical and laboratory findings. Writers generally have not given attention to this subject.

In the presence of the physical signs of an active lesion in the lungs, with or without tubercle bacilli in the sputum, the question of diagnosis between tuberculosis and mild thyrotoxicosis would not arise. Nor would it arise, on the other hand, in a case with well-defined thyroid hypertrophy, tremor, tachycardia and nervous irritability without physical findings in the lungs.

An early, small, central focus of infection may fail to yield signs that to the average physician are sufficient to justify a positive diagnosis of tuberculosis. The X-ray may help, but will not differentiate between an old and an active process, and a positive tuberculin reaction is not always convincing. A negative sputum finding is frequent. Such cases, with the results of physical examination uncertain, and showing constitutional symptoms suggestive of both early tuberculosis and thyroid disease, may give great difficulty in diagnosis. To differentiate the two conditions will demand a thorough familiarity with all the minor clinical distinctions.

It is foreign to the object of this paper to discuss the pathology of these cases of mild thyroidism. It is enough to say that they cannot be classed either as incipient myxœdema or incipient Graves's disease. They appear to be cases of perverted thyroid function, the exact nature of which has not yet been determined. From strictly clinical studies I have thought that this disturbance is primarily a fatigue subactivity of the gland, followed by a compensating hyperactivity with the elaboration of a toxic secretion. The recently published "Pathological and Clinical Studies," by Wilson and Plummer, show that such a toxic goitre, distinct from exophthalmic goitre, is a pathological and clinical entity. Further, the symptoms of this disturbed function respond to treatment by mental and physical rest, and by the administration of a suitable thyroid preparation.

Mild cases of thyro-toxicosis are seen chiefly in women at two periods of life; in early adolescence and between the ages of 40 and 50. Several cases have come under my observation in young men of neurotic type who have been subjected to prolonged mental over-fatigue or who have been reduced by acute infections or surgical operations.

For discussion of the differential diagnosis the symptoms of the two conditions naturally fall into three groups.

(1) The symptoms distinctive of thyroid toxæmia: (*a*) Enlargement of the thyroid gland, (*b*) tremor, (*c*) vaso-motor phenomena, (*d*) insomnia, (*e*) nervous irritability.

Inspection and palpation of the thyroid gland is a part of the routine of every complete physical examination. Enlargement of the gland would immediately suggest further inquiry for thyroid symptoms. This may, however, early in the disease, be slight or absent, and the examiner thus led astray. Tremor may not be marked and, unless sought for, is apt to escape detection; when noted it gives a clue to the nature of the trouble. It is not present in tuberculosis, and it is one of the most important symptoms differentiating the two diseases. Vaso-motor ataxia causing patchy blushing of the face and neck is a suggestive symptom, and not present in tuberculosis. Insomnia and nervous irritability are not often seen in early tuberculosis, but are frequent and distressing symptoms of thyroid disturbance. Not rarely they are the symptoms for which the patient first seeks relief.

(2) The symptoms and signs distinctive of pulmonary tuberculosis: (*a*) Tubercle bacilli in the sputum, (*b*) physical signs of an active pulmonary lesion, (*c*) the X-ray findings, (*d*) the tuberculin reaction, (*e*) loss of weight. The first four of this group need no detailed consideration; they are always sought for and, when found, fix the diagnosis. Loss of weight, however, is an important symptom, as it is not often seen in the mild thyroid cases we are discussing: in fact, these patients with their restricted activities often gain in weight.

(3) The symptoms common to both conditions: (*a*) Debility, (*b*) tachycardia, (*c*) pyrexia, (*d*) cough and dyspnœa, (*e*) derangements of digestion and metabolism.

Debility, or the more expressive term fatigability, is an almost constant symptom in both conditions under discussion, and is the one that often first attracts attention to the illness.

Thyroid fatigability is apt to be more pronounced than the loss of strength of tuberculosis, and is more distinctly a nervous symptom. It is easily excited by mental exertion or by emotion. It often shows itself in an uncertainty in walking or an unsteadiness in rising from a sitting posture. It seems to be the symptom that is back of the apprehension these patients often have on the street or in crowded cars. Another distinction of great significance is, that the loss of strength in thyroid toxæmia is not attended, as noted above, by loss of weight. In two recent cases under my observation, when I have strongly suspected an early tuberculosis, the fact that the patients did not lose weight first put me on the track of thyroid disease.

Acceleration of the pulse to 100 or 110, accompanied or not by a mild pyrexia, is a symptom of the greatest significance in the diagnosis of tuberculosis.

Thyroid toxæmia practically always shows a similar tachycardia. Thyroid tachycardia is, however, erratic. Trifling emotional disturbances excite and increase it. The rate will vary twenty beats or more in a brief period of observation. The wave is small and jerky and the blood-pressure often elevated. The pulse of tuberculosis is steadily above normal, maintains a uniform rate under observation, and the blood-pressure is usually low. In thyroid disease the rapid heart tends to be turbulent in its action. The patient is conscious of the condition and is distressed by it. In other words, there is palpitation.

Mild chronic pyrexia is one of the most characteristic symptoms of early pulmonary tuberculosis. Of this symptom Hawes, of Boston, says: "Combined with a loss of weight and strength and other suspicious constitutional symptoms, a slight afternoon fever up to 99·2° or 99·4° F., or a constantly subnormal temperature with rapid pulse, may be considered an almost positive symptom of tuberculosis, whether or not definite signs are found in the lungs." This expresses the general medical opinion of the importance of this symptom.

A pyrexia almost identical in its course is met with in many cases of mild thyroid toxæmia. I have been unable to determine to my satisfaction any well-defined distinctions that can be made in this symptom in the two conditions. The range is about the same and the diurnal variations are very similar. Perhaps, the early morning subnormal temperature so frequent in tuberculosis is not often in evidence in the thyroid pyrexia.

Pathological conditions of the upper respiratory tract are noted with great frequency in thyroid toxæmia. Hypertrophied and infected tonsils are found to be present in about 30 per cent. of the cases, and it is not improbable that absorption from chronically infected tonsils is an important etiological factor in thyroid toxæmia. An associated pharyngeal and laryngeal catarrh usually is present, and chronic cough is a frequent result. There is very little to distinguish this cough from that of incipient tuberculosis. It may, however, be paroxysmal in character, or plainly due to excessive pharyngeal secretion.

Disturbances of digestion and assimilation require but a word. They are frequently observed in both conditions. The relation of a persistent indigestion to an incipient tuberculosis is well recognized, and when accompanied by debility, rapid pulse, and fever, always arouses suspicion of infection. There is nothing distinctive, however, in the character of either a tuberculous or a thyroid dyspepsia.

DISCUSSION.

Dr. Swan: Disturbances of the ductless glands are common in that part of the country in which I live. I have seen many cases of thyroid disturbance in the last two years. Loss of weight is a common symptom; at least many of the patients are under weight. There is usually no evidence of pulmonary disease, however. Diarrhœa is a fairly common symptom. In my experience the blood-pressure varies: in some cases the systolic pressure is high and in others it is low. The question of the proper name for these cases occurs. I have been calling them cases of hyperthyroidism. It might possibly be better to call them cases of dysthyroidism; for, of course, we do not know whether the thyroid secretion is decreased in amount, increased in amount, or increased in amount and deficient in some of its chemical constituents. Thyroid disease and tuberculosis may occur in the same patient. I am sorry that Dr. Kinghorn has gone, because I recently sent him a patient who had both hyperthroidism and pulmonary tuberculosis, and he could give the details of the progress of the disease. The patient died recently from an attack of asthma. Some of the cases do well when treated with syrup of the iodide of iron. I have supposed that the iodine in this preparation activates the defective thyroid secretion that is present and so relieves the symptoms. Another remedy that has produced good results is quinine hydrobromide, 5 gr. three times a day. I have never treated these cases with thyroid preparations because I have believed there is great danger of converting a mild chronic case into a serious acute case. Such cases have been reported in the literature. In my experience, rest in bed out of doors is followed in many cases of hyperthyroidism by a prompt improvement in the symptoms.

Dr. Stone: In looking over the charts, I ran across a good number of thyroid cases that had been under treatment from a number of weeks to several months, and in none of these was there a tendency to abnormality in the blood-pressure. It was either normal or slightly above normal.

Dr. Gordon Wilson: I have seen a few of these cases in Baltimore. There is one point in the differential diagnosis to which I should like to call attention, and that is the rapidity of the reaction to rest. Tubercular cases give a quicker reaction to absolute rest in bed in their digestive symptoms, &c., while you get very little reaction in two or three weeks in cases of hyperthyroidism with reference to digestive symptoms.

Dr. Minor: In regard to the cases that Dr. Wilson refers to, I would say that one of these was a case that he sent down to me. In this case he and I were both at first uncertain of the diagnosis, but it cleared up later, when it became evident that it was one of hyperthyroidism. The temperature was more irregular than in tuberculosis, rising sometimes in the morning and sometimes in the afternoon; the neurasthenic symptoms were extremely pronounced, and there was profuse sweating on the slightest exertion. The treatment was all directed towards the neurasthenia, and I did not give treatment for hyperthyroidism. The patient improved greatly, however, and gained greatly in weight. Dr. Wilson has seen her since I have, and I believe that her present condition is good. The difficulty in feeling sure of the diagnosis at first was great; yet, after a period of study, we felt we could come to a definite conclusion. To settle it in two or three weeks, however, was impossible.

Dr. ROCHESTER: I was going to make that remark about the effect of rest in these cases myself. I think that we get a prompt reaction to rest in cases of hyperthyroidism. Just before I left home a case came under my observation. I put the patient to bed. She had been running a pulse of 140, and within three days after going to bed it was down to 96. I simply modified her diet, without giving any medicine at all. I think that this point in the differential diagnosis is not to be maintained. I am sorry to differ with Dr. Wilson in that respect. The question of the differential diagnosis between thyroid disease and tuberculosis is often fraught with great difficulty, and the occurrence of the two together, as Dr. Swan has said, it is not uncommon. I have found it in a number of cases.

Dr. ANDERS: I was glad to hear Dr. Jennings refer to the peculiarities of the tachycardia in the two conditions, and I agree with him in the points he made in that connection.

Dr. JENNINGS (closing): In reply to Dr. Swan's criticism of the use of thyroid extract in these cases, I would say that I think if I had the ordinary commercial thyroid preparations to deal with solely, I should express the same opinion; but these cases do respond to the thyroprotein of Beebe, which is the preparation I use. There is a great distinction between that and the ordinary thyroid preparations on the market. I obtain the product at the experimental laboratory of Cornell University, New York. This preparation relieves these cases, even when there are symptoms of hyperthyroidism. It is put up in 1, 2, and 5 per cent. tablets. The 2 per cent. tablets represent one-fiftieth of a grain of the thyroprotein of Beebe.

DRY AIR BATHS IN TREATING TUBERCULOSIS.

By CHARLES FOX GARDINER.

COLORADO SPRINGS.

Before considering the practical side of air therapy as applied to the surface of the body in tuberculosis, it is, perhaps, as well to outline briefly some of the more recent advances in physiological medicine bearing on the subject. The whole question of ventilation as affecting the human body, both by respiration and the skin, has assumed a new aspect, and we are now assured that the old idea of vitiated air poisoning the body by being re-breathed, as in respiration, is only partly true, but that the really poisonous effect of bad air is not due to rebreathing such air but to the blanket of stagnant, warm, moist air surrounding the skin. The problem, therefore, is not a chemical but a purely physical one. This has been demonstrated by the simple experiment of agitating foul air by the use of electric fans when the symptoms of illness and distress, induced in people confined in such foul air, disappear when the air is so agitated, although no fresh air has been introduced to relieve them.

This idea regarding ventilation is so unique and revolutionary that I prefer to give some proof in later articles written on the subject. But first I will quote an article written by a member of this society, Dr. Henry Sewall, of Denver, and published in the *Journal of the American*

Medical Association, vol. lviii, p. 74: "In 1905, Heymann, Paul and Ercklintz performed in the laboratory of Flugge, several series of experiments of fundamental importance. It was found that when a man was confined in an air-tight box no discomfort was felt until both temperature and humidity of the air within the box had increased to certain degrees. Then were experienced with increasing intensity the various symptoms produced by foul air, as headache, fatigue, dizziness, nausea, &c. When the confined air was set in motion by an electric fan the disagreeable sensations were almost immediately relieved. If, while suffering from the conditions within the box, the subject breathed pure air from outside, through a tube fastened in the wall of the enclosed space, no relief from the symptoms was experienced. If, however, the subject was situated wholly outside the box and, through tubes inserted in his nostrils, breathed air from within, which had already been made foul by another person, no discomfort was felt."

Leonard Hill, in an article in the *Journal of Physiology,* 1910, called "The Relative Influence of Heat and Chemical Impurity of Close Air," says: "Eight men were confined in an air-tight chamber. After forty minutes the discomfort felt was great. All were wet with sweat and the skin of all was flushed. On putting on the electric fans and whirling the air in the chamber the relief was immediate and very great, and this in spite of the temperature of the chamber continuing to rise." In "Air and Health," by Ronald Campbell Macfee, p. 131, he says: "There seems a fair presumption then that the skin is the chief source of poison in so-called vitiated air," and again, on p. 132, "now stagnant air is air that never occurs under natural conditions, and it implies an absence of skin reflexes which are important stimuli to normal metabolism." Again, on p. 313, "and we are driven to the conclusion that a very important factor in open window treatment is the mechanical and thermal stimulus of the air blowing on the skin."

Henderson, in the *Journal of the American Medical Association,* November 22, 1913, writes: "Warm, moist, stagnant air does, in some way, prevent the human machine from doing its work properly." How such moving air affects the body has been told very ably by Dr. Simon Baruch in his "Principles and Practice of Hydrotherapy." "They are, therefore, factors to consider in the physiology of hot air baths or thermic irritations. These are under the control of the nerve centres which are connected on the one hand by cerebrospinal and sympathetic fibres with the tactal nerves of the skin, and on the other with the abundant capillary network of the skin and muscles, both of which respond to the slightest temperature impressions by narrowing or dilating the cutaneous or muscular capillaries."

With the foregoing facts before us, a serious question arises. Have we not neglected the important factor of skin ventilation in our enthusiasm over fresh air as used in treating tuberculosis by respiration? If the skin, as has been shown, is such an important factor in metabolism, consider the case of the tubercular invalid. In this disease we have, as shown by Albert Robin in his "Treatment of Tuberculosis," p. 43, and by many others, a seriously deranged metabolism, a changed and exaggerated respiratory action, a skin unduly sensitive to impressions, covered with perspiration and possibly inducing some re-absorption of poisons. The average tubercular invalid, even when taking the outdoor air under the best conditions of heat and moisture, has a layer of air in contact with his skin, that is, air moist and stagnant. This condition has, of course, been observed, and different forms of baths, hot and cold, massage and the open-air sun exposure, are now part of the regular system used in sanatoriums. There is nothing new in changing air in contact with the skin. The nude body has been exposed from the earliest times as a means of cure in diseased condition. The work done by Rollier at Leysin, and probably at many other places, in curing tubercular joints and other forms of tuberculosis by exposing the nude body to the sun's rays must depend, partly at least, for their efficiency, to the tonic influence of dry, cold, moving air on the skin. Further, it is not alone a question of fresh air upon the skin that produces a beneficial effect. In fact we must not reason by analogy and look upon the skin as we do upon the respiratory function. The skin acts in a different way. The skin needs stimulation to produce an effect upon the body. Increased metabolism and better nutrition result from air in movement on the skin. Air which is dry by rapid interchange induces stimulation to the nerve endings, increases blood-pressure and evaporates perspiration. The reason why tubercular cases act so unfavourably in the Tropics is that the skin is in a warm, moist air which relaxes, debilitates, induces anæmia, loss of appetite and lack of general tone, with sleeplessness. Tubercular cases do better, as a rule, in winter when the air holds less moisture; and better in dry cold climates than in dry warm ones, the reason being the more rapid interchange of the layer of air in contact with the body. The inhalation of damp air is probably less of a factor in treating tuberculosis than was supposed. Air moisture within the lungs is a constant factor below the bronchi. Wet or cold, warm or moist, the air in contact with the diseased areas in pulmonary tuberculosis probably is of about the same humidity under any conditions. On the surface of the body, however, the changes from dry to damp are varied and noticeable. To draw in damp air by breathing rarely disturbs a tubercular invalid, but, if he stands in a draught with wet clothes, the result is often disastrous. The difficulty of changing the moist, warm, stagnant air imprisoned by warm clothes, lying continuously in a layer over the skin of a tubercular patient, is a problem, and one probably as important as giving the lungs pure, fresh air to breathe. The danger of catching cold with these patients is an ever-present fear, and chilling of the body must be avoided in changing this surface layer of air rapidly.

The nude, open-air treatment works very well with children, warmed as they are by the sun and, introduced gradually, it is to-day one of the most efficient weapons we have in the fight against tuberculosis. A few adults will also take kindly to such a procedure, but when a patient is ill with temperature and often feels chilly and despondent, any suggestion about exposing the body in the open-air is apt to be met with violent objection, and if even a slight increase of symptoms should occur after such exposure, the exposure is pointed out as the immediate cause; so, the difficulties encountered in exposing the skin of an adult suffering with tuberculosis of any gravity to the tonic outdoor air and sun are often embarrassing, except in selected cases. Then again, the nude exposure should be done in the sunshine, not only for the benefit derived from the actinic rays but for the warmth imparted. However, at least in many climates, there is such a large average of dark, overcast weather that the difficulties are greatly increased, making it almost impossible to utilize the sun's rays as desired, and much time is lost by fitful atmospherical conditions.

After giving considerable attention to this subject and trying numerous experiments, I have devised a scheme that, while not expensive or difficult for the unaided patient to apply, in a great measure at least, does away with the fear of outdoor exposure. It applies a constant interchange of air to the nude body with apparently all the beneficial effects connected with the outdoor air bath, without the sun's rays The dryness, rapidity of air movement and temperature can be easily controlled, and it is a method which can be applied in a patient's room and on a patient's bed without in any way disturbing him or exciting the nervous system. It can be given to those very ill, not able to sit up, is a valuable agent in reducing high temperature, and, properly controlled and applied in suitable cases, will prove to be an efficient and valuable aid to the other measures in use.

The method I have tried to perfect consists of an appara-

Air bath in use with the sheet thrown back to show patient's body.

tus that, as nearly as possible, represents conditions found in nature when the open-air bath is taken. The constant current of changing air found outdoors is artificially produced by an electric fan introducing a current of air, that is first passed through screens. These break up the current of air, making it flow gently and avoiding draught. The air at the intake is the room air at 70°, as it is not necessary to use cold, outdoor air, moving air being sufficient. This air, after its force is properly broken by screens, passes into a framework covered with the bedclothes, and placed over the nude patient who remains in bed undisturbed, with the head uncovered and not within the framework. Inside this framework six incandescent lamps give their heat to the skin and, although devoid of actinic rays, heat the body very much as does the sunshine in the open-air bath; if desired, a lamp can be used giving the actinic rays or artificial sunshine. The advantages of this device are that it supplies some of the stimulus found in the open-air baths, that the temperature and force of air can be regulated at will, which is difficult out of doors, that by the use of the lights and the moving air humidity is brought to a low point and, in short, an artificial climate can be created for the surface of the body that can be used in damp and cloudy weather when outdoor exposure is impossible, while in pleasant weather the nude sun baths can be used if desirable. One advantage is that those very ill are not moved from their position in the bed, and by gradually cooling the air in the framework by turning off in succession one lamp after another, a safe and efficient method of reducing temperature without any depressive reaction is obtained. These results have been found to follow my use of the air bath in treating tuberculosis. The skin humidity has been at once reduced from 22 to zero, and the general tonic effect has clearly followed that found in the open-air cure now so common, without the unpleasant and sudden changes due to overcast sunshine, wind and dust so often found outdoors.

The cost is small, the electricity consumed for both fan and lights being less than 5 cents per hour in Colorado Springs, and much less in some cities. The apparatus is strong, durable, light, and portable, and can be used by many different people in a day. The patients are not disturbed or excited more than by massage. This method does not take the place of the nude sun baths with the actinic rays, but it is a powerful substitute when the weather makes such an exposure impossible. Also, this bath can be used outdoors, the air of the room being conveyed to the framework while the patient is in the bed on a porch.

Conclusion.

The warm, moist, stagnant air, held by the clothes or coverings in contact with the body of a tubercular patient is not agitated rapidly enough even during the open-air cure. This air, physiologically considered, is of even more importance to health than the fresh air inhaled. A method by which this surface air in contact with the body can be rapidly changed without danger of discomfort to the patient will prove of much value, and should be used as part of the open-air cure in selected cases.

DISCUSSION.

Dr. Rochester : How do you heat the cage ?

Dr. Gardiner : I use two, four, or six electric bulbs, as the case may be.

Dr. Hinsdale : I think that Dr. Gardiner's contribution is valuable and certainly original, and I believe that this principle of air baths is one of the elements in the use of heliotherapy. Of course, in the Swiss Alps, and, indeed, on the French coast, where heliotherapy is largely used, sunlight is the principal force applied; but at the same time the patients are exposed to the atmosphere. Before being exposed to the direct sunlight, they are brought out on the balconies and are accustomed to the outside air. The skin is thus habituated to changes in temperature and hardened a little. Afterwards the process of exposure to sunlight and air is carried on so that I think that air baths supplement the action of sun baths.

Dr. Minor : If Dr. Gardiner thinks that the actinic rays have a potency for good in these cases, why does he not use them ?

Dr. Gardiner (closing) : In reply to Dr. Minor, I would say that it would be a very simple matter to use a special lamp so as to get the effect of the actinic rays. Such a lamp, called the "Cooper-Hewitt," and costing $125, would give the effect of the actinic rays, but I did not at the time feel I could afford such a lamp and therefore did not introduce it as part of my treatment. I think such lamps have a potency very nearly equal in effect to that of the sunlight. They have been employed for some years. I do not think I have anything more to add to what I have already said. I use this cage or framework for the reduction of temperature in tuberculosis. I employ it cautiously in selected cases, rarely using the air below the temperature of 60° F., first warming the cage by the electric lights to about 90° F., and then reducing the temperature by turning out the lights step by step.

Dr. MINOR: Why do you have the head out of the cage?

Dr. GARDINER: Because I have found it more comfortable for the patient to breathe the ordinary air of the room and the moving dry air on the head is such a small part of the body exposed as to be negligible in results.

HELIOTHERAPY IN TUBERCULOSIS OF THE BONES AND JOINTS.

By JOHN W. BRANNAN, M.D.

NEW YORK.

The systematic use of heliotherapy in tuberculosis of the bones and joints is of comparatively recent date. It is true that as long ago as 1774, Faure and other French surgeons reported the cure of ulcers of the legs by exposure to the sun's rays, and Gauvain, in 1815, and Bonnet, in 1840, advised the same treatment for chronic articular inflammations. Richli also founded in Austria an institution in which sun baths were used for the treatment of various general affections of the body. It was not, however, until 1880 that heliotherapy became a recognized therapeutic procedure in surgical tuberculosis. In that year, Ollier, of Lyons, declared that heliotherapy was the treatment *par excellence* for tuberculous arthritis, and later Poncet, his successor at the Hôtel Dieu, advised his students "to expose cases of osteitis and arthritis to the sun and to allow the skin and the tissues to breathe in the pure air and to avoid bandages *cache misère, through which* the light never filters." Other physicians of the South of France, especially on the shores of the Mediterranean, followed the teachings and practice of Poncet, adding the sun cure to the "cure marine," and in

1904, Bernhard, of St. Moritz, reported his four years' experience with heliotherapy in the high altitudes of the Engadine. Rollier, the Swiss physician, impressed by the results of Bernhard, established a hospital in Leysin, in the Vaudois Alps, Switzerland. Here, at an elevation of about 5,000 ft. above sea level, Rollier has practised heliotherapy on a large scale for fully ten years, but it is only

FIG. 1.—" Les Frênes," one of the buildings at Leysin, showing balconies facing the south.

within the last three or four years that his work has attracted much attention. His methods are not unknown to the members of this Association, especially since the recent publication of the admirable paper by our Secretary, Dr. Hinsdale. I shall, therefore, not describe them in detail.

The elevation of Leysin renders it comparatively free from the clouds and mists of the lower levels. The hospital buildings face the south and are protected by mountain ranges from the cold winds of the north and west. Even in mid-winter the temperature on the sunny balconies is often as high as 45° F. to 50° F. Owing to the purity of the atmosphere and the absence of moisture, there is no loss of the luminous and caloric radiation of the sun, which at that altitude is very rich in ultra-violet rays. The exposure to the sun is gradual, beginning the first day with the feet and wrists for three periods of five to ten minutes each. This is steadily increased as pigmentation of the skin appears, until finally the entire surface of the body is exposed from sunrise to sunset. In insisting upon total exposure of the body Rollier has improved upon the methods of Poncet, who only exposed the seat of the lesion and the skin adjacent to it. The head is always protected. With the development of pigmentation the cure progresses until recovery is complete. Rollier regards the pigmentation as an important element in the cure. It gives to the skin a remarkable resistance, favours the cicatrization of wounds, and confers a local immunity to cutaneous microbic infections.

In a recent number of the *London Nursing Mirror*, a nurse tells of her experience as a patient at Leysin. She writes: "It was so warm with the sun shining that although at the time I was there it was mid-winter—the month of February—with the snow four or five feet thick all round about, one could lie out with the greatest comfort, devoid of clothing and positively bask in the sun. The feeling of warmth was also quite enjoyable and soothing, but one had to be careful to have sweaters and warm clothing close at hand to put on hurriedly when the sun went in or a cold wind sprang up."

The same writer goes on to say, "During my stay at Leysin, from February 10 to April 6, we had fairly good weather on the whole for that period of the year, which is usually bad—two or three days' sunshine in the week. It snowed heavily, and there was a certain amount of fog—Leysin's great drawback. Also there were days when there was a very unpleasant wind."

The experience of this nurse is interesting as showing

FIG. 2.—Heliotherapy at Sea Breeze Hospital, June, 1914.

that even at Leysin there are fogs and cold winds to contend with—this by way of encouragement to those who practise in the changeable climate of this country.

I have spoken above of "the cure progressing until recovery is complete." What is meant by a cure and what is meant by recovery at Leysin I stated in a paper some two years ago. We know what is considered as a cure of a tuberculous joint by our orthopædic surgeons. I have seen many such cures at Sea Breeze Hospital. Arrest of the disease with ankylosis of the joint in as useful a position as possible is accepted as a satisfactory result. But at Leysin the cure of a tuberculous joint means the complete recovery of function—full flexion and full extension—as shown in the illustrations accompanying this article. The improvement in the general condition of the patient proceeds *pari passu* with the cure of the joint or other bone lesion.

My attention was called to the work of Rollier in 1910 by Biggs, of New York, and Austin, of Paris, but it was not until two years later that it was decided to add the sun cure to the "cure marine" at Sea Breeze. Rollier's frequent papers and demonstrations and those of other surgeons practising in the mountains of Switzerland had tended to create the impression that heliotherapy could be successfully carried out only at high altitudes. The excellent results reported by Poncet and his pupils along the shores of the Mediterranean had apparently attracted but little attention, even in France. About four years ago, however, Ménard, of Berck, where the outdoor and sea-air treatment of surgical tuberculosis had been employed for sixty years, adopted heliotherapy in addition, and now, as stated by Hinsdale, it is esteemed the essential feature of treatment. Since the construction of the new open pavilions facing the sea, all sinuses and suppurative lesions are left uncovered and exposed directly to the sunshine and sea air throughout the day, and are but lightly covered at night. Under this treatment healing progresses more rapidly than formerly, according to Ménard. Both he and Calvé, also of Berck, claim that the actinic action of the sun's rays is at least as powerful at the seashore as in mountain regions.

During the past two or three years the methods of Rollier have been followed by surgeons at lower levels, and even at points in the interior where they did not have the advantage of the intense sunlight of Leysin, nor the actinic action of the sun's rays at the seashore. Bardenheuer, of Cologne, has published his experience in the *Deutsche Zeitschrift für Chirurgie.* In the spring of 1911 he had visited Leysin and was greatly impressed with what he saw, and on his return to Cologne determined to employ heliotherapy even under the unpromising conditions offered by the municipal hospital in that city. The season, fortunately, was unusually favourable at Cologne throughout the spring,

FIG. 3.—Pott's disease, showing pigmentation. Complete paraplegia on entrance. Patient now up and about, wearing plaster of Paris jacket.

summer and autumn of 1911, and Bardenheuer obtained results such as he had never seen in thirty years of practice, and I am informed that he is a successful surgeon of high standing. Other surgeons in Germany report similar experiences. The brothers Felter-Stolzenberg, who were the first physicians in Germany to treat surgical tuberculosis at the seashore, introduced the sun cure some two years ago in their hospital at Wyk-Föhr on the North Sea. They were much impressed with its value, stating that often remarkable improvement took place after only a few weeks' exposure to the sun, and continued after the cessation of the treatment.

The sun apparently stimulated the healing process which had before been stationary.

In the spring of 1912, when heliotherapy was begun at Sea Breeze, we were not aware of the new departure at Berck, nor of the work of Bardenheuer at Cologne, and there were not lacking persons who, while perhaps willing to accept the cures claimed under the exceptional conditions at Leysin, did not believe that similar results could be obtained on our Atlantic coast. However, in spite of all doubters, treatment was started in April and from that time on practically all the patients have been exposed to the sun for several hours a day, weather permitting. In every case the seat of the lesion, especially if there be open sinuses, is selected for the chief exposure. Other parts of the body are also treated, but we do not often secure total exposure except in very small children, and in older children when confined to bed. One cannot handle patients in a hospital in the outskirts of a great city, and subject to visits from friends and relatives, with the same ease and freedom as at a distant and secluded point in the mountains, and in a building especially designed for its purpose. Little children do not mind running about on the porches or lying on the beds in a state of nature; in fact, they usually enjoy it, but boys and girls who have reached the age of 8 or 10 years are more difficult to control. We have always encouraged them to be up and about when freed from extension apparatus and spinal frames, and they like to spend every moment playing on the beach or about the grounds and porches. This spring, Miss Brass, the very efficient superintendent of the hospital, has arranged to have the children lie in the sun on the beds during the morning, especially in school hours, and the afternoon they have to themselves. Now that the warm weather has arrived they all spend much time in the water and on the sand, wearing only the breech clout and hat that make up the fashionable costume at Leysin. For years at Sea Breeze, before taking up heliotherapy, the nurses had noticed the favourable effect of the

FIG. 4.—Tuberculosis of hip, two sinuses, showing brace designed by Dr. Whitbeck to permit sea-bathing. On admission February 5, 1914, free discharge from sinuses, with most offensive odour. As result of daily baths in ocean the odour diminished greatly, and later disappeared entirely.

sea water on sinuses and skin lesions, and I have now no doubt that the sun's rays played a large part in the healing process.

What are the results of heliotherapy as carried out at Sea Breeze? In a number of cases we have seen sinuses of long standing show a rapid improvement. Occasionally a sequestrum of bone is extruded spontaneously and the sinus closes permanently, in the manner described by Rollier. In some cases the discharge increases and thickens at first, as if a Bier cup had been used, then grows thinner and finally ceases with closure of the sinus. In almost all cases the general condition is apparently much benefited. Sometimes it is necessary to interrupt the treatment or give it for very short periods, particularly with blond children in whom the pigmentation is of slow or imperfect development. Last week Miss Brass called my attention to a fair-haired, blue-eyed boy that was pigmenting with the rest and rejoicing in the sunshine, but generally the blonds do not do as well as those of darker skin. The best results are naturally obtained with the smaller joints and we have many cases of wrists and fingers and elbows and ankles in which the arrest of the disease is accompanied with good or perfect motion.

The greatest difficulty I have found in carrying out heliotherapy or any form of outdoor treatment is that it seems almost impossible to interest surgeons or physicians and secure their willing co-operation. Why this should be so I do not know, unless it is because they belong to the medical profession. In my association with hospital practitioners during the past twelve years I have found that only about one man in ten cared to take the trouble, or thought it worth the trouble, to put his patients on the balconies especially constructed for them. This applies to the visiting and house staffs alike and in about the same proportion. Halstead ten years ago told us of advanced cases of surgical diseases which he sent to the Adirondacks, where they got well without further operative procedure. How many surgeons in the United States have followed Halstead's example?

Quite recently in New York an encouraging movement has been started by the genito-urinary surgeon and specialist, J. F. McCarthy, to secure provision by the city or state for hygienic or climatic treatment of *adult* patients suffering from uro-genital or other forms of surgical tuberculosis. He has in mind especially post-operative or inoperable cases, for which there are now no hospital facilities, either in city or

FIG. 5.—Tuberculosis of hip. Originally four sinuses, was reduced to two, with very slight discharge, after seven months' treatment. Improvement in sinuses attributed mainly to heliotherapy.

country. Acting on Dr. McCarthy's suggestion, I have requested the city authorities to set aside a certain number of beds for these cases at Seaview, the new hospital on Staten Island, and also at Otisville, the Sanatorium hitherto devoted entirely to pulmonary tuberculosis. Sea Breeze, with its limited accommodations, receives only children, but I hope that in the new hospital now under construction on Rockaway Beach some beds may be reserved for adults as new pavilions are added in the future.

A few words in conclusion about this new Sea Breeze Hospital. The City of New York has given a site fronting 1,000 ft. on the ocean to the south and running back 700 ft. over the dunes. Our plans call for an ultimate structure of 1,000 beds. The first two pavilions, providing for about 150 children, were begun some four months ago and should be completed by the middle of next year. Here in this comparatively retired spot, far from the madding crowds of Coney Island, we ought to be able to practise heliotherapy in all its details after the manner of Leysin and Berck. The situation is ideal, with the ocean to the sunny south instead of the cold north-west, as it is at Berck, and with the hospital building less than one hundred yards from the water's edge. Of course, we shall arrange for the cubicles or alcoves such as are to be seen in the pictures of Rollier's hospital, into which the sun plunges and the patient is sheltered from the wind. There will also be a swimming pool in the building with warmed sea water so that the children may have their salt baths in all seasons. A glass roof to the pool will give the sun bath as well. But I must not let my fancy go further or I shall exceed my time limit, but will close by stating that in order to secure the fullest results in this fine location we must put the hospital under the control of a man who understands its main purpose and is in entire sympathy with it.

BIBLIOGRAPHY.

FAURE. "L'Héliothérapie," by Armand-Delille, *Mongraphies Cliniques*, No. 75, published February 6, 1914. Masson et Cie., Paris.

CAUVIN. *Ibid.*

BONNAT. *Ibid.*

RICHLI. *Ibid.*

OLLIER. *Ibid.*

PONCET. *Ibid.*

BERNHARD. *Ibid.*

ROLLIER. *Paris Médical,* February 15, 1913.

HINSDALE. *Interstate Medical Journal,* vol. xxi, No. 3, March, 1914.

Idem. "Tuberculosis and the Atmospheric Air." At the end of this volume.

London Nursing Mirror, May 2, 1914.
BRANNAN. *Medical Record*, June 7, 1913.
MÉNARD. *Archives de Méd. des Enfants*, August, 1912.
CALVÉ. *Ibid.*
BARDENHEUER. *Strahlentherapie*, Heft 3, 1912.
FELTEN-STOLZENBERG. *Ibid.*, Band i, Heft 4, 1912.

DISCUSSION.

Dr. OTIS : In 1912 it was my privilege to visit one of Rollier's sanitariums—about the 1st June, in 1912. In this institution, Rollier treats not only children, but also adults. What impressed me particularly was the extraordinary general good condition of the children. I never have seen happier and more rollicking children than those in these wards of Rollier's. It was difficult to tell to what race they belonged, they were so pigmented, the majority being a mahogany or chocolate colour. The prognosis, successful or otherwise, depends on the amount of pigmentation. It was a very extraordinary thing to go through those wards and see the children, some of whom had been operated on. In every instance the wounds were rapidly healing and the general good condition of the children was remarkable.

Dr. MINOR : I am glad Dr. Brannan has given his experience with this procedure, but I have run across some difficulties that, in the United States at least, have to be considered in applying this method of treatment. I have found some cases of tuberculous glands of the neck and a case of tuberculosis of the spine suitable for this treatment, and have discovered that it is not so easy in the United States to expose the patients in the way that is desirable as it is in Rollier's institution. You all remember that he always begins with the feet in applying the treatment, no matter where the trouble may be. He exposes the feet for five minutes at first, and then gradually moves further and further up, until he exposes the whole body. I have not got beyond the knees, so far. I am somewhat puzzled, in the conditions under which I work, as are others here, to get the proper opportunity for exposing these ladies and gentlemen naked to the sun. I think that in the United States we shall find this a serious handicap. Anyone, however, who has read Rollier's book, and looked at its pictures of wonderful results, will feel convinced that this treatment ought to be used in cases of surgical tuberculosis. Dr. Schroetter also uses it in pulmonary tuberculosis, but I have not investigated its use in such cases yet. I wish that someone could suggest a method of exposing these patients which would be in accord with American customs as to propriety.

Dr. GARDINER : I have been using heliotherapy for tuberculosis for several years at an altitude of 6,000 ft. where the air is very dry

According to Cleaves, of New York, this climatic condition is a great advantage in using heliotherapy. The actinic rays are more active and you get more actual benefits with less heat rays in proportion to the others. We have two or three advantages in dry climate of altitude. In the first place we have more days in the year in which we can expose the patient to the sun and are not interrupted by as much cloudy weather. Then the rays that we do receive are more efficient. At the sea level 40 per cent. of the active actinic rays are absorbed by the atmosphere before they reach the surface of the skin. The Germans have also claimed that an elevation is efficient and valuable, and that therefore they have advantages over lower countries. I have also used this treatment for tuberculosis of the lungs, and although of decided help to my patients, I had not the brilliant results reported by some physicians. It certainly has to be used carefully. I have commenced slowly at the ankles, and then, day by day, extended the exposure as Rollier suggests, and we should, I think, be especially careful not to overdo this exposure to the sun. I have myself seen high temperature and considerable discomfort from undue exposure. I think, however, that the treatment of heliotherapy is on a firm and scientific basis; that in tuberculosis it certainly is beneficial and favourably affects metabolism and, as it is more studied, it will be used in many places where it is now neglected.

Dr. POTTENGER: Regarding pulmonary cases, I have used similar exposures to the sun in their treatment for ten years, and have had no difficulty whatever. We have been using a large mirror, 3½ ft. in diameter, covered with a blue glass to cut off the heat rays, which concentrates the sun's rays in a focus 6 in. or 8 in. in diameter. We start the exposures at five minutes and increase their length five minutes a day until we use forty minutes, which is about as much as the patients can stand. We keep that up every day. I have seen no harm done by this treatment, and have thought that it did some good. It hardens the patients a great deal The man who devised this reflector claimed that the light penetrates the lung. I do not know why we should begin at the ankles. I have seen no ill effects from starting with the chest. It seems to me that Dr. Brannan covered the whole subject in his last statement, when he said: "If the trial of heliotherapy is to be a success, someone must be in charge of it who is in sympathy with the measure." That is true in every kind of treatment. Bier gets good results from his treatment with hyperæmia; Rollier gets good results from his method; and we must try to get them also. If we do not succeed, it is we who are failing, and not the method. We too often think if we do not get a certain result that it cannot be obtained; but it can. The result is due to the art of following out little details. The art of application is greater than the scientific fact itself. There is great good in this method, but we must not be faddists and depend upon it alone in either surgical or medical tuberculosis. I do not, as a matter of fact, believe that there is such a thing as surgical tuberculosis. Tuberculosis must be treated on the same principles, wherever it is found. I would not use anything exclusively. I would not use fresh air, heliotherapy, tuberculin, or hyperæmia alone; I would combine them all.

Dr. Minor: May I ask a question? As I understand it, Dr. Pottenger exposes his patients in a window of a room. Rollier begins outdoors with a small exposure and goes on to a greater surface, until he exposes the whole body. You could not do that with the mirror?

Dr. Pottenger: We have a false floor above the roof of one of our buildings and have the sides boarded up. We take eight patients at a time, all males or all females, and remove the clothing to the waist. We get the same browning of the skin that Rollier obtains. Some patients will carry this pigmentation for years. I have seen patients (brunettes) on whom it remained for four or five years afterwards. Blondes do not pigment much. I wonder whether it is true that pigmentation is a necessity for a successful result; I doubt it. We draw a great many conclusions that are not necessarily warranted We have had as good results in our blondes as in our brunettes. They burn and blister, but do not brown to the same extent as do brunettes.

Dr. Charles C. Browning (Los Angeles, Cal.): In regard to the question which Dr. Pottenger has brought up, I wish to say that I was for five years connected with him in this work. There is, by this method (the mirror), an exposure of both sides of the body. The mirror, if the sun is in the south, is set to the north side of the patient. The patient faces the mirror, and the mirror reflects the sun's rays on his chest. There does seem to be an especial effect on the tuberculous focus in the lung. This is shown by the fact that soon after the beginning of the exposures many patients show a decrease in the number of bacilli in their expectoration. A great many patients have an increased amount of expectoration for a time, but later this decreases. Occasionally a patient will expectorate a small amount of blood after each exposure. In such cases we discontinued the exposures, although the amount was slight; we always feared a hæmorrhage. At the County Hospital at Los Angeles, which is several miles from the coast, but on a lower level than Monrovia, there has been some work of this kind carried on during the last few months. We are not ready to report results yet, but we feel encouraged. Dr. Richardson, who is on the surgical service, has been putting some of his cases on my service. There have been some cases in children, and some in adults. There have also been some in which an Alby operation had been performed; and while we are not especially prepared for this work, yet our results have been encouraging. Where the sexes are segregated, we find that even in a very crowded hospital, where we frequently have 200 patients, although we should take only 125 or 130, we have very little trouble in overcoming the disadvantages, and are able to expose the patients sufficiently. I think that with slight additions to our hospitals, to protect the patients from the wind and their heads from the direct rays of the sun, it will be possible to carry the treatment out without much added expense. We are going to put up some new builindgs this fall, and hope to have some suitable for this purpose.

Dr. HINSDALE : I understand that Dr. Rollier takes some pulmonary cases. That, of course, is a very encouraging feature of the subject, because if the treatment is applicable to pulmonary cases as well as tuberculosis of the joints, so much the better for us who are engaged in general medicine. The question of pigmentation is very interesting, because while so much stress is laid on pigmentation as an index of the value of the treatment, if we deal with cases of racial pigmentation, as in the negro, who is peculiarly susceptible to tuberculosis, we find that the pigmentation of the skin does not seem to act as a protection against the disease. It would be interesting to see how negroes would react to heliotherapy. Although they already have pigmentation, it has been supposed by many practitioners that very few coloured people who contract tuberculosis ever get well. Whether they would do so under this sort of treatment we do not know.

Another thing affecting the treatment carried out at the high altitudes and that at the sea-shore is worthy of note, and that is that the higher we ascend the greater is the ionization of the air. This ionization rapidly increases until the air is almost completely ionized. The substances in the atmosphere are ionized, and the ionization is calculated to be twenty times as much in the higher regions as it is at the sea-shore. The actinic rays are also more active than at the sea level. The lower stratum of atmosphere, the envelope of air that covers the earth, is more dense at the sea level, and offers obstruction to the passage of the rays belonging to the violet end of the spectrum, but does not interfere so much with the rays belonging to the red end of the spectrum, the heat rays. The question of dosage thus comes in, because it is only a certain amount of this radiation that can be received or appropriated by the patient. Probably, for all practical purposes, we can get almost as good results at a favourably situated sea-shore as in the mountains; but the trouble is that on the Atlantic seaboard we do not get the same continuous record of sunshine as we do in Colorado or New Mexico, at higher elevations. It would appear, therefore, that better prospects for the success of the treatment would be had at an elevation of 5,000 or 6,000 ft. in Colorado or New Mexico than at the Atlantic seaboard. When I was at Sea Breeze last January I took the temperature on the porch. I saw, with my own eyes, that it registered 62° C. on January 21. The day was bright and comfortably warm. Nevertheless, there had previously been weeks of cloudy and bad weather, and these children had not been exposed to the sunlight for a long time. Therefore, you see, it is often necessary to interrupt the treatment on the Atlantic seaboard; and that is why there are so many difficulties in the way of carrying out the treatment.

There is one other institution, I have lately learned, where they have used heliotherapy for two years; it is the Crawford Allen Hospital at East Greenwich, Rhode Island. It is on Narragansett Bay, and is a branch of the Rhode Island Hospital. Favourable reports have been made by Dr. Raymond. Sea Breeze, Long Island, Dr. Pottenger's Sanatorium in California, and the Crawford Allen, Rhode Island, are the only ones where this work is done systematically for tuberculosis, as far as I know.

Dr. BRANNAN (closing): The paper has been so thoroughly discussed that I do not feel justified in taking much more of the time of the Society. Referring to the pigmentation, upon which so much stress is laid by Rollier, Dr. Hinsdale has raised the interesting question of the possible therapeutic effect of the sun's rays upon the negro with his inherent black skin. An answer to this question has been given by Dr. Dunn, an English physician residing at Luxor. He happened to be in New York about ten days ago and went down with me to Sea Breeze. While discussing the pigmentation of the children and its alleged curative importance, he said that there was much tuberculosis among the native children in Egypt, although they run about naked in the sun all day long. I do not recall whether he referred particularly to surgical tuberculosis or to tuberculosis in general.

A great deal has been written of the relative heliotherapeutic value of high altitudes and the seashore. Much of this rather controversial writing seems to me to be useless except as it may serve to make clear the climatic features of the two regions. Excellent results have been obtained in both situations, and also, as we have seen, at low levels in the interior. We cannot send all of our patients to the mountains, nor to the sea, but, like Bardenheuer, we can give them such sunshine as we have, and no doubt with equal benefit.

Dr. Hinsdale, in his paper,* gives rather too much credit, I think, to the French physicians for their work in heliotherapy. It is only during the past two years that they have practised it systematically, after the manner of Rollier. I was at Berck in 1905 and again in 1909, and it was not in use, nor was any mention made of it whatever by the physicians in charge of the hospitals there. But now the French journals contain articles in large numbers telling of the cures effected by heliotherapy in the hospitals on the various coasts of France. I have recently seen a brochure nearly ½ in. in thickness made up entirely of monographs on the subject by French writers, but making very little acknowledgment of their indebtedness to Rollier.

* "The Treatment of 'Surgical' Tuberculosis at the Sanatoria on the French Coast and in the Swiss Alps by Heliotherapy," *Interstate Medical Journal*, St. Louis, Mo., March, 1914. See also pages 44-54 and 71-74 in Dr. Hinsdale's article at end of this volume.

REPORT OF FOUR CASES OF TUBERCULAR MENINGITIS WITH APPARENT PERMANENT ARRESTMENT.

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TUBERCULOSIS in any tissue may be acute, subacute or chronic in its course. The terminal stage of tuberculosis may be infiltration, fibrosis, caseation, calcareous, or complete breaking-down and destruction of tissue, or a combination of two or more of these changes. It is always a replacement disease, the replacement remaining permanent.

These conditions must be considered in discussing the curability of tuberculosis of any tissue. If a return to the former condition of tissue is indicated by the term cure, such does not occur. If clinical restoration to health of the individual or restored function of an organ is the requisite, cures occur. Pathological cures may not occur. Clinical cures do occur. Tubercular conditions tend toward arrestment. These may only amount to slight amelioration of symptoms, or to a distinct remission of greater or less extent which may terminate in a condition of arrestment, temporary or permanent. This tendency varies greatly in different tissues, that of the meninges being very slight.

Tubercular meningitis is probably always secondary to active process in other tissues. The meningeal involvement may be general or localized, acute, subacute, or chronic.

The gravity of the meningeal infection may be such that the primary focus may be quite overlooked or cease to be of importance from a prognostic standpoint.

It may accompany an attack of acute general miliary tuberculosis, in which the general condition is so grave that the final outcome may not be materially influenced by the meningitis, but the existence of meningeal involvement is always sufficient cause for grave prognosis.

A sufficient number of cases, however, have been reported of prolonged arrestment of activity, or cures, to show that, while such termination is not frequent, it is possible.

George A. Crace-Calvert, London, reports four cases of recovery in the *Medical Press*, July 9, 1914. He quotes Martin, reported in *Brain*, vol. xxxii, recording twenty undoubted cases of recovery since 1894.

Reichman and Rauch, abstract in *Journal of the American Medical Association*, August 9, 1913, report two cases of recovery; one a child, aged 2, the other a robust young man. They collected eighteen other cases, more than half of which have been reported during the past five years.

Professor Rotch, in his "Pediatrics," 1903, reports two cases of recurrent meningitis, stating these cases are rare, the disease being almost uniformly fatal in first attack.

Case of child, aged 21 months, died of subacute tubercular meningitis, which gave history of having suffered from symptoms of meningitis at intervals since nine months of age. Autopsy showed old tubercular lesions in meninges, as well as those which produced the symptoms from which the patient died. This case showed tubercular lesions in other organs, both of a chronic and acute miliary character.

A case of Pott's disease developed symptoms of meningitis May 7, and continued five days, when it appeared well. Recurrence of symptoms for short periods followed by remissions for twenty-five days, when remission of two months occurred, with symptoms for two days. Following this there were no symptoms for ten weeks. Symptoms again recurred followed by death in four days.

Post-mortem showed recent tubercular meningitis. In addition older large tubercles of brain and remains of previous attacks of tubercular meningitis.

Professor Hutinol, *Paris Medical Press*, November 15, 1912, suggests caution against mistaking a remission for recovery, and cites case of girl, aged 9, who, in 1874, had tubercular meningitis producing hemiplegia. She recovered from all symptoms only to die twenty-five years later of tubercular meningitis. I think we would be justified in classifying this case as an arrestment.

The following cases have been reported (Phipps Institute reports):—

3 to 8 years inclusive	5	
9 ,, 20 ,, ,, ...	5	
21 over	4	
Total age limit stated	14	
Age not stated	18	
Total		32
Cases reported as undoubted cures (arrestments):—		
Martin (*Brain*) collected	20	
Crace-Calvert reported	4	
Reichman-Rauch reported	2	
Reichman-Rauch collected	18	
		44
		76
Following cases		4
Grand total		80

Some of these may be duplicated, but probably others which have been reported are not included. Even the most sanguine must conclude that recoveries are rare. These are sufficient to encourage me to report the following cases :—

In July, 1885 (twenty-nine years ago), I was called to see A.R., near Carthage, Illinois, aged 4, whose parents had died of tuberculosis before she was 1 year old, both having an active tuberculous condition before she was born; she having been cared for in a small house with them until their death. The patient had had, and still had at the time of the present illness, enlarged cervical lymphatic glands. The signs and symptoms were those of acute meningitis.

The case ran the ordinary course of this disease for about four weeks, during which time three physicians saw her in consultation with me. All agreed that it was probably a case of tubercular meningitis. At the end of the fourth week the symptoms began gradually to subside, a tedious convalescence terminating in apparent recovery.

After about a year the patient passed from my observation and was not seen again until two years ago, when she moved to California from Illinois and came to my office. Her health was apparently good, she having had no return of former symptoms. At last account she was teaching school in one of the counties in the central part of the State.

I am quite aware that this case lacks the scientific data which would be required at this time for diagnosis of tubercular meningitis, and were it not that other cases have been reported of which there could be no doubt of the nature of the illness, I should regard the diagnosis in this particular case as probably incorrect. I report at this time, leaving each person interested to draw their own conclusions.

H. G., aged 18, domestic, entered the County Hospital (via ambulance) May 12, 1912.

Family History.—One paternal and one maternal grandparent died of tuberculosis, otherwise history was negative.

Past History.—Patient gave a history of poor health all her life. She had had all the children's diseases in severe form, also typhoid fever and pleurisy, the latter in 1911, six months previously. Menstrual periods began at 13, had always been scanty, irregular and extremely painful. There was an indefinite history of "heart trouble" in 1911.

Present Illness.—Began four days before entrance to hospital, when patient states she "became cold and stiff." For some time previous there had been some loss of weight, fever, cough and expectoration (muco-purulent), night sweats and shortness of breath. Patient complained of severe abdominal pains, loss of appetite and obstinate constipation.

Physical examination of the chest revealed evidence of active pulmonary tuberculosis in both upper lobes. Temperature irregular, 97° to 101° F., frequently from 98° to 99·5° F.; pulse 70 to 100. Heart sounds weak and irregular, mitral regurgitant murmur.

Vaginal examination gave extreme tenderness and mass on right side.

Laboratory Examination.—Urine was negative. Sputum showed slight mixed infection. No tubercle bacilli. Cutaneous test actively positive.

Operation on June 7, 1912, twenty-six days after entering hospital, which consisted of an appendectomy, plastic work on both ovaries and a curettage.

The clinical pathological report was as follows:—

Sclerotic condition of ovaries and endometritis—evidence of tuberculosis in appendix and ovaries.

About the middle of July patient began to complain of headache, which soon become persistent and gradually increased in severity, with some remissions and exacerbations. The temperature range was generally low, frequently 97° to 98° F., occasionally taking a sharp rise to 100°, 101°, or over for a short time. The pulse was erratic, varying from 70 to 150. Is reported to have had some rigidity of muscles of neck for short intervals early in August. On August 12, had severe opisthotonos, convulsive seizures, loss of consciousness and retention of urine. Pulse ran to 150, temperature 99° F. Noguchi test for butyric acid in spinal fluid positive. Pulse dropped to 100 and temperature to 98° F., following withdrawal of fluid. About ten days later symptoms again became active. Removal of fluid failed to give relief. Succinamide of mercury, 1 gr., given August 28. Apparently slight relief from symptoms. Repeated with 1·2 gr. August 31. This was followed by marked relief of symptoms. With slight show of return of symptoms this was repeated September 7, 1 gr., and September 16, 8 gr. Patient left hospital September 17, 1912. At last report was without marked return of symptoms.

This was apparently a case which was subacute from the beginning, the first symptoms having become manifest about six weeks following operation on tubercular organs.

E. M. W. Referred from the office of Dr. H. G. Brainerd by Dr. Stephen Smith.

The following is abstract of history from Dr. Brainerd's office :—

December 30, 1910. E. M. W., female, single, aged 32. Book-keeper. Normal weight 140 lb. Has lost weight rapidly of late, most during the past three weeks. Complains of weakness, numbness of left hand, weakness and "nervousness."

History.—Always delicate. Severe malaria in childhood. Suffered severely with facial neuralgia for several years. Lupus of face twelve years ago—three foci. Treated with X-ray and Finsen light. Remains well after nine years. Typhoid fever 1908. Pulmonary hæmorrhage 1909, one year ago. Weight reduced to 122 lb. Improved, some gain in weight, slight cough, no fever until about three weeks ago, when began to lose weight rapidly.

About three weeks ago, December 10, stooped over and was unable to arise without help. Soon felt better. Next morning sister (who is nurse) found her lying with arms extended and rigid, fingers clenched around thumbs; was very restless and nervous. Four days later loss of consciousness accompanied by mumbling and heavy breathing, no twitching. After two weeks right arm relaxed, but the hand is numb and weak with some pain along back of hand.

Left arm less improved, much tenderness inner side of left arm; numbness and weakness much more pronounced in left hand than right.

Mental condition impaired since present exacerbation began three weeks ago. During this time has had chills at irregular intervals and fever reaching as high as 101° F. Appetite abnormally great, bowels regular, sleeps poorly.

Present Condition.—December 30, 1910. Much demented. Tests of sensation not wholly reliable on account of mental confusion, but all seem to be more blunted in left arm and hand than right; station fair; co-ordination very poor. Same is true in less degree of left leg and foot. Wrist and elbow jerk greater on left side than right, also knee and ankle-jerk greater on left side, but less than in upper limb.

According to notes, the above conditions appeared to increase slightly with remissions and exacerbations until January 15, 1911, when patient was taken with hiccough. Right eyelid dropped. Left eye turned in. Conscious. Muttering speech. About fifteen minutes following onset of these symptoms patient fell asleep for a time, followed by increased mental dulness, with increased impairment of left hand, arm and lower limb—intensity being in the order named. Slight amelioration of symptoms after twenty-four hours.

Similar attacks occurred on January 19 and 31, the last one being preceded by metallic taste in mouth.

January 25. Wassermann test by Dr. Warden reported negative.

February 13. Paræsthesia around mouth, talks with difficulty, tongue thick. Drinks with difficulty.

February 20. Very restless, distressed and depressed. Growing weaker. Weakness more pronounced on left side, most left hand. Paræsthesia around mouth more troublesome. Talks thickly. Sleeps with mouth open. Temperature variable, but subnormal most of the time, 97° to 98° F. Pulse 90 to 100. Believed to be tubercular.

November 11, 1911. About three months after beginning of symptoms of present attack she presented herself at my office, accompanied by sister.

She was much depressed mentally; would sob and tears start when I attempted to obtain history from her, and appeared to be incapable of answering questions intelligently. Complained of numbness in hands, arms and lower limbs, most pronounced on left side; would rub left hand and say "It has gone away." There was some ptosis. Her facial expression was blank and stupid; would wander away if not watched. Muscle power was much reduced in both hands, almost absent in left; gait unsteady, imperfect use of both lower limbs, the use of left limb being much more impaired than right. Would fall easily if not assisted while walking. Reflexes as given above. Weight, 137 lb.—loss of 16 lb. during three months. Temperature range, oral, 97° to 98° F. Pulse 80 to 90.

Physical examination of chest showed evidence of fibrosis in the upper lobes of both lungs, most extensive in right where cavity signs were apparent about second and third ribs. Cutaneous tests promptly positive, lumbar puncture not made.

Watery extract of tubercle bacilli was used, beginning March 6, with ·001 mg. doses, which were gradually increased to ·01 mg. in about two months. Focal reactions were easily excited, as evidenced by temporary exacerbations of symptoms and signs of increased degree of paralysis. The symptoms and signs began to improve and continued uninterruptedly until at the end of two months her muscular impairment of function and mental condition were greatly improved and she had gained about 10 lb. in weight.

May 4, referred to Dr. Brainerd for examination. The following is from their record:—

"May 4, 1911. Patient has been taking tuberculin treatment under Dr. Browning. Weight has gone up to 145 lb. Mentality and spirits greatly improved, pain in arm better. Condition and use of arm better. Sleeps well. Some recurrence of symptoms after several of the injections of tuberculin. Patient looks cheerful and bright, talks well. Very little difference in reflexes on the two sides."

She continued under treatment for a year, with steady improvement, until by the end of six months she could come to my office alone. Her muscular system never entirely regained its formed condition, but she walks well enough to get around without danger or attracting marked attention. Temperature gradually approached normal, 97·6° to 98·4° F., and her weight increased to 157 lb.—gain of 20 lb. No forced feeding.

She gradually lost her sensitiveness to tuberculin and felt much better for about five days following a dose, which was 10 mg. of watery extract. The interval between doses was gradually increased, she being instructed to return whenever she felt toxic. This she did, returning at intervals of from one week to three weeks for another year, until treatment ceased, she having nearly regained her normal condition, and so continues to the present time, about three years later.

This case apparently was a moderately acute meningitis terminating in a chronic form, followed by an arrestment.

September 22, 1909. L. W., female, aged 2 years 9 months.

Family History.—Youngest of family of three children. Maternal grandmother died as result of accident, other three grandparents living and well, aged 61, 63, 67. Father and mother aged 39 and 37 respectively, two brothers aged 4 and 7. Patient well until "severe cold on lungs," January 18, 1909—2 years of age. Coughed very hard, recovery incomplete. July 7, 1909, went on picnic, became exhausted

FIG. 1.—L. W., photograph taken July 18, 1909, when the child was 2 years 7 months old. Note evidence of emaciation.

and grew progressively weaker, appetite poor, cough aggravated, had fever and night sweats.

July 18, 1909. Aged 2 years 7 months.

Twenty days later. August 7, 1909. Note continuance of emaciation. Apparent slight flatness left side of face.

August 9. Mother states left eye disappeared, "went up and out." Consulted oculist. Systemic symptoms grew

FIG. 2.—L. W., photograph taken twenty days later than fig. 1. Note continuance of emaciation. Apparent slight flatness left side of face.

FIG. 3.—Photograph showing the condition of patient, L. W., on September 26, forty-eight days after first ocular symptoms were manifest. There had been improvement of general physical condition, but steady progress of focal manifestations.

FIG. 4.—L. W., photograph one month later than fig. 3. Note improved general condition. Less spasm of muscles of neck and back. Still pronounced ptosis, flatness of left side of face, limp condition of right hand and foot.

progressively worse, but eye made some improvement; external strabismus continued.

August 13. Mother noticed she was losing use of right

FIG. 5.—L. W., fifteen days later, improvement continues. Ptosis much improved, improvement less marked in left eye. Note storm on right side of face and calm on left.

hand and that she fell frequently when attempting to walk; soon noticed dragging of left foot, followed by abandoning all efforts to walk. Used electricity for a few days, when noticed "both eyes began to close."

August 20. Taken to clinic, seen by Drs. Dudley (oculist), Chas. Lewis Allen and Ross Moore (neurologists).

FIG. 6.—L. W., eleven days later. Continued improvement. Note healthy appearance of brothers—the other two children in the family.

Ptosis both eyes, more pronounced in left, with marked degree of paralysis in right arm and hand, slight in left hand, with marked paralysis in lower limbs, was observed.

There was evidence of lesion in apices of both lungs, and continuation of symptoms noted above. Syphilis was believed to have been eliminated, and after careful observation of symptoms and signs until September 22 the case was referred to me as probably tubercular meningitis.

FIG. 7.—L. W., showing condition on January 6, 1910, eighteen days following onset of measles.

On Examination.—Enlargement of cervical glands, evidence of tubercular involvement of both apices, more marked in right. Moro and von Pirquet tests promptly and very actively positive. Began the use of watery extract of tubercle bacilli in doses of ·000,001 mg., which was cautiously increased. Several times evidence of focal reaction was observed as noted by temporary exacerbation of physical signs during course of treatment. Marked im-

FIG. 8.—L. W., photograph taken May, 1910, five months after recovery from the active symptoms of measles; eight months after beginning treatment. Note slight strabismus and ptosis of left eye.

provement was manifest at once, as shown by amelioration of symptoms and rapid improvement of signs.

Photograph shows condition of patient September 26, forty-eight days after first ocular symptoms were manifest.

FIG. 9.—L. W., in good health after four and a half years. Slight external strabismus still exists, the only remaining manifestation of the disease.

There had been improvement of general physical condition but steady progress of focal manifestations.

October 27, 1909. One month later. Note improved general condition. Less spasm of muscles of neck and back.

Still pronounced ptosis, flatness of left side of face, limp condition of right hand and foot.

November 11, 1909. Fifteen days later, improvement continues. Ptosis much improved, improvement less marked in left eye. Note storm on right side of face and calm on left.

November 22, 1909. Eleven days later. Continued improvement. Note healthy appearance of brothers—the other two children in the family.

December 19, 1909. Attack of measles. Soon former signs began to manifest themselves. Fig. 7 shows condition January 6, 1910, eighteen days following onset of measles. Signs gradually disappeared. Maximum dose of watery extract given was 2 mg.

May, 1910. Five months after recovery from active symptoms of measles; eight months after beginning treatment. Note slight strabismus and ptosis of left eye.

May 5, 1911. Continued good health after two years. Still in good health after four-and-a-half years. Slight external strabismus still exists, the only remaining manifestation of the disease. Temperature of this case was taken per rectum, and was somewhat erratic. At times would reach 102°, but more frequently was subnormal. The daily range generally did not exceed $1\frac{1}{2}$°.

DISCUSSION.

Dr. R. C. Paterson (Ste. Agathe): I should like to ask Dr. Browning what evidence he had that the case was one of tubercular meningitis—whether lumbar puncture was done and bacilli found in the fluid? I had one case with many symptoms of tubercular meningitis which cleared up rapidly. I think that it was due to toxic meningismus, which must be differentiated from tuberculous meningitis.

Dr. Cleaveland Floyd: I should like to know how Dr. Browning in his cases would include an odd type of infant paralysis.

Dr. Browning (closing): I think, in the first place, that until comparatively recently, it was the consensus of opinion that tubercular meningitis was always fatal. I think that enough cases have been reported in literature to show conclusively that it is not necessarily so In tubercular meningitis we must consider that it may occur as an acute, a subacute, or a chronic condition, as tuberculosis does in other tissues. Meningitis may be confused with infantile paralysis, syphilis, and other conditions, and the differentiaton must be made from these. Focal reactions to tuberculin are strongly presumptive of tubercular meningitis. In each of these cases there was an active tubercular infection. There was at the time of one of these cases infantile paralysis existing in Los Angeles, this case coming from Pasadena. The differential diagnosis and laboratory tests had been worked out in the hospital, and Dr. Ross Moore, who was actively engaged in the campaign against infantile paralysis in the city, saw her in consultation with me. He excluded infantile paralysis. Spinal puncture was made in this case; a few lymphocytes were found, but the tubercle bacilli were not found. These, we know, are not always found. Frequently, in my tuberculosis wards, I get a considerable degree of relief from the distressing symptoms by spinal puncture, but after a time I fail to get relief. Sometimes we find the tubercle bacilli in the fluid withdrawn at one time, but fail to find them in that drawn later. The patients have all died. I have found recorded in literature only seventy-six cases of recovery, most of them reported within the last seven or eight years, so I do not want you to feel that I am at all enthusiastic about the recovery of cases of tubercular meningitis.

SOME OF THE PROBLEMS OF PRIVATE SANATORIA FOR TUBERCULOSIS AS OBSERVED DURING TEN YEARS' EXPERIENCE IN THE POTTENGER SANATORIUM FOR DISEASES OF THE LUNGS AND THROAT.

By FRANCIS M. POTTENGER, A.M., M.D., LL.D.

MONROVIA, CALIFORNIA.

The Pottenger Sanatorium for Diseases of the Lungs and Throat has just completed its tenth year. It was the writer's pleasure to conceive, build, equip, finance, and organize this institution. He has been intimately connected with every detail of its running from the start. As medical director he has literally lived with the patients of the institution during nearly all of this period, having his home on the grounds, and being intimately connected with the life of the place.

During this time there have been 1,521 patients treated in the institution. The stay of these patients has varied from one day to three and a quarter years. The majority of patients remained in the institution and were under close observation during a period of seven or eight months. This has afforded an exceptional opportunity to study both the laboratory and clinical side of tuberculosis; to acquaint oneself with every phase of its development and progress both toward dissolution and toward arrestment; to study all the various complications, tuberculous and non-tuberculous; to learn to know the patient from both a physical and psychological standpoint; and, in fact, to study every peculiarity of the disease and the patient.

Coincident with this sanatorium experience the writer has treated patients in his city office, a majority of whom were charity cases, and many of whom were compelled to work during the time that they were taking treatment. This has afforded a splendid opportunity of studying the disease as it presents itself in different social conditions, and of comparing methods of treating the disease under home and institutional environment. He has been led to the conclusion that the advantages which the sanatorium offer those who are able to avail themselves of it are many. The patient is isolated. He is removed from home and business, with their interests and worries. He is taken away from the influence of solicitous and other meddlesome friends. He is kept away from many of the acute respiratory infections which are common among people in the ordinary walks of life. He is placed in hygienic surroundings in the open air, such as are rarely fully obtained in the home, which raise his resisting power and help him to overcome infections should he be exposed to them. He is placed in an environment which is especially adapted to his needs, along with other people who are trying to overcome the same disease; consequently he is profiting by the moral support of many others trying to accomplish the same purpose. Another great factor is the close association with the physician. In an institution the man at the head must stand responsible for practically every act of the patient's life. He must tell him what to do, he must also see that he does it. He regulates the patient's mode of living, his hours of exercise, his hours of rest. He furnishes his food and knows what and how much he is eating. He knows his mental attitude; and, in fact, learns to know the patient intimately so that he can help him to make his fight for life in every way possible.

Where the patient must be treated in the home, on the other hand, there are many difficulties. He is compelled to associate with people who are well, and he must necessarily, to a greater or lesser extent, adapt himself to their evironment. He is often discouraged in doing the things he should do, and encouraged to do the things he should not do. He is constantly annoyed by solicitous friends. The physician, not being near where he can be consulted, the patient is advised by the neighbours and friends who see him, and he is often compelled not only to fight his disease but his friends as well. His food cannot be so well controlled; his hours of rest and exercise are more apt to be disturbed and his surroundings, as a rule, are less hygienic. He fails to have the help derived from an intimate association with his physician. He sees the physician in his office or when he calls, two or three times a week; at other times he is compelled to fight his own battles.

One of the most serious problems in the treatment of tuberculosis is keeping up the patient's interest long enough for him to get well. Tuberculosis is a chronic disease which develops slowly, taking years, probably, as a rule, in reaching the clinical stage. It also takes a long time to cure it. During a great portion of this time the patient feels fairly well; at other periods he feels depressed and discouraged. The physician must curb the patient's enthusiasm during the periods when he is feeling well and must supply him with encouragement and optimism during the periods of depression.

It is extremely trying for the physician to face the same patient day after day, week after week, month after month, during a period of one, two, three, or more years, as is sometimes necessary in the treatment of tuberculosis, and still hold the patient's interest, respect and confidence. This is one of the most serious difficulties in treating the disease. There are few men in medicine who are really fitted either by nature or by training to treat tuberculosis. It requires a special type of man. As a first requisite he should have an excellent training and a wide experience in general medicine, for he will have most of the problems of internal medicine to solve. He must be one capable of appreciating and caring for detail, one with an inexhaustible store of patience, an unlimited optimism, yet an optimism which is tempered by knowledge and judgment. He should not set himself on a high pinnacle, simply because he is head; he should be in sympathy with his patients; he should study the peculiarities of his patients as individuals, also the peculiar psychological characteristics produced by the disease; he should recognize the difficulties with which the cure of tuberculosis is surrounded from the pathological standpoint and the meaning of the struggle, sacrifices and deprivations which the patient is compelled to make in order to attain a cure. He should be a man of firmness, but his firmness should be tempered with a broad and intelligent sympathy.

The difficulties encountered in conducting an institution for the tuberculous are many. Some of them are inherent in the disease itself; some are on the side of the patient, and many of them on the part of the institution itself. One great difficulty is to fill the positions in an institution, particularly the responsible ones, with people who are capable of taking a broad view and who are in sympathy with their work. Tuberculous patients are much like children—they are easily angered, they are easily pacified. Those at the head of departments must remember that they are dealing with the sick, consequently they must have charity. On the other hand, the patient must learn that his personal ideas and personal whims must give way to the better judgment of those who are in charge and that he must adapt himself to the institution instead of expecting the institution to adapt itself to him. He must further be charitable, knowing that he himself is not perfect; he must not expect perfection in an institution made up of a great many assistants and employees.

There are two methods of running an institution. One is by military discipline, and the other by considering the entire community as a family and expecting mutual regard and support.

There must necessarily be certain rules that must be lived up to rigidly, but in the private institution, where the result in the individual case is the thing to be attained and hoped for, most of the rules must be somewhat elastic. The patient must be taken as an individual with an individual mind and individual temperament, and it is the province of those in authority to work with that mind and temperament and mould it into obedience. Personally, I prefer the family spirit. It is the one that has held sway in my institution. I have endeavoured to secure the co-operation of the patient through a sense of duty to himself and friends and to the other patients, and through a respect for, but not fear of, those in authority. I believe in a spirit of frankness in dealing with the patient and a willingness to explain and talk over difficulties. A heart to heart talk often secures co-operation where military discipline would call for expulsion. I prefer the plan where the patients look upon those in authority as their friends rather than as their masters. This engenders a good friendly helpful spirit and the patient feels that he is being guided by someone who understands him and is in sympathy with him. During ten years' experience in sanatorium work, I have only expelled four patients from the institution. At times it seemed an injustice to myself to allow others to remain, yet patience finally secured co-operation and a stable state of affairs. Excellent results have often been obtained where military discipline would have expelled the patient.

The patients who enter an institution belong to three classes. The first comprises the great majority of patients and consists of those who want to do what is right, who are conscientious and earnest in their desire to get well. To be sure these, at times, fall from grace; but most of the time they are working conscientiously for recovery. Then there is a small class, probably about 20 per cent., who have no well-defined principles, but who are willing to be conscientious if they fall in with the conscientious class, and who are just as willing to be insincere if they are led that way. Then there is still a small number, less than 5 per cent., who are vicious, wilful and unfaithful to themselves and all with whom they come in contact. This class, however, can often be controlled by patience and firmness. It is important to recognize those of this class early and upon the first infraction of a rule let them understand that the offence must not be repeated. The patient must be given to understand that he requires the service of the institution more than the institution needs him; that, while the institution has little to gain by his presence, he has a life at stake.

There is a general belief that there are many people who for one reason or another, particularly because of lonesomeness, or through the depressing influences of other sick people, cannot undergo sanatorium treatment. This is incorrect. It is not necessary that a sanatorium should be either lonesome or depressing. I have seen only three or four patients in my institutional experience who apparently could not adjust themselves to the institution; and, as might be expected, these particular patients would not adjust themselves to any régime. They were not willing to make the struggle or sacrifices necessary to get well. Whether or not an individual will undergo sanatorium treatment depends largely on the manner in which the question is presented to him. If he desires to get well and is impressed with the seriousness of the disease and the advantage of institutional treatment, he will nearly always adopt this policy if it lies within his power. He will usually be willing to sacrifice personal likes and comforts temporarily that he may recover his health. If unwilling to do this, as a rule, it is an indication that he will not be a patient who can be trusted for a whole-hearted co-operation during a protracted convalescence.

It is a great mistake for physicians to tell patients that they are not sick enough to go to a sanatorium or that they should not go there because of the danger of becoming infected. There is never a time too early for treatment to begin and there is no place where less danger of infection exists than in a properly conducted sanatorium. The importance of early treatment cannot be better emphasized than by the results which we have obtained in the past ten years, which are as follows :—

	I. Stage	II. Stage	III. S age
*Apparently cured and arrested	97 per cent.	81 per cent.	38 per cent.
Improved	3 ,,	14 ,,	40 ,,
Unimproved or died		5 ,,	22 ,,

*These figures are all in term of the original classification of the National Association.

The above results are far more eloquent than any comment could be in the plea for the early treatment of this disease. When the physician advises his patient not to undergo treatment early but to wait, he is taking upon himself the responsibility of advising him to wait until the disease has passed from the stage where 97 per cent. can be arrested and apparently cured to where 81 per cent. or 38 per cent. can be arrested and apparently cured.

The private sanatorium differs from those of the public and partially endowed class.

The tuberculosis problem is mainly connected with the poor but not wholly so, for the disease is found in all walks of life. It permeates every stratum of society, and in our solution of its problems we must make provision for fighting it among all classes.

We must recognize that it is most common among the poor and it is to this class that social workers and economists must direct their greatest efforts. The problem here is also greater because of the conditions under which these people live and work; also because of their helplessness and inability to care for themselves and their families during a long siege of illness such as that produced by tuberculosis.

In our warfare against this disease, however, we must not forget those who are not dependent. There are many who are not wholly helpless, but who are able to pay their way in part. These deserve as careful consideration as the helpless and every precaution should be taken to prevent the spread of the disease among them, and every opportunity for cure should be offered them that is offered to those who are wholly dependent. Then there is a third class, made up of those who are wholly able to pay their way, who, in spite of means and opportunity to live in hygienic surroundings, will, at times, develop this disease. The problem of the prevention and cure of tuberculosis must include these, the same as it does the others. The cure of these lies wholly in the province of the private sanatorium. The problem of handling these three different classes is the same in general, but different in detail. There is no hard and fast line separating these three classes, yet an acquaintance with the patient will usually determine to which class he belongs. It is just as wrong to pauperize the two upper classes by giving them free treatment as it is to compel the dependent to pay for their cure.

The position of the private sanatorium in the warfare against tuberculosis is misunderstood both by laymen and physicians. It is sometimes criticized where a greater knowledge of its real function would call for praise. If there is reason for the existence of private hospitals of any kind, general or special, or if there is reason for the existence of private physicians, there is the same reason for the existence of private sanatoria for the treatment of tuberculosis. The sanatorium is simply the man at its head with enlarged opportunities. The only rational excuse for the existence of a private sanatorium is for some man who is expert in treating the disease to thus have a better and larger opportunity to give his services to those who are in need of them. The private sanatorium for tuberculosis, the same as the partially endowed and wholly charitable institution, is in harmony with the fact that has been thoroughly established in modern medicine, that institutional treatment is the best treatment for practically all diseases.

The sanatorium problem in many particulars differs in no wise from the general problems of medicine. The institution should be governed by the same rules of ethical conduct and should be conducted on the same plane of high scientific standards as holds in private practice. The sanatorium differs, however, in that it occupies a conspicuous place and is open to comment, favourable and unfavourable, by the public at large, which the private practitioners largely escape. It is patent to all that it is a genuine success, that it is barely making a go, or that it is failing, and accordingly it is looked upon with admiration, even jealousy, indifference or contempt.

The idea is more or less prevalent that people go to a sanatorium because of the sanatorium, that there is something magic in the institution. This is not true in the private sanatorium. The institution is stamped by the man at its head and his ability to carry out his policies. It is folly to build large institutions which entail the outlay of vast sums of money and then put inexperienced men in charge of them and expect people who are accustomed to good medical service to patronize them. The patron of the private institution demands the same efficient type of medical service that he would in private practice. These are people who pay for good service and they must have it, and an institution to be successful must be capable of giving it.

The private sanatorium is the most difficult type of institution to conduct. In a charitable institution the undesirable patient can always be discharged. In partially endowed institutions the patient knows that he is getting more than his money could otherwise purchase and he must of necessity be fairly well satisfied. The patient in the private sanatorium, on the other hand, must be taken as he is and dealt with tactfully. He must be made to overcome his whims and educate his taste so that he will put himself in harmony with the institution and co-operate with the physicians in his cure, and make himself comfortable and contented long enough to get well. This is often an extremely difficult thing to do. It is much more difficult for the physician in an institution than it is for the one in private practice, because in private practice the doctor sees the patient once a day, or once every few days, and there his responsibility virtually ends. In an institution, on the other hand, the responsibility of the entire life of the patient is upon him. The physician must guide him in his every act; he must tell him what to do and see that he does it. He must not only deal with the patient and his peculiarities himself, but the tact or lack of tact employed by all of his assistants and subordinates eventually reflects upon him.

One of the serious problems in the private sanatorium and, for that matter, in all sanatoria, is the question of finding occupation for the patients. There are so few games and sports that the average patient can enter into advantageously that it forces those in authority to keep the patients happy and contented without employing the usual forms of diversion. Where the patients are in the earlier stages croquet, photography, chess, checkers, cards, walking, and a certain amount of driving can be permitted. When the patients are in the more advanced stages of the disease, even these must be denied. No game must be entered into by the tuberculous patient that he cannot quit at any time should it be tiring him. It is an unfortunate but well-recognized fact that as soon as patients get to the place where they are permitted to do much driving or engage in very vigorous sports they at once begin to overrate their strength and underrate the desirability and the necessity of further treatment. They lose interest in the cure. The old adage of giving an inch and taking an ell is all too true of the tuberculous patient. This pitfall must always be guarded against. The best way of helping a patient to occupy his time in the sanatorium is by breaking up his day and having some little thing in treatment carried out at intervals during the entire day. In the institution with which I have been connected we have taken this into consideration and planned rather a continuous programme.

Quoting from a former paper:* "Success in the treatment of tuberculosis depends on keeping the patient cheerful, optimistic, and interested in his own cure. To this end he must be kept busy, not busy working, for this is not consistent with the best treatment; but the day's programme must be so arranged as to leave little time at his own disposal. Probably I can best illustrate what I mean by

* "The Tuberculosis Sanatorium and What it Stands For," *Monthly Cyclopædia and Medical Bulletin*, April, 1911.

keeping the patient busy by describing the usual routine in our own institution.

"The patient's day begins at 7 o'clock in the morning, at which time the nurse calls to waken him and carry out any regular orders given by the physicians. The patient arises and takes a cold sponge bath, or, if he is not in condition to take it himself, it is given him by the nurse.

"At 7.30 the medical director begins his daily rounds and continues until he has visited each bed-patient. These visits are made in company with the assistant physician who has charge of the individual case. The condition of each patient is carefully noted, and the plan of treatment for the day agreed upon.

"At 8 o'clock breakfast is served, all patients who are able to be up and around going to the dining-room. Those who are confined to bed are served in their rooms and bungalows. After breakfast each ambulant patient reports to the medical director for consultation. If any special treatment is needed he is referred to the assistant physician having charge of the case. All who are suffering from local complications, as of the ear, throat, or nose, are also treated at this time.

"On one day of each week, between 10 and 11 o'clock, the patients are weighed by one of the staff.

"During the time between 9 and 1 o'clock the nurses are busy carrying out the physicians' orders and looking after the wants of the patients, devoting most of their time to those confined to bed.

From the time that the patients are through with their treatments until 1 o'clock, they while away the time in croquet or other allowable games, in visiting friends, and doing little things of a personal nature, and in exercising as prescribed by the medical staff.

"The medical director, aided by the assistant physicians, makes a careful examination of each patient monthly, charting the chest so as to note the changes in the tuberculous process. These examinations are made between 10 a.m. and 1 o'clock p.m.

"Lunch is served from 1 until 2 o'clock p.m. From 2 to 4 o'clock are rest hours, during which time all the patients recline in their rooms and bungalows, and are instructed to rest, to sleep, if possible, providing it does not interfere with their sleep at night.

"At 4 o'clock the nurses begin their rounds, carrying out the physicians' orders and attending to the wants of the patients. The assistant physicians make calls upon each bed-patient in their respective service and any ambulant patients who are not feeling well, and administer any special treatments that are required. They likewise prescribe for any new symptoms or complications that may have arisen since the morning visit.

"From 6 to 7 o'clock dinner is served. After dinner the patients usually amuse themselves by reading or games until bed time. Bed-patients, as a rule, go to sleep about 8 or 8.30, and all are required to be in bed with lights out by 9.15."

This aggressive plan of treatment requires an efficient corps of attendants. I think one of the greatest mistakes that is usually made in a sanatorium is attempting to run it with too small a number of medical assistants. The sanatorium should stand for results. Results in tuberculosis are only obtained by keeping the patient interested. The patient can only be kept interested by association with and receiving encouragement from those who know. To this end a corps of medical men, sufficient in number to look carefully after the wants of all patients is essential.

In this short paper I have endeavoured to take up some of the important questions bearing upon the sanatorium treatment of tuberculosis which are usually omitted from discussion. I have endeavoured to show the relationship which the private sanatorium bears to the public on the one hand, and the members of the medical profession on the other; I have further attempted to show the true relationship which should exist between the patient body and the medical staff and other attendants, thus pointing out the true place of the private sanatorium in the warfare against tuberculosis.

DISCUSSION.

Dr. Anders: What Dr. Pottenger has stated with reference to the sanatorium treatment of the better-to-do is absolutely true. It is next to impossible to get patients in this walk of life to go into the ordinary sanatorium, where they learn proper discipline, and for which of course, they are much the better after leaving, whether entirely cured or not. There is no doubt in my mind that the sanatorium treatment for this disease, even to a greater extent than is true of other diseases, is the correct ideal in the earliest stages. The discipline which the patients get with regard to the details of living and the methods of preventing the spread of the disease cannot be acquired so completely in any other way, to my mind; and I have not the slightest trouble with patients who have been in a first-class sanatorium in having them carry out the various modern ideas regarding methods of prevention and the different hygienic means necessary to complete the cure. I feel strongly that the usual attitude of the general practitioner towards sanatoria is one of too great indifference, and that we should endeavour to educate him to realize the importance of this method of treatment. He is too prone to continue the unsystematic treatment of these patients at home until all chance for cure is past. I see so much of this in my consultation work that I do not think that this point can be too strongly emphasized.

A CASE REPORT ON EMPYEMA DUE TO ACTINOMYCOSIS.

By BURT R. SHURLY, M.D.

DETROIT.

Human actinomycosis is a comparatively rare invasion of the lung or pleura. The literature upon ray fungus empyema in this country is sufficiently meagre to attract special interest.

Dr. T. D. Acland, in 1884, is given credit for the first isolated case in England. From the report of Erving in 1903, we learn that one hundred cases have been observed in America up to December, 1901.

Human actinomycosis involves the thoracic region in about 15 per cent. of reported cases. These are principally pulmonary in type. More than one-half are found in the head and neck, and may, secondarily, involve the mediastinum, lungs, or pleura. The most frequent area of the involvement is the lower right lobe.

The thoracic form is attended by marked mortality Only six cases of recoveries are reported in the literature up to 1907, and, according to Wright, most of these were of doubtful permanency.

Biologically, two kinds of parasites are recognized: *Actinomyces bovis* and nocardia. These are distinguished from streptothrix, cladothrix or atypical actinomycosis.

According to Wright the true specific infectious agent of actinomycosis is represented by the bovine alone. It is not considered contagious; yet one case of a nurse who was in charge of a patient is reported.

Pulmonary cases occur more frequently late in the spring, with no race immune. The disease attacks men in the proportion of 73 to 27 in 100. Infection evidently takes place with great difficulty. Pulmonary involvement may occur weeks or months after infection. A carious tooth around soft, spongy gums may infect the respiratory tract. Milk infection is rare, and cooking destroys the organism. Infection has arisen apparently from chewing straw.

Among a long list of therapeutic measures that have been used, potassium iodide and vaccines stand out preeminently as the survival of the fittest.

This case is reported on account of some unusual and interesting features.

Mr. J. M. B., of Michigan, active man, aged 74, occupation journalist, came under my observation in consultation March 23, 1914, with the following story: Had enjoyed a life of good health, interrupted by a severe attack of typhoid fever forty-two years ago without complication. Attack of quinsy in 1905 and 1911; bronchial asthma occasionally; epithelioma of the lower lip completely healed by X-ray treatment. Suffering from high blood-pressure, 220 for the last two years. Lumbago two years ago. The family history shows that his father died at 83 of pneumonia, and mother at the same age. Two brothers and four sisters are dead: one brother of apoplexy, one of old age, two sisters of cancer, one of congenital brain disease, and one accidental death. Patient has adult son and daughter in perfect health.

The present illness dates from an injury to the left side on February 19, caused by a fall against a chair in his room, Seven days later he consulted his family physician, complaining of cough, chill, muscular pain in the side and lumbago. The following day a chest examination in the doctor's office showed the physical signs of fluid. Aspiration was negative on two occasions on account of the fine needle used.

On March 23, I obtained by aspiration with a large cannula a small quantity of grey, mouldy-smelling pus. A diagnosis of fungus infection was made and confirmed by the laboratory. Dr. Jennings, in consultation, obtained a better specimen from which an autogenous vaccine was made. Resection of the sixth rib was done under local anæsthesia and an enormous quantity of fœtid pus evacuated which had an odour similar to colon infection of the appendix. The large drainage tube was replaced by a smaller ten days later. A smaller tube was inserted within the larger by the family physician, and, during the following night, the larger tube slipped into the chest cavity. As the opening had closed at this time to a diameter of ½ in. it was impossible to locate the tube. In a blind attempt the family physician punctured the lung, which was followed by a sharp hæmoptysis. I attempted the removal of the foreign body through the opening with a bronchoscope, but the light failed at the critical moment. The patient was removed to Harper Hospital, Detroit, and, under local anæsthesia, the tube was removed by our surgeon, Dr. McLean. The pulse and temperature show a typical mild sepsis. The patient has steadily improved in strength, and has left the hospital with encouraging signs of improvement.

This case is not reported as a cure, because like tuberculosis it is necessary that at least two years should elapse to demonstrate a permanent recovery. The vaccine was administered every fourth or fifth day, and potassium iodide was given continuously in full doses.

Pathological Report from Harper Hospital.

The organism isolated from the pleural exudate is a streptothrix, with a long branching filament. It occurs in the pus in clumps or colonies, of a dark green or greyish yellow colour, about the size of a pin point. The pus had a very foul odour. The culture grows as an absolute anaerobe best in glucose broth or on glucose agar, in which it weaves itself inextricably into the substance of the medium. The colonies in broth are small yellowish granules, and on agar the growth appears as pin-point, felt-like masses. The material both from cultures and the pus shows many of the organisms containing spores, giving the organism a beaded appearance. No typical clubs were seen.

The many cultures which we had of this organism were all destroyed in one night by the imperfect action of the thermoregulator in the new hot room, so that many interesting points regarding the exact classification were undetermined. The organism was never found in the sputum or in the blood.

Bacteriological diagnosis: Streptothricosis of the pleura.

DISCUSSION.

Dr. OTIS: Dr. Shurly referred to a possible cause of actinomycosis. The only cause that I remember, in my experience, of actinomycosis of the pulmonary form is the following, seen in consultation: A man, aged 35, was the driver of an express wagon, and the only cause that we could find was that in taking care of his horses he was accustomed to chew straw. He had acute symptoms and what seemed to be an abscess in the lung. I advised aspiration and examination of the fluid. This was not done; but the man, having recovered from his acute symptoms, went south for the year. On his return he developed symptoms such as so frequently occur in actinomycosis; swelling and suppuration in the neck, &c., and then, for the first time, the true nature of the disease was discovered. I had not made a diagnosis at the time I first saw him. The sputum had always been negative as to tubercle bacilli and the characteristic organism was not found in it. He went from bad to worse, and finally died, as most cases do.

Dr. ANDERS: Does anyone else wish to remark on this paper? If not, I will call on Dr. Shurly to close the discussion.

Dr. SHURLY: I have nothing to add.

THE EFFECT OF HIGH-FREQUENCY CURRENTS ON RESPIRATION AND CIRCULATION.

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I REALIZE that in attempting to discuss the effects of high-frequency currents on the respiration and circulation, I am departing somewhat from the beaten track of papers presented to our Society. My excuse for so doing lies in the fact that for the past twelve years I have been constantly on the watch for means of alleviating two conditions which confront us, especially in resort practice, namely, asthma and hay fever. I doubt whether there are many general practitioners or even specialists in our larger cities who will not have to plead guilty to advising a "change of climate" for their asthmatic and hay fever patients, after they have tried the usual remedies, so often with discouraging results.

These exiled sufferers come to us, often expecting to be relieved at once in some miraculous way by the change; and, as you all know, their disappointment is great, when they fail, as they so often do, to get the promised help. These conditions have urged me on to look for help from every source, and I trust that you will bear with me in bringing to your notice two cases, which, to me, have been of great interest.

Before outlining the cases, may I call your attention to a few points regarding the action of high-frequency currents. Dr. Albert C. Geyser, of New York, in a paper read before the Essex County, New Jersey, Medical Society, in October, 1911, has given so careful and scientific an explanation of the changes caused by high-frequency currents in the body, that I cannot do better than briefly summarize his findings.

Starting with the assumption that to cure a diseased condition the remedy must be applied as nearly as possible to the seat of the disease, Dr. Geyser has shown by repeated experiment that the passage of electric currents of high frequency by means of metallic electrodes applied to the surface of the body will cause certain changes in the intervening tissues, pre-eminent among which is a marked rise of temperature. I will quote one experiment only, using a guinea-pig whose normal rectal temperature is about 100° F. "Two metallic or sponge-covered electrodes are placed one on either flank of the animal, and the current turned on. As there is no sensation beyond a slight feeling of warmth, we need take no especial precaution with either the animal or the current. In the short space of three minutes the rectal thermometer will show a reading of 105° F. This increased temperature may remain for one to three hours without any apparent ill-effects upon the animal. Here then we have the circulating blood in no way interfering with the heating effect. On the contrary we produce all the essentials of a natural reparative process—heat, increased blood supply, and increased oxydation."

I have quoted this experiment because it seems to me to indicate the underlying basis of the good results obtained in the application of high-frequency current by the diathermic method, as it has been called. The technique is as follows:—

We use for treatment an apparatus which will give up to 3,000 m.a., carefully graded and accurately measured. The electrodes which I use are pieces of tinfoil cut and shaped to snugly fit over the skin and attached by flexible cords to the apparatus. The tinfoil must be held in close apposition to the skin to prevent sparking, which otherwise might be annoying. The amount of current used, measured by the milliampere meter, will depend on the portion of the body being treated and on the tolerance of the individual.

I start with short treatments, five to eight minutes, and lengthen the time according to the results obtained, up to twenty-five to thirty minutes.

In my work with this form of electricity I have found only rarely cases where the treatment was not borne well, as shown by general malaise, a feeling of constriction about the heart with increased pulse rate, or a condition described by the patient as "nervousness."

The two cases which I wish to present to you are one of typical hay fever and one of asthma.

Mr. C. C., aged 35, has suffered ever since childhood from hay fever, and has tried almost every means of relief. He is a clergyman who has carefully studied his case, and feels that apart from a sea voyage, which he can only occasionally take, he has practically no means of obtaining relief, and faces each summer and fall a period of distress, which incapacitates him for his work, and the results of which usually last until December.

In the summer of 1912 he presented himself to me about a week before his regular date, to know what I thought of the use of pollantin, which he had tried, but with little success. I suggested a trial of the diathermic use of the high-frequency current, to which he readily assented, and throughout the time of treatment, covering thirty days and consisting of sixty-eight treatments, he gave the most valuable assistance by his careful observations of his feelings before, during and after treatment. Before giving a brief outline of the treatment employed I will say that Mr. C. remained at Spring Lake, N.J., in comfort, living a normal life, bathing, reading, automobiling, eating and sleeping, a condition which had been impossible for many years past. After leaving Spring Lake on September 9, instead of going to the mountains for another month or six weeks, and then returning to his parish unfit for work and in distress during the fall months, he went to Princeton, N.J., and then home to Wilmington, Delaware, and wrote me that he was able to take up his work with ease and comfort. Mr. C. suffered from asthmatic attacks as well as the ordinary eye, nose and throat symptoms of hay fever.

The treatment consisted in applying a large tinfoil electrode to the back, covering the shoulders and neck, and a smaller one to the chest. A current of from 1,000 to 2,500 m.a. was then passed through the body for from five to fifteen minutes. On removing the electrodes the skin was found to be reddened and covered with profuse perspiration. After treating the chest a tinfoil electrode was fitted over the forehead and the bridge of the nose and the malar bones, and the current turned on again, commencing with a smaller quantity and running up to 1,000 to 1,500 m.a. Relief resulted, on days when the patient came in with commencing symptoms of discomfort, in about five minutes, and he always left the office comfortable. I cannot take the time or burden you with the details of treatment, which necessarily varied from day to day, according to the conditions of weather and the patient's feeling. One most important result of the treatment was the fact that Mr. C. was able to enjoy a summer with his family and gained confidence in himself, which enabled him to live a normal life without fear of the distress he had always suffered during the summer. Last year he went abroad and was free from trouble.

My second case is one of long standing cardiac asthma in a working man aged 30, who was practically incapacitated for continuous work by daily recurring attacks. The nature of his work—night watchman in a large building—and his poverty made a change of climate impossible, and he had settled down to the belief that there was no help, after having tried many remedies.

I applied large tinfoil electrodes to back and chest, giving him from 1,000 to 1,800 m.a. of current, and continuing the treatment daily for a week. Relief was experienced after the first treatment, and the nightly attacks lessened and disappeared. He had seven treatments in all. An hour after the last treatment he had a severe attack lasting for one hour, and since then, November 16, 1912, has never had a bad attack, though working continuously as night watchman, under the same circumstances as before.

I have had a number of other cases in which I have tried this method, some successes and some failures; but, from my limited experience, I do not hesitate to say that if the physician will give his personal attention to the details of treatment he can relieve and occasionally cure many cases which have heretofore been his despair. A great many of the bad results reported in the use of all kinds of electric currents are due to the fact that the physician usually leaves this work to students or nurses, and does not carry out the technique himself. Therefore, the whole thing falls into disrepute.

THE INTER-RELATIONSHIP OF DRY PLEURISY, PLEURISY WITH EFFUSION AND EMPYEMA.

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[READ BY TITLE.]

From the pathological standpoint different degrees of pleural inflammation are expressed by the terms dry pleurisy, pleurisy with effusion, and empyema; the distinguishing factor lies in the character of the exudate rather than in any individual pathological process peculiar to each. The etiological relationship between these lesions is not, however, so clearly demonstrable because of the modifying influences of body resistance, pleural accessibility to infection and variation in bacterial virulence. Whilst the large number of micro-organisms, including the typhoid bacillus, colon bacillus, influenza bacillus, Friedlander's bacillus, *Bacillus pyocyaneus,* and *Staphylococcus pyogenes aureus* occasionally are found as the cause of pleuritis; by far the most common bacteria are the pneumococcus, the *Streptococcus pyogenes,* and the tubercle bacillus. The pneumococcus may be the cause of fibrinous, sero-fibrinous or purulent pleuritis, being a common etiological factor in fibrinous pleuritis, but rarely producing a serous effusion. It is especially liable to give rise to turbid or purulent exudates. The *Streptococcus* *pyogenes* gives rise to dry pleurisy, occasionally to pleurisy with effusion, and is commonly found in empyema. The tubercle bacillus is not commonly present in purulent pleural exudates, either alone or with other organisms, but its presence in the pleural cavity far more frequently gives rise to a fibrinous or serous effusion. In the latter condition it has been found in from 22 to 85 per cent., according to different observers.

The ability of the pleura to protect itself from the severer forms of pleuritis is shown in the relatively small proportion of primary serous and purulent exudates which occur as the result of direct invasion from the pneumococcus, streptococcus and staphylococcus. While primary dry pleurisy is not believed to be uncommon, even this form of pleural infection more often accompanies infection elsewhere than it appears as an isolated lesion. Following lobar pneumonia the pleura is practically always involved, the lesion being either fibrous, sero-fibrous or a purulent exudate, and in Musser's series of 127 autopsies on pneumonia only five showed a serous effusion and twenty a purulent fluid. In pleurisy with effusion from all causes metapneumonic effusion, according to Lord, made up 5·2 per cent. in 1,185 cases, and a much smaller percentage followed arthritis, typhoid fever, and septic infections. While some writers state that 63 to 64 per cent. of dry or sero-fibrinous pleuritis are primary, yet the great proportion of these are due to tubercle bacillus, and exclusion of a primary focus in the lung is often impossible. Babcock, in writing of empyema, says that this condition is primary in a small percentage of cases, and that these occur mostly in children. Lord, in 252 cases, classes 83, or 32·9 per cent., as primary pleural infections, but further states that the very presence of this condition renders the detection of other coincident pulmonary processes impossible.

Empyema, where it occurs, is secondary to pulmonary infections as pneumonia, pulmonary tuberculosis and abscess in a proportion of about 64 per cent.

Netter, in investigating 109 cases of empyema, found the pneumococcus in 53 per cent. and the streptococcus in 46 per cent. The staphylococcus was relatively infrequent.

The fact which stands out in the study of pleural infection is that in the great majority of cases it is a secondary process, this being especially true where the pneumococcus and streptococcus is concerned, the chief exception being in fibrinous and sero-fibrinous pleuritis due to the tubercle bacillus.

The following work was undertaken with a view to determine the underlying factors in the resistance of the pleura to infection, and further, as to what controlled the degree of pleural response to irritation, so that dry pleurisy, pleurisy with effusion or empyema would result.

Inert Substances.

The rapidity of response to the injection of inert substances into the pleural cavity was first determined. Among those used was a sterile suspension of aleuronat in saline solution, sterile olive oil, saturated sterile solution of peptone and dextrine. A series of seven guinea-pigs weighing 150 to 200 grm. were used, and twelve rabbits, some partly and some fully grown. Both pleural cavities were inoculated at the same time, and the amount of material used varied from 2 c.c. in the guinea-pigs to 10 c.c. of aleuronat solution in the rabbits. Rabbits were observed for twenty-four to forty-eight hours after inoculation, and were then killed. The reaction of the pleura to the presence of aleuronat was very irregular. A few animals showed no evidence of pleural inflammation. In others the visceral pleura was inflamed, and scrapings from it showed some fibrin, numerous polynuclear leucocytes, eosinophiles, amphophiles, and endothelial cells. A large number showed the presence of an exudation, sero-purulent in character, containing great numbers of cells of ten as high as 20,000 to the cubic centimetre. At times both the pleural cavities in the animal were half filled with the effusion.

Three guinea-pigs inoculated with sterile oil showed at the end of three days the oil immeshed in fibrin with a few leucocytes. No fluid was produced. The result of the injection of dextrin was negative. Peptone solution at the end of forty-eight hours gave rise to well-marked serous effusion.

Twelve rabbits inoculated intra-pleurally with a solution of aleuronat. Autopsy results: Fibrinous, sero-fibrinous and sero-purulent pleurisy.

Three guinea-pigs inoculated intra-pleurally with sterile oil. Autopsy results: Fibrinous pleurisy.

Two guinea-pigs inoculated intra-pleurally with a solution of dextrose. Autopsy results: Negative.

Two guinea-pigs inoculated intra-pleurally with a solution of peptone. Autopsy results: Serous effusion.

A full-grown black rabbit was inoculated with 20 c.c. of a sterile solution of aleuronat. Killed in twenty-four hours. Mass of aleuronat adhered to the lung. Pleura injected. About 15 c.c. of fluid present, opaque in colour and contains 25,000 leucocytes to the centimetre.

A brown, two-thirds grown female rabbit was inoculated with 10 c.c. of a sterile solution of aleuronat into each pleural cavity. Killed in twenty-four hours. Mass of aleuronat found covering the outer surface of the lung and part of the diaphragm. From 7 to 10 c.c. of yellowish thick fluid found in each pleural cavity. Leucocyte count showed 7,000 to the centimetre.

A small white female rabbit was inoculated with 10 c.c. of a sterile solution of aleuronat into each pleural cavity. Autopsy showed a mass of aleuronat adhered to lung. Acute fibrinous pleurisy present. Four to 6 c.c. of a yellow fluid in each chest. Cellular exudate small.

A large black female rabbit was inoculated with 10 c.c. of a sterile solution of aleuronat into each pleural cavity. In twenty-four hours 10 c.c. of an opaque fluid present in each pleural cavity. Acute fibrinous pleurisy present. Cell count about 20,000 to the centimetre. Amphophiles, eosinophiles, and neutrophiles present. Protocols of a large number of rabbits inoculated with aleuronat show results varying from little or no pleural irritation to a large amount of serous effusion or a heavy cellular exudation.

A small male guinea-pig inoculated with $\frac{1}{2}$ c.c. of sterile olive oil into the right pleural cavity. Autopsy at the end of twenty-four hours showed a slight production of fibrin in which the oil globules were immeshed. No fluid.

A brown male guinea-pig, medium sized, was inoculated with ½ c.c. of sterile olive oil into the right pleural cavity. Autopsy at the end of forty-eight hours showed unabsorbed oil and slight dry pleurisy.

Two medium-sized guinea-pigs were inoculated with saturated solution of dextrine into the pleural cavity. Showed no pleural irritation.

Two small black guinea-pigs were inoculated with 2 c.c. of a saturated solution of peptone into the pleural cavity. Killed in twenty-four hours, 4 to 6 c.c. of a sero-sanguineous fluid in each pleural cavity. Visceral pleura injected. No macroscopic fibrin. Fluid showed blood corpuscles and a few leucocytes.

The response of the pleura in rabbits and guinea-pigs to the irritation of inert sterile solutions showed it to occur in a few hours. The character of the formed exudate varied with the intensity and area of excitation.

Micro-organisms.

The effect of bacterial action upon the pleura was studied as to the results of the presence of dead micro-organisms, living micro-organisms washed free from the products of their growth and the action of living organisms following sensitization of the pleura by their products. Observations were confined to the *Staphylococcus aureus, Streptococcus pyogenes* and the pneumococcus. Strains of these organisms were obtained from severe human lesions in each instance. The *Staphylococcus aureus* was obtained from cases of boils or carbuncles; the streptococcus from cellulitis and the pneumococcus from pneumonic lesions.

Thirty-five guinea-pigs and fifteen rabbits were used in this series of observations. As the guinea-pig is relatively insusceptible to the pneumococcus, rabbits were used entirely for work with this organism. The degree of resistance of normal guinea-pigs to pneumococci is shown by the failure of the pleura to give any evidence of inflammation following the injection of a heavy suspension of living pneumococci.

The injection of a heavy suspension of killed staphylococci which had not been washed free from the products of their growth into the pleural cavity of guinea-pigs produced acute pleurisy with a turbid effusion.

Washed staphylococci, pneumococci and streptococci gave no results in rabbits and guinea-pigs.

Suspension of living staphylococci, together with the products of their growth, were inoculated into several series of guinea-pigs in gradually increasing doses. Similar tests were carried out with streptococci and pneumococci. The emulsions of the organisms used were standardized according to the Wright method. In normal guinea-pigs, when fewer than 500,000,000 organisms were inoculated, very little pleural reaction was obtained. A series of six animals, each weighing from 100 to 500 grm., were each given one inoculation of 600,000,000 staphylococci intra-pleurally. At the end of twenty-four hours these animals were autopsied. The pleura was found to be injected at the point of inoculation and the pleural cavity contained 1 or 2 c.c. of a clear or slightly bloody fluid. Cultures taken from the surface of the lungs and the pleural fluid gave a growth of from one to ten colonies of staphylococci on each culture tube. A series of four guinea-pigs were then inoculated intra-pleurally with suspensions of staphylococci three or four times the previous strength. All these animals died or were dying in forty-eight hours. One animal showed a small area of pneumonia where the lung had been injured at the time of inoculation. All were prostrated by the infection and the pleural cavity in each showed a condition of fibrinous pleurisy accompanied with a small effusion which contained a few leucocytes and many micro-organisms; nothing resembling empyema could be obtained as the animal too quickly succumbed to the infection.

A series of five full-grown guinea-pigs were inoculated with a suspension of living streptococci into the pleural cavity. The suspensions were standardized to approximately 500,000,000 organisms. Following a single injection no constitutional disturbance was noted after three days and they were then killed. The pleural cavity was negative in all but one animal, which showed slight pleural injection and from which a few chains of streptococci could be cultured. The action of the pneumococcus on the pleura of rabbits when single injections of a heavy suspension were given was much more marked. Acute fibrinous pleurisy with or without effusion always resulted and a growth of the organism from the pleura was readily obtained. A number of injections of a suspension containing a relatively small number of micro-organisms gave no results.

The inoculation of a series of animals with emulsions of *Staphylococcus aureus,* the *Streptococcus pyogenes* or the pneumococcus gave rise to no pleural inflammation in small doses and in moderate amounts to a slight effusion. When the animals were overwhelmed by large amounts of the organisms acute fibrinous pleurisy with effusion occurred before death.

Inasmuch as the condition of empyema could not be produced by these methods, two further series of experiments were performed. In the first, animals were infected in other parts of the body before pleural inoculation was attempted. In the second series sterile extracts of bacteria were used to sensitize the pleura prior to the injection of living organisms. The extract or autolysate was made by allowing the micro-organisms to disintegrate at body temperature in sterile salt solution. After ten days the fluid was centrifugalized and the supernatant fluid was drawn off and cultured. The extract was found to be sterile and free from organisms. A series of ten guinea-pigs, each weighing from 200 to 400 grm., were repeatedly inoculated subcutaneously with the *Staphylococcus aureus,* resulting in a number of abscesses. Following four inoculations, 1 c.c. of a suspension of living staphylococci containing from 500,000,000 to 1,000,000,000 organisms were given each animal intra-pleurally. One animal died as a result of local abscesses. Following the intra-pleural injection, four animals died in forty-eight hours. In each of these the pleural cavity showed a small amount of turbid fluid containing many leucocytes and staphylococci, suggesting a purulent effusion.

In each instance also the pleura was acutely inflamed and covered more or less with fibrin, so much so, in one instance, as to give it a shaggy appearance. The other five animals of this series were killed within seventy-two hours of their intra-pleural inoculation. Each one showed an acute fibrinous pleurisy with fluid present in each case. In two of the animals a very small amount of effusion was present which contained a number of phagocyting leucocytes. Ten other guinea-pigs, weighing from 200 to 400 grm. each, were given five intra-thoracic inoculations of ½ c.c. each of sterile autolysate of the staphylococcus. One of the animals was injured at the time of inoculation and died; no effect upon the pleura from the autolysate was found.

Subsequent to the injection of this material into the chest, a moderately heavy suspension—500 to 1,000 million living staphylococci were put into the pleural cavity. The result of the single dose was evidenced in twenty-four hours by marked acute fibrinous pleurisy, together with a moderate amount of thick bloody fluid in the chest cavity. This contained many blood corpuscles, phagocyting leucocytes, and endothelial cells. Half of this series of animals was given more than one inoculation of staphylococci, but the results were identical with those obtained from one injection, except for a greater production of fibrin.

These experiments would seem to indicate that the guinea-pig succumbs to pleural infection from the staphylococcus as the results of the products of its growth. In those animals debilitated through concurrent infection the pleural response was not only an acute fibrinous pleurisy, but also the presence of a greater or less amount of a sero-purulent effusion. Where the animals were sensitized beforehand to the toxic products of the organism its presence in the pleural cavity gave rise to acute fibrinous pleurisy accompanied by a thick bloody effusion containing 10 to 200 leucocytes to the microscopic field.

A series of three guinea-pigs were given several subcutaneous inoculations of *Streptococcus pyogenes* a few days apart; at the end of ten days 1 c.c. of a suspension of streptococcus containing approximately a billion and a half of organisms was injected into the pleural cavity of each animal. At the end of forty-eight hours autopsy showed acute fibrinous pleurisy with a considerable amount of turbid fluid. This contained thirty to forty leucocytes to a microscopic field with eosinophiles and endothelial cells. Cultures were negative. The evidence presented here indicates that the normal pleural cavity of the guinea-pig can readily take care of a tremendous number of streptococci without recourse to a large cellular exudation. Where concurrent infection is present also, acute pleurisy with sero-purulent effusion takes place as the result of the tissue reaction.

A series of eight rabbits were sensitized with four inoculations each, with a saline extract of pneumococci into the pleural cavity. These injections were given three days apart. One of these animals was killed at the end of this period and the pleura was found to be in a normal condition. Three of the animals were given 1 c.c. of a suspension of pneumococci which contained 300,000 organisms. At the end of twenty-four hours one died and the other two were very sick. Autopsy showed acute pleurisy with a heavy purulent fluid in the chest cavity which contained much fibrin, a large number of leucocytes and pneumococci. A control animal, which was given a similar dose but which had not been previously sensitized, showed at autopsy an acute pleurisy with a small amount of serous effusion. Four other young rabbits that had also been sensitized were inoculated with a billion pneumococci. Autopsy at the end of twenty-four hours gave similar results. The pleuræ were acutely inflamed and covered with fibrin which contained pus in its meshes, and a purulent effusion was also present.

As the result of the infection of the pleural cavity in guinea-pigs and rabbits, following primary infection elsewhere, in every instance acute fibrinous or sero-purulent effusion was obtained. These lesions, furthermore, were produced with suspensions of living organisms that had previously failed where single inoculations were used to give this response. The result of pleural sensitization with subsequent pleural infection were equally striking. In every animal so treated, a condition closely simulating true empyema was obtained.

Two guinea-pigs were inoculated intra-pleurally with washed staphylococci, and two rabbits with pneumococci. Autopsy results: Negative.

Five guinea-pigs were inoculated intra-pleurally with living suspension of staphylococci, unwashed. A single injection was given each animal, varying from 600,000,000 to 1,500,000,000 organisms.

Autopsy results: When the smaller dose was given slight dry pleurisy was obtained. When large doses were given actute fibrinous pleurisy with effusion occurred.

Five guinea-pigs were each inoculated intra-pleurally with a suspension of living streptococci (approximately 1,500,000,000 to the c.c.). Autopsy results: Negative.

Three healthy rabbits were given a single intra-pleural inoculation of pneumococci. Autopsy results: Acute fibrinous pleurisy with small serous effusion.

Ten guinea-pigs suffering from subcutaneous abscesses were given a single inoculation of staphylococci intra-pleurally.

Autopsy results: Acute fibrinous pleurisy with sero-purulent effusion.

Ten guinea-pigs were, after pleural sensitization, each given one intra-pleural inoculation of staphyococci.

Autopsy results: Acute fibrinous pleurisy with purulent effusion.

Three guinea-pigs following subcutaneous injection of streptococci were given one intra-pleural inoculation.

Autopsy results: Acute fibrinous pleurisy with sero-purulent effusion.

Four healthy rabbits were given a single intra-pleural inoculation of living pneumococci.

Autopsy results: Acute fibrinous pleurisy with a serous effusion.

Eight rabbits following pleural sensitization were given one intra-pleural inoculation of living pneumococci.

Autopsy results: Acute fibrinous pleurisy with purulent effusion.

Illustrative Protocols.

Sterilized Cultures of Bacteria.

A medium-sized male guinea-pig was given a single inoculation of a suspension of pneumococci in each pleural cavity. One c.c. of fluid was injected which contained 100,000,000 micro-organisms. At the end of twenty-four hours no constitutional effect was noticed on the animal, and it was killed. Examination of the pleura on either side showed it to be entirely normal.

A full-grown brown female guinea-pig was inoculated with a thin emulsion of tubercle bacilli into each pleural cavity. The emulsion contained about $\frac{5}{10}$ grm. of the organism. No constitutional reaction was observed. At the end of three days the animal was killed. The condition of the pleura showed an acute fibrinous pleurisy involving almost all of the visceral pleura. No fluid was present.

Five full-grown guinea-pigs were each given a single inoculation of a suspension of *Staphylococcus aureus* into one pleural cavity. The strength of the suspension varied from 100 to 500 organisms. No constitutional reaction was observed in any of the animals. At the end of twenty-four and forty-eight hours examination of the pleura showed acute fibrinous pleurisy of slight extent. The pleural cavity contained no fluid.

Two full-grown male guinea-pigs were inoculated in the pleural cavity with a heavy suspension of *Staphylococcus aureus*, the fluid injected being 1 c.c., which contained approximately a billion organisms. One animal died in eighteen hours. On examination the pleural cavity which had been inoculated showed acute hæmorrhagic pleurisy over the entire lung. About 2 c.c. of a bloody fluid was present, which contained a number of leucocytes and endothelial cells and large numbers of micro-organisms. The second animal, which was given a similar intra-pleural inoculation, showed no constitutional symptoms, and was killed at the end of three days. In this instance the organisms had been previously washed in salt solution before being suspended. Autopsy showed a heavy mass of fibrin covering the pleura, and about 3 c.c. of a serous effusion in the pleural cavity. This contained considerable fibrin, and a number of leucocytes, and a few micro-organisms.

A full-grown male guinea-pig was given four intra-pleural inoculations of a heavy suspension of *Staphylococcus aureus* at a two-day interval, the amount of fluid injected being 1 c.c. at each inoculation, containing about 500,000,000 organisms. At the end of ten days the animal was killed and the pleura examined. A small amount of fibrin was found covering the visceral pleura, and 1 c.c. bloody fluid in the pleural cavity. This contained a few micro-organisms, a few leucocytes, and endothelial cells.

Living Cultures of Bacteria.

A full-grown female rabbit was given a single inoculation of ½ c.c. of a heavy suspension of *Staphylococcus aureus* in either pleural cavity. In six hours the animal appeared sick, and died in eighteen hours. Autopsy showed either pleura acutely inflamed and covered with fibrin. A small amount of clear effusion was present in each pleural cavity which contained a few leucocytes.

A full-grown male guinea-pig was given four intra-pleural inoculations in one side of the chest at a two-day interval, of a suspension of *Staphylococcus aureus*, each inoculation consisting of 1 c.c., which contained 500,000,000 organisms. At the end of ten days the animal was killed, there having been no constitutional symptoms as the result of the inoculations. A small amount of fibrin was found adherent to the visceral pleura, and about 2 c.c. of clear serous effusion was found in the pleural cavity. Cultures of this fluid gave only a single colony of staphylococcus.

A large male guinea-pig was given two intra-pleural inoculations, two days apart, of a heavy suspension of *Staphylococcus aureus*, 1 c.c. of the fluid being inoculated at a time which contained between 500,000,000 and 1,000,000,000 organisms. The animal died in forty-eight hours. The pleural cavity inoculated showed about 2 c.c. of a turbid effusion which contained numerous phagocyting leucocytes, a few endothelial cells, and many micro-organisms. The visceral pleura was covered with a heavy coating of fibrin in the meshes of which was a small amount of pus.

A full-grown male guinea-pig was similarly treated as the former, except the micro-organisms were washed in salt solution before being suspended. No constitutional reaction was produced by the series of inoculations given. At the end of ten days the animal was killed. About 2 c.c. of clear effusion was found in the pleural cavity, and a few colonies of *Staphylococcus aureus* were obtained from it on culture. A small amount of fibrin covered the pleura.

A full-grown female guinea-pig was given two intra-pleural inoculations at a three-day interval in one side of the chest, of a heavy suspension of washed *Staphylococcus aureus*. No constitutional reaction was observed. The animal was killed in forty-eight hours following the last inoculation and the pleura showed a mild degree of fibrinous pleurisy. No fluid was present. The cultures showed a moderate number of colonies of *Staphylococcus aureus*.

Two two-third grown male rabbits were given two intra-pleural inoculations of a suspension of pneumococci which contained 600,000,000 organisms to the c.c. One c.c. of the mixture was inoculated, and both injections were made in one side of the chest. One animal died in forty-eight hours. Autopsy showed acute fibrinous pleurisy and consolidation of the upper lobe of the lung as the result of injury. About 2 c.c. of a slightly turbid fluid was present in the pleural cavity which contained numerous phagocyting polynuclear leucocytes. The second animal was killed in forty-eight hours following the last inoculation, and it also showed fibrinous pleurisy with a small effusion which contained numerous leucocytes.

Three medium-sized male guinea-pigs were given from one to three intra-pleural inoculations of a heavy suspension of *Streptococcus pyogenes,* the amount of fluid inoculated being 1 c.c., and this contained from 500 to 1,000 organisms. The animals were killed in twenty-four hours following the last inoculation, and mild fibrinous pleurisy was present, involving the visceral pleura. The scrapings showed a few leucocytes, considerable fibrin, and a few chains of streptococci. Cultures were negative.

Two full-grown female guinea-pigs were each given two intra-pleural inoculations of 1 c.c. each of a very heavy suspension of *Staphylococcus aureus.* One animal died in twenty-four hours, the second in forty-eight hours. Autopsy on each showed an acute pleurisy with a heavy formation of fibrin and about 1 c.c. of sero-purulent effusion in the pleural cavity. This effusion contained numerous phagocyting polynuclear leucocytes with numerous micro-organisms.

Action of Living Cultures of Bacteria in Infected and Sensitized Animals.

A full-grown male guinea-pig with an abdominal abscess was given one intra-pleural injection of a heavy suspension of staphylococcus. The animal died in twenty-four hours. Lung was covered with thick fibrin. Considerable quantity of turbid fluid in the chest cavity. Numerous leucocytes.

Two full-grown guinea-pigs were given one intra-pleural inoculation of a heavy suspension of staphylococcus while suffering with superficial abscesses. One animal died in forty-eight hours, and the second one was killed. Autopsies showed the pleura to be inflamed and covered with fibrin. Sero-purulent effusion in considerable quantity containing numerous phagocyting leucocytes was present.

Four medium-sized guinea-pigs following several subcutaneous inoculations of staphylococci were each given one intra-pleural inoculation of a moderately heavy suspension of staphylococcus. One animal died in forty-eight hours, and the others were killed. All showed acute fibrinous pleurisy and moderate amounts of a sero-purulent effusion containing numerous leucocytes, red blood corpuscles, and some endothelial cells.

Three large guinea-pigs, following five intra-pleural injections of sterile autolysate of *Streptococcus pyogenes*, were given one inoculation of a moderately heavy suspension of streptococcus. Autopsies after forty-eight hours showed in each acute fibrinous pleurisy, together with about 2 c.c. of thick blood fluid in the pleural cavity. Smears showed an abundance of leucocytes and endothelial cells. Cultures negative.

Four small rabbits, following four intra-pleural injections of sterile autolysate of pneumococci were given a single intra-pleural inoculation of 300,000,000 pneumococci. At the end of twenty-four hours the animals were very sick. Autopsies showed the pleura covered with a thick coating of fibrin and pus. The pleural cavities contained a purulent exudate containing a large number of leucocytes (20 to 50 per field) and numerous pneumococci. Autopsy of control animal negative.

Four medium-sized guinea-pigs, following five intra-pleural injections of a sterile autolysate of streptococci, were each given a single intra-pleural inoculation of a suspension of staphylococci (250,000,000). Control animal showed marked sero-fibrinous effusion. Autopsy of other animals showed acute fibrinous pleurisy, considerable purulent effusion containing many leucocytes, epithelial cells and cocci.

Discussion.

Clinical observation has shown that the large proportion of cases of empyema develop subsequent to a previous pulmonary or general infection, and 64 per cent. of the cases of empyema follow pneumonia. Of forty cases in children studied by Bythell twenty-nine followed pneumonia and only six followed primary pleurisy. Primary pleural effusion in a great proportion of instances has been proven to be due to tubercle bacillus, and the so-called primary empyema is frequently due to this organism. It is the exception rather than the rule not to find at autopsy following pneumonia, acute pleurisy and often a little effusion. The onset of empyema following pneumonia is from a few days to several weeks. In this experimental work primary infection of the pleura produced acute pleurisy, and if the animal had been debilitated by a concurrent infection the pleural infection was much more marked and accompanied by a turbid effusion. When sensitization of the pleura was carried on for ten days the pleural response to infection took on the nature of a purulent effusion.

Rosenow has called the substance extracted from the pneumococcus by autolysis virulin, and it is upon this substance that the resistance of this organism to phagocytosis depends. Pneumococci soaked in virulin grew after inoculation into guinea-pigs and killed them, whereas those not so treated were readily destroyed in the animal. Netter has shown that the presence of streptococci in the pleural cavity does not tend to an empyema unless in sufficiently large numbers and with a chance to multiply.

The same holds true in regard to the peritoneal cavity of healthy animals. Gravitz found that in order to produce peritonitis it was necessary to suspend micro-organisms in a fluid which would of itself act as an irritant to the peritoneum.

Netter and Michant have pointed out that the blood and other fluids may be swarming with streptococci, and this and other organisms may be found upon the surface of the serous membrane after death without having produced visible change.

In this series of experiments it was shown that the pleura of a normal animal could readily take care of a very large number of pathogenic micro-organisms and the products of their growth without constitutional disturbance or visible change of the pleura. When the animal was given an overwhelming dose death occurred promptly in most instances and the pleural reaction consisted of acute inflammation and a moderate effusion. In those animals, however, in which the pleura was sensitized by the use of bacterial extracts and then subjected to infection, the production of fibrin and the influx of leucocytes and of endothelial cells gave the lesion an appearance much more nearly that of an empyema.

Froin classes pleural exudates according to whether the cellular or the serous characteristics predominate. When the infectious agent or cellularcide predominates, chemiotaxic action upon the cellular elements is slight and their destruction is rapid. When the chemiotaxic action is profound and the destruction of cellular elements is mild the character of the exudate is purulent. When the cylolytic action of the excited fluid and the action of chemiotaxis move parallel a serous or sero-purulent effusion occurs. It is probable that in the majority of pleural infections the deposited micro-organisms gave rise to a dry pleurisy and the infectious agent is readily taken care of.

Certain organisms, however, notably the tubercle bacillus, through the products of their growth or destruction excite the serous membrane to the pouring out of an effusion and the chemiotaxic action upon the cellular elements of the body is limited. In pneumonia, where the infection is a virulent one, the pleura is almost always invaded and its secretions in part neutralize the toxic products of the pneumococcus. Sensitization follows, and the destructive effect of virulin upon the cellular element is materially limited and empyema results.

That a larger proportion of cases of pneumonia are not followed by empyema is probably due to the ability of the pleura to care for great numbers of micro-organisms without the aid of a marked cellular invasion.

Conclusions.

Acute dry pleurisy, pleurisy with effusion and empyema are steps in one process. The extent of pleural reaction is controlled by virulence of the infection and body resistance. When the invading organism is one that excites little chemiotaxis, pleurisy, with or without an effusion, will result, but if chemiotaxic action is profound and the elaborated toxin not too destructive, empyema results.

REFERENCES.

Lord, F. T. Osler's "System of Medicine."

Babcock, R. H. Text-book: "Diseases of the Lungs."

Bythell, W. J. S. *Journ. of Path. and Bact.* (English), vol. ix, p. 359; Allbutt's "System of Medicine," vol. v, p. 346.

Rosenow, E. C. *Journ. Infect. Dis.*, vol. i, 4, p. 235.

Froin, M. G. *Memoires Soc. de Biol.*, 58, 1905.

Aprie, E. L. *Journ. Exper. Med.*, vol. x, No. 3.

BLOOD-PRESSURE STUDIES WITH ESPECIAL REFERENCE TO THE "ENERGY INDEX" AND THE "CARDIAC LOAD."*

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Two methods have recently been suggested for using the data obtained by pulse and blood-pressure observations for the purpose of estimating the work done by the heart.

The Energy Index.

This term has been suggested by Barach† as a gauge of cardio-vascular energy as indicated by the arterial pressure per minute. The index is determined by multiplying (1) systolic, (2) diastolic, and (3) combined pressure by the pulse rate per minute, e.g.

In systole	120 mm. Hg. × 72	=	8,640 mm. Hg.
In diastole ...	70 mm. Hg. × 72	=	5,040 mm. Hg.
In both.........	190 mm. Hg. × 72	=	13,680 mm. Hg.

It is quite evident that there may be great variations in the amount of energy expended dependent upon relatively

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† Barach, J. H.: "The Energy Index." *Journ. Amer. Med. Assoc.*, lxii, 1914, p. 525.

slight changes in any one of the factors under consideration. It appears that the normal average index is about 20,000 mm. Hg. per minute.

The Cardiac Load.

Another method of applying blood-pressure data has been designated by Stone* as the cardiac load. The rationale of the method is as follows :—

" The act of transferring energy, or work, of the heart in systole on a column of blood gives motion to that blood column. The energy thus acquired is kinetic energy, since kinetic energy is energy of motion and is opposed to static energy, which pertains to bodies at rest without motion. If resistance is offered to the movement of the column of blood, work is done against the resistance and the column loses kinetic energy in proportion to the amount of resistance offered. The column of blood which has acquired kinetic energy through the work of the heart exerts force or pressure. Newton's third law of motion, however, expresses the fact that all action of force is of a dual character in the nature, in this instance, of a stress between the end pressure of the blood-column and the restraining or lateral pressure of the arterial walls.

" The end or systolic pressure represents the sum total of effort developed by the heart systole to maintain the circulation. The restraining lateral or static pressure of the vessel walls on the blood-column represents the amount of pressure remaining at the moment the transfer of energy or work of the heart systole ceases—that is, during diastole. In other words, the diastolic pressure represents the stress or minimum pressure borne by the arterial system during diastole

* Stone, W. J.: " The Clinical Significance of High and Low Pulse Pressures with Especial Reference to Cardiac Load and Overload." *Journ. Amer. Med. Assoc.*, lxi, 1913, p. 1256.

as a force contrary to cardiac force. As the intra-ventricular pressure rises in preparation for the next systole, the diastolic pressure represents immediate pressure which must be overcome. When systole occurs, and the intraventricular pressure approximates the diastolic pressure in the aorta, the aortic valves open. The cardiac energy must be sufficient to overcome the diastolic resistance, and in addition must be sufficient to propel the blood-column forward toward the periphery, of which the systolic pressure is the culminating point.

"The difference between the maximum pressure exerted by the kinetic energy of the blood-column and the minimum pressure of potential energy exerted by the vessel walls is the pulse-pressure. It represents the intermittent burden of pressure imposed on the arteries by the heart's energy in systole in order to force the blood toward the periphery and maintain the circulation. The pulse-pressure may, therefore, be defined as the amount of pressure exerted by the heart during systole in excess of the diastolic pressure. It measures the excess of dynamic over potential energy. For clinical purposes it represents the load of the heart. Under normal conditions it is approximately 50 per cent. of the diastolic pressure. The systolic and pulse-pressures represent myocardial values, while the diastolic pressure represents arterial resistance. Incidentally, it may be mentioned that the pulse-pressure is that part of the heart's energy which produces the distention of the arteries which is recognized as the pulse."

With a systolic pressure of 120 and a diastolic pressure of 80, the pulse pressure is 40. The amount of energy required, therefore, to maintain the circulation in excess of that necessary to open the aortic valves is 40. The normal cardiac load may thus be considered as 40/80 or 50 per cent. of the diastolic pressure.

Several questions now suggest themselves as to: (1) How much overload the normal heart can stand before the symptoms of broken compensation arise? (2) Can the effects of therapeusis or disease be explained upon or correlated with the foregoing hypothesis?

With a view to investigating these questions we have made blood-pressure observations on the cases in our service in the wards of the Pennsylvania Hospital, the results of which will be considered in this article. In all, 57 cases were studied; an effort being made to take complete blood-pressure observations daily. In special cases observations were made more frequently, as, for instance, before and after bleeding, sweating, lumbar puncture, pneumonic crises, &c. The more important findings as summarized constitute the basis of this communication. The blood-pressure was estimated by the auscultatory method, the fourth phase being used as the criterion of the diastolic pressure.

I.—Lobar Pneumonia.

It is generally admitted that blood-pressure readings are of distinct utility in pneumonia, both from a prognostic and a therapeutic standpoint. Many cases die as the result of toxic vasomotor failure in which the heart is only secondarily at fault. As was pointed out by Gibson, a falling pressure and an increasing pulse-rate is of untoward significance and if the blood-pressure in mm. Hg. falls below the pulse-rate per minute, active treatment, directed toward increasing vasomotor tone, must be instituted.

Among five *fatal cases* studied by us, both the systolic and the diastolic pressure fell before death. The pulse-pressure and the cardiac load increased in two, and decreased in three cases, while the energy index increased in only one and decreased in four. Among nine non-fatal cases the *crisis* was accompanied by a fall of pressure amounting in one instance to 23 mm. Hg. It is quite common for pneumonia cases to require stimulation at this time, even when none was required previously. In one case studied just before and just after the crisis the cardiac load increased from 50 to 61 per cent., while the energy index decreased from 19,000 to 11,560.

The relative duration of different auscultatory phases may also be of some practical significance. The second phase as has been emphasized by A. A. Howell is the first to disappear, owing to circulatory weakness and a long, loud second phase is therefore prognostically favourable. The same statement may be made concerning all clear, tapping sounds, whether heard as part of the third phase or not, while, generally speaking, weak muffled sounds have the opposite significance, and point to vasomotor weakness.

Among nine *non-fatal cases* of *pneumonia,* the pulse-pressure and the cardiac load increased during the course of the disease in four cases. In five cases both factors showed a decrease, while in all the cases the energy index showed a diminution.

The following figures from a fairly representative case of pneumonia clearly show that too many factors enter into the problem of pneumonia to be estimated by any single index such as blood-pressure :—

No. 23.

On admission: Pulse 108, respirations 28, temperature 104·2° F. Systolic pressure 110, diastolic pressure 70, pulse pressure 40 mm. Hg. Cardiac load 57 per cent., energy index 19,440. There is slight *dyspnœa* and *cyanosis.*

Three days later: Pulse 104, respirations 44, temperature 104·1° F. Systolic pressure 110, diastolic pressure 55, pulse pressure 55 mm. Hg. Cardiac load 100 per cent., energy index 17,160. *Dyspnœa* and *cyanosis* have *increased.*

(3) *After the crisis:* Pulse 80, respirations 20, temperature 98° F. Systolic pressure 105, diastolic pressure 50, pulse pressure 55. Cardiac load 110 per cent.; energy index 12,400.

(4) *During convalescence:* Pulse 68, respirations 20, temperature 98° F. Systolic pressure 105, diastolic pressure 55, pulse pressure 50 mm. Hg. Cardiac load 90 per cent., energy index 10,880.

(5) *At time of discharge:* Pulse 72, respirations 24, temperature 98° F. Systolic pressure 110, diastolic pressure 55, pulse pressure 55. Cardiac load 100 per cent., energy index 11,880.

Here numerous blood-pressure values were essentially identical at the time of discharge and during the most critical stage of the disease.

II.—Typhoid Fever.

The blood-pressure curve, as studied in a number of cases, showed hypotension on admission, with a continued fall to 95 or 90 mm. Hg., which was more or less approximate to the degree of toxæmia, and a gradual rise during convalescence. Sometimes a more or less sudden increase occurred upon getting out of bed. The cardiac load and energy index showed nothing noteworthy.

III.—Pericarditis.

In one case of acute, non-fatal of endo- and pericarditis the systolic and diastolic pressures fell continuously from 115 to 87 and from 60 to 52 respectively. The cardiac load decreased from 109 to 67 per cent., and the index from 17,000 to 16,000. Neither dyspnœa, pain nor size of the pericardial effusion showed any constant relation to pressure variations. In another case of chronic pericarditis, with cardiac hypertrophy with systolic and diastolic values, ranging between 155 and 150 and between 130 and 105 mm. Hg., respectively, the cardiac load averaged 18 to 42 per cent., the index

25,000 to 36,000. The case progressed unfavourably and was taken home by his family. In this instance again neither increasing œdema nor loss of compensation showed any constant pressure changes. In a third case the onset of pericarditis was definitely associated with a temporary increase of the systolic pressure.

IV.—Valvular Disease.

Broken compensation in valvular disease may show either an increase or a decrease of arterial pressure coincident with symptomatic improvement. The latter occurs especially in cases of high pressure stasis in which the venous pressure is high and the arterioles contracted by an increase CO_2 content in the blood. A case of cardiac dilation with a systolic diastolic pressure of 210 to 130 mm. Hg. was bled with the result that the pressure fell to 175 and 120, a level which was afterward maintained, while the patient showed marked improvement.

V.—Nephritis.

A case of acute nephritis showed a marked decrease of all pressures with symptomatic improvement. The cardiac load decreased until the œdema disappeared and then steadily rose from 29 to 47 per cent.

A fatal case of chronic diffuse nephritis long under observation with pressures constantly about 210 systolic, 150 diastolic, showed a steady fall of pressure down to 105 systolic and 85 diastolic just before death. The cardiac load falling from 70 to 23 per cent. and the index from 17,000 to 2,800. This illustrates terminal hypotension and furnishes a text to warn against the ruthless depression of high pressure by medicinal treatment or otherwise. In the particular case in question, no such measures were employed, the fall of pressure being due to gradual exhaustion.

VI.—PHLEBOTOMY.

Phlebotomy was practised upon three cases (1 pneumonia, 2 uremia). The systolic, diastolic and pulse-pressure, and cardiac load were lowered in each instance, whereas the energy index was lowered in only one, and increased in two cases. The intravenous saline infusion with epinephrin in other cases caused a rise of all three pressures.

VII.—SWEAT BATHS.

Sweat baths which were employed in a number of cases of chronic nephritis with hypertension generally produced a marked fall of systolic and pulse pressure, as well as of the cardiac load and energy index. The diastolic pressure was much less affected.

The amount of "overload" which the heart can bear varies greatly. Stone's statement that when this factor exceeds 50 per cent. the patient must lead a restricted life, owing to the danger of myocardial exhaustion is, in our experience, correct, although some cardio-vascular systems do stand this strain for years.

VIII.—FATAL AND NON-FATAL CASES.

If we indiscriminately group all of the fatal cases we find no constant relation between the cardiac load or the energy index when we regard these factors as present at the time of admission and shortly before death. As a general rule, both factors decreased. Thus in Case No. 1 (endothelioma of the pleura) the following figures were collated :—

IX.—Lumbar Puncture.

In a case of cerebro-spinal meningitis, lumbar puncture caused a fall of 10 mm. Hg. in the systolic pressure, the diastolic pressure remained unchanged, the cardiac load and the energy index decreased 13 per cent. and 1,000 respectively.

X.—Intravenous Saline Infusion.

In a case of typhoid fever with toxic vasoparesis saline infusion with epinephrin temporarily raised both the systolic and the diastolic pressure 13 and 5 mm. respectively, even shortly before death, when intravenous infusion without epinephrin produced no effect. Both the cardiac load and the energy showed the highest readings just before death.

XI.—Urinary Secretion.

Our investigations failed to show any relationship between the quantity of urine secreted and any of the blood-pressure readings. The secretion of urine depends upon many factors other than those of blood-pressure, and while, as a general rule, high pressure cases secrete a larger quantity, and while most diuretics do not have a depressor action, yet local vascular changes in the renal vessels far outweigh the importance of general systemic changes in blood-pressure.

No. 1.—"Two Days before Death."

P. 132 ...	Syst. 95	30	Energy index 12,540	Patient slightly cyanotic and dyspnœic, with slight pretibial œdema
		— 65)3000(46% 260	Energy index 8,580	
R. 36 ...	Diast. 65	—— 400 390	Energy index 3,960	
			S. and D. 21,120	
T. 104°	P. P. 30	Cardiac load 46%		

"Six Hours before Death."

P. 160?	Syst. 95	25 — 70)2500(35% 210	Energy index 16,200 Energy index 11,200	Intense dyspnœa, cyanosis, cold perspiration.
R. 44	Diast. 70	—— 400	Energy index 5,000 28,400	
T. 100°	P. P. 25	Cardiac load 35%		

"One Hour before Death."

P. 160?	Syst. 80	10 — 70)1000(14% —— 300	Energy index 12,800 Energy index 11,200 Energy index 1,600	All symptoms have increased.
R. 40...	Diast. 70		24,000	
T. 100°	P. P. 10	Cardiac load 14%		

Conclusions.

(1) We do not feel that either of the methods studied offer any especial advantages over the routine blood-pressure observation. The calculation of the energy index perhaps helps us to visualize more clearly just how much energy the heart is expending, but the "cardiac load" feature teaches us nothing that is not evident from the mere inspection of the diastolic and the pulse pressures.

(2) When the results obtained by the two methods coincidently in a given case are contrasted they are often found to vary not only quantitatively, but often qualitatively. Either method is more useful for the continuous study of a given case than it is for the purpose of comparing different cases or for gathering statistical data.

(3) Comparative daily observations of the "cardiac load" and the "energy index" throw some light upon the progress

of the circulatory function, but identical figures may be obtained from a dying heart and from an organ which still has a good functional capacity and a large reserve force.

(4) The diastolic pressure which is now readily obtained by the auscultatory method is often of greater importance than the systolic pressure, which varies much more widely as the result of psychic processes and other evanescent causes.

[The discussion on this paper will be found combined with that on Dr. Rochester's paper on p. 300.]

HOW SHALL WE TELL WHETHER THE MYOCARDIUM IS COMPETENT?

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The determination of the functional capacity of the vital organs is a problem that is of the utmost interest in prognosis. If a man consults a physician for symptoms pointing to disturbance of the heart, the kidneys or the liver, it would be of great advantage not only to the patient but also to his adviser if some satisfactory means were known by which the power of the affected organ to do its work could be determined. So far as concerns the kidneys and the liver fairly reliable functional tests are at our disposal. Are we able to say as much of the myocardium? For example, a man, aged 50 or more years, presents himself in the consulting room complaining of dyspnœa, or perhaps of some symptoms less definitely associated with myocardial insufficiency. He proves to be a modern business man with important obligations. He has lived the life of his class. He has been a large and irregular eater and his diet has contained an over-proportion of proteid or of carbohydrate food, depending on his individual preference; he has drunk little or no water, two or three or more cups of coffee or tea, or of coffee and tea; more or less alcohol; sometimes malt liquors, sometimes distilled liquors, sometimes wine;

again a liberal amount of all. He has smoked from eight to ten cigars a day. He has always slept well; but perhaps now he is beginning to have trouble in getting to sleep, or, provided he goes to sleep promptly, he soon wakens and is restless. His bowels, which have always been regular, are beginning to require attention. He has to get up once or twice at night to urinate, and for thirty years he has not taken any more exercise than was absolutely necessary. In the course of the physical examination you find him to be over weight; you find that he is beginning to develop a definite pulmonary emphysema; that his heart is larger than it should be and that the rate is a little accelerated, but that it presents no endocardial murmurs; that his blood-pressure is a trifle higher than it should be; and that his urine is increased in quantity and is of low specific gravity, but shows neither albumin nor casts. Let us suppose that the cardiac hypertrophy in such a case seems to be the important pathologic finding; can we determine by any means the capacity of the myocardium of that individual?

The following tests have been advocated from time to time for this purpose:—

(1) The increase in the pulse-rate between the recumbent posture and the erect posture.

(2) The increase in the pulse-rate after slowly flexing and extending the right forearm (Selbsthemmungsprobe of Herz).

(3) The increase of the systolic blood-pressure on constricting the femoral arteries, proposed by Katzenstein.

(4) The increase of the systolic blood-pressure after certain exercises, proposed by Graupner.

The determination of the change in pulse-rate upon assuming the erect from the recumbent posture and after flexing and extending the right forearm a definite number of times is clinically easy of execution and may be applied equally well to patients of both sexes. The determination of increase of the systolic blood-pressure after constriction of the femoral arteries is less readily performed and is impossible in the case of female patients who are being examined in the physician's office. The procedure of Graupner requires a piece of apparatus which is not well adapted to the ordinary consulting room.

With the introduction of the auscultatory method of blood-pressure determinations it has been possible clinically to determine the diastolic pressure, and consequently the pulse-pressure, with accuracy. Hence it has become possible to determine certain mathematical formulæ which indicate the conditions under which the circulation is being carried on.

Tigerstedt [1] has suggested a formula for determining the efficiency of the heart as a pump. The pulse pressure multiplied by the pulse-rate gives the velocity of the circulation. The systolic pressure multiplied by the pulse-rate gives the work of the heart. The velocity of the circulation divided by the work of the heart, according to Tigerstedt, gives the efficiency of the heart as a pump.

$$\frac{\text{Pulse-pressure} \times \text{pulse-rate} = \text{velocity}}{\text{Systolic pressure} \times \text{pulse-rate} = \text{work}} = \text{efficiency of the heart as a pump.}$$

In other words, the pulse-pressure, divided by the systolic pressure. In a normal individual this co-efficient is from 25 to 35 per cent. In a normal individual in whom the systolic pressure was 126 mm. and the diastolic pressure was 81 mm., obtained by the auscultatory method, the pulse-pressure was 45 mm. and the cardiac efficiency was 35 per cent.

Many authors have agreed that the second phase (the murmur phase) of the auscultatory blood-pressure observation indicates cardiac strength. (Tornai [2], Fischer [3], Goodman and Howell [4 and 5].)

Goodman and Howell [4 and 5] have shown that the second and third phases of the auscultatory blood-pressure indicate cardiac strength and that the first phase and the fourth phase indicate cardiac weakness. They have suggested that by determining the percentage of the pulse-pressure formed by the different phases and adding the second and third phases together and the first and fourth phases together a proportion could be determined which would give an idea of the relative cardiac strength and cardiac weakness factors. They found that when the cardiac weakness factor was in excess of the cardiac strength factor there was evidence of inefficiency of the myocardium. In a normal individual they found the following percentages:—

Pulse-pressure, 45 mm.

First phase	31·1	per cent.
Second phase	44·4	,,
Third phase	11·1	,,
Fourth phase	13·3	,,
	99·9	,,

C.S. : C.W. :: 55·5 : 44 4.

Stone [6] has suggested the determination of a cardiac load and overload factor based upon auscultatory blood-pressure determinations. He pointed out that in sixty-one normal persons with an average systolic pressure of 123 mm. and an average diastolic pressure of 80 mm., the pulse-pressure average was 40 mm. "The amount of energy expended, therefore, to maintain the circulation in excess of that required to open the aortic valves and overcome the resisting pressure of 80, was 40. The normal load may, therefore, be considered to be $\frac{40}{80}$ or 50 per cent. of the diastolic pressure." He has shown that in fourteen cases of decompensated myocardial disease the load was 76 per cent., an overload of 26 per cent. In fifty-one cases of arterial hypertension the load was 69 per cent., an overload of 19 per cent. He says that an overload factor of 50 per cent. indicates that there is impending danger of myocardial exhaustion.

In this paper I have compared the variations in the pulse-rate in the recumbent and in the erect posture, the cardiac efficiency factor of Tigerstedt, the percentage of the pulse-pressure formed by the second phase of the auscultatory blood-pressure reading, the C.S. : C.W. ratio of Goodman and Howell and the cardiac overload factor of Stone in ten fatal cases of cardiac and cardiorenal disease; in seven cases of compensated cardiac disease; in six cases of cardiac decompensation which subsequently had compensation restored; in eight cases of chronic interstitial nephritis still living; and in nine cases of various diseases in which the functional capacity of the myocardium was of importance in prognosis.

The blood-pressure observations were all made in the recumbent posture, with a 12 cm. cuff. Those marked (*) were made with a Tycos instrument, those marked (†) were made with a Riva Rocci instrument, and those marked (§) were made with a Stanton instrument. The auscultatory method was employed in every case. The first point, the appearance of the first tap, was recorded as the systolic pressure; and the fifth point, the disappearance of all sounds, was recorded as the diastolic pressure.

In the tables – means that the observation was not made; + means that the formula could not be worked out.

In ten cases of cardiorenal disease fifty-three observations were made. At many of these observations the difference in pulse-rate between the recumbent and the erect posture could not be obtained because the patients were confined to bed; at none at which the observation could be made was the increase excessive. It is significant that at two observations the pulse-rate decreased when the patient stood; in

Case 424 there was a decrease of two beats; in Case 215 there was a decrease of six beats.

The cardiac efficiency factor was above 35 at forty-four observations; once it was 35. In Case 105, a patient with chronic interstitial nephritis, pleural effusion, hypertrophy and dilatation of the heart, the factor was within normal limits three times, and once it was much below normal—19 per cent. The last record in this patient was made eight months before his death, and the symptoms were more those of pleural effusion at the times at which I saw the patient than they were those of cardiac failure. In Case 180, likewise, although the patient died of uræmia, and the autopsy showed chronic parenchymatous nephritis, the symptomatology was that of indefinite abdominal disease (a chronic duodenal ulcer was found at autopsy) and the myocardium was not considered seriously impaired. The very high cardiac efficiency factor in Case 424, and in Case 511, is interesting in view of the fatal termination in two months in the one and within twenty-four hours in the other.

The second phase of the blood-pressure in these cases was below 40 per cent. of the pulse-pressure, when it could be worked out, at every observation except four. In Case 215, the second observation, which gave a percentage of 57·1, was made during a temporary improvement in the patient's condition.

The C.S. : C.W. ratio could be worked out at only twenty of these observations. The C.S. was greater than the C.W. factor at fifteen observations and the two were equal once. At four observations the C.W. factor was greater than the C.S. factor. In the majority of the cases an absent point in the auscultatory blood-pressure determination made it impossible to work out this proportion.

The cardiac overload factor was demonstrable in all cases except Cases 105 and 108. In these the cardiac load was below 50, and gave a negative overload factor. In both of these cases the pulse-pressure was low. In Case 424 the overload amounted to 88 per cent.; in Case 511 to 216 per cent.

In these seven cases thirty-nine observations were made. In none was it possible to say that active decompensation was present. In Case 15 the chief complaint was weakness; in Case 127 it was a sensation of being tired; in Case 129, nervousness; in Case 176, weakness; in Case 275, rapid pulse; in Case 277, retrosternal pain; in Case 419, dyspnœa.

In Case 15 the cardiac efficiency factor was above 35 per cent. at all observations except one. The second phase however, was above 40 per cent. at all observations except five. When the C.S. : C.W. ratio could be worked out it was on the side of C.S. seven times and on the side of C.W. once. The cardiac overload was above 50 per cent. four times and below 50 per cent. eight times.

In Case 127 the cardiac efficiency factor was never much above or below the normal ratio, 25 to 35 per cent. The second phase was below 40 per cent. at three out of five observations. The C.S. factor was above the C.W. at two observations at which the ratio could be worked out, and the two were equal at the other observation. There was no overload at two observations, and at the other three the overload was insignificant.

In Case 129 the cardiac efficiency factor was high at three out of four observations. The second phase was below 40 per cent at three observations. At two observations at which the C.S. : C.W. ratio could be worked out the C.S. factor was the higher. The overload was insignificant.

In Case 176 the cardiac efficiency factor was slightly in excess. The second phase was below 40 per cent. at all observations except the last. The C.S. : C.W. ratio could be worked out at four out of six observations, and the C.S.

Table I.—Fatal Cases.

No.	Date	Sex	Age	Recumbent	Erect	C.E.	2nd phase	C.S. : C.W.	Overload	Remarks
						Per cent.	Per cent.		Per cent.	
*100	Feb. 5, 1912	M.	67	—	—	42	3·5	+	23	Fibroid myocarditis.
	,, 13, 1912			82	90[1]	49	14·0	+	46	This observation of the pulse was made in the sitting posture.
	,, 19, 1912			76	—	39	14·8	22·2 : 77·5	15	
	,, 27, 1912			88	—	41	22·5	+	20	
	March 8, 1912			—	—	43	12·9	+	25	
	,, 14, 1912			—	—	37	16·0	+	9	Tr. digitalis gtt. v, nitroglycerin begun March 12, 1912.
	,, 18, 1912			—	—	48	11·4	71·4 : 28·5	41	Tr. digitalis stopped. The patient died three weeks after this observation was made.
*101	May 2, 1912	M.	64	54	—	38	17·6	+	11	Chronic parenchymatous nephritis. Cerebral thrombosis occurred to-day.
	,, 3, 1912			52	—	34	9·6	+	2	Admitted to hospital.
	,, 4, 1912			50	—	38	29·4	+	11	
	,, 10, 1912			44	—	44	+	+	30	
	,, 17, 1912			61	69[1]	47	30·0	+	38	This observation of the pulse was made in the sitting posture.
	June 8, 1912			84	88	42	37·5	+	22	Improved sufficiently to leave hospital.
	,, 15, 1912			84	86	36	31·4	+	8	The patient died twenty-three days after this observation was made.
*105	Feb. 20, 1912	M.	53	92	—	30	+	+	−7	Chronic interstitial nephritis.
	,, 28, 1912			100	—	19	21·0	+	−26	
	July 13, 1912			84[1]	88	27	52·6	+	−12	This observation of the pulse was made in the sitting posture.
	Aug. 11, 1912			106	—	26	+	+	−15	The patient died eight months later.
*180	,, 25, 1912	M.	47	82	82	29	22·7	+	−8	Chronic parenchymatous nephritis.
†	Sept. 16, 1912			84	—	31	13·6	+	−6	After three weeks' hospital treatment.
†	,, 26, 1912			94	100	37	52·9	76·4 : 23·4	10	Feeling well.
†	June 6, 1913			84	98	29	56·8	81·8 : 18·0	−9	Abdominal pain, nausea, vomiting, and vertigo.
†	Aug. 15, 1913			88	98	30	34·2	44·7 : 55·2	−6	Œdema of ankles, suborbital puffiness, tingling in fingers. The patient died seven months later.

†215	Nov. 19, 1912	M.	63	82	76	42	29·0	58·0 : 41·7	24	Angina pectoris.
	,, 29, 1912			70	72	35	57·1	67·3 : 32·6	4	After four brine baths 98 degrees. Death about four weeks later.
*220	,, 4, 1912	F.	44	122	—	44	9·4	71·6 : 28·2	30	Mitral regurgitation.
	Dec. 13, 1912			110	—	39	+	+	14	The patient died the next day.
*239	Jan. 8, 1913	F.	69	86	—	47	30·0	+	40	Chronic interstitial nephritis.
*	,, 10, 1913			78	—	45	39·0	82·9 : 17·0	32	Patient in bed, improving under treatment.
*	,, 15, 1913			80	—	41	38·8	49·9 : 49·9	22	
*	Feb. 3, 1913			84	—	50	13·0	86·9 : 12·9	52	Patient doing well.
*	March 3, 1913			72	—	49	20·4	+	48	Patient up and about, feeling well.
*	,, 20, 1913			—	—	50	7·0	85·9 : 13·9	53	Before a brine bath.
*	,, 20, 1913			—	—	50	7·0	85·9 : 13·9	53	After a brine bath.
*	April 11, 1913			—	—	49	9·0	+	46	
*	,, 21, 1913			78	—	45	20·4	79·5 : 20·3	33	The brine baths do not agree with the patient. They make her feel exhausted, and she does not sleep well.
*	May 1, 1913			78	—	44	15·2	28·2 : 71·7	29	The patient is not feeling well.
†	Oct. 1, 1913			82	—	52	12·0	87·0 : 13·0	61	
†	Nov. 29, 1913			76	—	51	5·2	20·9 : 78·8	55	Nausea.
†	Dec. 17, 1913			86	86	48	23·7	90·7 : 9·2	42	Fairly well.
*	Jan. 11, 1914			78	—	41	16·6	+	22	Beginning of last illness. Renal dyspnœa, nausea and vomiting. Pulmonary œdema.
*	,, 31, 1914			—	—	43	+	+	26	
*	Feb. 5, 1914			82	—	46	25·5	85·9 : 13·8	36	
*	,, 12, 1914			80	—	42	2·4	+	24	Temporary improvement.
*	March 18, 1914			82	—	39	20·5	+	15	Patient not so well. Death one week later.
*414	Nov. 11, 1913	M.	49	100	—	48	39·2	+	42	Auricular fibrillation. Nephritis.
	Dec. 1, 1913			92	—	36	2·9	+	6	
	,, 4, 1913			76	—	49	+	+	48	
	,, 8, 1913			74	—	51	+	+	58	
	,, 13, 1913			86	—	46	+	+	35	
	,, 14, 1913			80	—	45	33·3	+	31	Cerebral thrombus.
	Jan. 7, 1914			70	—	42	35·0	+	22	Some improvement in symptoms. The patient died about one month later.
†424	Nov. 24, 1913	F.	49	90	88	58	+	+	88	Mitral regurgitation. The patient died two months later.
*511	April 11, 1914	M.	67	92	—	72	18·7	81·2 : 18·7	216	Uræmia. The patient died the next morning.

TABLE II.—COMPENSATED HEART CASES.

No.	Date	Sex	Age	Recumbent	Erect	C.E.	2nd phase	C.S. : C.W.	Overload	Remarks
						Per cent.	Per cent.		Per cent.	
§15	Jan. 10, 1911	F.	26	–	–	40	52·2	+	18	Parenchymatous myocarditis.
	,, 12, 1911			–	–	34	+	+	6	Carbonated brine baths being given.
	,, 14, 1911			–	–	44	63·2	71·3 : 28·5	31	
	,, 16, 1911			–	–	52	28·3	36·9 : 46·6	59	
	,, 18, 1911			–	–	45	8·5	+	32	
	,, 20, 1911			–	–	39	26·1	73·7 : 26·1	15	Carbonated brine baths finished.
	,, 21, 1911			68	90	46	29·0	43·5 : 56·3	37	Resistance exercises begun.
	Feb. 13, 1911			–	–	56	10·9	51·5 : 48·4	78	
	,, 20, 1911			–	–	50	48·2	85·7 : 14·2	53	
	,, 27, 1911			–	–	43	46·9	69·3 : 30·5	35	
	March 6, 1911			–	–	50	46·2	+	51	
	,, 13, 1911			–	–	40	44·4	55·5 : 44·4	18	Resistance exercises finished.
*127	April 18, 1912	M.	58	96	104	31	26·0	+	−4	Mitral regurgitation.
*	May 11, 1912			74	–	38	32·0	84·0 : 16·0	12	During an attack of acute bronchitis.
†	Oct. 31, 1913			80	90	24	56·6	+	−19	Digitalis gtt. x p.c.
†	Nov. 7, 1913			72	80	36	43·7	62·4 : 37·4	8	
†	,, 14, 1913			90	–	38	30·7	49·9 : 49·9	12	
*129	April 23. 1912	F.	24	80	90	43	23·3	83·3 : 6·6	26	Mitral regurgitation.
*	May 23, 1912			90	100	46	30·4	+	0	
†	Feb. 15, 1913			78	100	44	31·0	65·3 : 34·3	30	
†	Sept. 8, 1913			88	108	37	55·5	+	10	
§176	Jan. 13, 1911	M.	46	76	90	43	28·3	62·2 : 37·7	31	Parenchymatous myocarditis.
§	,, 27, 1911			70	80	39	27·9	55·8 : 44·1	15	
§	Feb. 10, 1911			84	86	40	22·7	61·3 : 38·5	18	
§	,, 16, 1911			70	82	41	22·9	+	19	After a course of carbonated brine baths.
*	Aug. 11, 1912			64	78	40	18·1	+	16	
*	,, 13, 1913			72	90	36	48·5	68·5 : 31·3	8	
†277	March 10, 1913	M.	52	86	108	42	17·6	74·0 : 25·8	44	Angina pectoris.
	Jan. 28, 1914			94	110	40	+	+	16	In the interval the patient had had a cerebral embolism.
*275	May 13, 1913	M.	43	72	92	35	+	+	−8	Parenchymatous myocarditis.
*	March 20, 1913			68	–	35	+	+	−8	Carbonated brine baths begun.
*	,, 30, 1913			–	–	39	20·0	72·0 : 28·0	14	
†	April 4, 1913			92	114	23	50·0	75·0 : 24·6	−20	
†	,, 12, 1914			90	106	21	43·4	+	−19	
†	,, 15, 1914			106	120	22	26·0	+	−21	Carbonated brine baths finished.
†	,, 22, 1914			106	116	28	23·3	49·9 : 49·9	−10	
†419	Nov. 20, 1913	F.	25	100	114	30	+	+	−8	Mitral obstruction.
	Dec. 9, 1913			96	+	24	+	+	−18	Digitalis begun.
	Jan. 10, 1914			92	98	37	+	+	9	

factor was always greater. The cardiac overload was not great.

In Case 275 seven observations were made. The cardiac efficiency factor was always in the neighbourhood of normal limits. The second phase was above 40 per cent. at two only. At three only could the C.S. : C.W. ratio be determined; at two of these the C.S. was greater than the C.W., at the other the two factors were equal. The overload factor was a minus quantity at all observations except one, at which it was insignificant.

In Case 277 the cardiac efficiency factor was above the normal. The second phase was low at the observation at which it could be worked out. The C.S. : C.W. ratio was in favour of the C.S. factor. The overload was 44 per cent. at the first and 16 per cent. at the second observation.

In Case 419 the cardiac efficiency factor was about normal. The second phase of the C.S. : C.W. ratio could not be worked out. There was no overload factor except an unimportant one at the last observation (9 per cent.).

Cases in which Compensation was at first lost, to be restored subsequently.—In these six cases (Table III) compensation was lost at the time the patients were first seen, but was restored after treatment, so that they could resume their usual occupations. Three of the patients suffered from mitral regurgitation, two from aortic regurgitation, and one from auricular fibrillation.

In Case 147A the variation in the pulse-rate between the recumbent and the erect posture was fourteen, sixteen, and eight beats at three observations. The cardiac efficiency was below 25 per cent. when he was first seen; was 36 per cent. at the second observation, when compensation was good; 46 per cent. at the third observation, when compensation was again partially lost; and 33 per cent. at the fourth observation, when compensation had again been restored. The second phase and the C.S. : C.W. ratio could not be determined.

Table III.—Cases in which Compensation was at first lost, to be restored subsequently.

No.	Date	Sex	Age	Recumbent	Erect	C.E.	2nd phase	C.S. : C.W.	Overload	Remarks
						Per cent.	Per cent.		Per cent.	
†147a	Oct. 2, 1913	M.	28	84	98	24	+	+	−19	Mitral regurgitation. Decompensated. Ambulant.
	Nov. 4, 1913			76	92	36	+	+	8	Compensated.
	Jan. 8, 1914			84	—	46	+	+	36	Partially decompensated.
	April 4, 1914			66	74	33	+	+	0	Compensated.
†191	Sept. 28, 1912	M.	50	68	86	45	15·7	70·0 : 29·8	33	Mitral regurgitation. Compensated.
*	Dec. 3, 1912			64	70	49	+	+	46	Acute dilation.
†	,, 6, 1912			60	—	40	20·0	40·0 : 60·0	17	In bed under treatment; improving.
†	,, 17, 1912			70	90	48	31·0	68·9 : 30·9	43	Up and about the house. Compensation restored.
†	,, 26, 1912			76	96	52	29·8	74·5 : 25·3	61	After three carbonated brine baths.
†	Jan. 3, 1913			86	96	45	36·8	75·3 : 24·8	32	After six carbonated brine baths.
†	,, 10, 1913			68	84	49	22·0	55·8 : 43·8	48	After nine carbonated brine baths.
†	,, 17, 1913			70	86	50	30·6	72·5 : 27·3	48	After twelve carbonated brine baths.
†	Feb. 6, 1913			72	94	52	45·4	60·5 : 39·3	60	After eighteen carbonated brine baths.
†	April 10, 1913			72	84	44	45·0	64·6 : 35·2	29	Just before going to Bad Nauheim.
†	Sept. 10, 1913			70	80	52	46·1	76·8 : 22·9	58	Two months after returning from Bad Nauheim.
†	Jan. 10, 1914			86	114	45	+	+	29	After carbonated brine baths.
†	March 12, 1914			66	—	51	30·6	74·1 : 25·7	55	
*291	,, 24, 1913	M.	50	102	—	88	9·8	64·7 : 35·1	178	Aortic regurgitation. Marked decompensation.
*	June 5, 1913			112	—	58	+	+	90	Improving.
*	Oct. 9, 1913			86	—	71	16·0	86·0 : 14·0	200	Compensated.
†	Nov. 6, 1913			74	80	74	20·6	32·0 : 67·7	240	
†	Dec. 16, 1913			74	80	80	15·2	80·9 : 18·9	370	
†373	Aug. 27, 1913	F.	44	80	86	88	13·7	+	723	Aortic regurgitation. Decompensated.
	Sept. 1, 1913			68	76	84	4·5	22·6 : 77·2	500	Some improvement.
*404	Oct. 19, 1913	M.	57	82	90	40	15·3	19·1 : 80·7	16	Mitral regurgitation. Partially decompensated.
*	,, 20, 1913			84	—	34	+	+	2	Twenty-four hours rest in bed.
*	,, 22, 1913			78	—	43	+	+	26	
*	,, 28, 1913			82	—	50	19·3	70·9 : 28·9	50	
*	Nov. 6, 1913			72	—	44	23·3	33·3 : 66·6	31	Patient allowed to sit up.
*	,, 25, 1913			70	80	46	15·6	59·1 : 40·6	36	
*	Dec. 4, 1913			74	—	39	34·6	38·4 : 61·5	15	
*	,, 24, 1913			84	—	42	32·0	80·0 : 20·0	23	
*	Jan. 8, 1914			78	—	49	34·3	65·5 : 34·3	46	
†	Feb. 20, 1914			70	—	45	25·9	66·6 : 33·3	31	
†	March 27, 1914			76	82	45	13·1	86·8 : 13·0	32	
*456	Jan. 5, 1914	F.	71	88	—	39	+	+	14	Auricular fibrillation. Decompensated.
*	,, 27, 1914			84	—	30	91·0	+	−7	Compensation re-established.

The cardiac overload was 19 per cent. negative at the first observation during decompensation; 8 per cent. at the second observation, when compensation was restored; 36 per cent. at the third observation, when compensation was again lost; and 0 at the fourth observation, when compensation was restored.

In Case 191 the pulse increase between the recumbent and the erect posture was over ten beats at eight observations, both during an attack of acute dilatation and after compensation had been restored. The cardiac efficiency factor was above 35 per cent. at every observation. The second phase rose during the course of carbonated brine baths from 15·7 to 45 per cent.; the C.S. : C.W. ratio fluctuated, and the overload varied, being 46 per cent. just after the acute dilatation occurred, and increasing to 61 and 60 per cent. at two observations during the course of carbonated brine baths.

In Case 404 the observations on the pulse-rate in the recumbent and the erect posture were not systematically made. The cardiac efficiency factor fell from 40 to 34 per cent. after twenty-four hours in bed; but subsequently rose, and was 39 per cent. or over at all the subsequent observations. The second phase formed 15·3 per cent. of the pulse-pressure at the first observation, but improved, and at one time formed 34·6 per cent. of the pulse-pressure. The C.S. : C.W. ratio was at first 19·1, 80·7 and subsequently varied; but the C.S. factor was greater than the C.W. factor at six out of eight observations. The cardiac overload was never excessive, the highest being 50 per cent. nine days before the patient was allowed to get up.

In the cases of aortic regurgitation the cardiac efficiency factor was very high both during decompensation and during compensation. The second phase was low at all times, the C.S. : C.W. ratio varied and the cardiac overload was excessive.

TABLE IV.—CASES OF CHRONIC NEPHRITIS.

No.	Date	Sex	Age	Recumbent	Erect	C.E.	2nd phase	C.S. : C.W.	Overload	Remarks
						Per cent.	Per cent.		Per cent.	
*104	Feb. 19, 1912	M.	65	68	76	36	11·5	+	6	Chronic nephritis.
*	,, 29, 1912			76	–	54	7·1	+	70	Arrhythmia.
*	March 7, 1912			78	–	40	+	+	47	
*	,, 18, 1912			76	88	44	+	+	33	
*	April 24, 1912			60	64	57	17·5	+	83	
*	May 8, 1912			70	72	55	11·1	68·8 : 31·0	78	
*	,, 29, 1912			74	98	42	10·3	+	24	
*	June 26, 1912			74	84	33	+	+	1	Arrhythmia cleared up. Feeling well.
*	Aug. 13, 1912			68	78	36	13·3	+	7	
†	Sept. 15, 1912			80	88	33	+	+	1	
†	Dec. 30, 1912			82	94	29	25·5	46·4 : 53·4	–7	
†	Oct. 22, 1913			86	92	41	26·3	+	21	Return of arrhythmia.
*154	June 24, 1912	M.	48	74	88	41	32·5	+	21	Chronic nephritis.
	,, 30, 1912			74	88	42	16·2	+	24	
	July 8, 1912			82	96	40	27·7	+	16	
	,, 15, 1912			74	78	40	19·0	+	16	
	,, 22, 1912			72	74	38	31·7	+	13	Electric light baths finished.
	Aug. 5, 1912			–	–	42	31·2	+	25	
	Sept. 2, 1912			–	–	38	23·8	+	12	
†268	Feb. 28, 1913	M.	48	74	80	40	19·6	74·1 : 25·6	17	Chronic nephritis.
	April 8, 1913			68	72	39	21·3	29·4 : 70·4	14	
	,, 22, 1913			78	86	30	32·0	52·0 : 48·0	–7	
	June 2, 1913			72	78	39	48·4	64·0 : 35·8	14	
	,, 30, 1913			90	96	38	29·5	90·4 : 9·3	10	

	July 31, 1913			74	–	34	25·0	82·6 : 17·2	2	
	Aug. 28, 1913			–	–	37	16·6	33·2 : 66·6	10	
	Nov. 11, 1913			64	68	38	+	+	16	Electric light baths begun.
	Jan. 4, 1914			72	76	34	+	+	3	
	Feb. 28, 1914			70	74	38	23·7	88·1 : 11·7	11	
	March 19, 1914			60	68	28	68·5	+	–12	
	April 9, 1914			68	74	33	47·5	70·0 : 30·0	0	
†431	Nov. 24, 1913	F.	65	62	72	55	28·7	91·2 : 8·7	73	Chronic nephritis.
	Dec. 6, 1913			70	78	54	41·6	83·2 : 16·6	70	
	,, 22, 1913			70	92	52	34·8	95·4 : 4·5	61	Electric light baths finished.
†478	Feb. 18, 1914	M.	68	66	74	44	12·0	78·6 : 21·2	24	Chronic nephritis.
†	March 18, 1914			78	84	52	19·7	61·9 : 38·0	59	
*	,, 29, 1914			72	–	41	+	+	21	Attack of auricular fibrillation. In bed.
*	,, 30, 1914			72	–	36	+	+	6	
*	,, 31, 1914			104	–	42	+	+	24	
†479	Feb. 21, 1914	F.	43	100	–	44	+	+	29	Chronic nephritis. Hyperthyroidism.
*	,, 28, 1914			–	–	36	36·8	86·8 : 13·0	8	In bed one week.
*	March 9, 1914			–	–	42	6·9	+	22	Hospital. Hot brine baths and blanket packs.
*	,, 12, 1914			80	–	39	15·3	+	15	
*	,, 16, 1914			74	–	42	+	+	25	
*	,, 23, 1914			90	–	41	31·7	+	21	
*	,, 28, 1914			90	–	36	+	+	6	Returned from hospital.
†	April 8, 1914			96	96	44	3·6	+	31	
†	,, 22, 1914			108	120	41	6·5	85·4 : 14·4	19	

In the case of auricular fibrillation the cardiac efficiency factor was 39 per cent. during decompensation, and 30 per cent. during compensation. The phases could not be determined during decompensation; but after compensation had been established the second phase formed 91 per cent. of the pulse-pressure. The cardiac overload factor was 14 per cent. during decompensation, and was 7 per cent. negative after compensation had been regained.

We must not forget in the interpretation of these results that after compensation is restored these hearts are diseased. Valvular defect and the compensatory hypertrophy still make the heart an abnormal organ.

Cases of Chronic Nephritis.—In these six cases of chronic nephritis (Table IV) forty-eight observations were made. The pulse-rate in the erect posture was more than ten beats above that in the recumbent posture at eight observations. The cardiac efficiency factor was above 35 per cent. at forty observations. The second phase formed less than 40 per cent. of the pulse-pressure at thirty-two. The C.S. : C.W. ratio when it could be worked out showed the C.S. factor in excess of the C.W. factor at fifteen observations, and a C.W. factor greater than the C.S. factor at three observations. The overload varied, but was above 50 per cent. at seven observations. The load was below the normal of 50 per cent. at three observations.

In Cases 154 and 268, both of which showed a small overload, the symptoms were never urgent during the period of observation.

In general it seems safe to conclude that all of these factors may be looked upon as indicating to some extent the ability of the myocardium to perform its work. The variation in the pulse-rate between the recumbent and the erect posture is, perhaps, the least reliable.

A cardiac efficiency factor above 35 per cent., a second phase forming less than 40 per cent. of the pulse-pressure, and a cardiac overload approaching 50 per cent. or more than 50 per cent. may be looked upon as pointing to myocardial insufficiency. The C.S. : C.W. ratio in many cases cannot be worked out because the fourth point cannot be determined; but when it can be worked out a C.W. factor in excess of the C.S. factor points to serious myocardial disturbance.

I have selected nine cases from my records for the purpose of illustrating the way these factors work out on patients who, clinically, cannot be classed as cardiacs or as nephritics.

Case 125.—Male, aged 54 when first seen, April 7, 1912. Chief complaint: nervousness and irritability. Physical examination: over weight, weak heart muscle, low blood-pressure, irritable pulse. Blood examination, chloroanæmia, lymphocytosis. On May 3, 1913, a diagnosis of acute dilatation of the heart was made on account of an increase in the oblique diameter of cardiac dulness from 18 cm., on October 7, 1912, to 22 cm.; muffled heart sounds and an impure systolic sound with cyanosis, palpable liver edge, a drop of the systolic blood-pressure from 100 mm. to 95 mm., and a sensation of precordial distress. In August, 1913, he had an attack of acute dyspeptic diarrhœa after eating clams. In April, 1914, he had acute bronchitis. (See Table V.) A study of the factors set forth in tabular form would seem to show that this myocardium was competent.

Case 162.—Male, aged 37 when first seen, July 10, 1912. Chief complaint: a life insurance examiner had rejected him on account of pulmonary tuberculosis. Physical examination: healed pulmonary tuberculosis, slight hypertrophy of the heart, arrhythmia, gastrectasia, high blood-pressure. After a month spent in the Adirondack Mountains, at Fourth Lake, his symptoms had markedly improved, but the arrhythmia persisted. After taking sodium iodide for two months the arrhythmia was still present. A polygraphic tracing showed the irregularity to be due to ventricular extrasystoles. Later the arrhythmia temporarily disappeared. In March, 1913, he had an attack of spasmodic torticollis. In August, September, and October, 1913, he had two attacks of acute constipation, and two attacks of

TABLE V.

No.	Date	Sex	Age	Recumbent	Erect	C.E.	2nd phase	C.S. : C.W.	Overload	Remarks
						Per cent.	Per cent.		Per cent.	
*125	April 7, 1912	M.	54	66	86	26	+	+	−14	
*	July 14, 1912			60	70	35	36·8	+	4	
†	Oct. 7, 1912			66	72	30	23·3	+	−8	Clinically acute dilatation of the heart.
†	May 3, 1913			72	90	30	62·0	72·3 : 27·4	−7	
†	,, 23, 1913			58	68	35	42·8	57·0 : 42·8	4	
†	,, 27, 1913			64	74	32	46·8	+	−2	
†	July 20, 1913			56	64	31	40·7	+	−5	
†	Sept. 1, 1913			58	70	34	+	+	1	Tr. digitalis ℳ vi p.c.
†	April 12, 1914			58	—	33	+	+	0	Digitalis stopped.

TABLE VI.

No.	Date	Sex	Age	Recumbent	Erect	C.E.	2nd phase	C.S. : C.W.	Overload
						Per cent.	Per cent.		Per cent.
*162	July 10, 1912	M.	37	58	74	38	44·4	85·1 : 14·8	12
*	Aug. 19, 1912			66	82	39	26·8	+	15
†	Nov. 19, 1912			72	78	31	33·3	69·1 : 30·6	−4
†	Dec. 17, 1912			70	78	25	57·5	87·8 : 12·0	−15
†	Feb. 19, 1913			70	82	44	50·0	63·4 : 36·4	30
†	March 21, 1913			66	74	21	31·8	63·6 : 36·3	−23
†	Sept. 29, 1913			74	90	33	37·5	62·5 : 37·5	0
†	Oct. 18, 1913			76	—	31	42·8	59·9 : 39·9	−4

acute epigastric pain. A bismuth X-ray showed no organic stomach disturbance. The circulatory study would indicate a competent myocardium. (See Table VI.)

Case 203.—Male, aged 42 when first seen, October 30, 1912. Chief complaint: cardiac arrhythmia for sixteen or seventeen years. Physical examination: scoliosis, arrhythmia, high blood-pressure, rapid pulse. Urine: specific gravity 1·029 to 1·021; albumin trace at one examination in five; a few hyaline casts twice; a few epithelial casts twice; no casts once. Eye grounds negative after an attack of acute dyspeptic diarrhœa in March, 1914 (examination made by Dr. A. C. Snell). At the time a polygraphic tracing was made the pulse was regular. The increase in heart-rate between the erect and the recumbent postures I ascribe to nervous influence. The patient had been badly scared by serious prognoses given him about his heart. The study of the circulation would indicate a competent myocardium. (See Table VII.)

Case 233.—Male, aged 57. Chief complaint: three persistent colds in six weeks. Physical examination: acute nasopharyngitis, pulmonary emphysema, palpable liver edge. The examination of the heart gave the following results: P. M. I. fifth interspace, 10·5 cm. to the left of the midsternal line. Dulness, third rib, fifth interspace, 2·5 cm. to the right of the midsternal line, 11 cm. to the left of the midsternal line. Oblique diameter of cardiac dulness 17·5 cm. No murmurs. The aortic diastolic sound is louder than the pulmonary diastolic sound. The muscular quality of the systolic sound is good. Blood-pressure, recumbent, Riva Rocci instrument.

1st point, 157;	1st phase, 12·2 per cent.
2nd point, 150;	2nd phase, 26·3 ,,
3rd point, 135;	3rd phase, 52·6 ,,
4th point, 105;	4th phase, 8·7 ,,
5th point, 100;	

C.S. : C.W. :: 78·9 : 20·9.

Pulse-pressure, 57; cardiac efficiency, 35 per cent.; cardiac load, 57 per cent.; overload, 7 per cent.

The cardiac symptoms were dyspnœa and palpitation of the heart on exertion. The cardiac condition was considered at the time of the examination to be a part of an obesity; the patient was 5 ft. 9 in. tall and weighed 180 lb.

TABLE VII.

No.	Date	Sex	Age	Recumbent	Erect	C.E.	2nd phase	G.S. : C.W.	Overload	Remarks
						Per cent.	Per cent.		Per cent.	
†203	Oct. 30, 1912	M.	42	72	96	35	35·0	+	5	Electric light baths and massage.
†	Nov. 8, 1912			82	88	30	26·5	77·5 : 22·4	−6	
†	,, 22, 1912			78	80	27	37·5	+	−12	
†	,, 29, 1912			76	96	26	37·8	64·8 : 35·1	−15	Electric light baths finished.
†	Dec. 28, 1912			74	88	27	59·5	+	−12	
†	Feb. 8, 1913			78	88	33	65·2	+	1	
†	March 8, 1913			84	100	30	63·6	79·5 : 20·3	−6	
†	May 2, 1913			78	90	33	35·3	66·5 : 33·2	−1	
†	Nov. 18, 1913			88	—	27	11·9	+	−12	
*	March 4, 1914			—	—	28	50·0	+	−18	Acute dyspeptic diarrhœa.
†	,, 15, 1914			90		27	13·3	+	−13	

15 oz. The myocardium was thought to be competent. "The cardiac condition is thought to be due to the increased deposit of fat in the epicardium and not to degenerative changes in the muscle fibres."

Case 299.—Female, aged 40. Chief complaint: irregular heart. Physical examination: palpable liver, arrhythmia. "Heart, P. M. I. not obtainable. Dulness, third rib, fifth interspace, 3 cm. to the right of the midsternal line, 10·8 cm. to the left of the midsternal line. Oblique diameter of cardiac dulness 16 cm. The sounds at the apex are clear. The sounds at the base are clear. The pulmonary diastolic sound is louder than the aortic diastolic sound. The muscular quality of the systolic sound is good." Blood-pressure, recumbent, Riva Rocci instrument.

1st point, 124;	1st phase, 10·2 per cent.
2nd point, 119;	2nd phase, 38·7 ,,
3rd point, 100;	3rd phase, 40·8 ,,
4th point, 80;	4th phase, 10·2 ,,
5th point, 75;	

C.S. : C.W. : : 79·5 : 20·4.

Pulse-pressure, 49; cardiac efficiency, 39 per cent.; cardiac load, 61 per cent.; overload, 11 per cent. The urine contained neither albumin nor casts. The blood showed a polycythæmia, low colour index, high lymphocyte percentage (26·8 per cent.), and eosinophilia (8·4 per cent.). A polygraphic tracing gave a distinct pulsus bigeminus. The analysis of the functional tests would leave some doubt concerning the capacity of the myocardium. (See Table VIII.)

Case 309.—Female, aged 47. Chief complaint: attacks of palpitation of the heart. Physical examination: palpable thyroid body, hypertrophy of the heart, gallop rhythm, palpable and tender liver edge, gastrectasia, high blood-pressure. The urine contained a trace of albumin and a few hyaline casts at the first examination. Gastric analysis, after Ewald test breakfast: amount removed, 45 c.c.; free HCl, 28; total acidity, 48; lactic acid, negative, occult blood, negative. Microscopic, large amount of partly digested food not finely divided (examination made by Dr. C. C. Sutter). Bismuth X-ray showed cowhorn type of stomach, with the greater curvature just below the umbilicus (by Dr. M. B. Palmer).

At the first examination there was definite evidence of disturbance of myocardial function, which improved while under treatment directed towards the dilated stomach. After the patient had omitted her treatment for about ten days the evidence of myocardial disturbance returned. (See Table VIII.)

Case 327.—Male, aged 45. Chief complaint: pain in right side of chest. Physical examination: palpable liver edge, low blood-pressure, slow pulse. Urine: no albumin, one hyaline cast seen. Increase in pulse-rate between the recumbent and the erect posture ten beats; cardiac efficiency within normal limits; second phase below normal; impossible to obtain C.S. : C.W. ratio. No overload. It is possible that the low second phase and the impossibility of working out the C.S. : C.W. ratio on account of the absence of the fourth point may point to myocardial weakness; but then there was no clinical evidence of it. (See Table VIII.)

Case 405.—Male, aged 49. This patient had been refused the renewal of a life insurance policy because his systolic blood-pressure was high (154 mm.). Physical examination showed a slight increase in the oblique diameter of cardiac dulness (17 cm.), palpable liver edge, slow pulse and an increase of twenty beats between the recumbent and the upright posture. Urine examination: specific gravity, 1·030. No albumin, no casts. The second phase, 12·7 per cent. and the C.S. : C.W. ratio of 32·7 to 67·2 in favour of myocardial weakness are balanced by a cardiac efficiency of 35 per cent. and an overload of only 5 per cent. (See Table VIII.)

Case 409.—Male, aged 54. Chief complaint: abdominal pain. Physical examination: slight exophthalmos, enlarged thyroid body, beginning pulmonary emphysema, increased area of cardiac dulness, palpable liver edge, high blood-pressure, and rapid pulse. The patient complained of right-sided abdominal pain, which was relieved by a cathartic, and some dyspnœa and palpitation of the heart on exertion, which he ascribed to his weight. Although apparently in perfect health the physical examination showed definite but early changes in thyroid body, heart, lungs, and liver. He weighed $203\frac{3}{4}$ lb., an excess of 26 lb. for his height, 5 ft. $11\frac{1}{2}$ in. His urine had a specific gravity of 1·011 and 1·012. Neither albumin nor glucose was present. There was a slight excess of indican. The microscope showed pus, round epithelium and phosphates.

The cardiac efficiency factor and the second phase would point to some myocardial deficiency, although the C.S. : C.W. ratio and the overload factor would not indicate such weakness. A course of electric light baths was followed by subjective improvement; that is, while he was not complaining before the baths were taken, he felt better after they had been finished, and then realized that he had not been quite up to the mark. The cardiac efficiency factor, the second phase, the C.S. : C.W. ratio and the overload then all pointed to myocardial defect. Three months later his urine had a specific gravity of 1·026 to 1·028, and contained glucose. After two weeks on a low carbohydrate diet the total quantity of urine was 2,470 c.c.; specific gravity, 1·012; there was a trace of albumin by the Tsuchiya method; no glucose. Six weeks later total quantity 2,087 c.c.; specific gravity 1·016; neither albumin nor glucose; no excess of indican. (See Table VIII.)

Conclusions.

It appears to me legitimate, from the study of the cases herein reported, to conclude that all four of these factors have some value in determining the efficiency of the myocardium. I am inclined to think at present that the cardiac efficiency factor of Tigerstedt and the percentage of the pulse-pressure formed by the second phase are the most important. A cardiac efficiency factor of 40 per cent. or over would seem to point to distinct myocardial inefficiency. A second phase of 30 per cent. or under would seem to indicate the same condition.

The C.S. : C.W. ratio is less important, I think, because it so often cannot be determined; and again, because a small second phase is very frequently made up by a large third phase. On the other hand, a C.S. : C.W. ratio in which the C.W. factor is greater than the C.S. factor, is indicative of disturbance of the myocardium, functional if not organic. I am inclined to think at present that the overload factor of Stone is indicative more of peripheral resistance than of myocardial weakness. A cardiac load below 50 per cent. as

TABLE VIII.

No.	Date	Sex	Age	Recumbent	Erect	C.E.	2nd phase	C.S. : C.W.	Overload	Remarks
						Per cent.	Per cent.		Per cent.	
†233	Dec. 23, 1912	M.	57	88	94	35	26·3	78·9 : 20·9	7	Fat heart.
†299	March 17, 1913	F.	40	54	–	39	38·7	79·5 : 20·4	15	Hyperthyroidism
	Nov. 11, 1913			–	–	38	51·0	+	11	
*309	April 22, 1913	F.	47	100	–	41	35·0	64·7 : 35·1	21	Gastrectasia.
	May 22, 1913			84	114	31	31·8	49·9 : 49·9	−4	
	June 20, 1913			86	–	32	44·0	60·0 : 40·0	−22	
	,, 23, 1913			86	–	32	36·3	73·6 : 26·4	−2	
	July 22, 1913			84	100	32	21·7	43·4 : 56·4	−2	
	Sept. 30, 1913			90	–	39	10·3	+	14	
†327	Aug. 14, 1913	M.	45	56	66	28	24·1	+	−14	No definite organic lesion.
†405	Oct. 23, 1913	M.	49	66	86	35	12·7	32·7 : 67·2	5	Hypertrophy of the heart.
†409	Nov. 3, 1913	M.	54	100	114	37	18·6	74·5 : 25·3	9	Electric light baths begun.
	,, 20, 1913			72	–	40	26·7	73·1 : 25·8	16	
	Dec. 10, 1913			72	84	45	30·5	59·6 : 40·2	34	Electric light baths finished.

determined by this method, giving a negative overload, may have some significance, but it will require further study to determine its nature.

REFERENCES.

[1] HIRSCHFELDER. "Diseases of the Heart and Aorta," 1910, Ed. i, 26.

[2] TORNAI. *Zeitschr. f. diaet. u. physik. Therap.,* Bd. xiii, H. 8 u. 9; Abstract in *Deutsch. med. Wochenschr.*, 1909, xxxv, 2287.

[3] FISCHER. *Deutsch. med. Wochenschr.*, 1908, xxxiv, 1141.

[4] GOODMAN and HOWELL. *Univ. Penn. Med. Bull.*, 1910, xxiii, 469.

[5] GOODMAN and HOWELL. *Amer. Journ. Med. Sci.*, 1911, cxlii, 334.

[6] STONE. *Journ. Amer. Med. Assoc.*, 1913, lxi, 1256.

[The discussion on this paper will be found combined with that on Dr. Rochester's paper on p. 300.]

ANGINA PECTORIS.

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In speaking to you on angina pectoris, I shall be somewhat elementary in my introductory remarks, in order to lead up to the correct recognition of the condition and the prognosis and rational treatment of it.

It is, of course, a syndrome, which may accompany many different morbid conditions, and it is my purpose to discuss with you the most probable cause of the attacks, that is, the morbid state of the heart, which is always present with an attack of angina pectoris.

Angina pectoris has been defined as an attack of pain in the chest, extending down the arm and forearm, particularly of the left side, accompanied by a constriction of the chest producing a sense of suffocation, and also, in most cases, accompanied by a sense of impending death, associated with disease of the heart. The morbid conditions which are most commonly present are (1) aortic aneurysm, (2) aortic valvular disease, especially stenosis, (3) arterio-sclerosis with atheroma of the coronary arteries, (4) degeneration of the myocardium, high arterial tension generally accompanying one or more of the previously mentioned conditions.

In approaching this subject from the standpoint of morbid physiology, we have to consider more than the anatomy, for that is constantly present, whereas the attacks come on spasmodically, with nothing regular about their occurrence. What, then, are the conditions which give rise to the attacks? Emotional excitement, physical exertion, and exposure to cold. Any one of these, or any combination of them, can readily bring about the attack. If we analyse these conditions we find that the quality which they have in common is that, through raising peripheral tension, they throw extra work on the left ventricle of the heart, which is in a morbidly weak state.

Now, I ask you to review with me the physiology of the heart as revealed by the studies of the circulation in the last five years. The functions of the muscular fibres of the heart have been shown to be five, viz., stimulus production, excitability or power to receive a stimulus, conductivity or power to transmit the stimulus to other fibres, contractility or power to contract under stimulus, and tonicity or power to retain a certain amount of contractile tone even when active contraction has ceased.

In the majority of cases of heart disease with which angina pectoris is associated the first three of these muscle fibre functions, stimulus production, excitability, conductivity, are unimpaired. There remain the functions of tonicity and contractility. When these two functions are impaired there results dilatation of the heart. In by far the majority of cases with which angina occurs there is present dilatation of the left ventricle. There are, however, some cases in which dilatation cannot be demonstrated; so that, while in most cases tonicity is impaired, the fact that angina can occur without its impairment throws us back on the last function—contractility—as the one with the interference with which angina is always present. Then you will say this throws us back on the old theory of heart spasm as the morbid condition present during angina; but, as a matter of fact, muscle spasm, such as we see in the case of the hard contracting uterus, is impossible in the heart, for that would cause complete cessation of the cardiac activity and, of course, death. We can believe, however, and are forced so to do, that pain can be induced by the attempt on the part of a hollow viscus to contract forcibly against resistance. We certainly have evidence of this in the pain produced when an intestine contracts in the case of obstruction of the bowel. That this may explain the production of pain is evident, but why the peculiar distribution of the pain?

Here we have to recur to developmental anatomy to explain the distribution of the pain, and to morbid physiology to explain the origin and cause of the pain and chest constriction and sense of suffocation.

To refer once more to the intestines. In several instances where incision has been made into the abdomen under local anæsthesia, so that pain is not produced by the incision, and the bowel has been put on the outside of the abdominal wall, marked contraction of the bowel in peristalsis has occurred, and the patient has complained of pain. When asked to locate the pain, invariably the location of the pain has been in some part of the abdominal wall, usually in the neighbourhood of the umbilicus, and not in the contracting intestine. This phenomenon known as a viscero-sensory reflex, has been shown to be due to the carrying in of the stimulus of the contraction of the intestine by an afferent nerve to the spinal cord and hence to the brain, and this stimulation being sent out through a sensory efferent nerve to the region to which its filaments are distributed and its expression as pain.

We have also the well-recognized muscular spasm of the abdominal wall in cases of underlying visceral disease, as cholecystitis, appendicitis, &c. This phenomenon, known as a viscero-motor reflex, is explained in the same way, except that the efferent stimulus is borne out on a motor nerve causing muscular contraction of the overlying wall, instead of on a sensory nerve producing pain.

That muscle spasm, a viscero-*motor* reflex, has, as its purpose, protection, is plain. Hilton, in his excellent monograph on "Rest and Pain," has pointed out that the pain of viscero-*sensory* reflex origin also has, as its purpose, protection in that it demands cessation of any action which causes it.

The why and wherefore of surface pain and of muscular spasm of overlying body wall are, I think, thus properly explained.

The reason why the pain in angina pectoris has its peculiar distribution can be explained if we consider the origin of the cerebro-spinal and autonomic innervation of the heart and of the parts where the pain is felt. Both have their innervation originally from the same sources, so when a stimulus from an overworked organ is sent in on an afferent nerve the corresponding stimulus is sent out as pain or muscular contraction to the parts supplied. The nerve supply to all these parts comes originally from the last cervical and the first, second and third dorsal spinal nerves, and from certain of the cerebral nerves. The sensory filaments from these spinal nerves are distributed to the forearm, arm, and second and third intercostal spaces where the pain is felt. The motor filaments concerned are those distributed to the second, third and fourth intercostal muscles, causing them to contract and produce the sensation of constriction and suffocation.

So far as I know, the only other condition which can produce the peculiar distribution of pain referred to is herpes zoster of those nerves. This eventually shows itself in the eruption. So I believe we can put down at least 95 per cent. of cases of pain in these regions as of cardiac origin. The attack does not always follow immediately the exciting cause, but may appear several hours later, even after the exciting cause has ceased to be active. This has been so well explained by MacKenzie as being due to a summation of stimuli, that I cannot do better than to quote :—

"The fundamental functions of the heart muscle correspond to those of other involuntary muscles that form the walls of hollow organs; these functions being modified to suit its special work. Like the other viscera, the heart is insensitive when stimulated in a manner that provokes pain when applied to the tissues of the external body-wall. I may point out that a prolonged, strong contraction of a hollow organ can produce pain, and that this, undoubtedly, is the cause of the severe pain associated with renal calculus, gall-stones, spasm of the bowel, and uterine contractions. Can the heart give rise to pain in a similar manner? On account of the modification of its functions, the heart cannot pass into a prolonged state of contraction. Immediately it contracts the function of contractility is abolished and the muscle passes at once into a state of relaxation, and for this reason the pain cannot be produced by a 'spasm of the heart.' But I suggest that the heart muscle may produce pain when it is confronted with work greater than what it can readily overcome—a condition which produces strong peristalsis and pain in other hollow viscera. But the pain in the heart arises by a slightly different mechanism. A skeletal muscle will contract in obedience to stimulation of a sensory nerve going to the spinal centre of its nerve, if a stimulus of sufficient strength be applied. If the stimulus is too weak no contraction follows, but if this weak stimulus be frequently and rapidly repeated, then the muscle contracts in accordance with the law of the summation of stimuli. I suggest that the heart muscle induces pain on the principle of summation of the stimuli. If we minutely study our cases we find that the pain rarely arises at the first exposure of the heart to the effort that induces pain; sometimes effort has been undertaken a few minutes before pain comes on, and in certain cases it may not come on for hours after the casual exertion has ceased. From such observation we can infer that the heart muscle was exhausted by the exertion, and so great was the exhaustion of the reserve force that the heart was unable to regain its reserve with cessation of effort, so that the exhaustion persisted till it culminated in an attack of angina pectoris." The conditions predisposing to attack are then any condition which has lasted long enough to produce a weakening of the left ventricle wall and causing this wall to be put upon severe strain under exciting cause. All physicians of sufficient experience have noted that in some cases, subject to angina pectoris, in which a mitral insufficiency develops, the attacks cease when by this means the great strain is taken off the left ventricle by the yielding of the valve through dilatation of the auriculo-ventricular opening. The condition producing this weakness of the left ventricular wall is, in my opinion, always some form of arterio-sclerosis, affecting either the coronaries and so interfering with the proper nutrition of the myocardium or occurring in the aorta, either at the valve, producing stenosis, or beyond, causing inelasticity of the aortic wall, or further along in some of the peripheral arteries, especially those of the kidney, raising the tension permanently against which the heart has to work.

The exciting cause or causes inducing attack may be put down under three headings, viz., (*a*) over-exertion, muscularly, (*b*) mental or psychical excitement, (*c*) exposure to cold.

Of the symptoms of angina pectoris, the one which is always present is pain. The peculiar distribution of this pain and the mode of its production have been thoroughly discussed.

The pain varies greatly in its intensity and in its duration. If the proposition is true that the pain is produced by the attempt at contraction against resistance, which, for the moment, is too great, we can readily understand that it may occur in cases in which the myocardium is in a pretty fair state, but the peripheral resistance is too great for it. I recall one case in which there was no evidence of real disease of the heart, but there was a high peripheral pressure from a marked pyelo-nephritis, and the patient had been under a severe psychic strain when he was put to it by a disturbing letter read at the end of an exhausting day's work.

He was seized with the typical pain, together with the sense of chest constriction, which lasted about fifteen minutes, leaving him depressed mentally and physically. About one hour later, under the physical strain of mounting rather a long flight of stairs, the symptoms returned, lasting about thirty minutes. He has not had a return of the attack, though this was five or six years ago.

Some may say that this was pseudo-angina. The term pseudo-angina, in my opinion, had better be dropped. Either the pain is of cardiac origin or it is not. If of cardiac origin, due to this attempt at contraction against resistance, it is angina, even though it may not recur, and disease of the heart cannot be demonstrated by physical examination. The pain may be of this mild evanescent character, or may be of any grade of severity up to the point of anguish, which is usually given as the typical angina attack. The sense of constriction of the chest and suffocation is associated with a great many of angina attacks, the sense of impending death is not as common, and in my experience has never been present except in association with both of the other symptoms.

I recall the case of a man who had been the subject of angina attacks for several years; generally they yielded to nitrite of amyl inhalation and the administration of nitro-glycerine.

I was called to see him one afternoon in February. He had been feeling pretty well that day, and on returning from the office had taken a street car to within two blocks of his home and had walked that short distance in the cold against the wind. He had had to stop three times before he reached his home, and after resting there downstairs for a short period, had mounted the stairs and when he reached his room he was seized. When I arrived he was sitting on a chair grasping the arms with both hands, his collar was unbuttoned, his face was a bluish pallor, his forehead covered with a cold sweat, his mouth open and he was gasping for breath, with an expression of suffering and anguish upon his countenance which was most distressing to observe. There was the odour of amyl nitrite about and he had taken in divided doses $\frac{1}{25}$ gr. of nitro-glycerine in one hour without relief.

In this case, as in all severe attacks, the gripping of the chest, as though the breast-bone would break, adds tremendously to the suffering; especially as it usually develops after the pain, and both increase in severity together.

The fear of impending death is in all probability of psychic origin, and is brought about by the presence of pain and anguish referred to the region with which the continuance of existence has always been associated. Patients do occasionally die during an attack of angina pectoris, but death under such circumstances is not common when we think of the great number of attacks of angina which occur without such termination.

Having thus briefly reviewed with you the mode of production of attacks of angina pectoris, I think that we are justified in the statement that in at least 90 per cent. of cases in which angina pectoris occurs, arterio-sclerosis is present in some form or another, and that in one or more places it is quite advanced; that in the vast majority of cases it is present in the aorta, the aortic valves and the coronary arteries; that in the 10 per cent. of cases in which arterio-sclerosis cannot be demonstrated there is always some morbid process present which has produced a certain amount of toxic weakness in the myocardium at the same time raising the peripheral tension, as in the case of the pyelo-nephritis already referred to.

As the etiology, diagnosis, prognosis and treatment are so closely associated, I shall consider them together.

First, as to the diagnosis: if my premises are correct, I think we may make the diagnosis very easily.

The peculiar distribution of the pain when there is not local cause, such as growth pressing upon the nerves or injury which might cause it, especially if it has associated with it a gripping of the chest, is sufficient.

When we consider that arterio-sclerosis is so frequent a causative factor of angina pectoris, we are brought up against the fact that all the varied causes of arterio-sclerosis have to be considered in the etiology of this syndrome.

The chief of these are syphilis, hard muscular work, and chronic, commonly autogenous, toxæmias.

Therefore, in every case in which we have to consider the prognosis and treatment we must always get at the chief etiological factor.

In those cases in which syphilis can be shown to be at the bottom of the arterial change and heart degeneration (the Wassermann reaction should always be looked for in cases of angina) the outlook is not so bad if the degeneration has not progressed too far. I have been surprised at the improvement of such cases under the use of salvarsan and hypodermic administration of mercury.

If syphilis be not present, and it is possible to remove the active cause of the artério-sclerosis, as for example by changing the occupation and mode of life, good results sometimes come from institution of such treatment.

The prognosis is based upon the chief etiological factor and the ability to modify it, upon the degree to which degeneration has proceeded in the arteries and in the myocardium, and upon any accompanying complicating disease.

If we now revert to the physiologic ground of the attack, viz., the attempt of the myocardium to contract against an opposing pressure which is too great for the strength of the myocardium, the prognosis will be greatly modified by the conditions present. It will take less obstructing pressure to produce an attack in a very weak myocardium than in a stronger one. So we may say that generally the prognosis is worse when angina occurs in cases with relatively low blood-pressure, both for the relief of the attack and for the recovery of the patient. The pressure being already low we have to be careful how we use measures that will lower it still further, so that in such cases I generally feel my way with cardiac stimulants, such as strychnine and digitalis or caffein in combination with vaso-dilators.

I think I cannot do better here than to cite several cases to illustrate what I mean by the different plans of treatment that must be adopted in different cases. The treatment divides naturally into two parts, viz., the treatment during the attack, and the treatment of the morbid state which has led up to the attack. As for the attack, recognizing that physical over-exertion, emotional excitement and exposure to cold are the elements which enter into the production of the attack, our energies should be first devoted to producing the opposite state of affairs. We should put the patient at a physical rest, induce composure, and apply warmth to the surface of the body, especially to the extremities.

I recall one case of a man, aged 50, to whom I was called one evening. The history was as follows: Occupation, travelling salesman; married; in his early life worked hard on a farm for twenty years. Gave up this occupation some ten years previously because after an unusually hard day's work in the hay-field he had lifted a heavy piece of ice into the ice-box and had had a collapse from which he did not recover in four months. Since that time if he did any strenuous work or became chilled he would have an attack of pain in his chest. There was denial of any venereal disease and he was not under observation long enough to take the blood for the Wassermann reaction. On this occasion he had taken a long drive in the cold in a cutter and after arriving at the hotel, although he felt a little mean, as he expressed it, he ate a rather hearty meal. About one hour after, he felt distressed and nauseated and forced himself to vomit.

However, the unloading the stomach did not relieve him, the pain gradually grew worse and I was sent for.

I found that he had had previous attacks similar in nature, but none so severe as the present one. The pain and the gripping in the chest was characteristic. His pulse was 100; rather small, regular, systolic blood-pressure 165 mm. Hg., temperature 97° F.; his feet and hands were cold. The physical examination revealed a heart moderately hypertrophied with a harsh systolic murmur at the aortic area and a sharp closure of the valve. The first sound of the heart accompanying the murmur was not very strong and was rather short.

I gave him a few whiffs of amyl nitrite, which did not help him, and then I ordered his feet to be put in hot mustard water and applied heat to his body in the form of bottles filled with hot water. Five minutes after his feet were put into the mustard foot-bath he began to feel relieved and in twenty minutes he was comfortable, his blood-pressure having fallen to 150. This case did not remain under my care, so I do not know his further history.

This case illustrates the value of the application of surface heat to the body in causing dilatation of the capillaries in reducing the blood-pressure, against which his weakened heart was struggling.

The next case is important as illustrating the fact that we have no standard of blood-pressure applicable to all cases.

A single woman, aged between 60 and 70, with a previous medical history of no significance, except that she, for years, had been a very large feeder and had taken very little exercise, has been under my observation off and on for the last twenty-seven years. About ten years ago she developed a dietetic glycosuria, which disappeared under appropriate feeding and has reappeared but once, two years after the first. She has been the subject of interstitial nephritis for the last eight years, and has consequently taken pretty good care of herself in the line of sweat-baths, diet, &c. Her blood-pressure, under which she is most comfortable, is 200 mm. Hg. Six years ago, in February, she did considerable walking in the shops down town, and riding home in a sleigh became chilled. When she arrived at the house, she climbed quite a long flight of stairs and was seized with an attack of pain and gripping in her chest and faintness, with a very decided fear of impending death.

When I called to see her she was in collapse, her features pinched, breathing laboured, pulse small and frequent, heart slightly dilated, first sound of the heart short and weak, accompanied by a slight mitral insufficiency. Blood-pressure 165 mm. Hg. She had already taken a large dose of whiskey in hot water, and after being put to bed and covered up warm the pain in the chest still kept up and extended to her forearm. Her breathing was laboured and she was slightly cyanotic. Remembering her usual blood-pressure, under which she was most comfortable, I argued that the pain had come on from the increase of blood-pressure due to her exertion and the cold, that the myocardium was not strong enough to overcome the increased peripheral pressure, and that we were having an acute dilatation of the heart—that the pain was produced through the efforts at contraction which were proving ineffectual, and that if we were going to bring her through we should have to administer not only vaso-dilators but also some one of the digitalis group to help the contraction of the myocardium. She was accordingly given a combination of sodium nitrite, tincture digitalis, and fluid extract valerian. Her bowels were emptied by the use of an enema of Epsom salts and glycerine. Under this treatment her pain gradually ceased, her colour returned to normal; in fact, all her symptoms of a serious nature disappeared. When, at the end of four hours, she was feeling well I took her blood-pressure again and found that it had increased and was now 190 mm. Hg.

Here were two cases, in one of which 165 mm. Hg. was an abnormally high pressure, and in the other the same pressure was a dangerously low one.

I have had several cases subject to attacks of angina pectoris with high blood-pressure, who during one of the attacks have developed mitral insufficiency with the subsidence of the attack and no recurrence of same, but the gradual development of dropsies and eventual death from uncompensated dilatation.

Interesting in this respect are two other cases, in each of which the attack of angina disappeared with the development of mitral insufficiency, but in these cases under appropriate treatment compensation was re-established and the mitral insufficiency disappeared, but the tendency to the recurrence of the attacks of angina pectoris also returned. In one case this was so marked that the patient said that he wished that I had let him die.

I have another case: A man aged 65 called me one night to see him on account of severe pain in his chest and a tremendous fear of death.

I found him sitting in a chair with a pale face slightly cyanotic with cold sweat standing out on it. His pulse was 110, irregularly intermittent, his blood-pressure was 140 mm. Hg., and still he was suffering from a typical attack of angina pectoris. His heart was dilated, there was present a systolic mitral murmur and a very rough aortic first sound followed by a sharp aortic closure; a systolic mitral murmur was plainly perceptible in the carotids. Here was another case in which mitral insufficiency and aortic obstruction together reduced the bulk of blood passing into the general circulation and into the carotids, so that what was a moderate pressure for a man of his years was too high for his weak myocardium. It would have made matters much worse for him to have given him digitalis or any of its congeners. So I gave him a small hypodermic of morphine with nitro-glycerine, and repeated both in half an hour. The two injections, amounting to $\frac{1}{6}$ gr. of morphine and $\frac{1}{50}$ gr. of nitro-glycerine, did the trick and he was comfortable.

In cases of aortic stenosis in which angina pectoris develops, I have never succeeded in relieving the attack without morphine. I always combine nitro-glycerine with it, because in all such cases I think there is the element of arteriole constriction besides the stenosis acting against the contracting ventricle.

By the citation of these cases I do not wish to be understood as not advocating the use of amyl nitrite and nitro-glycerine during most attacks; in by far the large majority of cases it is the plan above all others which is successful; what I do wish to impress is the importance of studying each case on its own merit and to treat the case, not the symptoms. So much for the treatment of the attacks. The management of the case, so that the attacks do not recur, is in my mind the most important thing. Therefore, in all cases in which angina has occurred, whether there is evidence of aortic orifice disease or not, I strongly urge the investigation of the Wassermann reaction. If it is positive the administration of salvarsan and a course of mercury hypodermically, alternating with potassium iodide, are indicated. In this way, in many cases, the recurrence of the attacks may be prevented. In most cases the careful supervision of the diet, with the use of the minimum of meat proteids, sometimes the complete elimination of them, is necessary, and keeping the whole diet down to the minimum compatible with the health of the individual; the absolute prohibition of alcohol, excepting in medicinal doses at specified times; the full use of elimination by skin and bowels, and rendering the urine bland through the use of alkalis. The exercise of the individual is to be carefully supervised.

The regular administration in small doses of iodide or nitrite of sodium is highly recommended.

In many cases, especially in women, before the occurrence of the attack there not infrequently occurs a period of sleeplessness and nervousness, which should be treated with ammonium bromide in sufficient dose to produce sleep and quiet the nervousness. I generally administer 10 or 15 gr. t.i.d., and one large dose of 30 or 45 gr. at night.

Under some such general plan of management of life and careful medical supervision, the patient seeing the physician once a fortnight or so, the attacks are certainly diminished in number and severity and the patient given years of comfort.

SPONTANEOUS PNEUMOTHORAX.

By LOUIS HAMMAN, M.D.
BALTIMORE.

Pneumothorax is always secondary to disease of the lungs or of the chest-wall, and therefore is a complication and never a primary condition. As a rule, the disease to which it is secondary is obvious, but occasionally the pneumothorax dominates the clinical picture and the primary condition is obscure and in a measure unimportant. Pneumothorax occurring when the lungs are relatively healthy may cause such trivial symptoms as to be entirely unsuspected, and its presence be revealed in the course of a routine examination. Although the physical signs of pneumothorax are straightforward enough, still, if one is off guard they may be overlooked or misinterpreted.

My own experience with pneumothorax, until I made the observations herein recorded, had been gained by encountering it in cases with gross and obvious pulmonary disease or after injuries to the chest-wall. In these instances the symptoms were marked and the physical signs, though interesting, still were quite clear and direct in their significance. I was unprepared, therefore, for the following observation which aroused a keen interest.

Case 1.—A. G., white male, aged 22, came to the Phipps Dispensary of the Johns Hopkins Hospital, November 12, 1909, complaining of pain in the right side and cough. He had had some cough off and on for two years and the cough had been increased by a cold caught two weeks before. Examination showed a man of healthy appearance. There was slight impairment over the right upper lobe and a few fine, crackling râles after cough. The 1 per cent. and 5 per cent. conjunctival tuberculin tests were negative and the cutaneous test was negative. On November 28, while standing in his yard, the patient was taken suddenly with a pain in the right side of the chest, followed by shortness of breath. The shortness of breath was not urgent, but he could not walk without feeling some discomfort. On the following day he reported again at the Dispensary, and it was noticed that the breath sounds on the right side were remarkably suppressed. On December 4 a more careful physical examination showed hyper-resonance over the right side with practically absent breath sounds and voice sounds. An X-ray examination confirmed the diagnosis of pneumothorax. By the middle of January the pneumothorax had completely cleared up, the pulmonary examination then showing the conditions present on admission, namely, a little impairment over the right upper lobe with roughened breath sounds and a few râles. During these six weeks the patient had felt perfectly comfortable, had had very little dyspnœa, and the temperature, pulse and respirations were constantly normal.

On November 8, 1910, patient again appeared at the Dispensary, saying that after lifting a weight he felt a pain in the left side of the chest. He had practically no dyspnœa and no discomfort. Examination on this date revealed a complete left-sided pneumothorax, which was again confirmed by X-ray examination. By December 10 the pneumothorax had completely cleared up and the breath sounds were as loud on the left as on the right side. On December 27, 1910, patient returned again saying that three days previously, while sitting quietly in a chair after dinner, he was taken with a sense of discomfort in the left side, which gradually increased in severity. At the time of visiting the Dispensary he no longer had pain, but he had some shortness of breath on walking rapidly. Examination disclosed again a complete left-sided pneumothorax. At the end of January, 1911, patient felt perfectly well, had no cough or dyspnœa, and the signs of the pneumothorax had completely disappeared. In November, 1912, patient came again for examination, saying he had felt perfectly well during the interval until one week before when he began to have pain over the right side of the chest. He thought he had a recurrence of the pneumothorax, but examination showed, as it had on previous occasions, only impairment over the right upper lobe, with harsh breath sounds and a few fine râles.

On March 29, 1913, patient came again to the Dispensary complaining of severe pain in the left lower chest, but the examination showed no recurrence of the pneumothorax. On August 2, 1913, he returned to the Dispensary saying that ten days before he had had a severe pain in the right side, the pain being so severe that he fainted. His family physician diagnosed pleurisy and found tubercle bacilli in the sputum. The examination at this time showed, as before, the impairment over the right upper lobe, but breath sounds were more blowing in quality and definite moist râles were heard all over the right front and in the supraspinous fossa in back. The sputum contained abundant tubercle bacilli and the patient was sent to the State Tuberculosis Sanatorium. His last visit was made on April 25, 1914. His general condition had improved a great deal while at the Sanatorium, but there had been practically no change in the physical signs.

While the case above detailed was under observation I had the opportunity of seeing another instance of pneumothorax coming on in a healthy young man without apparent cause, which ran an almost symptomless course and subsided completely in a few weeks.

Case 2.—J. S., white male, aged 29, gave the following history. On October 29, 1910, after dinner, as he was opening the door to leave his house, he suddenly felt a sharp pain in the left side and had the feeling as though something had given way. He went down town to his office, and although the pain continued, still he walked a distance of about two miles to his club and sat there reading until midnight. The following morning, as he attempted to run for a car, he again felt the pain in his left side and came to me for examination. He was a large, well-nourished man, of healthy appearance. The examination revealed a complete left-sided pneumothorax which was confirmed by X-ray examination. Patient remained in bed for two weeks, then got up and went back to his practice. During this time he felt perfectly well and had no fever, no elevation of pulse or respiratory rate. Tubercle bacilli were not found in the sputum. He showed no reaction to the 1 per cent. and 5 per cent. conjunctival tuberculin tests, but a slight reaction to the cutaneous tuberculin test. He has remained quite well since then.

During the past year I have seen two more cases in many respects similar to the two described. The first of these is almost identical with Case 2, while the other presents interesting points of difference.

Case 3.—G. P., a policeman, aged 38, came to the Dispensary on July 7, 1913, complaining of severe pain in the left side of the chest. He is on night duty so sleeps during the day. On July 3 he was awakened from his sleep by a severe pain in the left side of the chest. However, that evening he went to work and noticed that he was short of breath on exertion. The pain has continued since then and he is still short of breath when he moves, although quite comfortable when he is still. Examination showed a large, well-nourished, muscular man, with a definite left-sided pneumothorax. The patient made his last visit to the Dispensary on August 2, 1913, when the pneumothorax had almost completely disappeared. During this period he had suffered no discomfort other than pain in the left side and a little shortness of breath on exertion. He had had no fever and no increase in the pulse or respiratory rate. Although the patient has not been seen since then he answers to inquiry that he has remained perfectly well.

Case 4.—E. H., a white male, aged 35, came to see me for examination on October 1, 1912. The previous spring he had had a heavy cold and the physician who attended him told him there were signs suggesting pulmonary tuberculosis. Patient was in good general condition, and had no symptoms of pulmonary involvement, but the examination revealed a definite lesion in both upper lobes.

Patient's general condition remained perfectly good except that he had frequent attacks of abdominal pain. In July, 1913, he was operated upon for appendicitis and had an uneventful recovery. On January 4, 1914, after dinner he felt a sudden sharp pain in the left side of the chest, associated with a feeling as though he were unable to draw a deep breath. He went home without any distress, and after getting in bed felt perfectly well, except that the pain was present on deep breathing. I saw him the following afternoon when he was lying quietly in bed without any discomfort, and to my surprise he had the evident signs of complete left-sided pneumothorax. After a week in bed patient got up and began slowly to go about. An examination on January 20 showed that the pneumothorax was rapidly clearing up. On February 21, 1914, all evidence of the pneumothorax had disappeared, the pulmonary physical signs being the same as those found at the first examination on October 12. During this period patient had had absolutely no fever and no elevation of the pulse or respiratory rate.

These four cases are of interest since they illustrate: First, how insidious may be the onset of pneumothorax; second, what very few symptoms it may occasion; third, how easily upon a casual examination the condition may be overlooked; fourth, the perfectly benign course of the affection; fifth, the occurrence of this insidious, benign type of pneumothorax in perfectly healthy individuals as well as in those with manifest pulmonary disease.

This benign type of pneumothorax coming on without apparent cause and subsiding uneventfully has received a fair share of literary attention. The condition has been frequently described in England, less commonly in France, only occasionally in Germany, and though there are a few good accounts of it in American literature, still it has not attracted wide consideration. Fussell and Riesman reviewed the literature of spontaneous pneumothorax in 1902 and analysed fifty-six cases. Nikolsky, in 1912, collected ninety cases from the literature. Some authors, emphasizing the obscure cause of the pleural rupture, have termed the condition "spontaneous pneumothorax," "idiopathic pneumothorax," and "pneumothorax in the apparently healthy," to distinguish it from pneumothorax following violence or gross pulmonary disease. Others, struck by the absence of the usual symptoms accompanying pneumothorax, have described it as "latent pneumothorax," "pneumothorax with insidious onset"; still others, having missed certain classical physical signs of pneumothorax, have called it "pneumothorax muet" and "pneumothorax silencieux"; finally, many have emphasized certain salient features, using such descriptive terms as "recurring pneumothorax," "pneumothorax with rapid recovery," "spontaneous, non-tuberculous pneumothorax," "curious instance of pneumothorax," &c.

None of the terms that have been suggested for this type of pneumothorax are satisfactory, but "spontaneous pneumothorax" is most commonly employed, and though it describes only one of the many important features of the condition, still it is the least objectionable if we will accept its extension to embrace them all. In this sense spontaneous pneumothorax signifies a pneumothorax coming on in apparently healthy individuals without ascribable cause, resulting in no infection of the pleura and therefore unaccompanied by constitutional symptoms, and healing rapidly and completely in a few weeks.

As regards the meaning of "apparently healthy," I may say that most authors would exclude from the group of spontaneous pneumothorax those cases in which examination before or after the occurrence reveals definite pulmonary disease. The "non-tuberculous" nature of the condition is constantly emphasized. I feel very strongly that no such sharp line can be drawn, and I would include tuberculous cases that meet the other requirements of the definition. Case 1 certainly belongs to the group of spontaneous pneumothorax, and still years later he developed a manifest pulmonary tuberculosis. Both immediately before and immediately after the attacks of pneumothorax the clinical evidence was not sufficient to make a diagnosis of pulmonary tuberculosis, although in the light of later developments it seems certain that even at that time he must have had the infection. Cases 2 and 3, in no way distinguishable from Case 1, have remained well. Case 4, though in excellent condition, still had a definite pulmonary tuberculous lesion before the onset of the pneumothorax. In all other respects the clinical picture was identical with that of the three previous cases. The absence of grave pulmonary disease, of mechanical conditions leading to high intrapleural pressure, and of pleural infection distinguish the condition from pneumothorax, as it usually occurs in pulmonary tuberculosis. Later I will speak of the mechanism of the production of the pneumothorax in spontaneous pneumothorax, and here wish only to remark that in all probability the mechanism in Case 4 was the same as in the previous cases and was not due, as pneumothorax in advanced pulmonary tuberculosis usually is, to the rupture of the pleura by a tuberculous focus.

While most cases of spontaneous pneumothorax remain simple, in a small number pleural effusion develops. Cases in which the effusion is the expression of an infection must be discarded from the group, but in a certain number the fluid remains sterile, no constitutional symptoms supervene, and the fluid and air are both rapidly absorbed. In some instances the fluid is bloody, apparently due to hæmorrhage at the time of the pleural rupture.

As regards the third characteristic in the definition, rapid and complete healing, we can set no absolute limit.

In most cases the pneumothorax disappears in from four to eight weeks. Occasionally it will persist longer than eight weeks and then clear up completely, but a duration of over eight weeks is against including the case in the group of spontaneous pneumothorax.

The changes in the lung that occasion the pleural rupture are not clinically ascertainable, but there are enough autopsies on record to make clear the mechanism in many instances. Zahn, in 1891, published the first thorough study of pleural rupture without inflammation and described four different modes.

(1) The rupture of vesicular blebs. In one case he reports there were a number of such bullæ in the region of the apex of the left lung, and upon inflating the lung one of these showed a small rent. In another instance associated with well-marked pulmonary emphysema numerous bullæ were found on the surface of the right lung, some as large as a hen's egg. One of these showed a tear 2 mm. in length.

(2) The rupture of interstitial emphysema blebs. In these cases air enters the interstitial tissue, then reaches the pleural surface where a vesicle is formed which then ruptures. All such instances of interstitial emphysema have been about pleural adhesions, and the pleural adhesions are the primary condition which give the mechanical explanation for the interstitial emphysema. Zahn reports two instances of pneumothorax produced by this mechanism. In both instances there was associated pulmonary tuberculosis, but the pleural rupture was about adhesions and not contiguous to tuberculous foci. He considers this the most common cause of rupture in spontaneous pneumothorax.

(3) A direct tear of the pleura by the tug of adhesions. Zahn reports such a case in a suicide and thinks the instance reported by Robertson belongs to this group.

(4) Senile atrophy of the pleura. A man, aged 61, with extreme emphysema, showed at autopsy a number of very minute openings in the pleural surface over an area where the membrane was extremely thin. Zahn remarks that he had never before seen such an extreme grade of emphysema, and he regards the pleural atrophy to be due to pressure. I have encountered no similar observation in the literature.

We may exclude group (4), since it is a very unusual cause of pneumothorax, and it is a technical refinement to separate groups two and three. Such *post-mortem* evidence as is available, therefore, points to the rupture of vesicular emphysematous blebs, and the tears produced by adhesions as the two common causes of spontaneous pneumothorax. The not infrequent finding of ruptured vesicular blebs has led some authors, for instance Bach, to speak of the whole group under consideration as "spontaneous pneumothorax in emphysema." Anyone who has had a large experience with pulmonary cases will remark at once how surprisingly infrequent pneumothorax is in the frankly emphysematous. It is noteworthy that spontaneous pneumothorax is a disease of early adult life, over 80 per cent. of the instances collected by Nikolsky occurring before the age of 40. Therefore, it is manifestly improper to regard spontaneous pneumothorax as having any direct relation with general pulmonary emphysema. When emphysema is its cause the emphysema is generally a local condition, and clinical evidence is, in my opinion, strongly in favour of adhesions being the usual condition underlying pleural rupture.

Having in mind the mechanism of spontaneous pneumothorax it will appear unreasonable to exclude from the group cases with pulmonary tuberculosis in which the onset and benign course of and the rapid recovery from the pneumothorax are the characteristic features. There is considerable evidence to influence us to believe that tuberculosis is the commonest cause of pleural adhesions, and if this be true it is further reason against drawing too close a line between manifest and obscure pulmonary tuberculosis, a distinction that at once involves serious clinical difficulties. Of course, it is possible that an isolated tubercle situated upon the pleura might rupture and the opening be so small that it would heal promptly without the pleura becoming infected. Such an occurrence, however, must be very uncommon. Letulle reports a diabetic without evidence of pulmonary disease who developed pneumothorax. Eight days later he died suddenly and autopsy revealed a single tuberculous nodule in the lung which had ruptured. West and Flint report instances of pneumothorax due to a single small tuberculous cavity. However, neither of these cases resembled clinically spontaneous pneumothorax, for West's patient died shortly after the onset of pneumothorax from exhaustion, and although Flint's patient died of pneumonia, the hydro-pneumothorax had persisted for a long time before.

The clinical symptoms in spontaneous pneumothorax indicate that in most instances the pleural opening must be very small. There are seldom symptoms of high intrapleural pressure, and in the two cases I followed carefully with X-ray examinations the lung was not fully collapsed. Apparently, as soon as sufficient air escapes into the pleural cavity to cause an appreciable decrease in the intra-pulmonary pressure, the pleura is relaxed and the opening closes. The size of the opening will determine the degree of pulmonary collapse.

In the definition of the symptom group the salient clinical features were emphasized. Briefly, the important points are these: The condition predominates in males; 45 males to 10 females in Fussell and Riesman's series; 73 males to 14 females in Nikolsky's group. The vast majority of the cases occur in young adults. In Nikolsky's table two instances are under 15 years of age, thirty-four (34) between 15 and 25 years, twenty-six (26) between 25 and 40 years, eleven (11) over 40 years. The right and left side are affected with equal frequency. The exciting cause in most instances is exertion, though the exertion may be entirely out of proportion to the results. Not infrequently the pneumothorax comes on without any provoking cause, and in five of the reported instances it apparently developed during sleep.

The symptoms at onset vary from extreme dyspnœa and collapse to disturbances so slight as scarcely to attract attention. In the instances reported in this paper pneumothorax was not suspected from the symptoms. Nearly always there is some dyspnœa on exertion, but there is seldom distress when the patient is at rest. The very mild character of the symptoms is a peculiar and characteristic feature of the condition. No doubt the size of the rupture determines largely the intensity of the symptoms. Cough without expectoration is often present, but frequently is entirely absent and is never troublesome. A characteristic feature of the condition is the absence of constitutional symptoms, no fever and no evidence of infection. The duration of the pneumothorax varies. In most instances there is complete restitution in six weeks. Of sixty-eight cases collected by Nikolsky, fifty-nine recovered completely within two months, six during the third month, three during the fourth month. Recurrence of the pneumothorax occurred in fourteen instances. In only one instance was the recurrence on the opposite side, as it was in Case 1, published in this report.

As regards the examination, it is important to emphasize that in these cases the physical signs of pneumothorax stand out in classical purity. Pneumothorax is so frequently accompanied by effusion and associated with gross disease of the lungs that there is a general tendency to emphasize accessory physical signs, namely, succussion, the coin sound, metallic tinkling, and movable flatness, rather than the fundamental signs peculiar to and characteristic of the condition. Laennec's description has been weakened by unessential additions. On inspection the affected side is not strikingly prominent, but there is always diminished mobility. Fremitus may be absent, but it is usually well felt, though greatly decreased as compared with the opposite side. The percussion note may be but little altered and the change escape notice if the examination be hurried. On careful percussion the note is discovered to be hyper-resonant, sometimes with tympanitic overtones. The striking feature on auscultation is the absence, or great diminution in the intensity, of the breath sounds. The voice sounds are less strikingly suppressed and at times have a curious, characteristic metallic echo.

I wish to call attention particularly to the value of percussion. The note is resonant or hyper-resonant, and on percussion of the lower lung border it is found that resonance stops on the affected side at the point reached by the lung on the sound side in full inspiration. This point is stationary, showing no variation with inspiration and expiration. The extension of pulmonary resonance to the full capacity of the pleural space with absent respiratory variation is absolutely characteristic of pneumothorax without effusion. If the note be hyper-resonant the hyper-resonance extends in front to the opposite border of the sternum. The heart is always displaced, and the position can be determined satisfactorily only by percussion.

The diagnosis is easily made if one thinks of pneumothorax, but in the entire absence of symptoms the condition may not be suspected and the physical signs be overlooked. Case 1 at first attracted attention as an instance of unusually feeble breath sounds without any satisfactory explanation for the enfeeblement. A physician experienced in the study of pulmonary diseases saw the patient and was sure he would have missed the diagnosis had the condition not been pointed out. Case 3 was first seen by an experienced instructor in physical diagnosis, who considered the presence of a mediastinal tumour pressing upon the bronchus.

The treatment for the condition is to do nothing. The pulmonary collapse closes the pleural opening, the air in the pleural cavity is gradually absorbed, and as the lung begins to re-expand the pleural rupture is tightly healed. Occasionally the pneumothorax recurs shortly after the lung has completely expanded, no doubt due to incomplete healing of the pleural wound.

DISCUSSION.

Dr. George W. Norris (Philadelphia, Pa.) : I have been very much interested in Dr. Hamman's report of these cases because I am inclined to believe, with him, that the condition is not so rare as some suppose. I make that statement on the basis of a paper by Dr. Perry Pepper, of Philadelphia, published a year ago, and from my own personal experience with such a case recently in a young man in Philadelphia whom, five years ago, I treated for incipient tuberculosis, but in whom I was never able to convince myself that such a lesion existed. He was treated simply on the basis of prevention. He never had any expectoration nor any tubercle bacilli, and after a few months he was practically a perfect specimen of physical manhood. He continued so for five years. Then suddenly, this winter, he woke up during the middle of the night with an acute pain in the right side, and was discovered, on examination, to have complete right-sided pneumothorax, with a few symptoms of shock, marked displacement of the heart to the left, &c. This condition cleared up completely in the course of six weeks, and although for a time he developed a slight effusion he has again made a complete recovery. He never at any time during the pneumothorax had any fever, and to-day he is in absolutely perfect physical health, as determined by physical examination, by his sensations, and by his ability to work and exercise.

Dr. Gordon Wilson : I had the strange coincidence of having two brothers with the same condition come to me for treatment, one in

May, 1912, and the other in May, 1914. The condition came on in both under exactly similar circumstances. On bending over they had pain. Both walked up town and went to their physician, who fluoroscoped them at once and made out a unilateral pneumothorax. Both went to the State Sanatorium for treatment; in both the sputum was found negative. Both had been exposed to tuberculosis. The exposure to the disease was through their father, who had died of spinal tuberculosis. One of the brothers had had tubercular glands of the groin removed seven years previously. Both had a normal weight of 20 lb. under the insurance weight. Their weight was normal for them, however, and they were without any symptoms of tuberculosis, one being 21, and the other 23 years of age. In each case the symptoms were slight and of short duration, consisting only of pain and moderate dyspnœa.

Dr. Minor: The question is whether tuberculous cases ordinarily present this picture of spontaneous pneumothorax. Of course, I have had a number of cases of pneumothorax in old cases of tubercle, all fatal and accompanied by bad symptoms. I was surprised the other day, however, to get hold of a tuberculous case in which most of the most important symptoms were absent. The patient was a young man in business, who had undergone syphilitic infection and was being treated for a syphilitic larynx. He developed symptoms pointing to the lung, but his doctor assured him that his lungs were healthy. Another doctor said that he had a badly tuberculous lung. Two other physicians said he had no tuberculosis. Then he got anxious and had his sputum examined, and tubercle bacilli were found. I saw him two weeks after this, two days ago. Now, in all the cases of pneumothorax I have seen pain was so agonizing that the patient went into shock and even morphine had no anodyne effect, but this man had no pain, and no symptom except sudden shortness of breath. When he came to me his shortness of breath was patent, so I put him in front of the fluoroscope, and found the right lung badly infiltrated from top to bottom and the left totally collapsed. Of course, the prognosis in this case is as bad as can be. The interesting thing about it is that this occurred with no symptoms but shortness of breath. It would be interesting to know whether we have a non-tuberculous class of cases of this kind, or whether all cases of spontaneous pneumothorax are not probably tuberculous, that is, whether they occur through weakness of the alveolar walls of the healthy lung, or whether the majority of cases having spontaneous pneumothorax are tuberculous, mostly not recognized.

Dr. Robert Childs Paterson (Ste. Agathe, Quebec, Canada): I should like to add two cases that came under my experience. They came to my notice within two months of each other. The first was one of spontaneous pneumothorax in a young man who had been playing hockey the night before apparently in good health. He woke up in the morning with pain in the left side. Afterwards this was found to be a pneumothorax due to secondary sarcoma in the lung. The air was absorbed before we found the cause. The other case was very much like that of Dr. Hamman. It was in a young architect, who had been attending to his work until one morning, on going to the window and pulling down the shade, he felt a sharp pain. He walked up to town and went to see his doctor, who made a diagnosis of acute indigestion. I think that both of these cases came under the category of spontaneous pneumothorax. One was tubercular, and in the other there was a slight thickening at the apex.

Dr. J. A. Miller: These reports are very interesting, particularly the case of recurrence of the same condition in the same case. I have seen only one similar case, about fifteen years ago, in the Presbyterian Hospital, N.Y. A man employed as a motorman came in from the dispensary. He had been reaching over to get at some part of his apparatus when he felt a slight pain, similar to that discomfort which Dr. Hamman has described. He came to the hospital dispensary because of shortness of breath, and was sent in to the ward because the pneumothorax was discovered. Within three or four weeks it disappeared. Inside of six months, however, he came back with a similar condition, but more in the way of discomfort. There was also some fluid in his chest, which was withdrawn. Bacteriological examination was negative. That attack lasted no more than two months, and then cleared up. Again, within a few months, he came back with more evident symptoms. He had fluid in the chest, fever, and more discomfort. The fluid was in large amount, and was turbid. Though negative for pyogenic organisms, it contained tubercle bacilli. The fluid became more purulent, and he was kept in the ward for a couple of months. Once or twice during this time the fluid was withdrawn. At the end of these two months, against the advice of his physicians, an enthusiastic surgeon opened up the chest to relieve him of the pus, which contained tubercle bacilli, but was sterile otherwise. Within a week after this he developed a high temperature. The condition then ran a septic course, ending in death. An autopsy was not obtained, but I have always considered this as a case of tuberculosis from the start, even though the onset of the pneumothorax was so insidious.

Dr. Pottenger: I recall that a few years ago a young physician from a country town in Illinois came to see me and stated that he had had two or three attacks of pneumothorax. Dr. E. Fletcher Ingals, of Chicago, saw him in that city. He had no tuberculosis demonstrable. I have also seen a patient this past year who was attended during a serious pneumothorax by our worthy President, Dr. Anders, five years ago. This year, while playing golf, the patient suffered a second pneumothorax. Pneumothorax in advanced tuberculous cases we see very often. The diagnosis is rarely made in general practice. I have noticed, what Dr. Minor mentioned, that there are no regular symptoms in pneumothorax. I suspect its presence in those patients whose temperatures I am recording regularly, if I see a sudden shoot-up in the temperature of a couple of degrees, although I have seen a drop in temperature where shock was severe. At times the patients are delirious. The shifting of the mediastinum must always be looked for, and if accompanied by the sudden rise of temperature mentioned is almost sure proof of its presence.

Dr. Dunn: Only two or three days ago a patient came to me who, eight or nine years before, after a debauch, had an attack of pneumothorax. At that time he was examined rather carefully. Evidences of an old atrophic kidney were found, and he was advised to discontinue his bad habits, which he did. At that time there was no evidence of pulmonary involvement, although a very careful examination was made. This man applied to me a few days ago, stating that he had developed, a year or so before, evidences of pulmonary tuberculosis, from which he had gained relief by a residence in the West; but upon his return home he had again had trouble, which was on the right side, where there was distress. On examining him I found an old left-sided lesion, but no evidence of trouble on the right side. He insisted that I was marking up the wrong side, but all the physical signs of tuberculosis were on the left side. The right side seemed to be perfectly well. The only things that I could take exception to were the breathing in the lower part of the right lung and some tympany, which might have been noticeable only from a comparison of the two sides. I was surprised to find that the stereoscopic plates showed a comparatively clear lung on the left side, with distinct pneumothorax in the lower part of the right lung, the lower lobe being almost completely collapsed. Of course, this pneumothorax occurred in a tuberculous patient, but it was in one with practically no X-ray evidence or physical signs of tuberculosis in that lung. Whether this is a very frequent occurrence or not is hard to say. It seems to me that it cannot be so very frequent, because the fluoroscope and the X-ray plate certainly show it very seldom. For many years I have examined all my patients either with the fluoroscope or by means of a stereoscopic pair of plates. I have examined, in one of these ways or the other, certainly not less than 2,000 patients, and it seems to me that the condition would have been rather frequently observed among these cases if it were of so frequent occurrence or were so frequently associated with a small amount of disease. Of course, it is not infrequently connected with advanced tuberculous lesions. I have been struck with how rarely I have seen pneumothorax, and cannot believe that it is of very frequent occurrence.

Dr. Hamman (closing): There are one or two points that I want to touch on. I believe that it must sound very pedantic to say that it is easy to overlook a pneumothorax. Still, when you do not think of looking for it, you may easily fail to notice its presence. If, however, it comes into your mind, the diagnosis is easy. The most important single sign is obtained by carefully percussing at the lower border of the lungs on inspiration and expiration. The usual difference is 10 or 12 cm. When pneumothorax is present the resonance on the affected side comes down to a point corresponding to the point reached by the lung on the healthy side in full inspiration. In other words, resonance fills the whole pleural space and the lower border of resonance shows no movement on inspiration or expiration. The second point I wish to refer to is the relation of these cases to tuberculosis. The autopsy records make it clear that the commonest mechanism in the production of spontaneous pneumothorax is the presence of adhesions, and the commonest cause of adhesions is tuberculosis. Therefore, most cases of pneumothorax are due to that disease; but the mechanism leading to a small rent in spontaneous pneumothorax is different from that in advanced tuberculosis, where the pneumothorax is due to rupture of a tuberculous lesion situated near the pleura. In the latter event the pleural cavity is always infected. Regarding the frequency of the condition, I would say that in 1902 Fussell and Riesman collected fifty-six cases from the literature, and ten years later Nikolsky collected ninety. Some of Nikolsky's cases, I think, do not properly belong to this class, while some that do he did not include. With these subtractions and additions there would be still about ninety cases.

PILOCARPINE IN HIGH BLOOD-PRESSURE.

By WILLIAM DUFFIELD ROBINSON, M.D.
PHILADELPHIA.

JUST what the official account* of pilocarpine ought to include is not clear, but certainly the first-named of the two species is a very inferior drug, and its recognition is excusable only on the ground that the market is often devoid of anything better. The leaflets yield four alkaloids, constituting about 0·5 per cent. of their weight, pilocarpine, isopilocarpine, pilocarpidine, and jaborine.

Pilocarpine is the dominant alkaloid and is official, together with its salt, the hydrochloride. The alkaloid jaborine differs from the others in its action in that it resembles atropine; while the researches of Bastedo conclusively prove that the action of pilocarpine on the end of the secretory nerves is directly antagonistic to atropine, as well as its action on the nerves governing smooth muscle, the termination of the vagus, and the third nerve in the internal eye.

When applied locally in strong solution, it stimulates to a small degree the gland and muscle cells. It does not affect, however, the sensory nerve endings or the striated muscles or their mótor end plates. In common with atropine, pilocarpine acts after nerve degeneration, and it is presumed that it affects a material which serves as a receptor

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* The leaflets of *Pilocarpus jaborandi*, Holmes, or of *Pilocarpus microphyllus*, Stapf (Fam. *Rutaceæ*), yielding, when assayed by the process given below, not less than 0·5 per cent. of alkaloids.—U.S.P.

of nerve impulses, most likely a colloid. For practical purposes we can omit the reference to the receptor, and say that it acts on the nerve endings.

In full physiological doses, pilocarpine is a powerful diaphoretic, causing a copious flow of sweat, containing an increase of solids. The reaction of the sweat is at first acid, then neutral, and later alkaline; the early acidity is probably due to the admixture of waste products from the sebaceous follicles. If the nerves between the ganglia and the sweat glands are cut, the action of the drug is not inhibited, so that its action must be on the nerve ends in the sweat glands or on the gland cells.

Pilocarpine is the antagonist of atropine; it stimulates those tissues which atropine depresses; in the presence of pilocarpine a much increased dose of atropine is required to produce its physiological action.

The action of pilocarpine is to stimulate all secretions, with the possible exception of that of the mammary gland. In the liver the production of sugar is increased, but not that of bile. The secretions most affected are those of the skin, the salivary glands, and the pancreas, but those of the eyes, ears, and stomach, with the intestines, all share very markedly in the result. There is hyperæmia of the tissues, whose activities are increased owing to the direct stimulating effect on the nerve endings in the gland or of the gland cells.

The marked pupillary contraction is due to stimulation of the nerve endings of the third nerve. The vessel walls are not affected, and there is no increase of vessel tension. The terminal filaments of the vagus in the heart are stimulated and the heart action is slowed, the cardiac muscle is directly depressed by full physiological doses. The digestive processes are stimulated by the increased activity of the pancreas, intestinal fermentation is thus lessened, and toxæmia, the strong factor in arterial hypertension, is decreased.

The action of pilocarpine on the skin, stimulating both the sebaceous and the sweat glands; its very beneficial action on the hair follicles, increasing the strength, lustre, and quantity; its stimulating influence on the growth of the nails, suggest a broad field for its employment more generally in cutaneous disease. To the kidneys (when used in small doses, $\frac{1}{30}$ gr. three times daily) it is a direct stimulant; the use by inunction of an ointment, containing pilocarpine 10 gr., wool fat 1 oz., rubbed well into the loins, has a favourable action in acute suppression of urine. Its beneficial action on the kidneys is best noted when given in small doses, as full doses are likely to produce free sweating and nausea. The drug is eliminated by the skin, kidneys, and salivary glands. Dangerous amounts of bronchial secretion may be induced by pilocarpine, if given in full doses. By some it is stated that the sugar in the milk and blood is increased. Locally applied it brings about its physiological results, and it has been stated by some observers that the hair growth is stimulated by it. It contracts the pupil after topical ingestion, by stimulating the third nerve endings.

The foregoing is a fair composite of the recorded observations of the effects of pilocarpine by the writers of the past decades. It shows that not a few persons respond abnormally to the foregoing action, when pilocarpine has been administered. It generally, but not nearly always, slows the pulse-rate when given in moderate doses. The pulse-rate and blood-pressure are both harmoniously reduced in the lower animals, but not always harmoniously so in human beings. The negro race is very susceptible to pilocarpine, and a very much smaller dose is toxic to them than to whites. A number of deaths from lack of knowledge of this fact have been reported. The late Dr. Rowland G. Curtin was probably the first to call attention to this peculiarity of the alkaloid, and he always advised his interns not to administer it to negroes as a diaphoretic, especially in the usual doses used in uræmia and in acute or late chronic nephritis.

For several years past the writer has used pilocarpine in practically all cases of hypertension of blood-vessels without marked cardiac hypertrophy, and with very gratifying results in nearly all instances. Its use gave evidence of modifying the cause of hypertension. The dose, of course, was a fraction of that usually taught as the normal dose. The records of heart action and blood-pressure change were always closely watched, as was also any effect on sensible sweat.

The starting dose for adults in fair condition was $\frac{1}{30}$ gr. in a glassful of water after meals. This occasionally had to be still further reduced and seldom increased, to secure a gradual decrease in blood-pressure amounting to about 30 to 40 mm. Hg. after four to six weeks of administration. In one case an idiosyncrasy seemed to exist, so that the dose had to be reduced to $\frac{1}{100}$ gr., well diluted, after meals. The relief it produced of distressing symptoms characteristic of high pressure in this case was most gratifying. The benefit derived from its use in cases of hypertension where apoplexy had previously occurred has been uniformly good; in fact, better than by any other former treatment, including magnetism and high frequency electric currents at the hands of experts.

S. W. Saunden says that pilocarpine causes rapid improvement in oral and faucial mucous membranes and prevents glandular infection in scarlet fever. Pilocarpine in membranous tonsillitis is of material curative aid. Pilocarpine increases the secretion of digestive juices without disturbing the proportion of hydrochloric acid. Graeme M.

Hammond has reported fifteen cases of Menière's disease cured by pilocarpine. Posey (*Transactions of the American Ophthalmological Society,* 1908) said that pilocarpine was more appropriate than eserine for the local preliminary treatment by miotics in glaucoma. The pruritus of senility is often most satisfactorily treated by nightly doses of pilocarpine. Ocular tension is markedly reduced by local use of a 2 per cent. solution. It is more effective than atropine 1 per cent., cocaine 10 per cent., novocain 2 per cent.

Cheron says it acts as a galactagogue. Walowske recommends it as good for catarrhal jaundice. Ringer states that children are less susceptible to it, even in large doses, than adults. Schwann states that it greatly increases intestinal peristalsis in lower animals. Aural vertigo, or disease of the eighth nerve, is often best relieved by pilocarpine. Pilocarpine causes leucocytosis.

Hypertension in nephritis is due to retention of waste products. Headache is relieved by reduction of pressure by increasing excretion and secretion. The causes of hypertension should be clearly worked out before any course of treatment is decided on. When the thoracic aorta and splanchnics are sclerotic, the hypertension is likely compensatory, and so reduction of pressure, other than by methods directed toward correcting the original cause of a general sclerosis, will be contra-indicated.

The intense continuous tension of life as it is lived to-day reacts on the nervous system in such a way as seriously to disarrange the functions of the body organs, especially by reduction of normal nerve impulse, to the glandular system. So metabolism, elimination, and the condition of the secretions are made constantly abnormal. Vitiated structural change must be the history following such a prolonged abnormal life record.

Chronic interstitial nephritis is practically always interlinked with arterio-sclerosis and gives the highest blood-pressure showing we meet. This condition of things would be quite impossible, except for impaired nerve force and sustaining power, and the presence of irritating, abnormal, chemical, and bacterial substances long present in the blood-stream, and therefore constantly presented to the kidneys for elimination. The hypertension in all such cases is an effort toward compensation by so intensifying the stimulation of the kidneys that poisons may be eliminated. Uræmia and eclampsia are examples. In pneumonia, typhoid fever, and the like, the toxæmia becomes so great as to pass beyond stimulation.

Dr. Samuel West, in "Index of Treatment," by various authors, 1912, states it as his observation that, "of drugs for chronic renal disease, I think pilocarpine the most useful. I cannot understand the prejudice that seems to exist against it in some quarters. I have used it very largely and have never seen any disadvantage follow its administration; on the contrary, nothing but good. Apart from its general action, many of the symptoms are distinctly controlled by it. Thus headache and the exhaustions and restlessness so common in the later stages of the disease may be relieved by pilocarpine more immediately and persistently than by any other means, and even threatened uræmia staved off. I consider it the most useful remedy of all." Pilocarpine increases the activity of probably all glandular tissue of the body, and in general arterio-sclerosis the blood supply to these glands is necessarily reduced. Pilocarpine acts as a vaso-motor dilator, and so tends to the re-establishment of normal functions in normal amounts.

The reverse of depression in properly adjusted doses of pilocarpine to respective cases occurs, yet it does not stimulate as stimulation is usually understood, but simply introduces an additional entity to the media, deciding normal glandular functions, which enables such functions to be performed under the existing inability to do so. So probably is the maintenance of normal metabolism assisted with its necessary influence on blood-pressure.

Better metabolic action throughout the body ensues, and to such extent a return of approach to health during its action results. Excretion and secretion are markedly increased. Particularly is this true of the sweat glands; there is great increase of the solids of the sweat. This is true, even though the dose stimulates action quite short of sensible perspiration. A harsh, dry skin becomes soft and in good tone, and carefully preserved washings from the body yield the solids in appreciably increased quantity. With the entire glandular system of the body increasing its functional activity so as to bring about the normal balance essential to normal efficiency of metabolism, there must be caused the removal of the most common causes of blood-vessel hypertension.

The effect of pilocarpine on gland substance suggests its playing a part in colloid combination and deciding the to-and-fro make and break of the giant colloid molecule combination, which receives its impulse charge from the terminal nerve ends, and discharges it in interaction with the gland cell.

Suffice it to say that pilocarpine does establish the activities and conditions necessary to health which are usually wanting in hypertension, and this to such a degree as should assure it a prominent place in the armamentarium for the treatment of that condition.

From private work, the writer has notes of fifty-three cases where distressing hypertension existed, in which he has tested the use of pilocarpine. Short notes on a few will be sufficient indications of the results, as they are cases selected to represent broadly its effects.

Case 1.—Miss M. M., aged 68, head of a department in a large millinery house. Cerebral apoplexy three years ago; bedridden three weeks. Gradual improvement, enabling return to employment after one year, but with impaired speech, gait and arm and leg power. Distressing vertigo almost constant and headaches very frequent, and at times so severe as to prevent work. Blood-pressure, systolic, 214; pulse, 84. Urine, average amount 30 oz., specific gravity 1012, urea 362 gr. per diem. Few granular and hyaline casts, indican, and acetone. Constipation, intestinal fermentation, and coated tongue constantly present. Feeble perspiration response to hot packs. Pilocarpine $\frac{1}{80}$ gr. in glassful of water, after each meal, begun eight months ago, when patient came into writer's care. No sensible perspiration induced, but full evidence of decidedly increased insensible sweat, beginning after two months' administration. Pulse 78, pressure 194, vertigo much decreased. Full perspiration response to hot packs, given twice a week. Appearance and feeling of general betterment. After four months, improvement, continuous in all symptoms, pressure 182, pulse 74, no casts or albumin or indican. Three months later, pressure 168, pulse 72, urea 462 gr., and evidence of improved health remark of all acquaintances.

Case 2.—J. F. K., man, aged 66, real estate operator, came into writer's care fourteen months ago. Intensely nervous, insomnia, vertigo at times alarming, tinnitus aurium, constipation, gastric and intestinal indigestion. Headaches frequent and severe. Condition necessitated partial retirement from business. Urine, albumin a trace, many hyaline and few granular casts. Average amount 28 oz., urea 346 gr. Blood-pressure 208. $\frac{1}{80}$ gr. pilocarpine muriate with glassful of water after each meal, ordered, also continuation of hot packs, which soon began for the first time to prove effective. Usual orders as to diet, including liquids taken. Improvement began promptly with fall of pressure to 188 after three weeks, and to 166 after eight months, about which place it remained constant. General health and feeling better than over eight years past.

Case 3.—Mrs. T. B. D., aged 71, slight build, palpable vessels, recognizably very atheromatous. Headaches frequent and severe, intensely nervous, harsh dry skin, bad digestion. Constantly coated tongue, present weight 106 lb., a loss of 19 lb. since an apoplectic stroke involving the entire left side, twenty months ago. The palsy was profound for some weeks, and it was four months before patient could walk without cane. Some improvement in this continued for six or eight months more, since when the condition had been practically stationary. The gamut of the usual lines of treatment in such cases had been tried with her by three or four different physicians who had her in care at her summer home and other places of temporary residence. These treatments induced a full course of high frequency electricity and magnetism, in an effort permanently to reduce a pressure which persistently remained from 212 to 220. She was three months ago started on $\frac{1}{30}$ gr. of pilocarpine, with full glass of water after each meal. The improvement in this particular case was surprising in every symptom. After six weeks the blood-pressure never recorded above 168 and there was no evidence of unpleasant cardiac depression, cyanosis, nor occurrence of sensible perspiration properly attributed to the drug. A study of this case inclined one to feel that the pressure reduction was at least in part properly attributable to the re-established normal glandular functions throughout the body, especially of the kidneys, sweat glands, and glands related to digestion.

Case 4.—C. T. C., man, aged 70, weight 206 lb., florid complexion, engorged facial and neck capillaries, bad station at times, staggering on turning movements, and distressing feeling of intense engorgement of head. Blood-pressure 190 to 206; usual treatments of no avail. Pilocarpine in $\frac{1}{30}$ gr. doses at the end of two months showed reduction in pressure only to 184; the dose was then increased to $\frac{1}{20}$ gr. and after two months more, when only 10 mm. additional fall was recorded, the dose was made $\frac{1}{15}$ gr. three times a day. The persistent maintenance of this dose for the past year has been associated with a remarkable re-establishment of normal physical conditions. No ill nor inconvenience seems to have resulted from use of the drug, and the vertigo, tinnitus aurium, and turgid condition of the face and neck disappeared, and a condition of comfort and well-being, such as had not been experienced for a number of previous years, became established. One particularly interesting feature in this case was that for the past twelve or fifteen years the man had annually suffered from so distressing a winter cough, more particularly at night, as to disturb his household and make himself wretched, so that several weeks' sojourn in the far South were made necessary at great business and domestic inconvenience. During the two winters he has been taking pilocarpine he has not been afflicted with the cough, which, by the way, has no associated expectoration.

Case 5.—M. A. S., retired nurse, aged 56, suffering from chronic interstitial nephritis with photophobia, constant eye pain, and intense and distressing headaches several times a week, lasting for a number of hours. The usual treatments failing to give relief, pilocarpine in $\frac{1}{30}$ gr. doses, three times a day, was added. A slow but steady improvement continued from the end of the second month, which was two years ago. Early in the treatment the $\frac{1}{30}$ gr. dose was followed by rather profuse night-sweats and cardiac distress. The dose was gradually decreased to $\frac{1}{90}$ gr., three times a day, at which it was kept constant. Copious quantity of albumin, many granular and hyaline, and some blood-casts were the continuous record. For the last three months these were absent. The blood-pressure, originally from 240 up to 270, was reduced to from 180 to 190, at which point it remained. On account of the great suffering of this woman several prominent physicians were associated in trying to secure comfort for her, especially for her eyes and head. The consensus was that pilocarpine should be credited with the very decided improvement in her case which made life quite comfortable.

Conclusions.

In intelligently selected cases of hypertension, pilocarpine has not failed to be of value, in many instances of very great value. The therapeutic dangers usually accredited to this drug have not been met with in the modified dose in which it has been used, a dose that is not mentioned in works on therapeutics and materia medica. The general feeling that the drug is a dangerous one, the writer feels, is due to the former habit of presenting the maximum dose of from

$\frac{1}{10}$ to $\frac{1}{4}$ gr. A thoughtful study in selecting cases for the use of pilocarpine and an unprejudiced testing of the possibilities to be derived from its use, will gain for it many friends.

Six colleagues, who have been using it as suggested, are all in accord in crediting it with great power for good, if thought and careful study of cases are associated with its use.

LITERATURE.

Medical Council, June, 1913.

POSEY. *Ophthalmological Review*, September, 1907.

LAVAL. *Therapeutic Gazette*, September 15, 1897.

DAVIS. *Kansas City Medical Index*, November, 1888.

Lancet, August, 1894.

CROSS, F. RICHARDSON. *British Medical Journal*, April 29, 1899.

SCHEFFER. *Médecin moderne*, May 19, 1900; *British Medical Journal*, December 8, 1900.

HUTCHINSON, R. *Scalpel*, June, 1899, and April 11, 1900.

HALL, F. DE HAVILAND. *Indian Medico-Chirurgical Review*, July, 1899.

DE SCHWEINITZ, G. E., and VEASEY, CLARENCE A. *Archives of Ophthalmology*, xxv, 2.

GLASS, ERNEST. *Medical Record*, May 9, 1896.

SKIKLAI. *Therapeutic Gazette*, November 15, 1895.

HEISCHFELD. *Australian Medical Gazette*, April, 1893.

SYME. *Australian Medical Journal*, May 15, 1891.

LUSTGARTEN and ALLEN. *Proceedings of New York Dermatological Society*, 1894.

MOLIERE, HEMDENT. *Lancet*, July 6, 1895.

BENESCH. *Journal de médecine de Paris*, 9.

ABRAHAMS. *Medical Record*, September, 1894.

United States Dispensatory, *National Dispensatory*, *passim*.

DISCUSSION.

Dr. HAMMAN (Baltimore): I have been very much interested in the use of tuberculin, and have had some experience in its use. I regret very much that my views are so completely opposed to those that Dr. Kinghorn holds, but since they are, I must make a perfectly clean breast of it. Dr. Kinghorn said in substance that the subcutaneous tuberculin test differentiates between the tuberculous and the healthy.

I wish to take exception to that statement, if the term tuberculous be used in a clinical sense. It is important, in all discussions about tuberculin, that this distinction should be sharply drawn : the difference between tuberculous infection and tuberculous disease, or tuberculosis. Plenty of individuals (in fact, nearly all of us) are tuberculosis infected, but we have no symptoms of our infection. In that sense, certainly, tuberculin does not distinguish between the tuberculous and the healthy. Our own experience and very large statistics, covering thousands of cases, show plainly that most adults react to this test. Take all the adults in this room, for instance, and 60 per cent. of them will react to it. If this is so, how can one say that it distinguishes between healthy and tuberculous individuals? And we are interested in the question only from a clinical standpoint, and not from the standpoint of the prevalence of tuberculous infection. From this viewpoint the subcutaneous tuberculin test does not differentiate between the tuberculous and the healthy.

Dr. POTTENGER : I am one of those who stand on the fact that the tuberculin reaction, either the subcutaneous or the skin test, is of value in the differentiation between active and inactive tuberculosis. I have made a great many examinations of suspected cases, and have followed this plan : I have taken a careful clinical history, made a thorough physical examination (including my own signs of the muscles and subcutaneous tissues), and then written down my opinion as to whether the case was one of active or inactive tuberculosis or was non-tuberculous. Then I have given the von Pirquet test; and I have found in those cases in which I had given the opinion that active tuberculosis was present that the von Pirquet test was positive, the patient reaching his maximum reaction within the first thirty-six hours in 80 per cent. of the cases. I believe that there is a great difference in the interpretation of the reaction. A prompt maximum reaction to Koch's full tuberculin coincides with my opinion of the presence of active tuberculosis; but a prolonged reaction, coming on later, five to nine days, as it does sometimes, nearly always means quiescent, old fibroid, or practically healed, tuberculosis. If used in this way the tuberculin test is of great value. Most of us will react if a sufficiently strong injection is given hypodermically. The one that did not react to 10, would to 20 or 30 or 50 mg.; but 10 mg. comes close to giving us a dividing line.

Dr. HAMMAN : The other two points that I wish to mention are : first, the subcutaneous tuberculin test is the most valuable excluding test that we have. If you give increasing doses up to 10 mg. and the patient does not react, this does not absolutely exclude tuberculosis, but it forms the most important clinical evidence we can obtain against the presence of tuberculosis. The second point is that the only aid in making a definite diagnosis is the presence of a focal reaction. What constitutes a focal reaction? Ideas differ on this point. Some find it in 80 per cent. of the cases, but we do not find it in more than 2 or 3 per cent. The evidence must be carefully gauged.

Dr. Cleaveland Floyd (Boston, Mass.): I should like to emphasize what Dr. Hamman said this morning with regard to the question of a differentiation between active and inactive tuberculosis by means of these tests. One great reason for contention among men discussing tuberculosis is that one man is speaking of a clinical disease and the other of a condition. I do not think you could say that active tuberculosis can be differentiated by one test and not by the other. Frequently a positive reaction is obtained with the von Pirquet test where you have not an active disease, and you may also get a focal reaction with this test. The difference between the tests is merely a differentiation of the susceptibility of the patient to tuberculin.

A Member: I should like to say a word. Some years ago I was interested in this test. I had a patient, a young woman, who gave private instruction in French and German in the family of a minister intimately associated with the Lutheran Theological Seminary. He had recently had an assistant come from Vienna, who claimed to have known the von Pirquet family very well, and to be acquainted with its history for some generations back. He said that it was strictly a Swiss family that had come from Berne to Vienna, and that the correct pronunciation of the name was to give the full sound to each consonant and the long sound to the vowel. Von Peerquet is the pronunciation accepted by my friends in Vienna.

Dr. Minor: I am glad to hear this lesson on pronunciation. I know Dr. v. Pirquet personally, and also his wife, and they, as I recall it, call themselves Peerket. They ought to know. It makes very little difference, however; what the world calls his name is his name. The world calls it Peerkay, but he calls it Peerket. I should like to say that it is a great pity that such a misuse is made of the reaction, and that so many cases of tuberculosis in adults are sent away as cases of tuberculosis on the strength of it. Adults, of course, commonly react to it, and it is, on the whole, in them considered to be an evidence of existing latent tuberculosis, but not of active tuberculosis. The use of the von Pirquet test on adults by general practitioners is to be discouraged. It frightens the patient and does not clear the diagnosis up. If doctors are not afraid of the ophthalmic test, which I am, they can do it, or the subcutaneous test. I have used the latter often, without any bad effects, and I am not afraid of it. The von Pirquet is leading to diagnoses of active tuberculosis in many cases in which the disease is really latent and not strictly a disease, but a condition.

Dr. R. C. Paterson (Ste. Agathe): I think that before we say that the tuberculin test is made, we must be very certain of the tuberculin we use. One instance came to my notice during the past year in which a man had been tested with tuberculin diluted and put up in an ampoule. A reaction was not obtained. I was not satisfied, and made a test with the same dose of a fresh preparation, and got the reaction.

Dr. DARLINGTON : A question came up in the paper of Dr. Rochester this morning in regard to the administration of ammonium bromide, as I understood, with nitro-glycerine. The bromide solution decomposes nitro-glycerine, and both drugs are then inactive.

Dr. GORDON WILSON : One point that I wish to speak of is the absolute unreliability of single systolic blood-pressure readings, as shown by the variations of systolic pressure under very slight stimuli. In one case, lately, a man came to me for diagnosis of a Jacksonian attack. Otherwise, he was in perfectly good health. He was put in bed and the blood-pressure taken. The systolic reading was 120, and the diastolic 80. A funny story was told and he laughed very moderately, and the pressure after this was 145, a difference of 25 on very slight exertion. In life insurance that question comes up. A case was sent to me for examination that had been "turned down" by another company, as it was said that the blood-pressure was 140. I wrote to the company, and found five readings had been taken varying from 140 to 178 systolic, but the diastolic had been 115 in each case. The latter, therefore, is far more important than the former, and any formula which includes pulse-pressure must be limited to many readings.

Dr. MINOR : Dr. Norris has made one statement in regard to which I differ with him. The general teaching has been that the end of the fourth phase and the beginning of the fifth is the best point for the correct reading of diastolic pressure. Dr. Norris, however, says that it is the beginning of the fourth. The latest work that I have seen is by two Johns Hopkins men, in the last number of the *Archives of Internal Medicine*, who also say that the end of the fourth phase is the right time.

Dr. ANDERS : I agree with Dr. Rochester that the term pseudo-angina should be dropped from medical nomenclature. I have seen a number of cases that had been diagnosticated pseudo-angina pectoris, which subsequently developed true angina. They simply passed from an atypical to a typical picture of this disease. In the next place, I quite agree with Dr. Norris when he says that, to his thinking, the energy-index and the cardiac load are no better criteria of cardiac efficiency than the older methods, *e.g.*, registering the blood-pressure, more particularly the diastolic blood-pressure. I believe that Dr. Swan also takes the same position. This is the conclusion that I have reached recently, not only from my own limited work, but also from that which I have seen in the experience of others. We must further investigate into these newer methods and perfect them before they will give any more reliable results than we can obtain from the older and more convenient methods of study of our cases.

Dr. SWAN (closing) : It is well known that there are many conditions that influence the systolic blood-pressure—emotion, food, drugs, muscular activity, &c.—but I think that a clinician who is constantly making blood-pressure studies and who always makes his observations in the same way gets very reliable pulse-pressure readings by using the auscultatory method. In the cases that form the basis of my paper the pressure observations were always made with the patient in the recumbent posture. The cuff was always applied to the naked arm. I think it is a mistake to take blood-pressure readings in the sitting posture, because the muscular activity necessary to maintain that posture has some influence on the systolic pressure. Clinically, we get the true systolic pressure as nearly as possible when the patient is recumbent and relaxed. Of course, one should be careful not to tell the patient a funny story when making a blood-pressure observation; and it is also necessary to try not to disturb him. The observations that I have reported have all been made during routine examinations in my own practice. I always make the blood-pressure observation last, by that time the patient has overcome most of the nervousness and anxiety incident to the examination, he has been lying down for some time and the conditions of the circulation are as near the normal as it is possible to get them clinically. I believe the proper point to read the diastolic pressure by the auscultatory method is at the fifth, the point at which all sounds disappear. I think there is some confusion in the nomenclature. In my opinion the word phase should be applied strictly to the distance between two of the points that are obtained in making the observation. In making an auscultatory blood-pressure observation one hears first a tap, then the tap is replaced by a systolic murmur, then the murmur disappears and the tap returns, then the tap becomes suddenly dulled, nearly all sounds disappear. These points are noted on the scale of the sphygmomanometer. They should be called points: first, second, third, fourth, and fifth. The distance in millimetres between the first and the second points is the first phase, the distance between the second and the third points is the second phase, and so on.

Dr. ROCHESTER (closing): I do not give ammonium bromide and nitro-glycerine at the same time. The ammonium bromide is administered not during the attacks, but during the preceding nervous period. A woman is restless before the attacks come on, and the ammonium bromide may ward off the attack.

Dr. HINSDALE gave a synopsis of his contribution on "The Atmospheric Air in Relation to Tuberculosis." Copies of this paper were subsequently obtained from the Smithsonian Institution for the TRANSACTIONS.

SMITHSONIAN MISCELLANEOUS COLLECTIONS

VOLUME 63, NUMBER 1

Hodgkins Fund

ATMOSPHERIC AIR IN RELATION TO TUBERCULOSIS

(With 93 Plates)

BY

GUY HINSDALE, A. M., M. D.

Hot Springs, Virginia.

Secretary of the American Climatological Association; Ex-President Pennsylvania Society for the Prevention of Tuberculosis; Fellow of the College of Physicians of Philadelphia; Associate Professor of Climatology, Medico-Chirurgical College; Member of the American Neurological Association; Fellow of the Royal Society of Medicine, Great Britain; Corresponding Member of the International Anti-Tuberculosis Association, etc.

(Publication 2254)

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ADVERTISEMENT

The accompanying paper, by Dr. Guy Hinsdale, on "Atmospheric Air in Relation to Tuberculosis," is one of nearly a hundred essays entered in competition for a prize of $1,500 offered by the Smithsonian Institution for the best treatise "On the Relation of Atmospheric Air to Tuberculosis," to be presented in connection with the International Congress on Tuberculosis held in Washington, September 21 to October 12, 1908. The essays were submitted to a Committee of Award, consisting of Dr. William H. Welch, of Johns Hopkins University, Chairman; Prof. William M. Davis, of Harvard University; Dr. George M. Sternberg, Surgeon-General, U. S. A., Ret'd; Dr. Simon Flexner, Director of Rockefeller Institute for Medical Research, New York; Dr. Hermann M. Biggs, of New York, General Medical Officer, Department of Health, New York City; Dr. George Dock, Medical Department, Washington University, St. Louis; and Dr. John S. Fulton, of Baltimore, Secretary General of the Congress on Tuberculosis. Upon the recommendation of the committee, the prize was divided equally between Dr. Guy Hinsdale, of Hot Springs, Virginia, and Dr. S. Adolphus Knopf, of New York City.

At the request of the Institution, Dr. Hinsdale has revised his essay so as to indicate some of the advances made in the study of the subject during the past five years.

CHARLES D. WALCOTT,
Secretary of the Smithsonian Institution.

WASHINGTON, DECEMBER, 1913.

TERMS OF COMPETITION

SMITHSONIAN INSTITUTION

HODGKINS FUND PRIZE

In October, 1891, Thomas George Hodgkins, Esquire, of Setauket, New York, made a donation to the Smithsonian Institution, the income from a part of which was to be devoted to "the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man." In furtherance of the donor's wishes, the Smithsonian Institution has from time to time offered prizes, awarded medals, made grants for investigations, and issued publications.

In connection with the approaching International Congress on Tuberculosis, which will be held in Washington, September 21 to October 12, 1908, a prize of $1,500 is offered for the best treatise "On the Relation of Atmospheric Air to Tuberculosis." Memoirs having relation to the cause, spread, prevention, or cure of tuberculosis are included within the general terms of the subject.

Any memoir read before the International Congress on Tuberculosis, or sent to the Smithsonian Institution or to the Secretary-General of the Congress before its close, namely, October 12, 1908, will be considered in the competition.

The memoirs may be written in English, French, German, Spanish or Italian. They should be submitted either in manuscript or type-written copy, or if in type, printed as manuscript. If written in German, they should be in Latin script. They will be examined and the prize awarded by a Committee appointed by the Secretary of the Smithsonian Institution in conjunction with the officers of the International Congress on Tuberculosis.

Such memoirs must not have been published prior to the Congress. The Smithsonian Institution reserves the right to publish the treatise to which the prize is awarded.

No condition as to the length of the treatises is established, it being expected that the practical results of important investigations will be set forth as convincingly and tersely as the subject will permit.

The right is reserved to award no prize if in the judgment of the Committee no contribution is offered of sufficient merit to warrant such action.

CHARLES D. WALCOTT,
Secretary of the Smithsonian Institution.

WASHINGTON, D. C., FEBRUARY 3, 1908.

PREFACE

The rapid progress in the antituberculosis movement throughout the world in the last five years has made it necessary to make some changes in the present essay as originally presented to the Smithsonian Institution in 1908. Much that then seemed novel appears almost commonplace now. An extraordinary amount of research has been carried out with reference to the atmospheric air during these later years. The whole theory of ventilation has been stated in new terms; the presence of ozone in the atmosphere, a subject that has always appealed to the popular fancy since its discovery, has been restudied and its physiologic action assigned a value different from that commonly ascribed to it; the properties of strong sunlight and Alpine air have been marshalled for the combat with surgical tuberculosis, particularly in children.

Physiologists in Europe and America have lately made most interesting studies of the blood at the higher altitudes and their observations are constantly throwing new light on the entire subject of aerotherapy, replacing old impressions and beliefs with a scientific basis on which we may confidently build.

There never was a time when the outdoor life and the accessories for the atmospheric treatment of all tuberculous persons were so well systematized and placed in harmony with the other hygienic measures adopted for their cure.

What the result has been we have endeavored to show and what the future holds for us we are eagerly awaiting.

May the Smithsonian Institution, through its Hodgkins Fund, continue to stimulate inquiry and disseminate the fruits of the worldwide efforts to the better understanding of the great problems that yet remain unsolved.

Guy Hinsdale.

Hot Springs, Va., December, 1913.

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Hodgkins Fund

ATMOSPHERIC AIR IN RELATION TO TUBERCULOSIS

By GUY HINSDALE, A. M., M. D., Hot Springs, Va.

(With 93 Plates)

CHAPTER I. INTRODUCTION

We are compelled to acknowledge at the outset the difficulty or impossibility of analyzing the relationship of atmospheric air to tuberculosis so as to isolate the influence of all other factors. It would be totally useless and impossible to consider air independent of sunlight, heat, rainfall, the configuration of the earth's surface; racial characteristics, social environment, including dwellings, clothing, food, and drink.

As a resultant of all these and many other factors in the tuberculosis problem, we obtain the figures of mortality which are published from time to time by various cities, states, and nations. The problem seems incapable of solution. One might as well survey an oak that has grown for centuries and set out to determine the relative value of the atmospheric air, the sunlight, the rainfall, and the various constituents of the soil and its environment in producing the sturdy, deeply rooted, and wide-spreading tree which has seen ages come and go.

The world-wide efforts now made to determine the nature of this infection and especially its bacteriologic and pathologic character are accompanied by a general effort to limit its spread. We are encouraged to believe that future generations will be provided with a practical and efficient method of destroying this insatiate monster.

Undoubtedly we have begun at the right end, but we only began within the memory of nearly all of us, only thirty-two years ago, when the true cause of the disease was first isolated and revealed to the human eye.

Previously we were as the blind leading the blind, groping about in search of special climates, special foods or medicines, meeting with more or less success in so far as the dietetic, hygienic, out-of-door plan of treatment was carried out. These curative measures succeeded then, as they succeed now, but preventive measures worthy the name were entirely unknown. The enemy once revealed in its hiding place, and various facts in its life history determined, the logical result was a gradual—very gradual—dawn which promised better things. Now the world has seen a great light and we wonder how intelligent men could have dwelt in those caverns of ignorance and even refused to come out for years while the men in the laboratory beckoned with signs which then seemed so uncertain but now so clear. As late as 1890 the medical mind did not grasp the necessity for preventive measures. As one asleep it heard voices but was slow to waken; it starts and rubs its eyes and looks about, waiting for some word or message that will bring it to its senses.

It was in 1891 that the first society for the prevention of tuberculosis was organized. This was started in France by M. Armaingaud, of Bordeaux. The second was the Pennsylvania Society for the Prevention of Tuberculosis organized in Philadelphia in 1892. These were the pioneers in Europe and America. They devoted their energies to a campaign with three cardinal features: (1) the education of the public in reference to the nature of the disease and its means of prevention; (2) the passage of suitable laws regarding notification, the restriction of expectoration, disinfection, etc.; and (3) the care of consumptives and the establishment of sanatoria by public or private means in suitable localities.

The wonderful growth of this movement for preventive measures is now seen in the establishment of 1,228 societies for the prevention of tuberculosis in America alone, and in the erection of 527 sanatoria in this country (1913).[1] The State of Pennsylvania alone has appropriated in one Act of Legislature $2,000,000 for this purpose and one citizen of the state, Mr. Henry Phipps, has given an equal amount for the scientific study as well as the practical treatment of this disease in all its bearings.[2]

---

[1] The State of New York leads all other states in the number of new organizations and institutions established during the last two years. The total number of beds for consumptives in the United States now exceeds 33,000.

[2] The Pennsylvania legislature appropriated $1,000,000 in 1907, $2,000,000 in 1909, $2,624,808 in 1911, and $2,659,660 in 1913 for tuberculosis work alone. This is under the direction of Dr. Samuel G. Dixon, the Commissioner of Health.

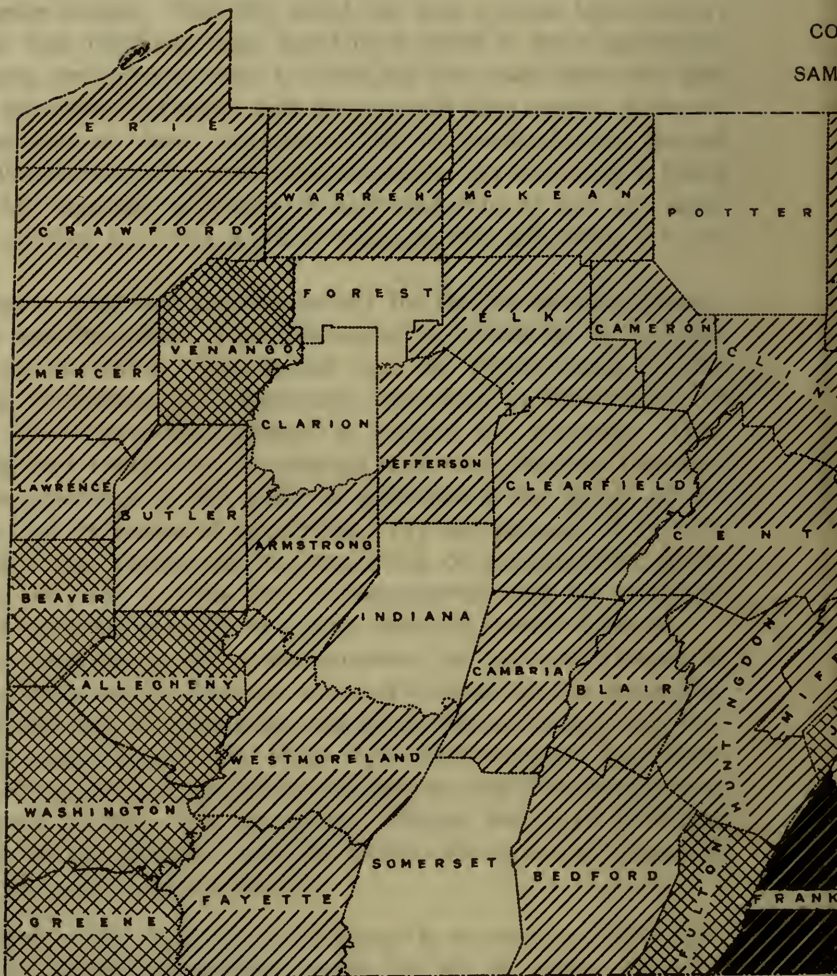
There are at the present time two State Sanatoria in Pennsylvania in operation.

Mont Alto, Franklin Co.

No. of patients under treatment.................... 957
Elevation ....1,650 ft.

CO

SAMU



Note:- The figures in Franklin County include the deaths at the State Sanatorium
The death rate for Franklin County exclusive of Mont Alto would be 118.

Deaths p

0-49

50-99

10

15

MAP SHOWING DISTRIBUTION OF PULMONARY TUBERCULO

ONWEALTH OF PENNSYLVANIA
EPARTMENT OF HEALTH
G. DIXON, M. D., COMMISSIONER

Tuberculosis at Mont Alto, numbering 248 in 1912.

100,000.
149 — 200 and above
199

IN PENNSYLVANIA BY COUNTIES FOR THE YEAR 1912

The late Dr. Henry I. Bowditch, of Boston, was one of the first physicians in America to recognize the value of constant out-door life in the treatment of tuberculosis and was accustomed to send such patients on easy journeys by carriage so that they might have the benefit of as much out-door air as possible, becoming gradually inured to the elements.

The late Dr. Alfred L. Loomis, of New York, was one of the first to systematically send tuberculous patients to the Adirondack forest that they might have the benefit of the purest and most invigorating air obtainable and, like the physicians of ancient Rome who sent consumptive patients to the pine forests of Libya, he believed that the terebinthinate exhalations from the standing pines exerted a most beneficial influence on pulmonary affections. Dr. Loomis's results were so gratifying that he encouraged Dr. Edward L. Trudeau to care for such patients in the Adirondack Mountains throughout the year, and Dr. Trudeau, with his help, founded in 1884 the first sanatorium for tuberculosis in America.[1]

This Adirondack Cottage Sanitarium, now in its thirtieth year, has been the inspiration of sanatoria for tuberculosis throughout the country. Its success in restoring so many patients to health and usefulness is not wholly estimated in figures. It has established

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Cresson, Cambria Co.
No. of patients under treatment.................... 337
Elevation ....2,550 ft.

Hamburg, Berks Co.
In the course of construction and will be completed some time in 1914.
Capacity 480
Elevation .... 550 ft.

These institutions care for both incipient and far advanced cases. The interior arrangement of the sanatoria at Cresson and Hamburg is such that they can be used for the different classes of cases as demand may necessitate. There is a waiting list of those desiring admission to these institutions at all times.

The State maintains 115 Tuberculosis Dispensaries, which are located throughout the 67 counties in the commonwealth. There are 220 physicians and 120 visiting nurses employed in these dispensaries.

By the courtesy of Dr. Samuel G. Dixon, Commissioner of Health, we are able to show in a map the distribution of tuberculosis in the counties of Pennsylvania (pl. 1). This shows, as in an earlier map by the author, that the disease is least prevalent in the higher, forest covered regions of the State.

[1] A. L. Loomis, M. D. Evergreen Forests as a therapeutic agent in pulmonary phthisis (Trans. Amer. Climatological Ass., Vol. 4, 1887). See page 134.

a practical method of cure and has done much to correct the earlier unfounded and mischievous notions that prevailed as to what was necessary for the cure of tuberculosis.

Taking this institution as an example, let us see what bearing it may have on our general subject, the relation of the atmospheric air to tuberculosis:

(a) It is in the midst of an evergreen forest of over 10,000 square miles; (b) the atmosphere is pure, or at least as pure as may be obtained on the continent; (c) the air is moderately moist; (d) the rainfall averages 35 inches; (e) the air is moderately rarefied, owing to (f) an elevation of 1,750 feet; (g) owing to its northern situation (latitude 44°) and its elevation (1,750 feet) (h) the climate is cold in winter and (i) subject to rather sudden changes with an annual range of 59° C. or 138° F.

CHAPTER II. VALUE OF FORESTS, MICRO-ORGANISMS, ATMOSPHERIC IMPURITIES

GENERAL BENEFIT OF FORESTS

It has come to be an axiom in phthisiology that the air of an evergreen forest is eminently suitable for a patient with tuberculosis.[1] As we have previously mentioned, the pine forests of Libya were used two thousand years ago for the cure of "ulcerated lungs." At that period the pines abounded and gave the locality a reputation as a health resort for affections of the lungs. But the ravages of time, aided by fire and sword, not to speak of domestic needs, have obliterated all vestiges of these ancient forests.

The successful institutions located in the Hartz Mountains, the Black forest of Germany, in the Forest of Ardennes, the State Forest Reserve of Pennsylvania, and the Adirondack Forest in New York owe much of their success to the abundant use of the purest air both day and night.

European Governments have long recognized the great value of

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[1] The following quotation from Pliny shows that it was generally agreed in his day that the forests and especially those which abound in pitch and balsam are the most beneficial to consumptives or those who do not gather strength after long illness, and that they are of more value than the voyage to Egypt:

"Sylvas, eas duntaxat quae picis resinaeque gratia redantur, utilissimas esse phthisicis, aut qui longa aegritudine non recolligant vires, satis constat; et illum coeli aera plus ita quam navigationem Aegyptiam proficere, plus quam lactis herbidos per montium aestiva potus."—C. Plinii, Hist. Nat. lib. XXIV, Cap. 6.

ST. BLASIEN IN THE BADEN BLACK FOREST, GERMANY
Courtesy of Dr. Sander

SANATORIUM ST. BLASIEN IN THE BADEN BLACK FOREST, GERMANY. ELEVATION 800 METERS (2,600 FEET). THE AIR OF THE FIR FOREST IN THE CURE OF TUBERCULOSIS

Photograph Furnished by Dr. Albert Sander their forests and have protected them by strictly enforcing intelligent laws so that they may be forever preserved and improved. The history of forestry in the United States and Canada has been that of ruthless, unrestrained, wholesale destruction of nearly all our standing pine, and heavier spruce. In recent years, however, we have seen the establishment of Government reserves, State reserves, and State laws for their protection; the organization of the American Forestry Association, the American Forest Congress, the Society for the Preservation of the Adirondack Forest; the Schools of Forestry at Yale, Harvard University and Mont Alto, Penna. All these remedial measures have come very late, but will undoubtedly exert a strong influence for good.[1]

Aside from the generally beneficial influence of forests, universally recognized by climatologists, these natural parks have proved the means of restoring thousands of persons suffering from tuberculosis and diseases of the respiratory system.

QUALITIES OF FOREST AIR AND SOIL

The qualities of forest air and forest soil have been studied by E. Ebermayer[2] who shows that, like that of the sea and mountains, forest air is freer from injurious gases, dust particles, and bacteria. It was shown that the vegetable components of the forest soil contain less nutritive matter (albuminoid, potash, and phosphates and nitrates) for bacterial growth; that the temperature and moisture conditions are less favorable; that the sour humus of the forest soil is antagonistic to pathogenic bacteria; finally that, so far, no pathogenic microbes have ever been found in forest soil; hence this soil may be called hygienically pure.

The soil is protected from high winds by forest growth and undergrowth; the upper soil strata are slow to dry out and wind sweeping over them carries few micro-organisms into the air. As may be expected, fewer microbes are found in forest air than outside their limits. Serafini and Arata have proved this experimentally.[3] They

[1] The chief forester of the United States has in 1913 under his care in 160 forest reservations a total of 165,000,000 acres of forest land. The present Chief Forester has done excellent work in the prevention of serious forest fires.

[2] E. Ebermayer: (1) Hygienic significance of forest air and forest soil. (2) Experiments regarding the significance of humus as a soil constituent; and influence of forest, different soils, and soil-covers on composition of air in the soil. Wollny, 1890 (Hygeia, August, 15, 1891).

[3] Serafini and Arata: Intorno all 'azione dei boschi sui mikro organismi transportati dai venti.

exposed plates in the forest air and on its outskirts and tabulated their countings of bacteria for forty successive days from May 6. They made three classes—molds, liquefying and non-liquefying bacteria. They found that, with one exception, one or two of these classes were always less numerous in the forest than on its outskirts and generally from twenty-three to twenty-eight times less. Serafini makes the point that bacteria coming from the outside are reduced in number by a sort of filtration process. Thus we see that the air of forests is comparatively free from endogenous and exogenous bacteria—none of them in any case being pathogenic.[1]

CARBON DIOXIDE IN FORESTS

Puchner shows that the air in the forest contains generally more carbonic acid gas than in the open, due to the decomposition of litter.[2] But this difference must be almost inappreciable. As we know, the law of diffusion of gases renders it impossible for variations in the relative proportion of the atmospheric constituents to be more than transitory. Diffusion is greatly favored by the winds which sweep through the tree tops, especially where they are not too crowded.

The fact that so many sanatoria for tuberculosis are located in or near forests makes it very important to dwell a little longer on the constituents of the air in these localities. We know that forests, as well as all other forms of vegetal growth, take up large quantities of carbonic acid, retaining the carbon and rejecting the oxygen, and the question naturally arises, does it sensibly change the relative quality of either constituent so that the composition of the air is slightly different in the woods? Prof. Mark W. Harrington, lately chief of the United States Weather Bureau, undertook to answer that question, both with reference to carbonic acid, oxygen, and ozone, with some interesting results.[3] Repeated observations show that each constituent is curiously uniform in quantity in the free air. It has been thought that carbonic acid is quite variable but the introduction of better methods of observation shows that, except in confined places where the gas is produced, the variations are very

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[1] See B. E. Fernow: Forest Influences, U. S. Dep. Agriculture, Forestry Division Bulletin No. 7, pp. 171-173.

[2] H. Puchner: Investigations of the Carbonic Acid Contents of the Atmosphere.

[3] M. W. Harrington: Review of Forest Meteorological Observations, U. S. Dep. Agriculture, Forestry Division Bulletin No. 7, p. 105.

DR. WALTHER'S SANATORIUM, NORDRACH-COLONIE, BLACK FOREST, GERMANY

DR. WALTHER'S SANATORIUM, NORDRACH-COLONIE, BLACK FOREST, GERMANY

VIEW FROM THE ADIRONDACK COTTAGE SANITARIUM
"In the foreground are the pines and my only business in life is to sit and look at them"
Courtesy of Journal of The Outdoor Life

small. A little study shows that the carbonic acid gas taken up by a forest is a very small quantity compared with that which passes the forest in the same time with the moving air. Grandeau[1] estimated the annual product of carbon by a forest of beeches, spruces, or pines as about 2,700 pounds per acre. This corresponds to 9,900 pounds of carbonic acid gas or 69,300 cubic feet. Now, if the average motion of the air is five miles an hour, a low estimate, and the layer of air from which the gas is taken be estimated at one hundred feet thick, there would pass over an acre 550 million cubic feet in one hour. This air must contain about three parts in ten thousand of carbonic acid gas and the total amount of the latter per hour is 165,000 cubic feet. But this is two and two-thirds, or more than twice as much as that taken up by the trees in the entire season, so that the air could provide in thirty minutes for the wants of the trees for the entire season. Prof. Harrington shows that the ratio of carbonic acid used to that furnished is only one part in 8,600.

OXYGEN IN FORESTS

Again, the additions of oxygen to the air would form a still smaller percentage of the oxygen already present, for this gas makes up 20.938 per cent of the air against a thirtieth of one per cent obtainable from this source.

OZONE IN FORESTS

The occurrence of ozone in the air of forests, especially coniferous forests, has been credited, since its discovery by Schoenbein in 1840, with affording remarkable health-giving qualities. This opinion has become firmly fixed in the minds of the public and, to a large extent, has been accepted by the medical profession as an evidence of high oxidizing power at once corrective of decaying vegetation and exhilarating and curative to mankind. Popular belief usually has some basis for its existence; indeed, meteorologists made regular estimations of ozone in the atmosphere by testing with sensitized papers and the results were published in connection with statistics of health resorts.[2]

The Schonbein test is based on the power of ozone to free iodine from a solution of potassium iodide in contact with starch, when a violet color is developed in the sensitized paper. Unfortunately the

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[1] See Belgique Horticole, Vol. 35, 1885, p. 227.
[2] See Transactions American Climatological Association, Vol. 5, p. 118.

discovery of important sources of error has destroyed the value of observations made in this manner. Other substances in the air have been found to act as reducing agents; secondly, the color after having appeared may be altered or destroyed by substances, such as sulphurous acid and many organic substances. Again, the test acts only in a moist atmosphere and, besides that, varies in intensity according to the amount of the wind, so that, in a way, it is a measure of humidity and of wind.

A more recent test, mentioned by Huggard as more sensitive, depends upon the use of what is known as tetra-paper, but is also considered uncertain. The full name of this reagent is tetramethyl-paraphenylendiamin paper. Notwithstanding the unsatisfactory nature of these tests, the conclusion seems to be accepted that ozone is more abundant in May and June and least abundant in December and January; more abundant in the forests and the seashore and in mid-ocean and least abundant in towns where it commonly cannot be detected. The following quotation is from page 332 *et seq.* of Vol. 1, Watts' Dictionary of Chemistry:

Very little is known respecting the proportion of ozone in the atmosphere, or of the circumstances which influence its production. The ozonometric methods hitherto devised are incapable of affording accurate quantitative estimations. Air over marshes or in places infested by malaria contains little or no ozone. No ozone can be detected in towns or in inhabited houses.

Houzeau determines the relative amount of ozone in the air by exposing strips of red litmus paper dipped to half their length in a 1 per cent solution of potassium iodide. The paper in contact with ozone acquires a blue colour from the action of the liberated potash upon the red litmus. The iodised litmus paper is preferable to iodised starch paper (Schönbein's test-paper) which exhibits a blue coloration with any reagent which liberates iodine, *e. g.*, nitrous acid, chlorine, etc. From observations made with iodised litmus paper Houzeau concludes that ozone exists in the air normally, but the intensity with which it acts at any given point of the atmosphere is very variable. Country air contains at most $\frac{1}{450000}$ of its weight or $\frac{1}{700000}$ of its volume of ozone. The frequency of the ozone manifestations varies with the seasons, being greatest in the spring, strong in summer, weaker in autumn, and weakest in winter. The maximum of ozone is found in May and June, and the minimum in December and January. In general, ozone is more frequently observed on rainy days than in fine weather. Strong atmospheric disturbances, as thunder storms, gales, and hurricanes, are frequently accompanied by great manifestations of ozone. According to Houzeau, atmospheric electricity appears to be the most active cause of the formation of atmospheric ozone.

It has been found that the air immediately above the tree tops and at the margin of the forest is richer in ozone than that of the interior, where a portion of it is utilized by the decaying vegetation. Ozone certainly aids in purifying the air by oxidizing animal or

SANATORIUM ST. BLASIEN IN THE BADEN SCHWARZWALD 800 METERS ABOVE SEA-LEVEL

RHODE ISLAND STATE SANATORIUM FOR TUBERCULOSIS AT WALLUM LAKE
Courtesy of Dr. Harry Lee Barnes

vegetable matter in process of decay and by uniting with the gases produced by their decomposition. It can, therefore, be found in considerable amounts where the air is particularly pure. This amount rarely exceeds one part in 10,000. " There is somewhat more ozone on mountains than on plains and most of all near the sea. Water is said by Carius to absorb 0.8 of its volume of ozone." [1]

This statement by Mr. Russell seems to us extraordinary in view of the minute quantity contained in the atmosphere and apparently needs confirmation, especially in view of Russell's next statement that a great excess of ozone is destructive to life, and oxygen containing one two-hundred and fortieth part of ozone is rapidly fatal, and further, that even the ordinary quantity has bad effects in exacerbating bronchitis and bronchial colds, and some other affections of the lungs.

Ozone is not found in the streets of large towns or usually in inhabited rooms, but in very large, well-ventilated rooms it is sometimes, though rarely, detected. According to Russell it may be formed by the slow oxidation of phosphorus and of essential oils in the presence of moisture. When produced by electric discharges its pungency of odor is said to make it easily perceptible when present only to the extent of one volume in 2,500,000 volumes of air and the smell may sometimes be noticed on the sea beach.

Since the discovery of ozone by Schönbein, not much has been learned about the actual origin of this allotropic form of oxygen. Its presence in and near forests and living plants has undoubtedly supported the popular view that the air of forests is particularly healthful and that living plants in our apartments are likewise beneficial.[2]

The existence of hydrogen peroxide in air was first established by Meissner in 1863, but we have no knowledge of the proportion in which it is present. All information as to its relative distribution is obtained from determinations of its amount in rain water and snow. The proportion seems to vary, like that of ozone, with the seasons of the year and with the temperature of the air. It is not improbable that the amount of hydrogen peroxide in air is greater than that of ozone, and it is possible that many so-called ozone manifestations are in reality due to peroxide of hydrogen. Watts' Dictionary of Chemistry.

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[1] Francis A. R. Russell: The Atmosphere in Relation to Human Life and Health, Smithsonian Miscellaneous Collections, Vol. 39 (Publication No. 1072), 148 p., Washington, 1896.

[2] See J. M. Anders: House Plants as Sanitary Agents, Lippincott & Co., 1887.

A recent paper by Sawyer, Beckwith and Skolfield[1] of the Hygienic Laboratory of the California State Board of Health, is one of the latest researches which discredit the claim made for ozone as a purifier of air. During recent years circulars have been issued in great numbers by manufacturers of apparatus stating that ozone is a "necessity" for the destruction of infectious germs and bacterial life, for the sterilization of air in operating rooms for the purification of air in homes of persons suffering from contagious diseases and for giving to offices and homes the invigorating air of the country, seashore and mountains.[2]

How false these claims are can readily be seen from the systematic work of these investigators, the details of which we cannot give here but to which the reader is referred. Among their conclusions are the following:

> During these tests certain physiologic effects of the "ozone" were noticed by the experimenters after they had been working around the machines. The immediate effect of inhaling the diluted gas was a feeling of dryness or tickling in the nasopharynx, and sometimes the irritation was felt in the chest. If the exposure was prolonged, watering of the eyes, and occasionally a slight headache, resulted. The smell of the "ozone" and its irritation was much more noticeable to persons who came suddenly under its influence than to those who were continuously exposed.
>
> 1. The gaseous products of the two well-known ozone machines examined are irritating to the respiratory tract and, in considerable concentration, they will produce edema of the lungs and death in guinea-pigs.
>
> 2. A concentration of the gaseous products sufficiently high to kill typhoid bacilli, staphylococci and streptococci, dried on glass rods, in the course of several hours, will kill guinea-pigs in a shorter time. Therefore these products have no value as bactericides in breathable air.
>
> 3. Because the products of the ozone machines are irritating to the mucous membranes and are probably injurious in other ways, the machines should not be allowed in schools, offices or other places in which people remain for considerable periods of time.
>
> 4. The ozone machines produce gases which mask disagreeable odors of moderate strength. In this way the machines can conceal faults in ventilation while not correcting them. Because the ozone machine covers unhygienic conditions in the air and at the same time produces new injurious substances, it cannot properly be classed as a hygienic device.

Another paper even more elaborate than this was published at the same time by Edwin O. Jordan, Ph. D., and A. J. Carlson, Ph. D.,

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[1] The Alleged Purification of Air by the Ozone Machine. Journ. Amer. Med. Ass., Sept. 27, 1913, p. 1013.

[2] See Amer. Journ. Physiologic Therapeutics, Nov.-Dec., 1911.

of Chicago.[1] This investigation was carried on at the suggestion of and under a grant from the Journal of the American Medical Association. Their experiments were carried out (1) to determine the germicidal action of ozone on pure cultures under the conditions commonly used in testing disinfectants, and (2) to determine the effect of ozone on the ordinary air bacteria. They found, after a long series of experiments detailed in full in their paper, that no surely germicidal action on certain species of bacteria could be demonstrated by the usual disinfection tests with amounts of gaseous ozone ranging from 3 to 4.6 parts per million. The alleged effect of ozone on the ordinary air bacteria, if it occurs at all, is slight and irregular even when amounts of ozone far beyond the limit of physiologic tolerance are employed.[2] The toxication of strong concentrations of ozone through injury to the lungs was marked. Even in moderate amounts it produced an irritation of the sensory nerve endings of the throat and a headache due to irritation, corrosion and consequent hyperemia of the frontal sinuses. Consequently the use of this poisonous gas as a therapeutic agent is either valueless or injurious.

USE OF FOREST RESERVATIONS FOR SANATORIA

We cannot leave the subjects of forests and forest air without strongly advocating the use of forests and especially State and Governmental forest reserves for institutions, hospitals, and camps for the tuberculous. The State of Pennsylvania has large forestry reservations, amounting at present to 1,000 square miles in 23 counties, and maintains a State School of Forestry, where young men are in training for its forest service. Acting under liberal forest laws, Dr. J. T. Rothrock, then State Forestry Commissioner, in 1903, announced that citizens of Pennsylvania are entitled to the privilege of using the forestry reservation of the state under proper restrictions as a residence while regaining health and recommended it especially to those in need of fresh air treatment of tuberculosis. In the spring of that year Dr. Rothrock, with State aid, started the construction of a few small cabins for the use of such patients and called it the South Mountain Camp Sanatorium.[3] This is situated

[1] Ozone: Its Bactericidal Physiologic and Deodorizing Action. (Journ. Amer. Med. Ass., Sept. 27, 1913, Vol. 61, pp. 1007-1012).

[2] This is corroborated by the recent article by Konrich, Zur Verwendung der Ozone in der Lüftung. (Zeitschr. Hyg., 1913, Vol. 73, 443.)

[3] Charities and Commonwealth, Dec. 1, 1906. Journ. Amer. Med. Ass., 1907. Journal of the Outdoor Life, Jan., 1907, and Feb., 1908.

in Franklin County, Pennsylvania, in the southern tier of counties where the state owns 55,000 acres. The altitude of the camp is 1,650 to 1,700 feet. It is now the site of the great State Sanatorium known as Mont Alto with a capacity of over 1,000 patients.

At first the patients were obliged to provide and to prepare their own food, but the legislature afterward appropriated enough to enable the management to furnish food, and the results were better than before. Only patients in the incipient stages were admitted, and of the 141 so cared for (up to the year 1908) about 75 per cent were either much improved or cured. The charge to the patients was one dollar per week for all supplies and services, excepting washing and the care of their cabins and their persons. The large forestry reserve allows of an indefinite extension of this method of dealing with the disease, and the small expense seems to point to it as a way to provide for the large class of patients who must be cared for in the incipient stages if the disease is to be checked and its victims restored to society as safe and potent factors in industrial progress. Dr. Rothrock, who has just closed twenty years of distinguished service to the state in the forestry commission, believes that the forest reservations furnish an answer to the further problem of how to care for the consumptive whose disease is arrested, but whose financial condition demands that he must still be cared for until able to return to his home. Pennsylvania has nearly a million acres of forest reservation, much of which needs replanting with young trees. To do this requires a large number of men, and the task of raising and transplanting trees is mostly light outdoor labor, well suited to the convalescent consumptive. In addition, there are various forms of woodcraft, such as basket making and the manufacture of small rustic articles that could easily be carried on under healthful conditions in the forests. The example of Pennsylvania suggests the propriety of other states taking similar steps and providing for the large number of consumptives who need care in an inexpensive and at the same time effective manner.

The United States Government should establish without delay large forest reserves in the Eastern, Middle, and Southern States. The White Mountains of New Hampshire and the Southern Appalachians should be placed under a system of Federal protection. It is encouraging to note that by a recent decision (November, 1913) of the Courts of New Hampshire the way is opened for the condemnation of mountain land in that State and indemnity has been awarded private owners for land so taken.

The United States has 165,000,000 acres of national forests and France and Germany combined, 14,500,000 acres.

The site of a model sanatorium for tuberculosis has the purest air or air nearly devoid of floating matter. It is only on very high mountain tops or in mid ocean, or in the Polar ice fields that we can have air free from suspended matter. The good results obtained in the higher Alpine sanatoria and in long sea voyages, in given cases of tuberculosis, are attributable in some degree to this absence of irritating or polluted atmosphere. In the more northern sanatoria, of which the Adirondack Cottage Sanitarium is a type, the long winter in which snow covers the ground for possibly five months, is always recognized as the best season for patients. The gain in health acquired during one winter equals that of two summers. The added freedom which the snow covering provides against dust and other atmospheric impurities may have its hygienic influence for the cure of tuberculosis.

MICRO-ORGANISMS IN RESPIRATORY PASSAGES

It is interesting to learn something of the fate of micro-organisms when inhaled by a person in health or by those whose respiratory passages are already suffering from irritation or disease. It has been calculated that upward of 14,000 organisms pass into the nasal cavities in one hour's quiet respiration in the ordinary London atmosphere.[1] Tyndall showed by his experiments with a ray of light in a dark chamber that expired air, or more exactly the last portion of the air of expiration is optically pure. In other words, respiration has freed the inhaled air from the particles of suspended matter with which it is laden. These experiments coincide with those of Gunning of Amsterdam in 1882 and those of Strauss and Dubreuil in 1887. Grancher has made many experiments with the expired air of phthisical patients and has never found in it the tubercle bacillus or its spores. Charrin, Karth, Cadéac, and Mallet have had corresponding results.

These germs are probably all arrested before reaching the trachea; they halt in the upper air passages. The interior of the great majority of normal nasal cavities is perfectly aseptic. On the other hand the vestibules of the nares, the vibrissæ lining them and all crusts formed there are generally swarming with bacteria. All germs are arrested here and the ciliated epithelium rapidly ejects them.

[1] On Researches by Drs. St. Clair Thomson and R. T. Hewlet. Lancet, January 11, 1896.

By experiments on the mucous membrane of the dorsal wall of the pharynx, Thomson and Hewlet found that a particle of wet cork was conveyed at the rate of 25 mm. or one inch per minute.

Wurtz and Lermoyez have published researches on the action of nasal mucus upon the anthrax bacillus and they hold that it exerts a bactericidal influence on all or nearly all pathogenic agents in different degrees of intensity.

Thomson and Hewlet corroborate this to the extent of saying that the nasal mucus "is possessed of the important property of exerting an inhibitory action on the growth of micro-organisms." Their experiments upon each other were very ingenious and highly interesting. They were able to demonstrate that in ordinary air of the laboratory under the conditions observed, 29 moulds and nine bacterial colonies developed; whereas after passing through the nose the air contained only two moulds and no bacteria.

On another occasion they found in nine liters of laboratory air, six moulds and four bacterial colonies, while the same quantity of air after passing through the nose exhibited one mould and no bacteria. Thus they show that practically all, or nearly all, the micro-organisms of the air are arrested before reaching the naso-pharynx; probably a majority are stopped by the vibrissæ at the very entrance to the nose and those which do penetrate as far as the mucous membrane are rapidly eliminated. They state that the nasal mucus is an unfavorable soil for the growth of organisms and in this it is aided by the ciliated epithelium and lacrymal secretion.

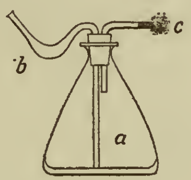
COMPOSITION OF EXPIRED AIR

Dr. D. H. Bergey in 1893-4 made some experiments in the Laboratory of Hygiene of the University of Pennsylvania under the provisions of the Hodgkins Fund of the Smithsonian Institution which are pertinent to this subject.[1] These were conducted to ascertain whether the condensed moisture of air expired by men in ordinary, quiet respiration, contains any particulate organic matters, such as micro-organisms, epithelial scales, etc. The expired breath was conducted through melted gelatin contained in a half liter Erlenmayer flask, for twenty to thirty minutes. The gelatin was then hardened

[1] J. S. Billings, S. Weir Mitchell, and D. H. Bergey: The Composition of Expired Air and Its Effects on Animal Life. Smithsonian Contributions to Knowledge, Vol. 29 (Publication 989), Washington, 1895. This investigation seemed to disprove the renowned experiments of Brown-Séquard and D'Arsonval in 1887.

by rolling the flask in a shallow basin of ice-water, thus distributing the culture in a thin layer over the bottom and sides of the flask.

These cultures were kept under observation for 20 to 30 days. About 150 cc. of gelatin was used for each experiment. The glass tube (b) of the apparatus used, which served for the entrance of the expired air, was inserted far enough to just impinge on the fluid culture medium in the flask, so that the air produced a slight agitation of the fluid in passing through the apparatus. The tube of entrance (b) is provided with a bulb-shaped enlargement which serves to retain any saliva that may flow into the tube. The tube (c) is closed with cotton so as to prevent the entrance of micro-organisms from this side of the apparatus, and a similar cotton plug is inserted in *b* when the apparatus is not in use.



Apparatus for Determining the Presence of Bacteria in Expired Breath.

It was found that the organisms developed in the cultures were all of the same character—a small yellow bacillus, common in laboratory air. When special precautions were taken to sterilize the apparatus with dry heat for an hour previous to introducing the gelatin, besides the subsequent sterilization of the gelatin, the results were negative—no growths developed. If, after standing in the working room for several days, it was found that the culture medium was sterile, the expired breath was then conducted through the apparatus and the culture was kept under observation (for the specified time in the table) at the room temperature. The nature of the organisms that developed in the first two experiments, and the absence of any growth in the others, make it probable that they developed from spores that survived the fractional sterilization of the culture medium. It is improbable that they were carried in the expired breath. Dr. Bergey also made a careful examination of the fluid condensed from the expired air with high powers, both in hanging drops and in six dried and stained preparations, but nothing resembling bacteria or epithelium was found.

The conclusion was reached that there is no evidence of a special toxicity of the expired air. Billings, Mitchell, and Bergey say, in the monograph referred to, that the injurious effects of such air observed appeared to be due entirely to the diminution of oxygen, or the increase of carbonic acid, or to a combination of these two factors. They consider that the principal, though not the only, causes of discomfort to people in crowded rooms are excessive temperature and unpleasant odors.

We shall see, further on, that later studies show that the relative proportions of oxygen and carbonic acid are not *per se* such important factors.

Dr. Milton J. Rosenau, professor of preventive medicine and hygiene in Harvard Medical School, said in his recent address[1] on "Ether Day" at the Massachusetts General Hospital:

> One of the fallacies that has fallen is the relation of the air to the spread of infection. The virus of most communicable diseases was believed to be in the expired breath, or exhaled as emanations of some sort from the body. These emanations were said to be carried long distances—miles—on the wind. The easiest, and therefore the most natural way, to account for the spread of epidemic diseases was to consider them as air-borne. Nowadays the sanitarian pays little heed to infection in the air except in droplet infection, and the radius of danger in the fine spray from the mouth and nose in coughing, sneezing and talking is limited to a few feet or yards at most. The more the air is studied the more it is acquitted as a vehicle for the spread of the communicable diseases.
>
> It was a great surprise when bacteriologists demonstrated that the expired breath ordinarily contains no bacteria. Most micro-organisms, even if wafted into the air soon die on account of the dryness, and especially if exposed to sunshine. The relation of the air to infection is nowhere better illustrated than in the practice of surgery. At first Lister and his followers attempted to disinfect the air in contact with the wound by carbolic sprays. Now the surgeon pays no heed to the air of a clean operating room, but ties a piece of gauze over his mouth and nose, and also over his hair, to prevent infective agents from falling into the wound from these sources.

How complicated this entire subject is we can readily see from the review[2] made by Dr. Henry Sewall, of Denver, of recent experimental studies by Zuntz, Haldane, Rosenau and Amoss, Heymann, Paul, Ercklentz and Flügge, Leonard Hill and others. This review deserves to be read carefully. It sums up our latest knowledge and leads to some surprising conclusions. After describing the Black Hole of Calcutta, in which one hundred and forty-six Europeans

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[1] Boston Medical and Surgical Journal, November 6, 1913.

[2] On What do the Hygiene and Therapeutic Virtues of the Open Air Depend? by Henry Sewall, Ph. D., M. D. (Journ. Amer. Med. Ass., Jan. 20, 1912).

were confined on the night of June, 1756, and only twenty-three survived, he shows that numberless observations have all led to the one conclusion that prolonged confinement in close air tends to lower vitality and increase the incidence of certain infections, especially pulmonary tuberculosis. However, it was found many years ago that animals and men can tolerate without distress an increase of carbon dioxide in the air far beyond any concentration which it is likely to acquire under the worst conditions of crowding, provided the oxygen tension is maintained at a high level. Zuntz and Haldane and his associates show that the normal excitement of the respiratory nerve-center depends on the accumulation within it of carbon dioxide, a waste product, which it is a prime object of respiration to remove. Sewall refers to Brown-Séquard and D'Arsonval's work and, as bearing on it, the very recent work of Rosenau and Amoss.[1] These workers condensed the vapor of human expiration and injected the liquid into guinea-pigs. No symptoms followed this procedure. But after an appropriate interval of some weeks a little of the blood-serum from the person supplying the moisture was injected into the same animals. The outcome was an unmistakable anaphylactic reaction. According to current beliefs the result showed that the expired air must have contained proteid matter which sensitized the pigs toward proteids in the blood of persons from whom the first proteid was derived. The authors offer, as yet, no opinion as to whether the proteid in the expired air possesses hygienic significance.

Prof. Sewall finds a suggestive analogy in the physiologic relations of carbon dioxide which it is one of the chief objects of respiration to remove. Added to air in sufficient percentage it is deadly to animals, yet so far from its being useless in the body, Haldane and Priestley found that it must form four to five per cent of the alveolar air for the maintenance of normal respiratory movement, and a considerable lowering of its tension in the body would be followed by speedy death. Boycott and Haldane note that the subjective sense of invigoration and well-being excited by cold weather is associated with a high tension of carbon dioxide in the alveolar air.[2] After summarizing the experiments of Heyman, Paul,

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[1] Organic Matter in the Expired Breath (Journal of Medical Research, 1911, Vol. 25, 35).

[2] Haldane and Priestley: The Regulation of the Lung Ventilation (Journal of Physiology, 1905, Vol. 27, p. 225).

Boycott and Haldane: The Effects of Low Atmospheric Pressure on Respiand Ercklentz in Flügge's laboratory[1] which seem to show that, in people both well and sick, chemical changes in the character of the air in inhabited rooms exercise no deleterious effect on the health of the dwellers Dr. Sewall reviews Leonard Hill's work which shows that the motion of the air in the experimental chamber by means of electric fans almost entirely annulled the sense of discomfort.[2] He then cites the astonishing experiments of F. G. Benedict and R. D. Milner[3] who kept a subject for twenty-four hours in a chamber, the air of which held an average carbon dioxide content of 220 parts per 10,000 or over seventy times the normal, together with a reduction of oxygen to less than 19 per cent. The humidity was kept down and the temperature held uniform. The subject of the experiment suffered no discomfort.

Boycott and Haldane, referred to above, express the opinion that "the alveolar carbon dioxide tends to a lower level in warm weather" and that this diminution in the alveolar carbon dioxide is associated with a feeling of warmth of a rather unpleasant kind rather than with any absolute point on the thermometer; they hold that the rise in the carbon dioxide tension is associated with the general exhilaration and stimulation produced by cold air.

And now comes Leonard Hill, the physiologist, of London, who with his staff at the London Hospital conducted several noteworthy experiments which he described before the Institution of Heating and Ventilating Engineers in March, 1911.[4] In view of the fact that

ration (Journal of Physiology, 1908, Vol. 37, p. 359). See also Preventive Medicine and Hygiene, by Milton J. Rosenau, M. D., Chapter 4, D. Appleton & Co., 1913. Prof. Rosenau's work contains the latest word on the bacteria and poisonous gases in the air, ventilation, etc.

Thomas R. Crowder, M. D.: A Study of the Ventilation of Sleeping Cars (Archives of Internal Medicine, January, 1911, and January, 1913). This elaborate investigation is illustrated by numerous diagrams showing the carbon dioxide content in the air from the aisles, the upper and lower berths and smoking rooms.

[1] Zeitschrift f. Hygien. u. Infectionskr., 1905, Vol. 59.

[2] Leonard Hill: The Relative Influence of Heat and Chemical Impurity of Close Air (Journal of Physiology, 1910, Vol. 41, p. 3).

See also Leonard Hill, Martin Flack, James McIntosh, R. A. Rowlands, H. B. Walker: The Influence of the Atmosphere on our Health and Comfort in Confined and Crowded Places, Smithsonian Miscellaneous Collections, Vol. 60, No. 23, p. 96 (Publication 2170), 1913.

[3] Experiments on the Metabolism of Matter and Energy in the Human Body, Bulletin 175, U. S. Dep. Agriculture Office Experiment Station, 1907.

[4] Journ. Amer. Med. Ass., April 8, 1911.

the London health authorities insist that in factories the percentage of carbon dioxide must not rise above the usual amount allowed, say ten parts in ten thousand, he remarks that the regulations do not prescribe any limitations of the wet-bulb temperature adding that while carbon dioxide does not do any harm whatever a wet-bulb temperature of 75° F. is very bad and ought not to be tolerated in any factory. All the current teaching of the hygiene of ventilation runs on the subject of chemical purity of the air; but according to Prof. Hill the essential thing in ventilation is heat, not chemical purity. It does not matter if there is 1 per cent more carbon dioxide and 1 per cent less of oxygen. In the worst ventilated rooms there is not 1 per cent less oxygen. The only effect of an excess of carbon dioxide is to make one breathe a little more deeply. A much higher amount has to be attained to have any toxic effect. As to organic impurities derived from respiration there is no physiologic evidence of their toxicity or that they are of any importance except as an indicator of the number of bacteria in air. The way to keep air best from the physiologic point of view is shown by the following experiment performed by Hill at the London Hospital: Into a small chamber which holds about three cubic meters he put eight students and sealed them up air tight. They entered joking and lively and at the end of 44 minutes the wet bulb temperature had risen to 83° F. They had ceased to laugh and joke and the dry bulb stood at 87° F. They were wet with sweat and their faces were congested. The carbon dioxide had risen to 5.26 per cent and the oxygen had fallen to 15.1 per cent. Hill then put on three electric fans and merely whirled the air about just as it was. The effect was like magic; the students at once felt perfectly comfortable, but as soon as the fans stopped they felt as bad as ever and they cried out for the fans. These and other experiments related, according to Hill, show that all the discomfort from breathing air in a confined space is due to heat and moisture and not to carbon dioxide. Even after five repetitions of the experiment there were no after-effects, such as headache. The obvious inference is that the air must be kept in motion to avoid bad effects. The open air treatment of disease is not altogether a matter of fresh air, but the constant cooling of the body by the circulation of air which makes us eat more and promotes activity. This leads to the general strengthening of the body because the blood is not only circulated by the heart but by every muscle in the body.

There cannot be efficient circulation without constant movement and activity. If there is constant cooling by ventilation, then a person is kept more active and the general health is improved.

As Dr. M. J. Rosenau said in his recent address:

> Thus our entire conception of ventilation has changed, owing to the fact that we now do not believe that fresh air is particularly necessary in order to furnish us with more oxygen or to remove the slight excess of carbon dioxide. It is plain that it is heat stagnation that makes us feel so uncomfortable in a poorly ventilated room rather than any change in the chemical composition of the air. It has been made perfectly clear from the work of Flügge that one of the chief functions of fresh air is to help our heat-regulating mechanism maintain the normal temperature of the body. It is necessary to have some 2,000 to 3,000 cubic feet of air an hour to maintain our thermic equilibrium—just the amount that was formerly stated to be necessary to dilute the carbon dioxide and supply fresh oxygen. The practice of ventilation, therefore, has not altered so much as has our reason for attaching importance to clean, cool, moving air, which has completely changed.[1]

The foregoing résumé is perhaps not complete without mentioning the recent work of Prof. Yandell Henderson, of Yale University, who has brought forward his "Acapnia" theory (acapnia meaning diminished carbon dioxide in the blood). He says:[2]

> We have really at the present time no adequate scientific explanation for the health-stimulating properties of fresh air and the health-destroying influence of bad ventilation. . . . The subject needs investigating along new lines rather than a rehearsal of old data.

Dr. Crowder's recent experiments[3] also furnish additional evidence against the theory that efficient ventilation consists in the chemical purity of the air, in its freedom from "a toxic organic substance." Even were a poisonous protein substance present in the expired air —a fact no experimenter has yet been able to demonstrate—the human organism under every-day conditions is apparently well able to adjust itself to the reinhalation of this hypothetic substance, since a considerable quantity of the expired air is always taken back into the lungs.[4]

We consider that experiments like these demonstrate most valuable and practical truths and that is our excuse for introducing them so particularly in this place. When we consider that the average man exhales from 9,000 to 10,800 liters of air in twenty-four

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[1] Boston Medical and Surgical Journal, Nov. 6, 1913.

[2] Trans. Fifteenth International Congress on Hygiene and Demography, Vol. 7, p. 622.

[3] Crowder, Thomas R.: The Reinspiration of Expired Air (Arch. Int. Med., October, 1913, p. 420).

[4] Editorial in Journ. Amer. Med. Ass., Nov. 29, 1913. See also page 108.

hours[1] it would indeed be a terrible situation if it were true that the expired breath could convey pathogenic or other bacilli. The millions of bacilli which we take into the air passages are arrested in the air passages and for the most part mercifully destroyed by the secretion.[2] In any event we have the assurance that the expired air is free from micro-organisms. With reference to tuberculosis this means that if healthy persons are exposed only to the expired air of tuberculous subjects no infection can occur. Only through bacilli contained in the sputum or in tiny drops of moisture coughed by the patient is the disease communicated; and it is further probable that, as in the case of other infectious organisms, when once received into the nose and mouth and upper air passages, they quickly lose their activity or are soon extruded. (See page 13 *et seq.*)

ATMOSPHERIC IMPURITIES

In view of these facts it would scarcely seem necessary to state that for the treatment of all respiratory diseases and especially for the treatment of infections such as tuberculosis, which invades the larynx and the lungs, or for the treatment of patients whose throats and lungs owing to other infections, such as tonsillitis, pneumonia, or influenza, may be specially susceptible, no city air can be considered favorable. It is our duty to provide as nearly as possible air with a very low bacterial content such as may be obtained in forests or in the neighborhood of the seashore.

COAL AND SMOKE

Aside from the presence of bacteria in the air of cities and towns there are other impurities which are of great disadvantage to tuberculous patients. The prevalent use of soft, or bituminous coal in Great Britain and America, especially in manufacturing centers, undoubtedly shortens human life and hastens many a consumptive to his end. Volumes have been written on this subject and most valuable contributions have been made by Dr. J. B. Cohen, of Leeds, Mr. Francis A. R. Russell, Henry de Varigny and others, published in connection with the Hodgkins Fund.[3]

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[1] About 380 cubic feet which is equal to a volume 7⅓ feet (220 cm.) in height, width, and thickness.

[2] It has been calculated that in a town like London or Manchester, a man breathes in during ten hours 37,500,000 spores and germs. F. A. R. Russell.

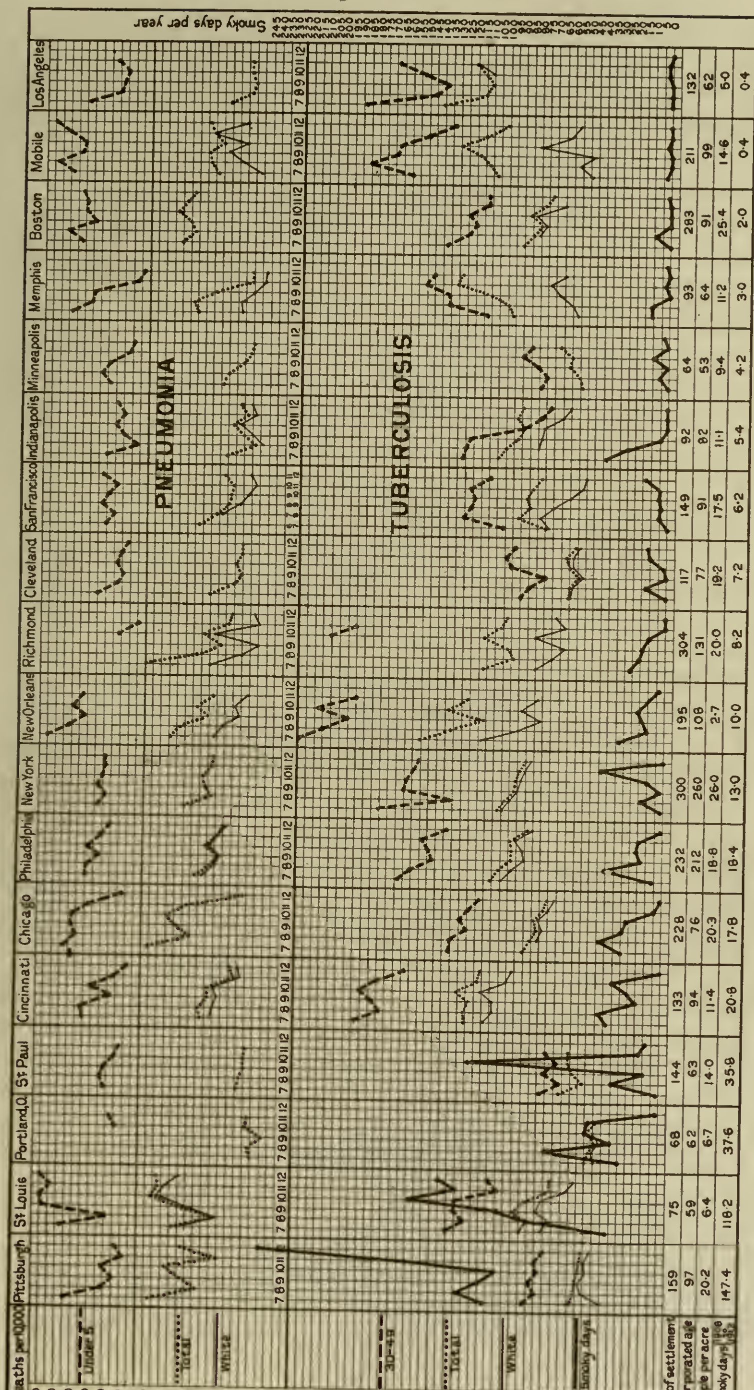
[3] See Smithsonian Miscellaneous Collections, Vol. 39, 1896 (Publications 1071, 1072, 1073).

See also "The Influence of Smoke on Acute and Chronic Lung Infections," by Wm. Charles White, M. D., and Paul Shuey, Pittsburg. Trans. Amer. Climatological Association, 1913.

Dr. William Charles White and Paul Shuey, of Pittsburgh, have recently made a study of the influence of smoke on acute and chronic lung infections, selecting pneumonia and tuberculosis as a cause of death in Pittsburgh, St. Louis, Portland, Oregon, St. Paul, Cincinnati, Chicago, Philadelphia, New York, New Orleans, Richmond, Cleveland, San Francisco, Indianapolis, Minneapolis, Memphis, Boston, Mobile, and Los Angeles. They plotted the number of smoky days per year, 1907 to 1912, with the smokiest cities first and so on to the least in the order indicated above. The mortality for white population and total population and other data are noted on the accompanying chart. This study is in some respects unsatisfactory, because of the difficulty of getting data as to smoky days. The conclusion was that if we except Portland and St. Paul there is a general tendency of the tuberculosis death rate to rise as the number of smoky days in the city decreases. On the other hand, it will be seen that there is a general tendency for the number of deaths from pneumonia to fall as the number of smoky days in the city decreases. In this instance, also, Portland, St. Paul, and Boston must be excepted. All this needs confirmation.

It is a matter of common knowledge that coal miners are liable to a disease called fibrosis, anthracosis, or miners' consumption, in which the lungs receive and retain coal dust, which penetrates every nook and cranny of the lungs and adds one more element of danger to a most hazardous occupation. But we have it on the authority of Sir Frederick Treves that he had seen the lungs of many persons, who had lived in London, which were black from their surface to their innermost recesses. Such a condition, in his opinion, not only made it more difficult to resist disease, but started disease, and it was entirely due to dirt and soot inhaled. The black-fog of London owes its color to coal smoke, which gives it its filthy, choking constituents, and kills people by thousands. Experiments showed that during a bad fog six tons of soot were deposited to the square mile.[1]

[1] Some six hundred years ago, the citizens of London petitioned King Edward I to prohibit the use of "sea coal." He replied by making its use punishable by death. This stringent measure was repealed, however, but there was again considerable complaint in Queen Elizabeth's reign, and the nuisance created by coal smoke seems to have been definitely recognized at this period. Since this time there has been continual agitation, together with much legislation, both abroad and in this country. In the seventeenth century, King Charles II adopted repressive measures in London, and in the present century anti-smoke crusades have been frequent. In fact, the smoke problem will undoubtedly continue to demand attention until it is either



	Pittsburgh	St Louis	Portland, O.	St Paul	Cincinnati	Chicago	Philadelphia	New York	New Orleans	Richmond	Cleveland	San Francisco	Indianapolis	Minneapolis	Memphis	Boston	Mobile	Los Angeles
Age of settlement	159	75	68	144	133	228	232	300	195	304	117	149	92	64	93	283	211	132
Incorporated age	97	59	62	63	94	76	212	260	108	131	77	91	82	53	64	91	99	62
People per acre	20·2	6·4	6·7	14·0	11·4	20·3	18·8	26·0	2·7	20·0	19·2	17·5	11·1	9·4	11·2	25·4	14·6	5·0
Av. smoky days 1906–1912	147·4	118·2	37·6	35·8	20·8	17·8	18·4	13·0	10·0	8·2	7·2	6·2	5·4	4·2	3·0	2·0	0·4	0·4

Death-rates per 10,000 for Pneumonia and Tuberculosis in Eighteen Cities, 1907-1912. The number of smoky days are noted for each year (heavy line). Total death-rates (dotted line). Age of settlement and population per acre noted.

The Lancet undertook by means of a system of gauges of its own design to estimate the annual deposit in London of all adventitious matter from the atmosphere. In the city proper it was calculated to be nearly five hundred tons to the square mile or about four and a half pounds per acre each day. Were it mere dirt it would not be so serious, but it is charged with gases and fluids of a deleterious character such as sulphates, chlorides, ammonia, and carbon that is more or less oily and tarry. One of the experts employed by the Meteorological Council in connection with the County Council of London, found that the sulphur contents of the coal ranged from one to two per cent and that from half a million to a million tons of sulphuric acid were diffused in the air every year. The loss to property from this erosive influence he estimated at about five and a half million pounds sterling. The effect upon health was a more elusive question, but stress was laid on the rise in death rate during foggy weather in which coal smoke plays a prominent part. Owing to the activity of the Coal Smoke Abatement Society, under the presidency of Sir William Richmond, atmospheric conditions are greatly improved, and it is claimed that there is a steady diminution in the number and density of the black fogs.

In an article on London as a Health Resort and as a Sanitary City, by S. D. Clippingdale, M. D., Trans. Royal Society of Medicine, February, 1914, there is an interesting historical account of London air and fog, with a bibliography.

CARBON DIOXIDE

Parallel conditions are observed in cities like Leeds, Liverpool, Manchester, and Glasgow, and in less degree in cities like Pittsburgh, Cincinnati, Chicago, Cleveland, and St. Louis, during periods of comparatively calm, and of heavy and humid atmosphere. Egbert[1] states that "it has been calculated that for every ton of coal burnt in London something like three tons of carbon dioxide are produced," and as the city's coal consumption is over 30,000 tons per diem, its atmosphere must receive the enormous daily contamination of about 300 tons of soot and 90,000 tons of carbonic acid every day! How important, then, the adoption of practical means to abate the smoke nuisance! Engineers assure us that such means

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entirely solved by the abolishment of the use of solid fuel or by the installation of devices and methods which shall prevent the formation of smoke in furnaces, regardless of the nature of the fuel.

[1] Seneca Egbert: A Manual of Hygiene and Sanitation, Philadelphia, 1900. p. 74.

are perfectly feasible and economical. It does not need an engineer to assure us that they are hygienic.

Prof. Charles Baskerville, of the College of the City of New York, has vigorously attacked the problem of smoke and other air impurities. He shows [1] that the sticky properties of soot are due to the tar contained in it. This tar adheres so tenaciously to everything that it is not easily removed by rain. In large manufacturing districts, particularly in those where bituminous coal is used as fuel, vegetation is blackened, the leaves of trees are covered and the stomata are filled up, thus inhibiting the natural processes of transpiration and assimilation. In addition, the soot is frequently acid and the deposition of acid along with soot is probably one of the principal causes of the early withering which is characteristic of the many forms of town vegetation.

SULPHUR DIOXIDE

Aside from the solid material which pollutes the atmosphere of cities, there are correspondingly enormous quantities of noxious gases which are equally injurious to persons with tubercular disease or other diseases of the respiratory tract. Mention has already been made of the vast amounts of carbonic acid gas generated by furnaces, not to speak of the quantities exhaled by human beings. The production of this carbon dioxide by the combustion of coal offers a definite measure of the production of sulphur dioxide. These two gases have the same origin and the measure of one is the measure of the other. Recent studies by Prof. Theodore W. Schaefer, who has made many observations of the air of Kansas City during fogs, tend to show that the presence of sulphur dioxide has an unfavorable effect on persons suffering from bronchitis, pharyngitis, pneumonia, and asthma. In January, 1902, the heavy fogs occurring in St. Louis, Missouri, caused serious injury to the throat and lungs of prominent singers and in an action brought against the city and its chief smoke inspector, it was alleged that owing to the additional presence of smoke, suffocating gases, and acid, the health of the complainant was injured. In a mandamus proceeding it was asked that the authorities be compelled to abate the smoke nuisance.

Prof. Schaefer has used the data mentioned previously as to the output of carbonic acid in London and states that he finds that at least 2,700 tons of sulphur dioxide are generated daily in that city and pass into surrounding atmosphere. This gas, after uniting with

[1] Medical Record, New York, November 23, 30, 1912.

the oxygen and aqueous vapor of the air, is converted into sulphuric acid.[1]

The presence of sulphur in coal, or in iron pyrites contained in coal, is responsible for this acid product and Prof. Schaefer believes that sulphur dioxide, being a very heavy gas, with a specific gravity of 2.25, is alone capable of creating a fog, or is at once shown when it is brought in contact with the atmosphere, from which it absorbs aqueous vapor, causing dense, heavy fumes. The dust or carbon particles, coming in contact with this acid vapor, enhance its gravity materially.

Prof. Baskerville some time ago made a number of determinations of the sulphur dioxide content of the air of New York city. Stations were established throughout greater New York city, including high office buildings, parks, subways, stations, and railroad tunnels; and very variable results, as might be expected, were obtained. The determinations may, in part, be thus summarized:

Locality	*SO_2 in parts in a million*
Elevated portion of city, near a high stack	3.14
Various parks	0.84 (maximum; others negative)
Railroad tunnels	8.54—31.50
Subway	None
Downtown region	1.05—5.60
Localities near a railroad	1.12—8.40

In 1907, the residents of Staten Island, as well as some on Long Island, complained of the noxious nature of the air wafted over from various plants in New Jersey. This induced the Department of Health of the City of New York to investigate the air and vegetation in the vicinity of the Borough of Richmond, Staten Island, and some of the results obtained are given below by permission of the Department.

Substance	*Impurity*
Air	Trace of sulphuric acid
Air	0.0066 per cent. SO_2 by weight
Air	Trace of sulphuric acid
Grass (three samples)	Sulphuric acid present
Grass	0.24 per cent SO_3
Grass	0.70 per cent SO_3
Leaves	0.19 per cent SO_3
Leaves	0.28 per cent SO_3
Soil	0.0015 per cent SO_3

[1] Theodore W. Schaefer: The Contamination of the Air of our Cities with Sulphur Dioxide, the Cause of Respiratory Disease. Boston Medical and Surgical Journal, July 25, 1907.

These results do not really give us anything definite, as the comparative factor is absent.

Fog usually collects in the lower portions of a city, especially in depressed localities known as hollows, where it remains until dispersed by air currents. The well-known increase of mortality in cities during the continued presence of heavy fog with these additional contaminations have been recorded and commented upon for years. The heavy, suffocating, poisonous quality of sulphur dioxide is well known and has been the subject of several investigations. In general, it may be said that the chief symptoms of poisoning with sulphurous acid are those of irritation of the mucous membranes. Even in five parts in 10,000 it acts as an irritant, causing sneezing, coughing and lacrymation, bronchial irritation and catarrh (Cushny). It is also credited with causing pneumonia and Prof. Schaefer notes its power to produce asthma.[1] Undoubtedly it would aggravate pulmonary and laryngeal tuberculosis and either delay or prevent a cure under the conditions described.

AMMONIA IN THE AIR

This gas is constantly present in the atmosphere, but in very minute quantities. Fifty years ago Boussingault and, later, Schloesing made careful investigations of this impurity of the atmosphere and devised ingenious methods of estimating its amount in air and rain water. It usually exists only in combination with carbonic or nitric acid; very little is free. Water absorbs it freely and it has been estimated that in France the annual rainfall brings to the earth in the form of nitrogen nearly 5 kilograms per acre. The presence of ammonia indicates organic putrefaction. Its amount does not usually exceed a very few parts per million. It is usually perceptible, as we all know, in and about stables.

As far as any relation to tuberculosis is concerned, ammoniacal air has for us only a remote interest. At one time it was strongly advocated as a cure for pulmonary consumption and perhaps some historic details may be of interest here.

Dr. Thomas Beddoes, of London, published in 1803, "Considerations on a Modified Atmosphere in Consumption Cases," and strongly advocated residence in a cow stable for such cases. One of his patients was Mrs. Finch, a daughter of Dr. Joseph Priestley,

[1] This accords with the conclusions of W. C. White and Paul Shuey, *loc. cit.* The relation of Sea Fog to Tuberculosis is considered in the next chapter, page 52.

famous for his epoch-making discovery of Oxygen. The patient, from the description given, had a well-marked case of pulmonary tuberculosis in the second or third stage. She was placed in a stable 14 by 20 feet and 9 feet high, and her bed was in a small recess a few inches above the ground of the stable, where two or three cows were kept. The temperature was maintained at 60° to 70° F. Mrs. Finch remained in this cow house nearly all the time from the autumn of 1799 until the spring of 1800. In a letter, dated August 15, 1800, the patient wrote, "I am happy in being able to say that my chest continues perfectly well; and from the difference of my feelings now, and some years back, I am more than ever a friend of the cows. I avoid colds and night air; and by rides in the country am anxious to brace myself against winter and the necessity of a sea voyage."

OXYGEN FOR TUBERCULOUS PATIENTS

Shortly after the discovery of oxygen, physicians were stimulated to try the effect of various gases in the treatment of phthisis. Fourcroy and Beddoes both observed the effects of the inhalation of oxygen and found that it accelerated the pulse and respiration, and, as they believed, increased inflammatory action so that they concluded that its effect was prejudicial. Beddoes held that in phthisis there is an excess of oxygen in the system and consequently, that free air was injurious to the patient. He says in the essay quoted previously:[1] "As it seemed to me hopeless to propose residence in a cow house, I advised that the patient should live during the winter in a room fitted up so as to ensure the command of a steady temperature. This advice was followed. Double doors and double windows were added to the bed room. The fire place was bricked up round the flue of a cast iron stove for giving out heated air." What a contrast to the fresh air cure of the present day! But the doctor persisted in his plan of treatment until the patient died.

The amount of oxygen present in the atmosphere, 20.938 per cent, is precisely adapted to the needs of animal life and the same proportion of oxygen is preserved in the atmosphere everywhere, without regard to altitude.[2] It has been found that animals die if the ratio of oxygen is artificially decreased by as much as twenty-five per

[1] Thomas Beddoes: Observations on the Medical and Domestic Management of the Consumptive. American edition, Troy, 1803, p. 42.

[2] Analyses by Gay-Lussac of Air Collected at 7,000 meters; and observations by Dumas and Boussingault.

cent; but Paul Bert[1] also showed that too much oxygen was equally prejudicial to life and, indeed, poisonous, animals dying in a super-oxygenated atmosphere as soon as their blood contains one-third more than the normal ratio of oxygen, because in such an atmosphere the hemoglobin of the red blood corpuscles is saturated with oxygen—a fact which never occurs under normal conditions—and a proportion of this gas then dissolves in the serum of the blood. Here lies the danger, for the tissues cannot withstand the presence of free, uncombined oxygen and death follows. The question immediately arises: Why do the tissues require combined oxygen and why does free oxygen kill them? No one knows. Henry de Varigny, who deals with this subject with reference to ærobic and anærobic organisms deals with this curious fact and acknowledges our limited knowledge on this point. He states, however, that while a certain increase in the ratio of oxygen results in death, lesser increases of a temporary character may be beneficial. Every poison kills, doubtless, but there are doses which not only do not kill, but even confer benefit and improve health.

Lorrain Smith has shown that oxygen at the tension of the atmosphere stimulates the lung-cells to active absorption; at a higher tension it acts as an irritant, or pathologic stimulant, and produces inflammation.[2]

As far as the respiratory processes are concerned the respiration of pure oxygen takes place without disturbing them for even in an atmosphere of pure oxygen animals breathe as though they were respiring normal atmospheric air.[3]

Sir Humphrey Davy believed that when pure oxygen was inspired there is no more chemical change induced than occurs when atmospheric air is breathed; in other words, let the vital actions be a constant quantity, the addition of oxygen to the inspired air does not materially increase vital transformation. Fifty years ago there was great confusion in the minds of otherwise intelligent observers and false reasoning led them into grave errors. Those who, like Beddoes, believed that there was too much oxygen in the system held that the inhalation of air containing carbonic acid was the proper plan of treatment and this theory of hyper-oxidation was revived

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[1] Paul Bert: La Pression Barometrique, 1878.
See also monograph by F. G. Benedict quoted on page 31.
[2] Lorrain Smith, in Journal of Physiology, 1899, Vol. 24, p. 19.
[3] An American Text Book of Physiology, Vol. 1.

by Baron von Liebig, who recommended that in phthisis the respiratory action should be lessened.[1]

The Boston Nutrition Laboratory of the Carnegie Institution of Washington has undertaken a most painstaking series of investigations bearing on this subject. They include an examination of the comparative oxygen-content of uncontaminated outdoor air under all conditions as to wind direction and strength, temperature, cloud formation, barometer, and weather. In addition, samples of air were collected on the Atlantic Ocean, on the top of Pike's Peak, in the crowded streets of Boston, and in the New York and Boston subways. The results of the analyses of uncontaminated outdoor air showed no material fluctuation in oxygen percentage in observations extending over many months and in spite of all possible alterations in weather and vegetative conditions. The average figures are 0.031 per cent of carbon dioxide and 20.938 per cent oxygen. The ocean air and that from Pike's Peak gave essentially similar results.

The extraordinary rapidity with which the local variations in the composition of the air are equalized is accentuated by the observations on street air in the heart of the city, where the contaminating factors might be expected to be of sufficient magnitude to affect perceptibly the analytic data. Only the slightest trace of oxygen deficit is shown, with a minute corresponding carbon-dioxide increment. Observations such as these tend to demonstrate the extent of the diffusion of gases and the establishment of equilibrium by air-currents.

Most unexpected are the figures in regard to the extremely small extent to which the air was vitiated in the modern "tube" or subway, even during "rush" hours. There was, on the average, a fall of 0.03 per cent in oxygen accompanied by a rise of 0.032 per cent in the carbon dioxide. Professor Benedict points out that while the measurement of carbon dioxide has been taken as an index of good or bad ventilation, the fact that the proportion of oxygen is actually lowered by an increase in the carbon dioxide has never before been clearly demonstrated. As a result of this, the determination of the content of carbon dioxide in the air, which can be made with ease and accuracy, suffices to establish the approximate percentage of oxygen. For every 0.01 per cent increase in the atmospheric carbon dioxide one may safely assume a corresponding decrease in the percentage of oxygen. Aside from minor fluctuations ex-

[1] See Edward Smith: Consumption, Its Early and Remediable Stages. Blanchard and Lea, Philadelphia, 1865.

plained above, it may now truly be said that "the air is a physical mixture with the definiteness of composition of a chemical compound."[1]

Since the introduction[2] into medical practice of oxygen compressed in cylinders its use has been tried in tuberculous cases, but no satisfactory results have been obtained and its use is discontinued, except, so far as we know, in the hands of charlatans.

The inhalation of oxygen gas may not *per se* exert any curative action on a tuberculous lung, but that fact should not lead us to the conclusion that the voluntary respiration of an increased quantity of air is not beneficial. It is stated that the air in the central parts of the lungs is richer in carbonic acid than that found in the larger tubes and hence deep inspiration followed by deep expiration causes a larger amount of the air richer in carbonic acid, to be exhaled. From this the conclusion is drawn that increased chemical change will result, for if the carbon dioxide be removed from the air cells its place will be filled by quantities of the same gas which will escape from the blood. Furthermore, the removal of carbon dioxide from the blood facilitates and makes possible those metabolic changes which with a supply of suitable food improve nutrition.

Nowadays we often speak of oxygen as synonymous with atmospheric air and in this sense we give it a prominent place in pulmonary therapeutics. We are tempted to reproduce the placard of an old boot-maker and chiropodist of fifty years ago which read:

> The best medicine! Two miles of oxygen three times a day. This is not only the best, but cheap and pleasant to take. It suits all ages and constitutions. It is patented by Infinite Wisdom, sealed with a signet divine. It cures cold feet, hot heads, pale faces, feeble lungs and bad tempers. If two or three take it together it has a still more striking effect. It has often been known to reconcile enemies, settle matrimonial quarrels and bring reluctant parties to a state of double blessedness. This medicine never fails. Spurious compounds are found in large towns; but get into the country lanes, among green fields, or on the mountain top, and you have it in perfection as prepared in the great laboratory of nature.
>
> Before taking this medicine . . . should be consulted on the understanding that corns, bunions, or bad nails, prevent its proper effects.

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[1] See the recent monograph by Benedict, F. G.: The Composition of the Atmosphere with Special Reference to Its Oxygen Content, Carnegie Institution of Washington, Publication 166, 1912. Review in Journ. Amer. Med. Ass., Jan. 25, 1913.

[2] The late Dr. Andrew H. Smith, of New York, was the first in the United States to use Oxygen in medical practice, 1860. "Oxygen gas as a Remedy in Disease," A. H. Smith, 1870.

The old London boot-maker had more wisdom than most of the doctors of his time.

CHAPTER III. INFLUENCE OF SEA AIR; INLAND SEAS AND LAKES.

SEA VOYAGES

The value of sea air in tuberculosis has been discussed *pro* and *con* for ages and, like the tide, there is an ebb and flow of sentiment regarding its value in the treatment of tuberculosis. Undoubtedly there is, at present, a stronger belief in the efficacy of sea air in the various forms of tuberculosis than at any previous time. This is especially true as regards tuberculosis of the bones, the tuberculosis of children and in the important class of cases termed fibroid phthisis.

Aretaeus, about 250 B. C., recommended sea voyages for the cure of consumption, and 300 years later Celsus advocated voyages from Italy to Egypt, if the patient were strong enough. Celsus was a layman whose learning was truly encyclopedic, but only his medical writings have survived. When the Roman sufferer from tuberculosis was not able to make the sea voyage to Egypt he was sometimes advised to pass a large portion of his time sailing on the Tiber.[1]

At Kreuznach, Ems, and other continental resorts, salt inhalations are given to patients with scrofulous and chronic bronchial affections. Instead of trusting to sea breezes the patients are taken to halls where saline particles are present in a higher precentage than they can ever be at the sea side. They inhale the salt-laden air and make use of pulverization apparatus. Hours are spent in the open air near the "evaporating fences" so as to inhale salt air at interior stations. At Ems this treatment is carried out in pneumatic chambers capable of holding ten people in compressed atmosphere for about 1¾ hours.

Sea air is of acknowledged purity as to micro-organisms, dust and adventitious gases. As previously remarked, there is at sea a maximum of ozone and a minimum of all foreign deleterious substances. (See page 9.) Without considering, as yet, the amount of watery vapor in the air of the ocean and other features of ocean air such as its movement and temperature, we recognize some physical contents such as a minute quantity of sodium chloride, iodine and bromine as characteristic of sea air when contrasted with air from any other

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[1] "Opus est, si vires patiuntur, longa navigatione, coeli mutatione, sic ut densius quam id est, ex quo discedit aeger, petatur; ideoque aptissime Alexandriam ex Italia itur." Celsus, De Med. lib. III, Cap. 22.

STORM AT BLACKPOOL, ENGLAND. SHOWING HOW SALINE PARTICLES ENTER THE ATMOSPHERE
Photographs by Courtesy of Dr. Leonard Malloy

locality. The wind carries aloft fine particles derived from the crests of the waves and this saline matter from sea water and foam is constantly present near the surface and is carried for miles inland.[1] It is well known that plants near the seashore have a perceptible coating of saline matter which modifies their growth.

As far as the present subject is concerned we have to deal with the influence on the tuberculous processes exerted by a marine climate. This can be obtained by undertaking sea voyages or by a residence on islands, or on the seaboard.

Ocean voyages were formerly strongly advocated as a means of cure in tuberculosis and were given an extended trial especially by English physicians. The constant commercial intercourse between England and her possessions all over the world made the practice easy and the results have been carefully weighed. Before the days of steam the typical ocean voyage from London to China or India involved vastly different conditions, as to time, route and accommodations. Some features will always be the same. Seasickness, the confined air of cabins, storm and wet will remain to harrass and terrify the traveler. But the clipper ships of the past are now, for the most part, doing duty as coal barges and the steam "tramp" and ocean liner carry the cargoes of the world.

After ruling out the tramps, cattle ships, and the coasting schooners, we have left a few sailing vessels still engaged in the East India trade and the fast liners. Modern systems of ventilation and cold storage have corrected some of the great disadvantages of the past and the presence of competent surgeons on board all the larger passenger steamers make the trip comparatively safe for a tuberculous patient if the necessity arises for him to make the voyage. But as a strictly therapeutic measure such trips are not to be recommended and in this we are supported by nearly all good authorities.[2]

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[1] Two illustrations from a storm at Blackpool, England, are supplied by the courtesy of Dr. Leonard Molloy.

[2] Huggard, A., Handbook of Climatic Treatment, London, 1906, says: "Sea voyages were formerly in great repute for persons with phthisis; but it is now recognized that, except in certain well-defined instances they generally do harm. Only slight or mild cases without fever and without active symptoms, are likely to benefit. The patients most suitable for a sea voyage are those in whom the disease has become partly or entirely arrested." Dr. Burney yet doubts whether phthisis at any stage is benefited by ocean travel. Prof. Charteris, of Glasgow, approves of a sea voyage in the early stage of phthisis in a young person, but after that stage all experience testifies that degeneration proceeds more rapidly on sea than on shore and the patient, if he reaches land, only does this to find a grave far away from the surroundings of friends and home.

Dr. W. E. Fisher, for many years surgeon to the Pacific Mail Steamship Co., while observing that patients affected with chronic diseases, such as phthisis, dyspepsia, etc., are not so liable to seasickness as others, states that a large percentage of tuberculous patients stand the sea voyage badly. Dr. Fisher's experience relates to the trip from New York to San Francisco by way of Panama. During the first part of the voyage until the Bahama Islands are reached, the invalid experiences bracing weather. From that point to the Isthmus and thence up the coast during the long voyage of three weeks or more, a distance of nearly three thousand miles, the temperature averages 90° in the shade and on many days rises as high as 95° or 96° F. This occurs during the winter months and is the direct cause of deaths on the voyage or shortly after arrival on the California coast.

Dr. R. W. Felkin, of Edinburgh, says:[1] "Fifteen years ago I used to advocate sea voyages in my lectures on Climatology in Edinburgh, with great confidence; now I am more cautious. I do not send phthisical patients to sea as I once did. The risk of spreading infection is, to my thinking, too serious to be incurred. I well remember once sending two sisters to Australia; the elder suffered from phthisis; the younger was healthy. The elder certainly did gain some temporary benefit, but the younger sister and also a cabin companion became infected, and all three girls were in their graves within a year of their return to this country. I am sure that occupying a joint cabin as they did caused the mischief."

Dr. F. Parkes Weber, of London, takes a more hopeful view.[2] He says that sea voyages are often useful in the milder and quiescent forms of pulmonary tuberculosis, provided the patient's general condition be such as otherwise to fit him for life on shipboard. "Long voyages are to be preferred to all other methods of treatment in the case of male patients who have a taste for the sea, who are strong physically, or who possessed an originally strong constitution and were infected by 'chance' or when weakened by overwork, worry, improper hygienic conditions, or acute diseases."

In pulmonary tuberculosis complicated by syphilis, or syphilitic phthisis, as it was formerly designated, a marine climate seems to be particularly suitable.[3]

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[1] Journal of Balneology and Climatology, January, 1906.

[2] F. Parkes Weber: System of Physiologic Therapeutics, Vol. 3, p. 87, Philadelphia, 1901.

[3] See Roland G. Curtin, Trans. Amer. Climatological Ass., Vol. 4, p. 31.

The vicissitudes of sea-travel, the narrow cabins and the difficulty of obtaining a suitable diet, even such common requisites as milk and eggs, should be enough to condemn this plan. Tuberculosis patients ought not to travel more than is absolutely necessary. Imagine the bacteriological condition of a consumptive's stateroom, for instance, at the end of a month's voyage! What sea-captain or steward would ever put such a cabin into a sanitary condition for the next passenger?

The author has some experience of life at sea under both sail and steam, although he has never taken very prolonged voyages. Taking into account the character of the food supply and the necessity of at least sleeping in small cabins and probably spending days in them, with uncertain medical attention; and, besides this, the dangers of various kinds that pertain to seaports, the author feels bound to condemn sea voyages for the tuberculous in any stage.

"Non mutant morbum qui transeunt mare."

MARINE CLIMATE OF ISLANDS

It is far better for the tuberculous patient to remain on *terra firma* than to traverse the sea. Whatever is of value in the sea air can be obtained in islands such as Ireland, the Isle of Man, the Isle of Wight, Nantucket, the Isles of Shoals, Newfoundland, Long Island, the Bahamas, the Canaries, the Philippines, Samoa, and many other islands.

Just as in the case of sea voyages, there are concomitant influences, many of which are notoriously unfavorable, that in themselves over-balance any possible advantage from sea air. Take, for instance, the problem as it presents itself in Ireland or the Isle of Man.

Among the various countries of the world Ireland stood fourth in the order of mortality from tuberculosis, being exceeded by Hungary, Austria, and Servia. During the last thirty-five years the mortality in Great Britain has been reduced one-half among females and one-third among males but, until 1907, there had been no such fall in Ireland.

Sir John Byers, of Belfast, in his address[1] entitled "Why is Tuberculosis so Common in Ireland?" characterized its prevalence in that country as "appalling." Among the nine causes which are assigned for this condition of affairs attention is first directed to the *damp climate*. An investigation of places with rather worse con-

[1] The Lancet, January 25, 1908. See also Alfred E. Boyd, M. B.: Tuberculosis and Pauperism in Ireland, British Journ. Tuberculosis, July, 1908, p. 159.

ditions of climate led Sir John to say on this point: "I cannot, therefore, admit that there is much in the dampness of the atmosphere as a cause of tuberculosis in Ireland." Sir William Osler takes precisely the same ground and pointed out at the opening of the Tuberculosis Exhibit in Dublin, that Cornwall, with a much damper atmosphere than that of Ireland, was so free from the disease that consumptives were sent there. In Cardiff, Wales, with a damp climate and with the ground water in many places near the surface in the gravel and with the lower part of the town on a stiff marine clay, very retentive of moisture, the tuberculosis death rate for 1906 was only 1.20 per 1,000. On the other hand in Belfast, with a smaller rainfall (34.57 inches as against 42.43 inches) the mortality was more than twice as much, or 2.77 per 1,000. The figures for 1906 were:

	Rainfall inches	Death rate from tuberculosis per 1000
Manchester, notoriously damp, foggy and smoky....	....	1.82
Liverpool	....	1.82
London	....	1.42
Cardiff, Wales	42.81	1.20
Bolton, England	42.43	1.11
Belfast, Ireland	34.57	2.77
Cork	....	4.53
Dublin, Ireland	27.73	2.91
North Dublin, Ireland	....	4.70

After taking up in turn dampness of soil, emigration as a cause for tuberculosis, the asserted susceptibility of the Irish to tuberculosis, poverty and social position, food and drink and industries, and after weighing them carefully they were all discarded as insufficient causes of this mortality. The prime cause was declared to be *want of Sanitary Reform* and the *prevalent domestic or home treatment of the advanced cases of pulmonary tuberculosis.*

Since 1907 an encouraging decline in the mortality from tuberculosis has been noted. Whereas the rate for both sexes throughout Ireland was 273.6 per 100,000 in 1907 it had dropped by gradual stages to 215.2 in 1912. Sir William Thompson, the General Register for Ireland, justly attributes this well marked decrease during the past six years to the exertion of Her Excellency, the Countess of Aberdeen.[1]

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[1] Trans. National Association for the Prevention of Consumption and Other Forms of Tuberculosis, 5th Annual Conference, London, August 4 and 5, 1913. See also Sir John Moore, Interstate Medical Journ., April, 1914.

Sir William shows that this decrease indicates 17,000 fewer people suffering from tuberculosis in Ireland in 1912 than there were in 1907. This corresponds to a decrease of nearly one-fifth of the total number of cases of tuberculosis. He seems hopeful that within the next few years the death-rate from tuberculosis in Ireland will not be above the average in other countries.

Undoubtedly hygienic and philanthropic measures are entitled to the credit for this marked improvement and it gives us pleasure to note in this connection the remarkable work of Her Excellency, the Countess of Aberdeen. This noble woman founded in 1907 the Women's National Health Association of Ireland and a vigorous campaign was started which soon roused the whole country to a sense of responsibility in matters of public health and, in particular, to measures necessary for the prevention and cure of tuberculosis. The influence of this organization rapidly spread and within eighteen months no less than seventy branches had been opened throughout Ireland, for the most part opened in person by their excellencies, the Lord Lieutenant and Countess of Aberdeen, and now it has 150 branches and 18,000 members.

While undertaking the reduction of infant mortality, the improvement in the milk supply and better school hygiene, the association made a systematic attack on the prevalence of tuberculosis. This included home treatment and its strong ally, the tuberculosis dispensary, on a plan similar to that originated by Sir Robert Philip, of Edinburgh; it included sanatorium treatment; and it provided special treatment for advanced cases of tuberculosis. In this phase of the work the association had the benefit of £145,623. through the provisions of the National Insurance Act. Charitable Americans also contributed handsomely toward the erection of sanatoria now comprising one thousand beds, the maintenance of dispensaries and of depots for the supply of pasteurized milk.[1]

It is interesting to note that the Association also lent its support to the formation of an "Irish Goat Society," believing that the best way to meet the scarcity of milk experienced in many parts of Ireland is to encourage the keeping of a good breed of milking goats. Then, too, through the administration of the Laborer's Acts nearly fifty thousand cottages with garden plots ranging up to one acre have been built for rural laborers by rural sanitary authorities at an outlay of over £8,000,000.

We have cited this remarkable campaign of the anti-tuberculosis

[1] The late Mr. R. J. Collier and Mr. Nathan Straus.

movement in Ireland to show how close are its relation to the broader field of general hygiene and sanitation and to show that such work pays; and furthermore what great service one person of noble birth, by her foresight, solicitous care and untiring devotion, can initiate and carry out. As Prof. Thompson says: There is no doubt that it will rank as one of the greatest philanthropic efforts of our time.

Take the Isle of Man. This island in the Irish Sea has a population of over ten thousand and for six hundred years has been singularly free from the admixture of English, Irish, or Scotch blood. The island has a more equable climate than any other part of the British Isles. The mean annual temperature is 49° F. There is comparative absence of frost, fog, or snow. But careful records since 1880 show that the Manx tuberculosis death rate is about double that on the mainland.[1]

	1880-82	1883-1897
Isle of Man	31.63	25.70 per 10,000
	1887	1893
England and Wales	15.08	13.07 per 10,000
	1888	1894
	14.28	12.17 per 10,000
	1889	1895
	14.35	12.43 per 10,000
	1890	1896
	15.06	11.39 per 10,000

The Bahamas and Bermuda in the Atlantic Ocean have a subtropical marine climate that experience shows to be far too relaxing and enervating for tuberculous patients.

The Philippines and all other tropical islands are likewise entirely unsuited for tuberculous patients for the same reasons.[2] Newfoundland, with a harsh, damp, colder air, is equally bad.

Dr. Newsholme, of Brighton, President of the Epidemiological Section of the Royal Society of Medicine, in an elaborate inquiry into the principal causes of the reduction of the death rate from phthisis in different countries, came to the conclusion that the one

[1] Charles A. Davies, M. D.: Tuberculosis in the Isle of Man (Tuberculosis, London, Oct., 1900).

[2] According to Dr. Issac W. Brewer, U. S. A., "Notes on the Vital Statistics of the Philippine Census of 1903," American Medicine, Oct., 1906, the death rate from tuberculosis is one-third that in the United States.

common factor present in all cases where a fall was noted was the segregation of the patients in hospitals or sanatoria. In each country where the institutional has replaced the domestic relief of destitution there has been a reduction of the death rate from phthisis which is roughly proportional to the change.

As to the cause, then, of the spread of tuberculosis, we shall find that it probably always lies in ignorance, indifference and other moral or sociologic causes, and, in many of the cases cited, not to climatic or atmospheric conditions.

Our opinion of sea air is fortunately not confined to that of the high seas or even that of islands. The sea air sweeps the mainland and, as we know, modifies the climate of all adjacent portions of the Continent. The great source of atmospheric moisture is found ultimately in the oceans. The invisible watery vapor and the visible clouds are carried inland and deposit their water over the Continent. The monsoons which are most highly developed in India and other parts of Asia, prevail also in Texas and on the Pacific coast of the United States. These seasonal winds are of great importance from a climatic standpoint and hence should be taken into account in reference to the climatic treatment of tuberculosis.[1] During the summer and autumn in India these seasonal winds sweep inland from the sea and deluge the country with rain. This amounts, in the Khasi Hills, 200 miles north of the Bay of Bengal, to between 500 and 600 inches a year and reaches its maximum at points about 1,400 meters, 4,600 feet, above sea level.

Fortunately in the United States these seasonal winds, while present, are not so dominant as climatic factors. We are more concerned in the present study with the diurnal winds of the seashore. The sea breeze which tempers the heat of our coasts is a distinctly beneficial feature of the shore and not only tends to moderate the heat of the summer day, but sweeps inland for fifty or a hundred miles the pure ocean air and provides all the desirable features of a marine climate.

ARCTIC CLIMATE

Passing still farther north we have the Arctic climate. It is marine or insular and cold. Arctic voyages have been proposed for the treatment of tuberculosis and, as adjuncts to the voyage, a summer sojourn in the northern fjords of Greenland. A trip of this

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[1] See William Gordon: The Influence of Strong, Rainbearing Winds on the Prevalence of Phthisis, H. K. Lewis, London, 1910, Observations in Devonshire.

kind has been seriously planned by Dr. Frederick Sohon, of Washington, D. C., but has never yet been carried out.[1]

It is a significant fact that Arctic explorers from Dr. Elisha Kent Kane down, including General A. W. Greely, Admiral Peary, Mr. W. S. Champ, Mr. Herbert L. Bridgman, the late Dr. Nicholas Senn, and others comment on the healthfulness of the Polar climate. Dr. Sohon made two voyages with Commander Peary, in 1896 and in 1902, and states his opinion that in summer the Arctic regions are entirely suitable for, and beneficial to, the tuberculous, and that the unequaled natural advantages for a cure can be practically utilized. Few understand the fascination which the Polar regions undoubtedly exert on all who enter that charmed circle. The expressions used by Arctic explorers seem so extravagant to the average mind. The late Professor Senn says: "Nature there lends such efforts toward prophylaxis, as to leave no need for therapeutics."[2]

The air of the Arctic regions is free from dust and germs. It is not, in itself, responsible for any disease which may be carried into Arctic settlements by ships' crews, or by means of the migration of animals or birds. Colds and catarrhal conditions are conspicuously absent. There is no pneumonia. The only "Arctic Fever" is that which explorers are almost sure to contract on their first visit and which has an annual periodicity. It is not a self-limited disease, as Admiral Peary can testify after nearly fourteen consecutive summers in the Polar regions.

Another feature of the atmosphere in the Arctic is absolute clearness and abundance of sunshine. Dr. Sohon, in 1902, exposed dishes of agar and introduced into culture tubes pebbles, bits of vegetation and water from the ground and from pools at Commander Peary's winter quarters. Of six dishes exposed for from one-half to two hours, two were sterile and four gathered only a common white mould (P. glaucum). Only the hay bacillus was obtained from the pebbles. Water yielded the hay bacillus, *B. liquefaciens*, *B. fluorescens* and an unclassified non-pathogenic saprophytic rod organism.

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[1]Frederick Sohon, M. D.: Personal Observations on the Advantages of Certain Arctic Localities in the Treatment of Tuberculosis (American Medicine, April 23, 1904).

Idem. The Therapeutic Merits of the Arctic Climate Meteorological Data of a Summer Cruise (Journal American Medical Association, February 3, 1906).

[2]Nicholas Senn: Medical Affairs in the Heart of the Arctics (Journal American Medical Association, 1905, Vol. 45, pp. 1564, 1647).

The atmosphere has a bracing quality and is always credited with developing a prodigious appetite. It is pointed out that a taste is developed for the kind of food the tuberculous patient needs, viz., fatty food and meat. The craving for this kind of food is usually accompanied by a corresponding adaptability to digest it and, in healthy subjects, flesh is always gained. Dr. Sohon says that in both of his trips to Greenland he has exceeded his usual maximum weight, gaining the first time thirty pounds in two months, and the second time nineteen pounds in six weeks. In the latter voyage even the crew made an average gain of ten pounds in weight.

A large share of the beneficial influence of any atmospheric change is that which conduces to a good appetite and digestion. In this respect the summer Arctic voyage may fairly claim preeminence. With qualities such as these it is natural that, for a portion of the year at least, the merits of the Arctic climate in the treatment of tuberculosis should at least be considered.

An atmospheric feature is its great penetrability for light and especially for the actinic and ultra-violet rays. Tanning of the skin always occurs and sunburn is not uncommon. During summer the sun never sets and, though not very high in the heavens, its generous rays must exert a very beneficial influence on any morbid process, especially of a tubercular type. Arctic plants develop rapidly from seed to flower and seed again in surprising manner and the wild animals seem to be the largest and most vigorous of their kind.

In judging of the weather to be encountered in the Arctic regions, we are too much inclined to recall the harrowing accounts of the ill-fated expeditions of the past; but in the Northern fjords of Greenland, some miles from the coast, or in the protected inland bays, the atmospheric conditions of summer are quite agreeable and are especially suitable for the open air treatment.

The fluctuations of temperature are very moderate. The average minimum temperature between July 28 and September 6, between 69° and 78° north latitude on these Greenland Fjords, was about 38 F.; the average maximum was 49° to 50°. Temperatures as high as 56° were recorded at North Star Bay and about 52° at Etah.

The humidity averaged low. The records were made at 8 a. m. and 8 p. m., and, owing to the constant daylight, are much more representative estimates of relative humidity than in the case of records of relative humidity at those same hours in temperate latitudes.

	Maximum Humidity		Minimum Humidity		Average	
	8 a. m.	8 p. m.	8 a. m.	8 p. m.	8 a. m.	8 p. m.
New York	100	95	62	50	81.3	74.1
Denver	90	90	41	13	66.1	37.1
North Star Bay	72	71	56	39	63.1	54.
Etah, Greenland	81	70	40	35	57.6	52.4

The relative humidity was much lower while at anchor in the harbors of Northern Greenland than while en route through the Strait of Belle Isle and off Labrador and in Davis Strait and Smith's Sound.

We have given some attention to this subject on account of the very enthusiastic claims made on behalf of the atmosphere of the Arctic regions during summer treatment of tuberculosis. Although the plans for sending a ship with tuberculous passengers on this voyage failed to be carried out owing to inability to get the necessary permission from the Danish Government to land at the northern ports of Greenland, it is possible that at some future time the attempt will again be made.

The fact that Icelanders and Greenlanders may contract tuberculosis in numbers and may die from it is not to be overlooked; but the filth of winter quarters in the far North and the foul air of these huts is responsible for much of the illness of the native inhabitants. The Eskimo survives the dangers of the winter because he leads a totally different life in summer. It is difficult for those who have never been to the Polar regions to realize what a change is wrought by the advent of constant sunlight. This unique feature of the summer climate contributes to health and energy. The atmosphere, free from all germs and dust, bracing in its quality, is a strong stimulant to bodily functions as gain in weight testifies.

As a practical measure for the treatment of tuberculosis Arctic voyages have not yet been proved to be beneficial, although there is some presumptive evidence in their favor and, in view of the abundance of proof that the disease can be successfully combated at numberless places on the continent, such expeditions will scarcely meet with favor.

FLOATING SANATORIA

In 1896, Mr. M. O. Motschoutkovsky[1] advocated floating sanatoria for patients with incipient tuberculosis. These specially fitted vessels were to be shifted from port to port according to the season so as to get the most favorable climatic conditions.

[1] The Lancet, April 4, 1906, p. 939.

OPEN AIR CLASS ON FERRY BOAT "SOUTHFIELD," EAST RIVER, NEW YORK CITY. SLEEPING HOUR
Courtesy of Dr. J. W. Brannan

OPEN AIR SCHOOL FOR TUBERCULOUS CHILDREN. FERRY BOAT "SOUTHFIELD," BELLEVUE HOSPITAL. SEE PAGE 43

The vicissitudes of sea-travel, the narrow cabins and the difficulty of obtaining a suitable diet, even such common requisites as milk and eggs, ought to be enough to condemn this plan. Tuberculous patients ought not to travel more than is absolutely necessary. Old ferry boats have been recently utilized in New York as classrooms for tuberculous scholars. The ferry boat " Southfield " has been equipped for this work through the Miss Spence's School Society under the direction and courtesy of Bellevue Hospital in cooperation with Dr. John Winters Brannan and Dr. J. Alexander Miller.

There are three classes on the " Southfield "; two for pulmonary cases of about thirty-six children; these classes being part of the regular Bellevue Clinic work and entirely supported by Bellevue.

The third class is for tuberculous cripples with about twenty children. The cost of nurses and special equipment for this class together with incidental expenses is borne by the Spence School Society.

The teachers for all three classes are supplied by the New York Board of Education so that they are a part of the regular school system.[1]

Owing to the fact that these old ferry boats seem to answer a useful purpose and in view of the reported use by the Italian Government of three discarded men-of-war as floating sanatoria in the treatment of tuberculous patients, a request was made to the Navy Department of the United States for similar ships by the Fourth International Congress on School Hygiene at Buffalo, N. Y., August 29, 1913, in a resolution, a portion of which is as follows:

> WHEREAS, It has been demonstrated in New York and other cities that discarded vessels lend themselves admirably to transformation into all-year-round hospitals and sanatoria for consumptive adults, sanatoria for children afflicted with joint and other types of tuberculosis, and into open air schools for tuberculous, anemic, and nervous children;
>
> *Resolved,* That the fourth International Congress on School Hygiene petitions the United States Government to place at the disposal of the various States of the Union as many of the discarded battleships and cruisers as possible to be anchored according to their size in the rivers or at the seashore and to be utilized by the respective communities for open air schools, preventoria, sanatorium schools for children, or hospital sanatoria for adults.

The Secretary of the Navy, however, for the following very good reasons, declined.

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[1] See Buffalo Medical Journal, 1907-8, Vol. 63, 41.

I am of the opinion that battleships are not suitable for floating sanatoria. This opinion is based on the following reasons.

The cost of maintaining a battleship in proper sanitary and structural condition is very high.

Battleships, particularly the older types, have very limited deck space, and this is so cut up by hatches, turrets, davits, cranes and winches that there are few spaces large enough for a cot. The cost of removing these obstructions would be equivalent to that of building more suitable floating hospitals.

The ventilation in the enclosed spaces of these vessels is so poor that it often has an unfavorable effect on those chosen especially for their health and vigor. Its effect on those already diseased could not be favorable. The openings are very small and admit but little sunlight; it is necessary to use artificial light for a large part of the day. To correct these conditions would involve great expense, even if it were possible of accomplishment.

The passages are narrow, the ladders steep and the hatches small, making transportation of the sick very difficult.

Very respectfully,

JOSEPHUS DANIELS,

Secretary of the Navy.

Under the title "Una nave-scula-sanatorio per fanciulli predisposti" Federico di Donato has urged this plan in Italy but up to the present the Italian Government has not assented.

The remark has been made that: "If the right sort of ship could be sent to the right place in the right kind of weather with the right sort of patients, a great deal of good might result."

SEASIDE SANATORIA FOR CHILDREN

In the United States notable attempts have been made to utilize sea air in treating tubercular disease in children. Individual cases have been treated by sea air, but on a larger scale we should mention the experience of two institutions.

In 1872, Dr. William H. Bennett, of Philadelphia, established the Children's Seashore House at Atlantic City, New Jersey. This institution is open during the entire year, and in 1912 more than 3,500 mothers and children were cared for. Among the first patients admitted to the Institution at its inception were the hospital children suffering from tubercular diseases of the bones, glands, and joints. The wonderful improvement wrought in such cases by the sea air led to a steadily increasing demand for their admission, and now throughout the year seventy beds are set apart for their care and treatment.

The most notable and most recent attempt in the United States to treat cases of tuberculosis of the bones, joints and lymph nodes is at the Sea Breeze Hospital at Coney Island on the Atlantic

SEA BREEZE HOSPITAL, SEA GATE, CONEY ISLAND, NEW YORK. TUBERCULOUS CHILDREN ON THE BEACH

TREATMENT OF POTT'S DISEASE OF THE SPINE ON A BRADFORD FRAME. SEA BREEZE HOSPITAL, SEA GATE, NEW YORK. PATIENTS REMAIN FOR MONTHS, NIGHT AND DAY, ON THESE FRAMES, BUT ARE REMOVED TWICE DAILY FOR BATHING AND POWDERING

Courtesy of Dr. J. W. Brannan

SEA BREEZE HOSPITAL, SEA GATE, CONEY ISLAND, NEW YORK. MORE CITY CHILDREN ARE STARVED FOR SLEEP THAN FOR FOOD. VIEW AT 6 A. M. IN SPRING. CHILDREN SLEEPING TEN HOURS ON PORCH ALL NIGHT. CANVAS OVERHEAD ROLLED BACK.

Ocean, ten miles from New York City. This was undertaken by the New York Association for Improving the Condition of the Poor. Ten tents were erected on the beach and were opened to children between the ages of two and fourteen on June 6, 1904. These tents had a capacity of fifty patients. In the autumn permanent buildings were occupied and have since been used. While the main reliance has been on fresh sea air and good food, the very best surgical aid has been employed, and for all major operations the children were temporarily removed to hospitals in New York City. This co-operative arrangement is a great advantage to the seashore institution, as the distance is not great and avoids the necessity of enlarging the surgical staff and at the same time provides the highest surgical skill. To avoid mistakes most of the cases admitted are seen by at least one other surgeon besides the attending surgeon. While pulmonary cases are refused the staff admits severe, desperate, and even hopeless cases.

In a recent report by two of the members of the staff[1] there are histories of forty-two cases and illustrations of the methods of treatment; but the noteworthy feature of the report is the prominence given to residence at the seashore as the chief means of cure. The conclusions from seventy-six histories which form a basis of the report are as follows:

(1) The seashore is the best place for treating children with tuberculous adenitis. The children make a better recovery here than elsewhere. Those with adenoids and enlarged tonsils should be submitted to an operation as a start of the cure. Sea air does not permit us to dispense with this.

(2) The seashore is probably the best place for children with tuberculous joints, provided they can have there the same skilled orthopedic care as elsewhere. Their disease runs a somewhat milder and probably a shorter course, and the functional results are better than those obtained elsewhere.

(3) Our results have been largely due to the careful attention (including feeding and nursing) which has been given the children.

(4) Our results justify pushing the work.

(5) A hospital such as this does better work than a public hospital under control of the municipality.

(6) Many cases of co-called bone tuberculosis are in reality syphilis.

We do not know whether there is anything "specific" about the seashore,

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[1] Leonard W. Ely and B. H. Whitbeck, Medical Record, March 7, 1908. See also Charlton Wallace, Medical Record, July 22, 1905; John Winters Brannan, Trans. American Climatological Association, 1905, p. 107; John Winters Brannan, Trans. National Association for the Study and Prevention of Tuberculosis, 1906. Roland Hammond: Heliotherapy as an Adjunct in the Treatment of Bone Disease, Amer. Journ. Orthopedic Surgery, May and October, 1913.

or whether children simply thrive better and so overcome more quickly their disease.[1]

As to treatment other than diet and fresh air, little need be said. We use plaster when we can in preference to braces. In Pott's disease we use first the Bradford frame, then plaster jackets; in hip joints, the short Lorenz spica. In knee-joint disease after the acute stages, we also use plaster-of-Paris. Patients with large cold abscesses are transferred to the Manhattan hospitals, where their abscesses are opened, wiped out, and sewn up again with proper aseptic precautions.

On January 21st of the present year, 1914, the author revisited Sea Breeze Hospital, Coney Island, New York, in order to see what is being accomplished. Six cases of hip disease were being treated by partial exposure of the body to the sun. The patients were in bed on the balcony with the usual extension apparatus in place. General exposure, beginning with the feet and gradually involving the entire body, is not adopted at Sea Breeze, as a rule, and only the area of abdomen, hip and thigh adjacent to the diseased joint was exposed to the air and sun. Continued cloudy and unfavorable weather had prevented much progress in the newer patients who were then undergoing treatment; others who had been cured of serious tuberculous disease by the open-air method had recently been discharged. The fresh-air system is, however, well carried out, but not upon the naked body as in Switzerland and France.

The temperature on the open balcony next to the wooden wall of the building was 62° F. at noon in the sun. It was the first bright day after weeks of storm and cloud. It is probable that the very encouraging experience of the last two years will lead to the adoption of Rollier's method in all its details as modified by the less favorable climatic conditions of this part of the Atlantic seaboard.[2]

Results at Sea Breeze Hospital in the treatment of tuberculosis of the bones, joints and glands have been so good that the city of New York has acquired a new location with 1,000 feet of beach front on what is known as Rockaway Point, ten miles beyond Coney Island. The plot runs back about 600 feet to Jamaica Bay and cost the city, after condemnation proceedings, $1,250,000. The plans include an arrangement of grounds and buildings which will involve a total

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[1] Charlton Wallace, M. D.: Surgical Tuberculosis and Its Treatment (Journal of the Outdoor Life, March, 1913). This author, who is Orthopedic Surgeon to St. Charles' Hospital, Long Island, and the East Side Free School for Crippled Children, New York, says: The author is not in a position to produce scientific proof that sea air is better than country air, but he does believe such to be the case, although there are some individual patients who do better in the country than at the seashore.

[2] Heliotherapy is used at the Crawford Allen Hospital, Rhode Island.

outlay of $2,500,000, and there will be accommodation for 1,000 patients in the eight pavilions. Contracts for two of these pavilions have been let and will be paid for by a fund raised by the New York Association for Improving the Condition of the Poor. The new hospital will be turned over to the city of New York and will be conducted by Bellevue and Allied Hospitals. The plans include an immense playground running back to Jamaica Bay for the use of the public.

Credit is due to Dr. John Winters Brannan, of New York, president of Bellevue and Allied Hospitals, for much of the great work which has so far taken about nine years to accomplish and for which America will be justly proud.

Encouraged by the success at Sea Breeze, another hospital for surgical tuberculosis in children was started six years ago at Port Jefferson, on the north shore of Long Island, opposite the Sound. The situation is said to be ideal. It accommodates two hundred children and is a handsome fireproof structure. It is called St. Charles' Hospital; it is under the active care of the "Daughters of Wisdom," a Roman Catholic Society. The children, according to Dr. Wallace, receive every physical, mental, spiritual and industrial care necessary to produce good moral men and women. It is an active orthopedic hospital admitting any deserving case and keeping him there until the lesions are healed. Patients in advanced stages of bone tuberculosis are received as well as those with pulmonary complication. Under the good hygienic surroundings at St. Charles' Hospital, the children have shown great improvement in every way. Dr. Wallace adds: "The removal of the diseased bone with the knife is no longer attempted, because such a procedure not only takes away the root from which the bone grows, but also fails to eradicate the affected area. Reliance must therefore be placed on other than cutting methods for local treatment of the affected parts." Immobilization by plaster-of-Paris, properly applied and fresh air on the shore of Long Island Sound, conjoined with every other hygienic aid possible, constitute the line of treatment.

The New York Hospital for Ruptured and Crippled has lately removed to a new site on a hill near the East River, where the outdoor treatment for the tuberculous cripple is carried out as well as it can be in a large city.

In England it has long been customary to send scrofulous children and those with surgical tuberculosis to the eastern and southeast coast. At Margate the Royal Sea-Bathing Hospital, founded by

Lettsom and Latham in 1791, is the oldest institution of the kind in Great Britain, and retains its pre-eminence. There are similar institutions at Brighton, Bournemouth, Folkestone, and Ventnor, Isle of Wight (see plate 12).

The impression prevails at present in England that sea air is the best for these cases. The bracing air suits them perfectly and children with tuberculous bones, joints, or glands can stand a much colder and fresher air than children with pulmonary disease. Sea air improves the general health and keeps nutrition at the highest level. Italy and France, however, take the lead in seashore sanatoria exclusively devoted to tuberculous children. They have been in existence on the Italian shore at Viareggio since 1856, and on the French coast since 1860, and are conducted on a very extensive and systematic scale. The first sanatorium at Berck-sur-Mer was established in 1860 by the city of Paris, and is almost exclusively for children suffering from tuberculous disease of the joints, bones and glands, and has at present considerably over one thousand beds and accommodates children from the poorest quarters of Paris.[1]

Two private hospitals for similar cases are located at Berck-Plage. One was founded by Baron Rothschild and is maintained by his widow and contains 600 beds. Four-fifths of the cases are surgical; one-fifth, medical.[2] The other is in Cazin Perrochaud and accommodates 200. At Pol-sur-Mer there is a similar institution maintained by the city of Lille, which is designed to have 900 beds.[3] At Cannes there is an excellent private institution, the Villa Santa Maria, for the " cure helio-marine des tuberculoses chirurgicales " under the direction of D. A. Pascal.

Besides these institutions for surgical tuberculosis there are others which are intended mainly for pulmonary tuberculosis. These are located at Hendaye, Ormesson, Villiers-sur-Marne and Noisy le Grand. There are now fifteen sanatoria on the French coast open throughout the year and, in addition, a number open for only a part of the year, containing in all over four thousand beds. In 1904 there were twenty-three Italian hospitals distributed along the Mediterranean and Adriatic shores of Italy, with over ten thousand beds.

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[1] See article by the author on "The Treatment of Surgical Tuberculosis," etc. Interstate Medical Journal, St. Louis, March, 1914.

[2] See article by Douglas C. McMurtrie, Boston Medical and Surgical Journal, Jan. 2, 1913.

[3] See article by John W. Brannan, *loc. cit.*

VENTNOR, ISLE OF WIGHT, ENGLAND. SITE OF THE ROYAL NATIONAL HOSPITAL FOR CONSUMPTION
Courtesy of Dr. T. A. Ross

WEST GALLERIES, MARITIME HOSPITAL FOR TUBERCULOSIS, BERCK-PLAGE, FRANCE. 300 BEDS

SOUTH GALLERIES, MARITIME HOSPITAL FOR TUBERCULOSIS, BERCK-PLAGE, FRANCE. 216 BEDS

These hospitals are said to be closed in winter. (Brannan.) Every other country in Europe, with the exception of Turkey and Greece, has one or more seashore sanatoria for tuberculous children, so that there are as many as seventy-five such hospitals on the shores of Europe. The Argentine Republic has two seashore sanatoria, one established twenty-three years ago with three hundred beds and a new one with five hundred beds.

The plan of treatment at all these institutions is very simple and ought to have been carried out on this side of the Atlantic long ago. The brilliant experience at Sea Breeze, Coney Island, is simply due to a repetition of the methods adopted for decades in France and England. The régime at all these sanatoria is about the same. The patients are kept out of doors all day on the beach or on verandas, which are covered but are open on the front and sides. Four meals a day with unlimited milk are provided. All through the winter the children occupy themselves on the grounds or on the beach; those confined to bed are on the open porches enjoying the sunshine and the sea air, the best tonics in the world, and developing a ruddy color and better general circulation than they have ever known. Their warm hands in the coldest winter weather is the wonder of all who visit them. At night the windows are wide open and the air has practically the same temperature as at any point on the coast, varying from 12° to 40° F. If the snow drifts in at night, as sometimes happens, nobody seems to be the worse. The windows are, however, closed for a half hour morning and evening while the children are being washed and dressed.

The surgeons at Berck-Plage, although engaged in active orthopedic work, are all firmly convinced that residence at the seashore, with the greater part of the twenty-four hours spent in the open air, does more for the children than could be accomplished even in the best appointed hospitals in the cities.[1] One of the surgeons at Margate, after fifteen years of constant work in the wards, states his opinion that the knife plays a very secondary part to climatic and general influences.

For an institution of this kind to attain the highest efficiency one thing seems plain; the patients must be admitted at a very early age, not from six years old and upwards, but as early as two years of age. In this respect the French and American sanatoria have the advantage of the English. The point has been made that at six years

[1] Each year during the early part of August vacation clinics are held, which are attended by large numbers of French and foreign physicians.

of age a child with tuberculous disease is often past cure. Much can be done with a tuberculous case if "caught young."

After serious operations, the surgeons at the seaside sanatoria note that progress is much more rapid when patients can live in the open air and the practical point has been discovered that subsequent dressings of a much more simple character are permissible under the open air régime. For instance, in Metropolitan hospitals the practice of packing and draining wounds has untold terrors for the unfortunate patients. Dr. Charlton Wallace found that at "Sea Breeze" tuberculous sinuses heal more rapidly and permanently when all packing and drainage are omitted and only a sterile absorbent dressing is applied. As the general instability of these patients is such as to cause them almost to collapse at the thought of having their wounds probed and packed, it led him to believe that they would gain strength and local resistance if they were not nervously upset at the time of each dressing. In the beginning, in order to ascertain whether there would be full drainage comparisons were made of the amount of discharge, with and without the full dressing, and as there was no diminution he concluded that packing or tubing was not essential to drainage. Not only was the danger of infection less, no infected wound being observed, but he found that no sinus healed which still contained pus. This certainly simplifies the treatment of surgical wounds and the credit is given to the favorable atmospheric conditions.

At Sea Breeze the children receive from one to two hours instruction daily, the teachers being furnished by the Brooklyn Board of Education. It has been noted that the educational training given at this Sea Breeze Hospital has a most happy effect on the morals of the patients and at this early age much more can be accomplished in combating vice and ignorance, which constitute the greatest obstacles in dealing with the tuberculosis problem.

(For open air schools for tuberculous children, Waldschule, etc., see pp. 103-107).

In estimating the value of sea air in non-pulmonary tuberculosis in children, we naturally look to France for some data based on the enormous experience now extending over a period of nearly fifty years. During the last twenty years in France alone 60,000 children have been treated in these sanatoria and Dr. Brannan is authority for the following statement:

Cures, 59 per cent. Decidedly improved . . 25 per cent
Total of favorable results . . . . 84 per cent
Cures in Pott's Disease . . . . 32 per cent
Cures in glandular tuberculosis . . . . 74 per cent

HELIOTHERAPY. VIEW OF THE SOUTH GALLERIES OF THE MARINE HOSPITAL, BERCK-PLAGE, FRANCE. THE CHILDREN ARE EXPOSED ALL DAY NAKED TO THE SUN

SEA BREEZE HOSPITAL, SEA GATE, NEW YORK. OPEN AIR SCHOOL
Courtesy of Dr. J. W. Brannan

HELIOTHERAPY. SEA BREEZE HOSPITAL, SEA GATE, NEW YORK, MARCH 18, 1913. CURED CASE OF TUBERCULOSIS OF THE KNEE. NO SINUS.

Courtesy of Dr. Brannan

HELIOTHERAPY AT SEA BREEZE HOSPITAL, SEA GATE, NEW YORK, OCTOBER, 1912. CHILDREN ON THE BEACH. CURED CASES OF TUBERCULOSIS OF THE WRIST AND ANKLE. THERE WERE OPEN SINUSES IN EACH CASE.

These results of the treatment of surgical tuberculosis at seashore sanatoria are much more favorable than in the case of pulmonary tuberculosis, in adults, in corresponding localities (see pp. 71-73).

Nevertheless, the Department of Public Charities of the City of New York has just built and equipped at an expense of $3,500,000, a new hospital for adults having pulmonary tuberculosis in the second or third stage. The site selected is on the highest point of Staten Island in New York Bay, 400 feet above tide and only five miles from

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[1] See R. Russell, M. D.: Glandular Tabes, or the Use of Sea Water in Diseases of the Glands. London, 1750.

Ebenezer Gilchrist, M. D.: The Use of Sea Voyages in Medicine. London, 1771.

Albert L. Gihon, M. D., U. S. N.: The Therapy of Ocean Climate (Trans. Amer. Climat. Ass., 1889, p. 50).

M. Charteris, M. D.: Ocean Climate (Trans. Amer. Climat. Ass., 1890, p. 278).

Wm. Ewart, M. D., F. R. C. P.: The Present Position of the Treatment of Tuberculosis by Marine Climates (Journ. Balneology and Climatology, July, 1907).

W. S. Wilson: The Ocean as a Health Resort, London, 1880.

J. V. Shoemaker, M. D.: Ocean Travel for Health and Disease (The Lancet, July 23, 30, 1892).

Hughes Bennett, M. D.: Life at Sea Medically Considered (Medical Times and Gazette, Vol. 1, 1884, p. 244).

Thomas B. Peacock, M. D.: Beneficial Influence of Sea Voyages in Some Forms of Disease (Medical Times and Gazette, Vol. 2, 1873, p. 687).

John L. Adams: Report of 17 cases of Surgical Tuberculosis in Children (Boston Medical and Surgical Journal, 1906, Vol. 154, p. 17).

A. Crosbee Dixey, M. R. C. P.: Edinb. Lancet, Vol. 2, 1888, p. 264.

Boardman Reed: Effects of Sea Air Upon Diseases of the Respiratory Organs (Trans. Amer. Climat. Ass., Vol. 1, 1884, p. 51).

D'Espine, of Geneva. International Congress on Tuberculosis, Paris, October, 1905.

Armaingaud, of Bordeaux: International Congress on Tuberculosis, Paris, 1905.

Guy Hinsdale, M. D.: Treatment of Surgical Tuberculosis at the French Marine Hospitals and Alpine Sanatoria (Interstate Medical Journal, St. Louis, March, 1914).

Trans. Congrès de L'Association Internationale de Thalassotherapie, Cannes, April, 1914.

See also Willy Meyer: Open-Air and Hyperemic Treatment as Powerful Aids in the Management of Complicated Surgical Tuberculosis in Adults (Trans. Sixth International Congress on Tuberculosis, Washington, 1908, Vol. 2, twenty illustrations).

See also "Open Air Treatment of Tuberculosis," by the late Dr. DeForest Willard, *ibid.*, page 257. Also Trans. Amer. Orthopedic Ass., 1898. Shacks, bungalows, sleeping tents, sanatoria and day camps are discussed.

the ocean. This new addition to New York's equipment has one thousand beds and is called the "Sea View Hospital."

At the Second Annual Meeting of the National Association for the Study and Prevention of Tuberculosis held in Washington in 1906, the following resolution was offered by Dr. John W. Brannan and unanimously adopted:

> WHEREAS, Recent experience in Europe and in this country has shown that out-door life in pure air has the same curative effect in surgical tuberculosis as in tuberculosis of the lungs, therefore, be it
>
> *Resolved,* That in the opinion of members of this Association hospitals and sanatoria should be established outside of cities either in the country or on the seashore for the treatment from its incipiency, of tuberculosis of bones, joints, and glands in children.

SEACOAST AND FOGS

Marine climates naturally include the strictly ocean climate and that of the seacoast. In the former sea air comes from every point of the compass. It is always moist and it is the most equable air that blows; it is of infinite variety from the dead calm of the doldrums to the fierce gales of the North Atlantic.

The atmosphere of the seacoast is naturally modified at times by continental influences. Indeed the characteristic "sea breeze" which springs up in the morning and subsides toward sun-down is brought about by the ascent of heated air back of the coast. The hotter the interior and the more rapidly this air ascends the stronger is the sea breeze which rushes shoreward from the ocean and penetrates for fifty or a hundred miles the adjoining country.

But under other conditions land breezes occur and bring to the shore the Continental atmosphere of a totally different type. These atmospheric conflicts between sea and land involve most interesting meteorological problems; they tend to lessen the equability of the purely marine or oceanic climate. Freezing weather is the product of the Continent and the descent of cold waves from the interior; it brings to our northern seacoast frost and snow for a time, and never trespassing far upon the high seas. The seacoast has thus a mixture of two climates, but the sea air predominates and is never absent very long.

There are well-known places in America and in the British Islands where the sea breeze greatly predominates; Nova Scotia, Cape Cod, and Cape May in the United States; Land's End and the Cornish Coast in England are cases in point. In such exposed situations the air is generally poorly adapted to the tuberculous patient. The air

SEA BREEZE HOSPITAL, SEA GATE, NEW YORK. TREATMENT OF POTT'S DISEASE OF THE SPINE WITH PLASTER JACKETS AND HELIOTHERAPY
Courtesy of Dr. J. W. Brannan

FIG. 1. HELIOTHERAPY FOR SURGICAL TUBERCULOSIS. DR. ROLLIER'S SANATORIUM, LEYSIN, SWITZERLAND. DORSAL EXPOSURE

FIG 2. HELIOTHERAPY FOR SURGICAL TUBERCULOSIS. DR. ROLLIER'S SANATORIUM. From the author's article in Interstate Medical Journal, March, 1914

is said to be "too strong" and certainly for an all-the-year-round residence the capes and headlands are too much at the mercy of high winds which render out-door life disagreeable. About Cape Cod, Nantucket, and Martha's Vineyard there is a peculiar liability to fog which is as unwelcome to the consumptive as it is to the mariner.

The author has had experience with the fogs in these waters and considers it one of the great drawbacks to an otherwise agreeable climate. The summer and early autumn fogs of the eastern Maine coast and of the Bay of Fundy and Nova Scotia are worse in their chilly and penetrating qualities. The towns of Massachusetts on or near the seacoast seem to have somewhat more tuberculosis than those of the interior.

Deaths from Pulmonary Tuberculosis in Massachusetts per 100,000 Population

Five Maritime Towns	1905	1908-1912	*Five Inland Towns*	1905	1908-1912
Boston	224	155	Pittsfield	168	98
Salem	154	111	Springfield	125	89
New Bedford	164	124	Chicopee	125	109
Newburyport	181	131	Holyoke	154	131
Plymouth	162	90	North Adams	81	98
Average	177	122	Average	131	105

Mr. Hiram F. Mills, of the Massachusetts State Board of Health, has lately published a most painstaking analysis of the mortality from tuberculosis in all the towns and cities of that state.[1]

He shows that there are sixty cities and towns bordering on the sea having a total population of about one-third of the entire state, or 1,293,625, in which the average death-rate per 100,000 for the five years, 1908-1912, was 135. During this period the rate for the entire state was 131. Omitting Boston, which has peculiar conditions, from both calculations the rate was 111 for the remaining 59 maritime towns and cities against 124 for the remainder of the State. This throws the balance in favor of the seaboard. It should be noted that all the small and sparsely settled towns have low rates in almost regular gradation when compared with more and more populated districts.

Boston has had a noteworthy decrease in its tuberculosis death rate as shown by the following figures representing the rate for the last five years, namely, 271, 283, 254, 176, 182, or a decrease of one-third in five years. There are sixteen small towns having an aggre-

[1] Address to the State Inspectors of Massachusetts, November 3, 1913.

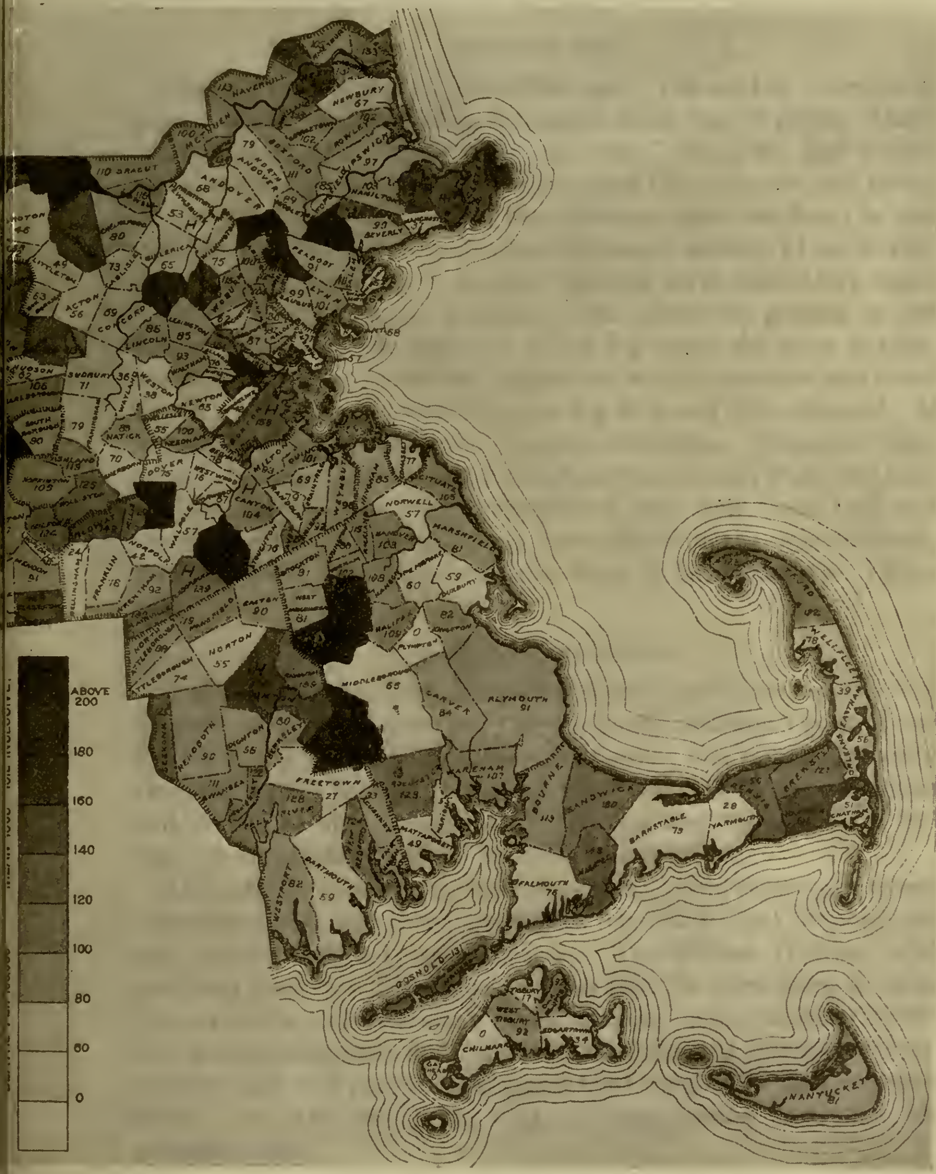
STATE BOARD OF HEALTH

MAP OF THE

STATE OF MASSACHUSETTS.

DEATHS FROM CONSUMPTION

SCALE OF MILES


ABOVE 200
180
160
140
120
100
80
60
0
HAVERHILL
NEWBURY
ROWLEY
IPSWICH
HAMILTON
BEVERLY
ANDOVER
NORTH ANDOVER
DRACUT
PEABODY
LYNN
LITTLETON
ACTON
CONCORD
LINCOLN
SUDBURY
WESTON
WALTHAM
NEWTON
NATICK
DOVER
WESTWOOD
MILTON
CANTON
WALPOLE
NORFOLK
FRANKLIN
MANSFIELD
EASTON
NORTON
ATTLEBOROUGH
REHOBOTH
DIGHTON
FREETOWN
MIDDLEBOROUGH
CARVER
PLYMOUTH
PLYMPTON
HALIFAX
HANOVER
NORWELL
MARSHFIELD
DUXBURY
KINGSTON
WAREHAM
BOURNE
SANDWICH
BARNSTABLE
YARMOUTH
DENNIS
BREWSTER
ORLEANS
CHATHAM
EASTHAM
WELLFLEET
FALMOUTH
MASHPEE
MATTAPOISETT
DARTMOUTH
WESTPORT
GOSNOLD
WEST TISBURY
TISBURY
EDGARTOWN
CHILMARK
NANTUCKET

checks the advent of fog and where the early morning hours are as bright and dry as the afternoons.[1]

RADIATION FOGS

Fogs are born of the sea and of the land. The sea fog is obviously purer and less injurious than the smoke-laden fog of cities. There are fogs and fogs; "dry" fogs and "wet" fogs; the fogs of the coast and the fogs of mountain valleys and river courses; but rarely of the plains. Radiation fogs are different from sea fogs; in dry weather, on a cold still night when the lowest stratum of air is rapidly cooled by contact with the cold radiating earth, the watery vapor is precipitated as minute globules. The colder the ground or the deeper and colder the water on which fog rests, the more persistent is the fog; but as the sun warms the watery particles and overcomes the heat lost by radiation, the fog lifts and floats upward. It is bound to lift as its specific gravity diminishes. Slopes of hills, especially their southern sides, some hundreds of feet above the lowland or seashore, are thus comparatively free from these fogs and are much drier and warmer than lower places in the neighborhood. Such locations are far preferable to those of lower altitude. (Russell.)

FOGS IN THE MOUNTAINS

And here we see how local geographic conditions modify the whole aspect of the question. On the North Atlantic Coast of the United States there are no mountain ranges; one cannot get away from the fogs if he would; while on the Pacific Coast, the mountains and their foot hills are comparatively near and one can be in full view of the seashore and yet be above the fog line.

At Santa Barbara, one of the favorite California resorts for tuberculous patients, fogs occur frequently from May until October, but are comparatively rare at other times. Dr. William H. Flint, who practiced there for thirteen years, says that the fogs creep in from the sea in the late afternoon, in the evening, or in the early morning, disappearing at an uncertain hour the following forenoon. Occasionally fogs will persist all day and for a number of days consecutively. In May and June, 1903, a foggy period continued for seventeen days.[2]

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[1] See A. G. McAdie: The Sun as a Fog Producer, Monthly Weather Review, Washington, 1913 (778-779).

[2] Trans. Amer. Climat. Ass., 1904, p. 20.

The late Dr. C. H. Alden, Asst. Surgeon General, U. S. A., who passed his later years, and died of tuberculosis, in Pasadena, California, says:

> The climate of Southern California is not a dry one, as some suppose. As this region lies along the coast, and its most frequented portions are nowhere very distant from the water, the climate cannot be dry. The humidity lessens as one goes inland, but is always considerable, except in the uninhabited desert. The fogs which, in the absence of much rain, are a large factor in sustaining vegetation, penetrate many miles from the sea and add to the humidity. *The fact that the humidity is not favorable for pulmonary tuberculosis which is at all advanced is evidently not appreciated as it should be.* [Italics, author's.]

Even as far as Redlands, over fifty miles from the coast, according to General Alden, who lived there for two winters, "fogs come up from the sea during the spring, but they are shorn of most of their moisture." Nevertheless, Redlands, from its comparative dryness, is a favorite place in winter for patients with pulmonary tuberculosis and they no doubt do better there than at Los Angeles, Pasadena, or at resorts directly on the coast. General Alden's conclusion is that while the mild temperatures and continuous sunshine of this region are favorable for the aged and the feeble from many causes, needing an out-door life, the warmth and moisture are unfavorable for cases of pulmonary tuberculosis that are at all advanced.

In June, 1902, the author traveled through the mountains and visited the principal resorts throughout California. The sea air with its frequent accompaniment of fog seemed to him too strong or fresh for tuberculous patients. North of Santa Barbara or Monterey the sea air is certainly cold and harsh during most of the year and, wherever it penetrates, tuberculous patients feel worse. This is particularly true of the neighborhood of San Francisco. From the summit of Mt. Tamalpais, elevation 2,375 feet, on almost any summer afternoon fog can be seen driving in from the Pacific and spreading over San Francisco Bay. As the sun descends the temperature of the air drops, so that saturation is reached. Fog results. Now on the southern California coast the cold, ocean atmospheric currents contain much less actual moisture than the warm, clear air on shore and the resultant mixture will now contain less water than the warm air did before and hence it is claimed with reason that notwithstanding the dripping roofs and wet pavements, there is less absolute moisture in the air than before the fog appeared.

We did not find the California fog either so cold or chilling as we have observed it on the extreme eastern coast of Maine; nor is it so

FOG WAVES. FROM THE SUMMIT OF MOUNT TAMALPAIS, OVERLOOKING SAN FRANCISCO BAY
Photograph by Prof. A. G. McAdie. Courtesy of the Chief of the United States Weather Bureau

"Banked in a serried drift beside the sea,
Rolling, wind harried in a snowy spray,
Majestic and mysterious, swirling free
The ghostly flood is massing cold and gray."

MORNING FOG OVER VALLEYS
Photograph by Prof. A. G. McAdie. Courtesy of the Chief of the United States Weather Bureau

depressing and relaxing as the heavy misty weather observed in central and western Virginia mountain valleys during the rains of early summer and autumn, certainly not so depressing as the relaxing moisture of the tropics. The California fogs have been likened to the Scotch mist. They never deter the fishermen from curing their fish on their racks along the seashore. Raisins and other fruit are dried in the open fields and residents claim that during the rainiest weather nothing molds or rots. (P. C. Remondino.)

Mr. Ford A. Carpenter, of the U. S. Weather Bureau, has published an interesting book, in which he gives a lucid description of the fogs of the Pacific Coast.[1] He shows that on that coast the maximum fog is reached in San Francisco, with moderately high averages north to the Canadian boundary and decreasing in frequency and duration with the latitude, San Diego having the least on the coast. He says that daylight fogs are practically unknown in San Diego. A "day with fog" is one on which there is one hour or more of fog dense enough to obscure objects one thousand feet distant. At San Diego the hours of greatest frequency were between eleven at night and six in the morning. Mr. Carpenter notes the beneficial effect of California fogs and says that it is impossible to measure accurately the amount of moisture conveyed by fog. There is no doubt that over a region covered by vegetation exposing a natural condensing surface, such as eucalyptus, palm, iceplant, etc., not less than a ton of water to the acre is thus distributed during the prevalence of every dense fog. It also checks evaporation.

"It is not fog in the generally accepted meaning, for this 'light veil' is neither cold nor excessively moisture-laden. Neither is it high, for its altitude is less than a thousand feet. To one who has spent a few weeks of spring, summer or fall in southern California, the picturesque description of the musical Spanish *el velo* is quickly recognized as both expressive and truthful." *"El velo de la luz"*: "the veil that hides the light." *"Velo qui cubre la luz del so"*: "The veil which shades (covers) the light of the Sun." *"El velo de la mañana"*: *"The veil of the morning."*

There is probably no place on the entire coast line of the United States that offers so many climatic advantages for tuberculous patient as San Diego and its attractive neighbor, Coronado.

It is a mistake to believe that because there is fog, the humidity is necessarily high during its presence. The United States Weather

[1] The climate and weather of San Diego, California. San Diego, 1913. See Review in Journ. Royal Meteorological Society, Jan., 1914.

Bureau has taken pains to determine the relative humidity during fogs observed during ten years at Chicago on Lake Michigan. Observations were made on 118 foggy days by Dr. Frankenfield, whose results are given as follows:

Relative humidity 90 per cent (or more) in 75 per cent of days.
Relative humidity 80 to 90 per cent in 13 per cent of days.
Relative humidity below 80 per cent in 12 per cent of days.

The observer noted dense fog on one occasion when the relative humidity was as low as 52 per cent; on another, when it was 58 per cent.

The Pacific coast, as a whole, is much foggier than the Atlantic coast, because the winds on the Atlantic are mostly off-shore and consequently carry less moisture than the westerly on-shore winds of the Pacific.

In the interior of the United States, especially the western half, the average number of foggy days per year is less than ten each year; in the Lake region the number rises to fifteen or twenty per annum. In isolated localities, local conditions increase this number greatly.

At Colorado Springs genuine fogs occur, sometimes very dense and lasting all day, but they are uncommon and scarcely worth mentioning were not their existence so often denied. (Ely.)

In the Adirondack Mountains fogs and mists are not uncommon along the rivers and on the lake shores in the early morning in the summer and autumn. They are examples of the radiation fogs already referred to and, like dew and frost, they are associated with clear weather. The presence of a light fog over an Adirondack lake in the early morning foretells a bright, sunny, warm day.

Fogs are not at all unusual in the Alleghany and Blue Ridge Mountains. They follow river courses and settle in low valleys. The humidity attendant on the melting of snow or during the rains of early summer or autumn is not so readily exchanged for dryer air in the long narrow valleys as at the seaboard. In many localities the high ridges on either side shut out the direct rays of sunlight for several hours; while at the seaboard there are no such natural barriers.

At some of the higher elevations in the Blue Ridge Mountains of Pennsylvania, fog is noted during the summer and autumn. One observer, himself a tuberculous patient, recorded at Mount Pocono, in Monroe County, Pa., elevation 2,000 feet, fifteen days with fog part of the day, usually early morning, and seven with fog all day,

FOG LIFTING, SAN FRANCISCO BAY

Photograph by Prof. A. G. McAdie. Courtesy of the Chief of the United States Weather Bureau

SEA OF FOG FROM SUMMIT OF MOUNT WILSON, CALIFORNIA
From Photograph by Ferdinand Ellerman

FIG. 1. RUTLAND, MASSACHUSETTS, STATE HOSPITAL FOR CONSUMPTIVES

DAY CAMP FOR TUBERCULOUS PATIENTS, HOLYOKE, MASS.

UNDERCLIFF, A CAMP ON LAKE PLACID, ADIRONDACKS, NEW YORK
Courtesy of Dr. C. D. Alton

between June 1 and December 1. But this patient adds the significant remark: "However, it seems ridiculous for me to find fault with Mount Pocono when I did so well there. My cough and expectoration decreased considerably; I gained five pounds and grew somewhat stronger."[1]

At Rutland, Massachusetts, the site of the Massachusetts State Sanatorium, there were 24 days with fog for the year ending November 30, 1907. Nevertheless, out of 4,334 cases of pulmonary tuberculosis treated since its opening, 43.39 per cent of cases were arrested or apparently cured, and in addition, 47.38 per cent were improved.[2]

From what has been said, it is, therefore, not surprising that claims are made that there is a noticeable difference in the character of fogs on the New England Coast.[3] Dr. Bowditch has described the fogs on the Maine Coast as sometimes "dry fogs." "The light vapory mist which drives in frequently from the sea has no definite sense of moisture as it strikes the face, and in the midst of it the air frequently feels dry. In the vicinity of Mount Desert, the presence of the mountains has, doubtless, an effect upon the quality of the atmosphere, and would partly account for what is often spoken of—the effect of sea and mountain air combined. Its peculiar dryness, even though on the coast, has been often so marked that I have frequently thought that certain phthisical patients, who need a dry bracing atmosphere, might improve there, although I have never quite dared to recommend it for such cases."

SEA AIR FOR SURGICAL TUBERCULOSIS

Halsted, of Baltimore, however, has recorded a favorable result in a case of tuberculous glands of the neck, treated simply by an outdoor life on the Maine coast. The patient was a young lady of seventeen, whose cervical glands were actively inflamed and softened, the overlying skin having rapidly reddened and thinned during a treatment of six hours a day out of doors at a seashore further south. No operation was done, but she was sent to the Maine coast and lived *out-of-doors day and night* for four months. At the end of this period no one could tell, from the appearances, which side had been affected, and Halsted remarked that, to surgeons whose daily bread not long ago was tuberculous glands of the neck, such a

[1] Journal of the Outdoor Life, February, 1908, p. 15.
[2] Eleventh Annual Report, 1907.
[3] Vincent Y. Bowditch, Trans. Amer. Climat. Ass., 1897, p. 25.

resolution foretells a revolution in treatment.[1] That revolution is, fortunately, to-day *un fait accompli.*

Some of the European sanatoria of the best grade are in situations not altogether free from fogs and mists. This is true of Falkenstein, elevation 1,378 feet (420 m.), whose atmosphere is a little misty and foggy.

AIR OF INLAND SEAS AND LAKES

The region of the Great Lakes lying between the United States and Canada has been studiously avoided in selecting a site for any of the large sanatoria for tuberculosis. It is a matter of common observation that nasal, pharyngeal, and bronchial catarrhs are exceedingly common in adjacent districts. The lake winds are damp and are partly frozen during several months in the year, giving to the surrounding country a harsh climate.

The lower lake region is also the favorite track of storms or cyclonic atmospheric movements which sweep the lakes and the St. Lawrence valley on their way to the seaboard. As these areas of low atmospheric pressure advance they are attended by increasing cloudiness in front and are usually followed by colder air from the Northwest, the fall in temperature being sufficient at times to constitute a cold wave.[2]

The winter storms on the Great Lakes are quite as violent as any on the seacoast, and on Lake Superior and Lake Huron floating ice may be seen in May and sometimes, in Lake Superior, as late as June. Lakes Michigan, Erie and Ontario are more southerly, but their shores are low and the skies are notably cloudy. The author has experience of the cold fogs of Lake Superior in July and August, and was impressed with their penetrating quality. A summer spent on both the northern and southern shores of Lake Superior was wonderfully exhilarating; the air has a purity and stimulus such as one might expect from millions of miles of forest roundabout. But not a single place on that vast shore can be recommended as a residence for a tuberculous patient. The vicissitudes of the weather are such that the approved methods of cure could not well be carried out.

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[1] Trans. Nat'l Ass. for the Study and Prevention of Tuberculosis, 1906.

[2] To constitute a cold wave, so called, there must be a fall of twenty degrees or more in twenty-four hours, free of diurnal range and extending over an area of at least 50,000 square miles, the temperature somewhere in the area going as low as 36° F.

WALLUM LAKE, RHODE ISLAND. PATIENTS OF THE STATE SANATORIUM FOR TUBERCULOSIS
Courtesy of Dr. Harry Lee Barnes

In the location of the state sanatorium for tuberculous patients in Minnesota, an interior and northerly location was wisely chosen, 150 miles south of Lake Superior, at Lake Pokegama, near the headwaters of the Mississippi.

The Wisconsin State Sanatorium has been located on Lake Nebagamon, thirty miles from Lake Superior.

Such small lakes as Lake Pokegama in Minnesota; the Muskoka Lakes in Ontario, where the Canadian National Sanitarium Association has established two sanatoria for consumptives; and the Saranac Lakes in the Adirondack Mountains, have no such power to modify the qualities of the atmosphere. Whatever influences are attributable to these smaller bodies of water are small, compared with that of the forest and mountains. Undoubtedly a small lake is a desirable feature in connection with a sanatorium, as it provides sources of amusement throughout the year and adds greatly to the beauty of the landscape. The writer spent six summers at Lake Placid in the Adirondack Mountains at an elevation of 1,860 feet. This is somewhat more protected than the Saranac Lakes, St. Regis Lake or Long Lake, and, in his opinion, is quite as well suited as a residence for tuberculous patients as any other locality in the Adirondacks. The State of New York has built its large State Sanatorium at Ray Brook only four miles distant from Lake Placid. The State of Rhode Island has chosen Wallum Lake for its new Sanatorium, views of which are here given.[1]

CHAPTER IV. INFLUENCE OF COMPRESSED AND RAREFIED AIR; HIGH AND LOW ATMOSPHERIC PRESSURE; ALTITUDE

No phase of the tuberculosis question has been so vigorously debated as the influence of altitude; no feature of the subject is so far from satisfactory solution. The battles between the Highlanders and the Lowlanders of Scotland seem to have been revived in the attempts to settle this question. Instead of the claymore and battle-axe, we have an array of statistics in serried columns marshalled by the leaders of the opposing forces. This history of the conflict would make as large a record as the Medical and Surgical History of the War of the Rebellion. And the end is not yet in sight.

After trying for years to cure consumption by means of an "equable climate" obtained at home by housing the patient behind double

[1] The large German Sanatorium Grabosee is located on the shores of Lake Grabow.

windows, or by sending him to the islands of the sea, such as Madeira and the West Indies, the medical profession began to be impressed with the good results reported from the Rocky Mountains and the plains of the Western states and territories.

In the rush to the California gold fields in 1849 and in the rapid emigration from Eastern states to Colorado, Utah, California, overland in the "prairie schooner" and on horseback during subsequent years, the Western country became known for wonderful health-giving qualities. It was not long before Colorado became widely heralded as a health resort for consumptives. English physicians sent their patients to Colorado instead of sending them to Australia, Algiers, or to the Riviera and the results obtained were remarkable. The late Dr. S. E. Solly, who practiced in Colorado for thirty-three years, was sent from London on account of the higher altitude and better air of Colorado, and was one of a large number of English residents who have made their home in that state on account of pulmonary tuberculosis.

In 1876, the late Dr. Charles Theodore Williams, of London, published his report to the International Medical Congress and in 1894 issued his work on Aero-Therapeutics, in which are detailed the histories of 202 consumptives who were sent to Colorado at an altitude of 5,000 or 6,000 feet. They represented a residence of 350 years at this elevation and the results were exceedingly satisfactory.

Jourdanet, a French physician practicing in Mexico, published two works, one in 1861 and one in 1875, which undertook to explain the influence of barometric pressure and, incidentally, why, on the plain of Anahuac, 6,000 feet in elevation, there is an entire absence of pulmonary phthisis.[1]

Jourdanet aided the great French physiologist, Paul Bert, in establishing costly apparatus for investigating the physiological action of compressed and rarefied air and Paul Bert's classic work is an accepted authority on this subject. Later studies by Mosso and Marcet[2] should be noted, but it is impossible here to give more than passing notice. They show that a diminution of the barometric pressure increases the respiration rate and the volume of air respired, but if allowances are made for the increase of volume of the air at the lower pressure, the actual volume respired is less. Conversely,

[1] D. Jourdanet: Influence de la Pression de l'Air, Paris, 1875. Herrera and Lope: La Vie Sur Hauts Plateaux, Hodgkins Prize Memoir, 1898.

[2] An American Text-Book of Physiology, Phila., 1901, Vol. 1, p. 434. Angello Mosso: Man in the High Alps (Der Mensch auf den Hochalpen, Leipsig, 1899), Translation by E. L. Kiesow, 1898.

an increase of pressure lowers the rate and the volume of air respired. The effects of the respiration of rarefied air and compressed air on the circulation and on the composition of the blood are very marked and are of a complex character owing to the additional influences of the abnormal pressure on the peripheral circulation. Not only is the circulation affected but, in the case of residence at high altitudes, the proportion of red blood corpuscles and of hemoglobin is notably increased. This increase in the red blood count at the higher altitudes, while not so great or so permanent as was at first supposed, is an established clinical fact and adds undoubted strength to the claim that altitude *per se* is a characteristic of the favorable climate for tuberculous patients.

DIMINISHED ATMOSPHERIC PRESSURE

The influence of diminished atmospheric pressure on the blood has been studied by Paul Bert in 1882,[1] Zuntz,[2] P. Regnard,[3] Viault,[4] Egger,[5] Woolff,[6] Koeppe,[7] Solly,[8] by W. A. Campbell and Gardiner and Hoagland,[9] by L. S. Peters[10] and by F. Laquer.[11] One of the

[1] Paul Bert, *loc. cit.*, studied the blood of animals at La Paz, in Mexico, at an altitude of 12,140 feet (3,700 meters) and found that they had an oxygen-carrying capacity far in excess of that exhibited by the animals on the lower plains.

[2] Zuntz: Experiments on the Pic du Midi, Elevation 9,000 feet. He emphasized the possibility of an altered distribution of corpuscles.

[3] Regnard, P.: La Cure d'Altitude, 2eime Ed. Paris, 1898.

[4] Viault: Experiments at Merococha, Peru, elevation 14,275 feet. 1890. He noted that his blood contained 7 to 8 million red corpuscles per cubic millimeter.

[5] Egger: The Blood Changes in High Mountains. Verhandlungen d. xii, Congr. Inner. Med., 1893.

[6] Woolff: Verhandlungen d. xii. Congr. Inner Med. 1893, pp. 262-276.

[7] Koeppe, xii. Congress für Inner. Med., 1893; Arch. Anat. Physiol., 1895, pp. 154-184.

[8] S. E. Solly: Blood Changes Induced by Altitude. Trans. American Climatological Association, 1899, p. 144; also 1900, p. 204.

S. E. Solly, Therapeutic Gazette, February, 1896.

[9] Campbell and Hoagland: Trans. American Climatological Association, 1901, p. 107.

[10] For the effect of altitude, 6,000 feet, on blood pressure in tuberculous patients, see article by L. S. Peters, Silver City, New Mexico, in Archives of Internal Medicine, August, 1908 and October, 1913. The latter report covers 600 cases and shows that altitude tends to raise blood pressure rather than lower it both in consumptives and in normal persons living at high altitudes.

[11] F. Laquer: Höhenclima und Blutneubildung, Deutsches Archiv für klin. Med. Leipzig, 1913, cx, Nos. 3 and 4, p. 189.

most thorough original studies is by Drs. Ossian, Schaumann and Emil Rosenquist, of Helsingfors, Finland.[1] Turban, also, has made a study of this subject.[2]

Much of the earlier work has been proved incorrect as instrumental and laboratory technic has been improved. Hematologic work has made rapid strides and several important correcting factors have been introduced. Attention has been called to the more rapid evaporation of blood samples at high altitudes where the climate is always dry and errors from this source are considerable.

Not only that, but the human organism itself loses water more readily than at lower levels and so do animals used for experimental purposes. How much value should be given to these corrections we do not know, but there is evidently a revision downwards noticeable in nearly all the later studies of the blood count at high altitudes. Prof. Bürker, of Tübingen, and his colleagues show at best only a comparatively small increase amounting to only four to eleven and a half per cent at an altitude of six thousand feet.[3]

These observers made comparative observations at Tübingen (altitude 1,030 feet or 314 meters), and at the Sanatorium Schatzalp (altitude 6,150 feet or 1,874 meters, about 300 meters above Davos).

Bürker's findings, which appear to result from an exceptionally careful personal investigation with every precaution to avoid experimental error, show that altitude does exert an unquestionable influence on the blood in the direction of an increase in both the number of erythrocytes and the content of hemoglobin. The increase is an absolute one, not merely relative. The red cells increased from 4 to 11.5 per cent, the hemoglobin from 7 to 10 per cent. These figures, it will be noted, are smaller than those usually given for the effect of moderate altitudes, yet they represent substantial and undeniable gains quite in harmony with other previous observations.

The responses of the different persons in Bürker's Alpine expedition varied in degree; but the qualitative examination of the blood established the fact that no hemoglobin derivative other than oxyhemoglobin was concerned in

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[1] Ossian, Schaumann and Rosenquist: Ueber die Natur d. Blutveranderungen in Hohen Klima, Zeitschr. f. klin. Med., 1898, Band xxxv, Heft 1-4, pp. 126-170 and 315-349.

[2] Turban, Münch. Med. Wochenschr., 1899, p. 792.

[3] See Editorial Altitude and the Blood Corpuscles, Journ. Amer. Med. Ass., February 3, 1912, p. 344; September 21, 1912 and November 1, 1913.

Bürker, K.; Jooss, E.; Moll, E., and Neumann, E.: Die physiologischen Wirkungen des Höhenklimas: II. Die Wirkung auf das Blut, geprüft durch tägliche Erythrozytenzählungen und tägliche qualitative und quantitative Hämoglobinbestimmlungen im Blute von vier Versuchspersonen während eines Monats, Ztschr. f. Biol., 1913, Vol. 61, 379.

the increment at altitudes. In agreement with most observers the adjustment of the blood to the new atmospheric conditions in ascending to higher levels occurs promptly; there is a rapid increase in the factors involved at the start followed by a more gradual continuation of the effect; but on returning toward the sea-level the blood does not resume its "low altitude" composition so promptly. There may be a prolonged delay in the adjustment and return to normal figures.[1]

Cohnheim[2] regards evaporation as the cause of the concentration of blood under these conditions and that this is not due to a lack of oxygen. These studies in hematology have an important bearing on the course of tuberculosis at high altitudes, and constitute a very live question at the present day.

Professor Cohnheim and Dr. Weber[3] have recently reported the results of examination of the blood of twenty-three persons who have been engaged for long periods in the operations of the railway ascending the Jungfrau peak in the Alps. Most of them spent considerable portions of their time at altitudes from 2,300 meters (7,546 feet, Eigergletscher Station) upward to 3,450 meters (11,319 feet, Jungfraujoch Station). The importance of these observations lies in the fact that they furnish data regarding persons who have had prolonged experience in the higher altitudes so that the incidents of temporary residence and change of scene may be regarded as equalized or eliminated. They supplement the earlier records from the South American plateaus by results obtained with approved and up-to-date procedures. The new statistics agree in exhibiting values both for red blood-corpuscles and hemoglobin distinctly higher than the "normals" of sea level. Cohnheim maintains that the high figures thus obtained on a large scale from subjects accustomed to live at high atmospheric levels leave no alternative except to assume a new formation of corpuscles under such conditions. Where contrary conclusions have been reached—and there are many such—it is not unlikely that the period of residence was too brief to permit the stimulating effects of altitude to manifest themselves in any conspicuous way.

The renewed assumption of an increased functioning of the hemopoietic organs at high altitudes has further been supported by observations conducted on Monte Rosa in the Alps relating to the regeneration of blood after severe anemias. In the international laboratory built on the Col d'Olen at an altitude of 2,900 meters (9,515 feet) and dedicated to the memory of Angelo Mosso, Laquer[3] has found that dogs deprived by hemorrhage of half their blood-supply regenerate it in about sixteen days. Under precisely comparable experimental conditions twenty-seven days are required at lower levels for the restoration of the same blood loss. Laquer believes that the lower partial pressure of the oxygen is the effective stimulating factor in this more pro-

[1] Editorial in Journ. Amer. Med. Ass., Nov. 1, 1913, *q. v.*

[2] For a recent review of this subject see Cohnheim, O.: Physiologie des Alpinismus, II. Ergebn. d. Physiol., 1912, xii, 628; also Anglo-American Expedition to Pike's Peak, Journal Amer. Med. Ass., Aug. 10, 1912, p. 449.

[3] Cohnheim, O., and Weber: Die Blutbildung im Hochgebirge, Deutsch. Arch. f. klin. Med., 1913, cx, 225.

nounced regeneration so strikingly shown at great heights. How long this latest explanation will withstand the attacks of the increasing number of Alpine physiologists remains to be seen.[1]

The latest observations show that arterial blood contains considerably more oxygen at high altitudes than at sea level. The pulmonary alveoli have a special power of extracting or secreting oxygen and this power is increased in high altitudes, this increase not disappearing until a considerable time after descent to sea level.

W. R. Huggard, of London, an unbiassed and judicial observer, says: "The diminished frequency of tuberculosis with altitude may, I think, be taken as established."[2] Hirsch[3] held the same opinion and based his statement on statistics from various places.

Thirteen years ago, Dr. Solly endeavored to show this statistically and arranged three tables which we append.

TABLE I

Comparative Results in Sanatoria in High and Low Climates

COMBINED FIRST AND SECOND-STAGE CASES ONLY

(Taken from Dr. Walters, pp. 52 and 53)

1876–1886	Altitude	Number of Cases	Number Benefited	Per Cent
LOWLAND CLIMATES				
Goerbersdorf (Manasse)	1,840 ft.	3,615	1,294	36
Falkenstein (Dettweiler)	1,375 ft.	1,022	746	73 } 71
Reiboldsgrün (Driver)	2,300 ft.	2,000	1,400	70 }
Total	....	6,637	3,440	Average, 51
HIGHLAND CLIMATES				
Leysin (Bernier)	4,150 ft.	37	34	92
Davos (Turban)	5,115 ft.	302	269	89
Arosa (Jacobi)	6,000 ft.	259	212	82
Total	....	598	515	Average, 86

The total average of benefited in low climates was 71 per cent[1]
" " " " " high " " 86 "

[1] Without Goerbersdorf.

The Goerbersdorf reports up to 1884 are so much lower in the percent of benefited to the others—owing, perhaps, to some different method of estimating results, or, perhaps, to their being taken so many years ago, when the material was worse and the treatment perhaps not as efficient—that probably it would bring out the truth better to omit them.

[1] Editorial in Journ. Amer. Med. Ass., July 26, 1913.

[2] W. R. Huggard: A Handbook of Climatic Treatment, London, 1906, p. 124.

[3] Hirsch: Geographical and Historical Pathology, New Sydenham Society Translation, 1886, Vol. 3, p. 440.

TABLE II

COMPARATIVE RESULTS IN OPEN RESORTS IN LOW AND HIGH CLIMATES

ALL STAGES

(Taken from Handbook of Climatology, Solly, pp. 132 and 133)

	Number of Cases	Number Benefited	Per Cent
LOWLAND CLIMATES			
Desert Climates	154	100	65
Island Climates	568	295	52
Coast Climates	2,328	1,369	59
Inland Climates	136	77	57
Total	3,186	1,841	Average, 58
HIGHLAND CLIMATES			
Alps (Davos)	2,027	1,551	77
Colorado	571	420	73
Total	2,598	1,971	Average, 76

The total average of benefited in lowland climates was 57 per cent
" " " " " " highland " " 76 per cent

The first table, Table I, deals with the comparative results in sanatoria in high and low climates, first and second stage cases combined being alone taken, and the different variety of forms of improvement being grouped under the head of benefited. Of the lowland sanatoria the lowest elevation above sea-level was 1,840 feet, and the highest 3,300 feet. Of the highland climates the lowest elevation was 4,150 feet, and the highest, 6,000 feet. The total average percentage of benefited in low climates was 71, and in high climates 86.

Table II gives comparative results in open resorts in low and high climates. The total average of benefited in lowland climates was 57 per cent, in highland climates 76 per cent.

TABLE III

COMPARATIVE RESULTS IN HIGH AND LOW CLIMATES IN OPEN AND CLOSED RESORTS

Sanatoriums	Per Cent Benefited	Open Resorts
LOWLAND CLIMATES		
Hygeia (A. Klebs)	69	
Goerbersdorf (Brehmer)	76	
Adirondacks (Trudeau)	77	
Average	74	Average percent of benefited, 58
HIGHLAND CLIMATES		
Davos (Turban)		
Arosa (Jacobi)		
Average	84	Average percent of benefited, 76

Table III shows the comparative results in high and low climates in open and closed resorts. The cases, however, could not be obtained in first and second stage cases alone, but only of all stages combined. In lowland climates the closed sanatoria show 74 per cent benefited, and the open resorts 58 per cent benefited. In highland climates the closed sanatoria show 84 per cent benefited and the open resorts 76 per cent, exhibiting the relative superiority of sanatorium over open resort treatment in the two classes of climates, respectively. Doubtless the sanatorium cases were on the whole in better condition upon first coming under treatment than those in the open resorts and, therefore, the superiority of sanatorium treatment over open methods is probably not as great as it appears here; but, nevertheless, even if the material were exactly the same, the sanatoria would show a greater percentage of benefited over the open resorts.

Table III also proves that climate exercises a beneficial influence over patients in closed sanatoriums as well as in open resorts. In all stages combined the percentage of benefited in sanatoria in low climates was 74 per cent, while in high climates it was 84 per cent.

In the first and second stage cases combined (see in Table I), the difference in favor of mountain sanatoria is still greater—lowland sanatoria 71 per cent; highland sanatoria 86 per cent.[1]

The following is the classification of the National Association for the Study and Prevention of Tuberculosis adopted in May, 1913. The data given in the table on page 69 are given in terms generally used up to that time.

CLASSIFICATION OF SUBSEQUENT OBSERVATIONS

Apparently Cured: All constitutional symptoms and expectoration with bacilli absent for a period of two years under ordinary conditions of life.

Arrested: All constitutional symptoms and expectoration with bacilli absent for a period of six months; the physical signs to be those of a healed lesion.

Apparently Arrested: All constitutional symptoms and expectoration with bacilli absent for a period of three months; the physical signs to be those of a healed lesion.

Quiescent: Absence of all constitutional symptoms; expectoration and bacilli may or may not be present; physical signs stationary or retrogressive; the foregoing conditions to have existed for at least two months.

Improved: Constitutional symptoms lessened or entirely absent; physical signs improved or unchanged; cough and expectoration with bacilli usually present.

Unimproved: All essential symptoms and signs unabated or increased.

Died.

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[1] Dr. S. E. Solly, in the Philadelphia Medical Journal, December 1, 1900.

It is practically impossible to draw accurate conclusions from data furnished by different institutions, under such wide variations as to the character of the patients and varying standards as to what constitutes an apparent cure or arrested disease. A glance at the chart or table shows that good results are obtained at all eleva-

Sanatoria	Elevation	Apparently Cured	Disease Arrested	Improved	Unimproved	Died	Year	Stage
	feet	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*		
Sharon, Mass.	250	56	18	33	9	......	1891–1911	All
Barlow, Los Angeles, Cal.	300	3 3.5 16 31.14	4 6 16 14.7	40 39.5 42.8 32.8	35 27.5 9 9.8	13 22 1.7 6.5	1907 1903–7 1912 1913	All Chiefly advanced
Wallum Lake, R. I. (State)	650	8.5 6.7	32.9 27.4	33.6 38.3	23.7 24.9	1 2.5	Previous to 1912 1912	All
Muskoka, Canada	700	5.54	20.8	45.41	24.56	3.67	1902–12	All
Pottenger, Monrovia, Cal. (Private)	1000	68 25 8	21 50 33	11 17 36	...... 4 8	...... 4 15	1909 to 1912	Incipient Second Third
Otisville, N. Y. (State)	1200	12	47.3	27.7	10.5	1.3	1913	All
Rutland, Mass. (State)	1165	26.1	35.6	29.5	9	......	1906	Early
New Jersey State (Glen Gardner)	900	12	29	42	16	1	1912	All
White Haven, Pa. (Free Hospital)	1250	......	17.1	59.9	13.7	3.3	1901–13	All
Adirondack Cott. Sanitarium, Saranac Lake, N. Y.	1750	48.3 8.8	36.3 48.2	....	15.4 43	...... 4.2	1885–1911	Incipient Moderately and far advanced
Ray Brook, Adirondacks, N. Y. (State)	1635	34.4	31.6	17.3	14	.9	1912	All
New Mexico Cottage Sanitarium, Silver City (600 cases, Private)	6000	83 50 13	17 33 30	...... 8 25	...... 6 26	...... 2 4	1904–13	Incipient 19% Moderately advanced, 19% Far advanced 62%
U. S. Public Health Service Sanatorium, Fort Stanton, N. M. (For Sailors)	6231	11.7	15	29.1	9.5	34.5	1899–1912	All
U. S. Army Hospital, Fort Bayard, N. M.	6400	2.02 4.78	2.87 11.40	69.25 52.38	19.59 23.80	6.25 7.64	1911 1912	All All

tions. The best results are claimed in incipient cases by the Pottenger (Private) Sanatorium, Monrovia, California, 1,000 feet, and New Mexico Cottage Sanatorium, Silver City, New Mexico, 6,000 feet.

INSOLATION. DIATHERMANCY OF AIR. ALPINE RESORTS

Associated with diminished atmospheric pressure are other important and inseparable atmospheric qualities which contribute largely to the resultant influence on man's welfare in the higher altitudes. These other qualities have a special influence on pulmonary tuberculosis and should be recognized in estimating the effect on patients of this class.

We have, first, greater insolation. The part played by the earth's atmosphere in arresting the sun's rays is very important and second only to the influence of the atmosphere of the sun itself in arresting the radiation of light and heat from the sun. Slight changes in the sun's atmosphere would speedily alter the terrestrial climate. On the earth's surface at sea level the energy of light of the sun and that of the heat rays are considerably less than at the higher altitudes and recent measurements are of great interest and practical value.

Dr. Julius Hann, the great meteorologist of Vienna, has noted that on the lower plains thirty to forty per cent of the total amount of the sun's heat was absorbed by the earth's atmosphere, whereas at the summit of Mt. Blanc, at 15,730 feet (4,810 meters) elevation, nearly one-half of the absorbing mass of the air is lost and the amount of the sun's heat absorbed was not more than 6 per cent. One can readily understand that when the resistance is removed the light rays are more effective than at sea level. The late Prof. S. P. Langley showed by delicate measurements at this height that the blue end of the spectrum grows to many times its intensity at sea level.[1] This marked diathermancy of the atmosphere goes hand in hand with altitude. The increased facility with which the solar rays are transmitted through an attenuated air accounts for the tan and sunburn so readily acquired on mountain tops and this quality is, in the author's opinion, of value in the prevention and treatment of tuberculosis.

Owing to the increased diathermancy of the atmosphere at elevated stations there is a remarkable difference between the atmospheric temperature in the sun and in the shade. At the higher Alpine resorts for tuberculous patients, such as Davos (5,200 feet), St. Moritz (6,000 feet), Arosa (6,100 feet), and Leysin (4,757 feet), the excessive heat in the sun compared with shade temperatures in winter favors the outdoor life during the "invalid's day." It also, incidentally, impresses all newly arrived visitors as a marvellous climatic feature. At St. Moritz, now a fashionable winter resort, ladies find parasols almost a necessity while friends are skating, and those

[1] S. P. Langley: Researches on Solar Heat and Its Absorption by the Earth's Atmosphere. Papers of the U. S. Weather Bureau, No. 15, Washington, 1884, p. 242.

who indulge in this Alpine pastime revel in summer clothing. Although the climate is a cold one it is characterized by great diurnal ranges of temperature, freedom from dust, winds and fogs, and eminently suitable for the climatic cure.

As the snow lies on the ground at these resorts for from three to five months, sleighing, skating, skiing and tobogganing are popular and some of these sports are allowable in suitable cases of tuberculosis. In March or April the snow melts and the roads become slushy and muddy, so that the air becomes very damp, and patients are accustomed to make temporary visits to lower stations, such as Wiesen (4,760 feet), Seewis (2,985 feet), Thusis (2,448 feet), Gais in Appenzell (2,820 feet), or Ragaz (1,709 feet), returning later to the higher stations.[1]

SURGICAL TUBERCULOSIS TREATMENT IN SWITZERLAND

No chapter on high altitude treatment would be complete at the present time without noting the brilliant success of Dr. A. Rollier in the treatment of surgical tuberculosis at Leysin, in the Vaudois Alps, Switzerland. This station has an altitude of about 4,500 feet above sea level. The hospital buildings face the south and are protected by mountain ranges from the cold winds of the north and west.[2] Rollier states that even in midwinter, with snow on the ground, the temperature on the sunny balconies is often as high as 95° to 120° F. Owing to the purity of the atmosphere and the absence of moisture there is little loss of the luminous and caloric radiation of the sun. Rollier established his first hospital for the treatment of tuberculosis of the bones and joints in 1903, but it is only during the last two or three years that his method has attracted so much attention, though Bernard, of Samaden, had practiced it in the pure mountain air of Graubunden in the Engadine; and probably this influenced Rollier to select an elevated site for his hospitals. These are three in number and are located at 1,250, 1,350 and 1,500 meters, or 3,800, 4,100 and 4,500 feet. The exposure of

[1] See Walter B. Platt, M. D.: The Climate of St. Moritz, Upper Engadine, Switzerland (Trans. Amer. Climat. Ass., Vol. 4, p. 137).

Arnold C. Klebs: St. Moritz, Engadine (Trans. Amer. Climat. Ass., 1906, Vol. 22, p. 15).

[2] See description by John Winters Brannan, M. D., Medical Record, June 7, 1913. Also Rollier, Paris Médical, January 7, 1911, and February, 1913. The author is indebted to Dr. Brannan for his data and to Dr. Rollier for the illustrations and descriptions of his method.

the patient to the sun is the essential feature and after three to ten days of acclimatization indoors he begins with five minute exposures of the feet, five times a day. This is steadily increased as pigmentation appears until finally the entire surface of the body is exposed from sunrise to sunset. The head is, however, protected with white caps and shaded glasses. With the development of the pigmentation the cure progresses until recovery is complete. Dr. Rollier has sent us photographs of a boy who had 32 foci of tuberculosis, even the lungs being involved. This boy was considered cured after fifteen months of treatment. See plate 26.

In another case there were multiple lesions, including a badly disorganized and anchylosed elbow with seven sinuses and a history of three resections of the joint and forearm. This boy also made a good recovery with complete return of function, full flexion and full extension. See plate 27. Dr. Brannan adds that he has seen many such cures at "See Breeze" and has kindly furnished photographs of some of these patients. See plate 16.

According to Rollier the pigmentation is the important element in the cure, inasmuch as it affords to the skin a remarkable resistance, favors the cicatrization of wounds and confers a local immunity to microbic infections. On days when there is no sunshine recourse is had to radiotherapy for the adults and the Bier treatment (local lowering of atmospheric pressure) for the children; at all times, whether the sun shines or not, the skin has its bath of air and light.

Two hundred beds in Rollier's sanatoria are reserved for children.

Dr. Rollier presented to the XVII International Medical Congress at London in 1913, a résumé of his method of heliotherapy and refers to eighteen separate communications to medical literature, in which he and his associates have described the method. Among other things we notice that he reports the number of adults having external tuberculosis treated by him as greater than that of children, 522 to 477. The prognosis for the former is as favorable as for the latter and the duration of treatment is never much longer. In Rollier's paper, referred to, all his cases for the past eleven years are tabulated and out of 1,129 patients, 951 are reported cured. Of the total number only three underwent the operation of resection. These were cases of gonorrheal arthritis; one was adult of over fifty years. Two cases of tuberculosis of the foot were treated by amputation; both were adults of over sixty years.

Rollier uses fixation by means of plaster, especially in Pott's Disease, but in all cases insists strenuously that the tuberculous joint

TWO VIEWS OF THE SAME CHILD. THERE WERE 32 FOCI OF LUNG, GLANDULAR AND BONE TUBERCULOSIS; GENERAL CONDITION VERY BAD. AFTER ONE YEAR OF HELIOTHERAPY AT DR. ROLLIER'S SANATORIUM WELL ESTABLISHED CURE. HEALED SCARS AT SIGHT OF OPEN SORES; VIGOROUS.

FOUR ILLUSTRATIONS OF THE SAME CHILD. HE WAS ADMITTED TO DR. ROLLIER'S SANATORIUM, LEYSIN, AT THE AGE OF FIVE, WITH NUMEROUS TUBERCULOUS FOCI IN THE BONE AND PERIOSTEUM AND ABOUT THE RIGHT EYE. THERE WAS TUBERCULOSIS OF THE ELBOW AND RIGHT FOREARM. THREE PREVIOUS OPERATIONS. SEVEN FISTULOUS OPENINGS IN THE ELBOW; SEVEN IN THE FACE. JOINTS IMMOVABLE; GENERAL CONDITION BAD. THE TWO LOWER VIEWS SHOW THAT AT THE END OF ONE YEAR THE OPEN SORE HAD HEALED. CHILD VIGOROUS.

or other site of the disease must not be covered over by any unremovable apparatus so as to interfere with the full exposure to the sunlight. Rollier's last paper goes very fully into the technic of heliotherapy and the reader is referred to this and to the fully illustrated paper in "Paris Médical," February, 1913, in which there are forty-five remarkable photographs covering the most interesting features of this work. It is at present attracting great attention and American physicians can find in the recent review of Rollier's work by Dr. Henry Dietrich, of Los Angeles, California, an excellent summary of its theory and practice.[1]

Rollier,[2] in his address before the Gesellschaft deutscher Naturforscher and Aerzte in Münster in 1912, says:

> It is in surgical tuberculosis that we have seen the best results from heliotherapy, and we have made the treatment of it our life work. As a result of my experience in the use of the light-cure in higher altitudes, based on an experience of nine years, I maintain to-day that the cure of surgical tuberculosis in all its forms, in all stages, as well as at every age of life, can be accomplished.
>
> The closed surgical tuberculosis always heals, if one will only be patient, and above all if one understands how to keep it closed. To transform a closed tuberculosis into an open one means to increase the gravity of the case a hundredfold. A diminution of the vitality of the tissues is the inevitable consequence. . . . . To regard a surgical tuberculosis as a local disease which can be cured by local treatment alone is a ruinous error. On the contrary,

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[1] Journ. Amer. Med. Ass., December 20, 1913, p. 2232.

[2] References: Rollier (Verhandl. d. Gesellsch. f. Kinderheilk. d. 84 Versamml. d. Gesellsch. deutsch. Naturforsch. u. Aerzte in Münster), 1912. A report of 650 cases in which 355 patients were adults and 295 children. There were 450 cases of closed surgical tuberculosis and 200 cases of open surgical tuberculosis. In the cases of closed surgical tuberculosis 393 patients were cured, 41 improved, 11 remained stationary, and 5 died. Of the patients with open surgical tuberculosis, 137 were cured, 29 improved, 14 remained stationary, and 20 died.

Rollier and Rosselet: Sur le rôle du pigment épidermique et de la chlorophylle (Bulletin de la Soc. des sciences nat. 1908).

Rollier and Hallopeau: Sur les cures solaires directes des tuberculoses dans les stations d'altitude. Communication à l'Académie de Médecine, Paris (Bulletin de l'A. d. Méd., 1908, page 422).

Rollier and Borel: Héliothérapie de la tuberculose primaire de la conjonctive (Rev. méd. de la Suisse romande, 20 avril 1912).

Witmer, T. and Franzoni, A.: Deutsch. Zeitschrift für Chirurgie, No. 114.

P. F. Armand-Delille: L'Heliotherapie, Masson et Cie, Paris, 1914.

P. Vignard and P. Jouffray: La Cure Solaire des Tuberculoses Chirurgicales, Masson et Cie, Paris.

it is a general affection which requires general treatment. Of all infectious diseases it is the one in which the individual resistance plays a deciding part. Our first effort, therefore, is directed to improve general conditions and thus to bring about a healing of the local focus by treatment of the entire system. A rational local treatment is necessary as well, provided it is not too one-sided.

In cases of spondylitis, or Pott's disease, the children wear jackets having a large fenestrum cut anteriorly, as the vertebræ in children are not much further removed from the surface of the abdomen than from that of the back. After healing is verified by X-ray a celluloid corset is worn. One or two years are required for the cure. Plate 29 shows a girl thus cured of pronounced Pott's disease with gibbosity, and paraplegia and muscular atrophy. There was complete healing after fifteen months of the solar cure which the illustration well shows.

CASES OF HIGH ALTITUDE TREATMENT

As illustrations of the good effect of high altitude treatment, two cases from the practice of the late Dr. Charles Theodore Williams, of London, may be cited. They were both cured at St. Moritz (6,000 feet).

Miss C., aged 18, was first seen by Dr. Williams, July 20, 1887. She had lost a sister from tuberculosis and she had a history of cough and expectoration for five months and wasting and night sweats for two months; total loss of appetite and aspect very pallid. Slight dulness, crepitation in first interspace to the right. Ordered to St. Moritz for the winter. In the spring the patient spent six weeks in Wiesen, elevation 4,760 feet. She entirely lost her cough and expectoration, gained twenty-four pounds in weight and became well bronzed, looking the picture of health. Her chest increased enormously in circumference and measured, on full expiration, five inches more at the level of the second rib than before she left England. She stated that she had burst all her clothes. Careful examination at the end of eleven months, when these later notes were taken, showed great development of the thorax and hyper-resonance everywhere, but no abnormal physical signs. After more than three years in England the chest measurement had somewhat decreased.

Another patient, Miss R., aged 21, was seen in November, 1879, with a history of cough with expectoration, loss of flesh, night sweats, pain in the left chest and evening pyrexia of a month's dura-

FIG. 1. POTT'S DISEASE WITH PRONOUNCED DEFORMITY, PARAPLEGIA AND MUSCULAR ATROPHY. CLINIC OF DR ROLLIER, LEYSIN.

FIG. 2. THE SAME PATIENT AFTER FIFTEEN MONTHS OF HELIOTHERAPY. CORRECTION OF DEFORMITY. COMPLETE RESTORATION OF MUSCULATURE AND GENERAL STATE. CLINIC OF DR. ROLLIER.

FIG. 1. HELIOTHERAPY AND IMMOBILIZATION IN PLASTER FOR SURGICAL TUBERCULOSIS. BALCONY OF DR. ROLLIER'S SANATORIUM, "LE CHALET," LEYSIN, SWITZERLAND. THE JACKETS HAVE LARGE OPENINGS TO ALLOW ACCESS OF SUNLIGHT TO THE DISEASED SPINES. SOME PATIENTS IN DORSAL POSITION; OTHERS IN VENTRAL POSITION.

FIG. 2. CHILDREN WHO CAME TO DR. ROLLIER VERY SICK NOW INDULGE IN WINTER SPORTS. NO CLOTHING BUT CAPS AND LOIN CLOTHS. NOTE THE MUSCULATURE OF THE CHILDREN FORMERLY SUBJECTS OF COXALGIA, ARTHRITIS, PERITONITIS AND ADENITIS.

tion. Dullness and deficient breath sounds were detected close to the left scapula. After three years of unsuccessful treatment in England, during which time two winters were spent at Hyères, on the Mediterranean, losing ground and growing thinner and showing evidence of commencing disease in the opposite lung, she was sent for the winter to St. Moritz. She returned the following May vigorous and well bronzed, having taken plenty of exercise, skating, walking, and tobogganing. She had lost all cough and had gained much strength. The chest measurement showed an increase of one inch. The whole thorax was found hyper-resonant and no physical signs of consolidation could be detected. After eleven years of residence subsequently in England, she was free from chest symptoms.

In this case, notwithstanding the improvement following two winters spent at Hyères, at sea level, the disease was not arrested and increased the following year. But during one winter's residence at St. Moritz, elevation 6,000 feet (diminished atmospheric pressure and out-door life with winter sports), there was complete arrest of the disease, as the experience of eleven years with absence of physical signs testifies.

There is a wealth of clinical material to show the advantages of high altitude treatment at the well-known European and American resorts. Sir Hermann Weber, of London, and his son, Dr. F. Parkes Weber, have had a long and favorable experience in the treatment of pulmonary tuberculosis in high altitudes and they support Dr. C. T. Williams in a higher estimate of treatment of this disease at high elevations as contrasted with results at the sea level.

Twenty-five years ago Sir Hermann Weber stated that out of 106 tuberculous patients sent to high altitudes, 38 were cured, either permanently or temporarily, 16 were stationary or but slightly improved and 10 deteriorated. More than half of the cases in the first stage were cured.

The American statistics of Drs. Samuel A. Fisk,[1] W. A. Jayne,[2] S. E. Solly,[3] Charles Denison and S. G. Bonney, all of Colorado,

[1] Fisk, Samuel A.: Concerning Colorado (Medical News, Sept. 16, 1899); Climate of Colorado (Trans. Amer. Climat. Ass., 1888, p. 11).

[2] Jayne, W. A.: Climate of Colorado and Its Effects (Trans. Amer. Climat. Ass., 1888).

[3] Solly, S. E.: Invalids Suited for Colorado Springs (Trans. Amer. Climat. Ass., 1888, p. 34).

are certainly convincing as to the effect of high altitude treatment in the cure of pulmonary tuberculosis.[1]

Solly said in 1888, "Taking the medical profession throughout the world, it is unquestionable that a large majority of those who have made a study of the subject believe that where a change is made, a change to an elevated country is the most likely to benefit a consumptive."

Solly lived for thirty-three years in Colorado after having removed, as a tuberculous invalid, from England. Every one of the physicians mentioned above went to Denver or Colorado Springs as a tuberculous patient, recovered his health there, acquired a reputation and successful practice during fifteen to thirty years of residence and the majority are alive to-day (1913). Those who died succumbed to other affections.

According to Solly, 76 per cent of all patients, good, bad and indifferent, and 89 per cent of those in the first stage that undergo climatic treatment in Colorado are benefited. Would such patients as we have mentioned have derived equal and as lasting benefit at Alpine Stations, such as Davos or St. Moritz, which have a corresponding altitude and an equal barometric pressure? Judging from recorded clinical experience, we believe that they probably would have done equally well. We can never know absolutely. Would they have done equally well at sea-level or at very moderate altitude? None of the physician-patients whose names are quoted would admit it.

Dr. Solly, with his inimitable humor once remarked, "If I were living in London to-day, I'd be dead." In all human probability most, if not all of them, are fair examples of the curative power of the Colorado climate.

Of late there have been dissenting voices, challenging some of the cardinal principles involved in the altitude treatment of tuberculosis. Not only altitude, with its concomitant rarefied atmosphere, but even sunlight itself which lightens the heart of every invalid, have both been denied the value so generally assigned them in tuberculo-

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[1] Charles Theodore Williams: Aerotherapeutics, or the Treatment of Lung Diseases by Climate. The Lumleian Lectures, 1893; Macmillan, 1894, pp. 111-179.

Charles Denison: Dryness and Elevation the Most Important Elements in the Climatic Treatment of Phthisis (Trans. Amer. Climat. Ass., Vol. 1, 1884, p. 22).

therapy. These discordant notes find utterances among those who have been compelled to treat the poorer class of consumptives in our cities at the seaboard and who have obtained some excellent results. Stress is laid on the beneficial influence, for example, of cold.[1] The fact that patients improve more in winter than in summer is cited to prove that "cold air in itself seems to cure in a manner which nothing else can accomplish. * * * Sunshine is not essential—excellent results may be obtained in climates where the sun is rarely seen. Mere outdoor living seems to be the essential element, and yet there does not seem to be any doubt that quicker results are obtained in the cold season than in the summer."

EFFECT OF COLD AIR

There is truth in the proposition that cold air is better for the consumptive than heated air. It is usually purer and is unquestionably more stimulating to the vital forces. Warm sleeping rooms are positively bad because of deficient ventilation. Warmth debilitates and opens the way to bacterial invasion. Hot weather is relaxing, while moderate cold, or greater cold with proper safeguards, acts as a tonic and fortifies the well and sick alike against disease.

The good effect of cold air in tuberculosis is commonly noted by physicians and patients. The following extract from a letter from a tuberculous patient, dated Saranac Lake, New York, February 19, 1908, is interesting:

> I have not felt the cold up here this winter as I feared I might, although the mercury has nearly disappeared on one or two memorable nights. 46° below zero is the coldest I have seen it but it was reported 50° below in the village. I am quite used to the cold now as I sit out on the porch all day and have not missed a day yet; but there is one redeeming feature about the cold up here and that is that zero weather does not seem nearly so cold as 20° above in Philadelphia. I really do not begin to feel it until it gets to 20° below, although it is usually too cold to use my hands even in milder weather. J. D.

This patient was 22 years old, had been at Saranac fifteen months and is reported perfectly well and weighs 180 pounds. He is apparently cured. He remains well, Nov., 1913.

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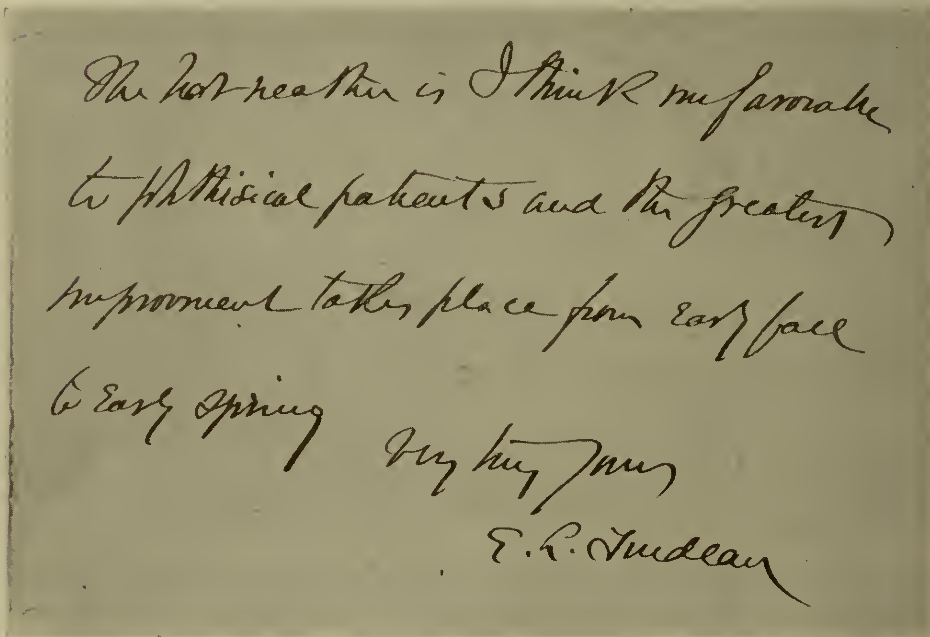
[1] Editorial, American Medicine, Philadelphia, January 20, 1906.

See A. D. Blackader, M. D.: The Advantages of a Cold, Dry Climate in the Treatment of Some Forms of Disease (N. Y. Med. Journ., Aug. 3, 1912).

The minimum temperature at Saranac Lake for 1912 was —32° F. on January 25, and the maximum was 88° F. on July 10. The mean temperature was 40.98° F. The total precipitation was 43.19 inches, with a total snowfall of 124.24 inches. Clear days, 153; partly cloudy, 77; cloudy, 136.

The extract here reproduced from a letter dated Saranac Lake, July, 1886, is interesting. It was addressed to the author.



The hot weather is I think unfavorable to phthisical patients and the greatest improvement takes place from early fall to early spring

Very truly yours

E. L. Trudeau

The best and clearest statement of seasonal influence on body weight of consumptives that we know of was made by Dr. N. B. Burns, of the North Reading State Sanatorium, Massachusetts. His observations are based on one thousand patients during three years. Fully forty per cent of the cases admitted to this sanatorium were of the far advanced and progressive type. It was noted that August, September and October show that the largest percentage of patients gaining, while the three months immediately preceding show the opposite.

Dr. Burns also charted the aggregate gain in pounds of the male patients treated at North Reading, December, 1911 to 1912, inclusive. There was a rise in January and February, 1912, to 850 pounds for 76 patients which was maintained well through March and April.

NORTH READING STATE SANATORIUM, MASSACHUSETTS

TABLE ONE

N B. BURNS, M. D.

PER CENT	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Patients Gaining	64.5	59.4	42.7	47.2	42.0	44.2	46.9	71.9	74.9	66.4	60.7	64.9
Patients Losing	27.9	35.4	50.2	44.5	50.7	50.4	47.6	27.3	17.3	25.5	29.8	27.8
Patients Stationary	7.6	5.2	7.1	8.3	7.3	5.4	5.5	0.8	7.8	8.1	9.5	7.3

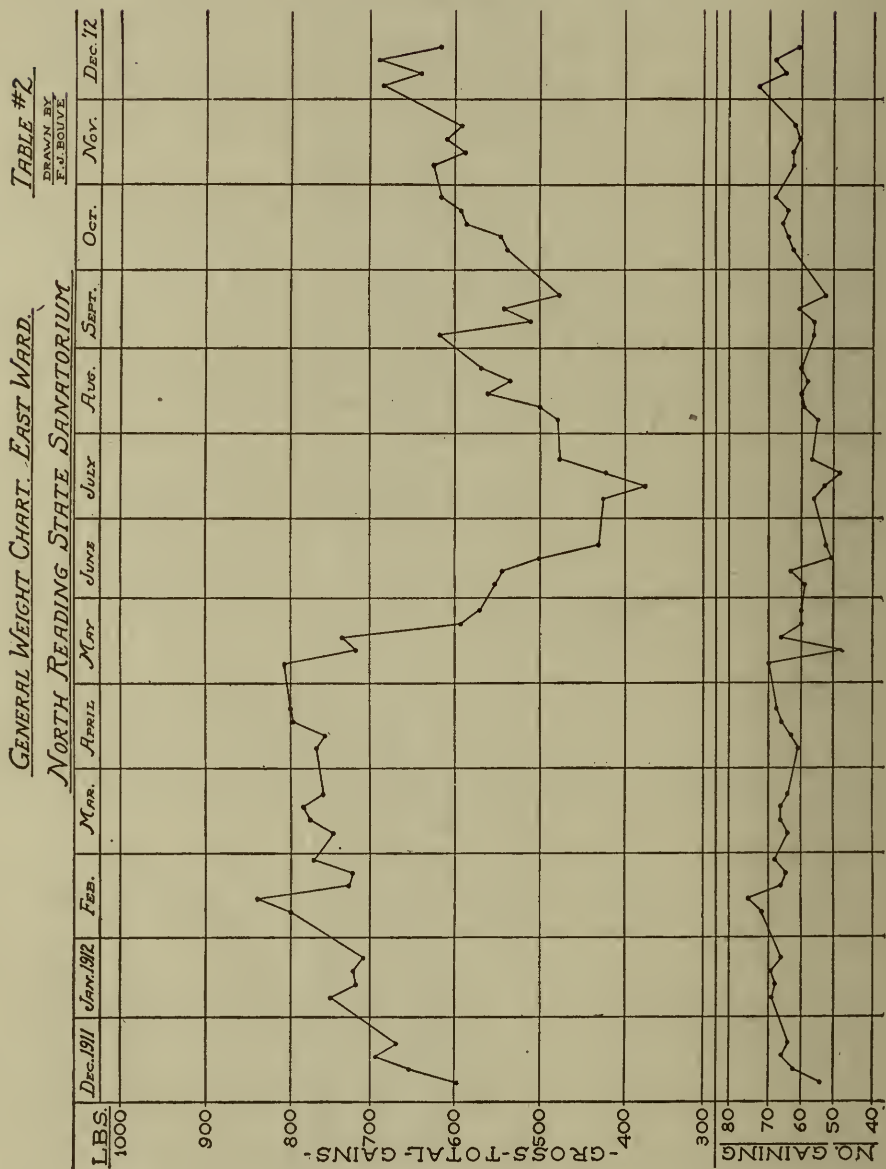
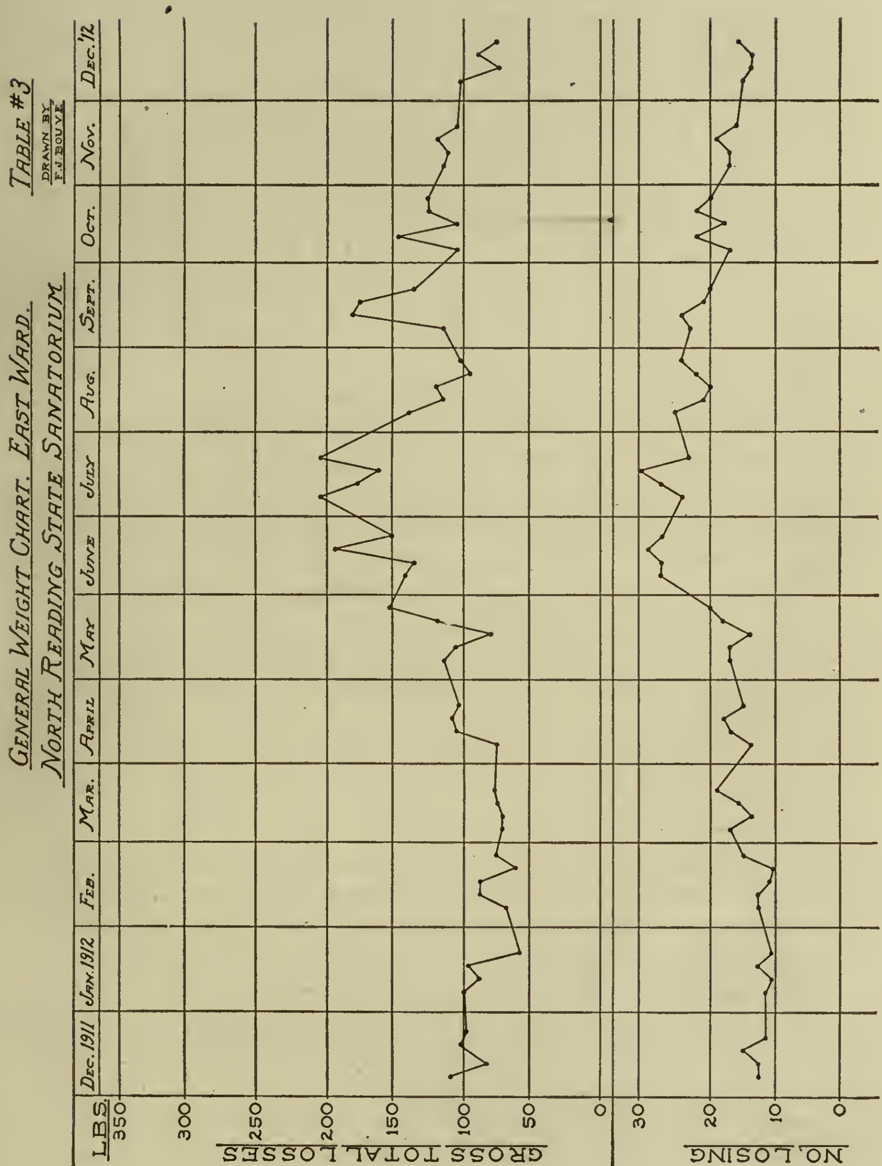


TABLE #2
DRAWN BY F. J. BOUVE
GENERAL WEIGHT CHART. EAST WARD.
NORTH READING STATE SANATORIUM
DEC. 1911
JAN. 1912
FEB.
MAR.
APRIL
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC. '12
LBS.
1000
900
800
700
600
500
400
300
-GROSS-TOTAL-GAINS-
80
70
60
50
40
NO. GAINING


GENERAL WEIGHT CHART. EAST WARD.
NORTH READING STATE SANATORIUM
TABLE #3
DRAWN BY F.J. BOUVÉ
DEC. 1911
JAN. 1912
FEB.
MAR.
APRIL
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC. '12
LBS.
350
300
250
200
150
100
50
0
30
20
10
0
GROSS TOTAL LOSSES
NO. LOSING

There was a subsequent sharp decline in May, the index dropping 250 points. This fall continued without interruption in June, to culminate July 11, at the low point for 1912.

The conclusion of this study was:

Phthisical patients are apt to lose rapidly in weight and general condition in May, June, and the first two weeks in July, which season constitutes an unfavorable and critical period.

Phthisical patients make an extraordinary recovery in weight and general condition in the month of August, which is a surprisingly favorable time of the year.

August, September, January and February are the most propitious months for obtaining successful results in treating pulmonary tuberculosis.

Forced feeding in the unfavorable season seems to have availed very little in limited number of cases studied at North Reading.

We have already referred to the beneficial influences of the Arctic summer climate (see pages 39-42), and we attributed much of it to the perpetual sunshine; consequently we cannot agree to the illogical statement that sunshine is not essential. We believe that the "Fireside Cure" has no place in the treatment of tuberculosis and we must admit that whereas only a few years ago the cold air fiend, who slept with windows wide open in the coldest winter, was considered a crank, he now has been proved to be the only sensible one among us.[1]

EXPANSION OF THORAX AT HIGH ALTITUDES

Without dwelling further at this time on the effect of cold air compared with warm air on tuberculous disease (see pp. 28, 40, 71), we must note some of the undeniable effects of diminished atmospheric pressure on physical development and especially on the thorax and pulmonary tissue.

One striking change is the expansion of the thorax in various directions and a corresponding increase in the mobility of the thoracic walls. We have previously referred to one case in which the circumference increased five inches during a residence at St. Móritz, elevation 6,100 feet. (See page 74.) Changes of from one to three inches are more commonly noted even at much more moderate elevations. These changes are conveniently recorded by means of

[1] American Medicine, *loc. cit.*

the instrument known as the cyrtometer which gives accurate tracings for recording the progress of the patient.[1]

Inasmuch as tuberculous patients in whom the disease is actively progressing show a shrinking of the perimeter *pari passu* with the advance of the disease, and those who are recovering show an increasing circumference, it is a fair inference that the physiologic increase in thoracic measurements due to residence in the higher altitudes is an advantage in the prevention and treatment of pulmonary tuberculosis. Man is not adapted to live permanently at altitudes above 13,000 to 16,000 feet (4,000-5,000 meters), but at somewhat lower elevations as, for instance, at 10,000 feet we have some thriving cities such as Leadville and Cripple Creek in Colorado, and Quito in Equador, elevations 10,000 and 9,350 feet (3,000 and 2,850 meters). The altitude of the permanent habitations in the Ortler Alps is about 5,450 feet (1,640 meters), and that of the highest health stations from 5,000 to 7,000 feet (Arosa). It is a well-known fact that the Indians of the Andes, the Swiss guides, the Tyrolese hunters and other mountain dwellers have a large thorax with correspondingly deep inspiratory power and remarkable endurance.[2] The increased respiration and the quickening of the circulation promote health and vigor in mountain races and comparisons between the highlanders and those in deep and flat valleys are always in favor of the former. All observers have remarked on the immunity from disease, and especially scrofulous and tuberculous disease, characteristic of mountain races, provided they live in the open, avoid overcrowding, have sufficient and suitable food and observe ordinary hygienic methods of life. Failure in this respect provides an opening for tuberculosis which, as we well know, is the scourge of the North American Indian and his relatives in Mexico and South America. Even in Quito, that city of remarkable equability, where it is perpetual spring, tuberculosis has effected an entrance, and enters largely into the mortality lists.[3] In Bogota, South America, in La-Paz, Mexico (elevation 11,000 feet, 3,360 meters) and in other densely populated towns in these countries, the later records show increasing numbers of cases of tuberculosis. This fact, however,

[1] See Minor, Charles L.: The Cyrtometer: A Neglected Instrument of Pulmonary Diagnosis and Prognosis (Trans. Amer. Climat. Ass., 1903, p. 221).

[2] "Mexican Indians, though of medium height, have unusually large and wide chests, quite out of proportion to their size." Jourdanet.

[3] Jacoby: Thèse de Paris, 1888. Quoted by Huggard.

should not afford the slightest ground for controverting the general proposition that life at altitudes of from 3,000 to 6,000 feet favors immunity from tuberculosis and the cure of the disease in suitable cases.

CHOICE OF CASES FOR HIGH ALTITUDE

The question then arises, what are suitable cases for altitude treatment? What kind of patients may be sent to stations of lower barometric pressure?

In choosing a location, the late Dr. F. I. Knight, of Boston, formulated some opinions based on his long experience.[1] He limited the age of those resorting to altitudes to fifty years. In temperament he preferred the phlegmatic to the nervous, with an irritable heart, frequent pulse, and inability to resist cold; and with the latter we must be careful not to include those who show nervous irritability from *disease,* not temperament, as they are generally benefited in high places. As regards disease, he first considered cases of early infection of the apices of the lungs with little constitutional disturbance, and, although these generally do well under most conditions, yet considerable experience assured him that more recover in high altitudes than elsewhere.

It is best to begin with low altitude in patients with more advanced disease showing some consolidation but no excavation; also when both apices or much of one lung is involved and the pulse and temperature are both over 100.

Hemorrhagic cases, early cases with hemoptysis and without much fever are benefited by high altitudes. Patients with advanced disease, those with cavities or severe hectic symptoms should not be sent to high altitudes. A small, quiet cavity is not a counter-indication; hectic symptoms are counter-indications.

This accords with the latest report from the U. S. Public Health Service Sanatorium at Fort Stanton, New Mexico, altitude 6,231 feet. Dr. F. C. Smith reports 56 deaths from pulmonary hemorrhage in a total of 524 patients since the hospital was opened in 1899. His conclusion is that pulmonary hemorrhage is not more frequent at high altitude than at sea level, but the results are perhaps more often serious, especially in those with impaired circulation.[2]

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[1] Trans. Amer. Climat. Ass., 1888, p. 50.

[2] Public Health Reports, U. S. Public Health Service, No. 51, by F. C. Smith, Passed Ass't Surgeon, Washington, 1910. See also Report No. 93, Washington, 1912.

SNOW SCENE AT UNITED STATES PUBLIC HEALTH SANATORIUM, FORT STANTON, NEW MEXICO. HOUSE AT RIGHT, WITH PORCH, QUARTERS OF OFFICER IN CHARGE. ROW IN CENTER SETS OF QUARTERS USED BY JUNIOR OFFICERS AND OTHERS

TUBERCULOSIS SANATORIUM OF THE UNITED STATES PUBLIC HEALTH SERVICE, FORT STANTON, NEW MEXICO. AMBULANT SICK CALL. PATIENTS TAKING BREATHING EXERCISES

Patients in an acute condition should not be sent. Cases of fibroid phthisis, in Dr. Knight's opinion, are not suitable. Convalescents from pneumonia or pleurisy are usually well suited for elevated regions. Advanced cases of tubercular laryngitis, if good local treatment and freedom from dust can be obtained, may do no worse in elevated regions than elsewhere.

In cases complicated by cardiac dilatation we cannot advise altitude; but a cardiac murmur resulting from a long-past attack of endocarditis with no sign of enlargement or deranged circulation should not prevent. Nervous derangements of the heart are usually counter-indications.

The observations made at the United States Public Health Sanatorium at Fort Stanton, New Mexico, by Surgeon F. C. Smith, of the service are commended as a valuable contribution to the Relation of Climate to the Treatment of Pulmonary Tuberculosis. This sanatorium is open to sailors in the merchant marine and they are transferred from the twenty-two marine hospitals on the coasts and rivers to this admirable inland sanatorium. It was found that the results have been nearly three times as good in the cases which left the home stations, *i. e.,* the local marine hospitals, without fever as in those who had a temperature of 38° C. (100.4° F.) or more within two weeks of departure. The deaths in those leaving afebrile were to those leaving with fever as 22 to 59; the arrests, as 19 to 7½; the apparent cures, as 10 to 3. Dr. Smith holds that the case that should be sent to a distant climate immediately upon diagnosis is exceptional and he also adds that neglect to make an early diagnosis does not warrant precipitate haste in sending the victim away when it is finally established. The psychologic moment for a climatic change is when there is a comparative quiescence of the lung process under treatment at home, when nutrition is improved and further improvement is slow (Francine). Climatic change, however, must sometimes be made, as we will see later on, when the hoped for stage of quiescence does not occur.

Before allowing patients with pulmonary diseases to go long distances or to make any great change to higher altitudes, some caution should be given. In the first place, patients should not make any physical exertion for two or three weeks after arrival. The air may be stimulating, there may be sights to see and many dangerous invitations given, but it is absolutely necessary that the patient should be adjusted to the new atmospheric conditions. Acclimatization is necessary to comfort and safety. In the old days it was accomplished by the slow ride in the stage-coach over the plains. We cannot go back to the old methods, and therefore we must exercise greater caution. No febrile case should be sent on these journeys or to any elevated resort. Hemorrhage is not a counter-indication to a change of altitude, and it is not any more liable to occur at five to six thousand feet than at sea-level. However, no advanced case of pulmonary tuberculosis should be sent away. Financial considerations are highly important. Expenses are usually underestimated, and the want of sufficient means, the need to economize as regards the necessities, not to speak of the luxuries, of life, is a dreadful handicap, and should bar out many a case that succumbs for want of the very comforts he had left behind. It would be far better for such patients if they should enter some special hospital or sanitarium for consumption, such as are found in most of our Eastern States.

No one should be sent away without definite and satisfactory knowledge of the place to which he is sent, and without a letter of introduction to some favorably known practitioner containing a statement of the main points in the case.

In matters of climate, as in many other fields, it is the man behind the climate who will help the patient, save him from errors and indiscretions, advise him and direct him as to local surroundings, and enable him so to live that his disease shall be arrested.

Some localities favorable for tuberculous patients have already been mentioned. Taking the country as a whole we naturally look to the elevated, sparsely settled regions of Colorado, New Mexico, Wyoming, Montana, Nevada, Utah, Arizona and California. The slopes of the Rocky Mountains and the Great Basin are justly entitled to first choice, provided always that other safeguards than climate are to be had for the protection, the comfort and nutriment of the patient. Texas, especially the central and higher western portion, must be included in this great area. Life in Texas was formerly rather too rough and food and accommodations were too primitive for fastidious people, but now at places like San Antonio and El Paso, these defects have been remedied. The winter climate of Texas is very agreeable, except when the Texas norther descends and holds everything in an icy clasp. However, this is not altogether a disadvantage, if not too severe.

Florida suits some cases of phthisis. The interior of the state is sandy and the winter and spring climate is excellent. The cultivation of orange groves and other agricultural features of the state have given many a patient a profitable occupation that he would never have found elsewhere.

Thomasville, in Georgia, sixteen miles from the Florida line, and Aiken and Camden, in South Carolina, have long had a reputation for the relief of pulmonary affections. Asheville, North Caroline, is more elevated (2,300 feet) and has an excellent "all the year round" climate. Special attention is given to tuberculous patients at this resort, and this is something that cannot be said of all the good places. In Pennsylvania, suitable places are found in the Pocono Mountains, at White Haven, Kane, Cresson, Mont Alto and Hamburg. In New Jersey, there are Lakewood, Brown's Mills, Haddonfield, Vineland, and, for special cases, such as chronic fibroid phthisis, we may advise Atlantic City.

In New York, there are the Adirondacks, especially the vicinity of Saranac; Loomis, in Sullivan County, where there is an excellent sanatorium. In New England, there are institutions at Rutland and Sharon, Massachusetts; Wallum Lake, Rhode Island; Wallingford, Connecticut. But, as we have said before, the choice of a place, whether near home or at a distant point, involves all the questions of diagnosis, of temperament, of financial resources, all of which the physician must weigh as conscientiously as though his own life depended on it.

Of late, English physicians have been making more extended use of the higher Alpine resorts. Among these, Davos Platz, altitude 5,200 feet; St. Moritz, 6,000 feet; Arosa, 6,100 feet; and Leysin, 4,712 feet, are usually chosen. Their chief characteristics are an atmosphere of dry, still, cold, rarefied air; absence of fog, few clouds and very little wind. There is, therefore, strong sunlight with a grateful warmth in the sun's rays.

In selecting cases for treatment by change of climate, we must exercise as much discrimination as in applying any other remedial measure. Indeed, more caution should be used, for the patient will pass out of observation and in most cases the advice given involves the most vital consequences.

CHAPTER V. INFLUENCE OF INCREASED ATMOSPHERIC PRESSURE; CONDENSED AIR

Celsus, in treating of pulmonary tuberculosis in the first century A. D., advocated a change of climate and to "seek a denser air than one lives in."[1]

A few places in California and in Asia Minor are below sea-level.

[1] De Medicina, Paris edition, Delahay, 1855.

But the consequent increased atmospheric pressure in these localities is not in itself worthy of note. Such desolate regions as the Dead Sea, the Mojave Desert, Death Valley, and Salton Lake, California, are entirely unsuited for the tuberculous, and, for obvious reasons, all subterranean pressures are out of the question. Divers and caisson workers become anemic and hence artificial pressures increased beyond the normal at sea level are injurious.

Even the natural variations in atmospheric pressure at any given station may be sufficient to have some appreciable influence, *per se,* on the course of pulmonary tuberculosis. Changes of pressure of 20 mm. (.7874 inches) occasionally take place, but they are comparable to a gradual change of level amounting to only 200 meters (656 feet), and it has been assumed that no appreciable physiologic effects can be attributed to these gradual alterations, at least as far as tubercular diseases are concerned. Hann[1] and Thomas[2] state that in experiments with pneumatic chambers, pressure changes amounting to 300 mm. (11.8 inches) a day have been produced without causing any notable injurious effects upon the sick persons concerned in these experiments.

EFFECT OF BAROMETRIC CHANGES ON THE SPIRITS

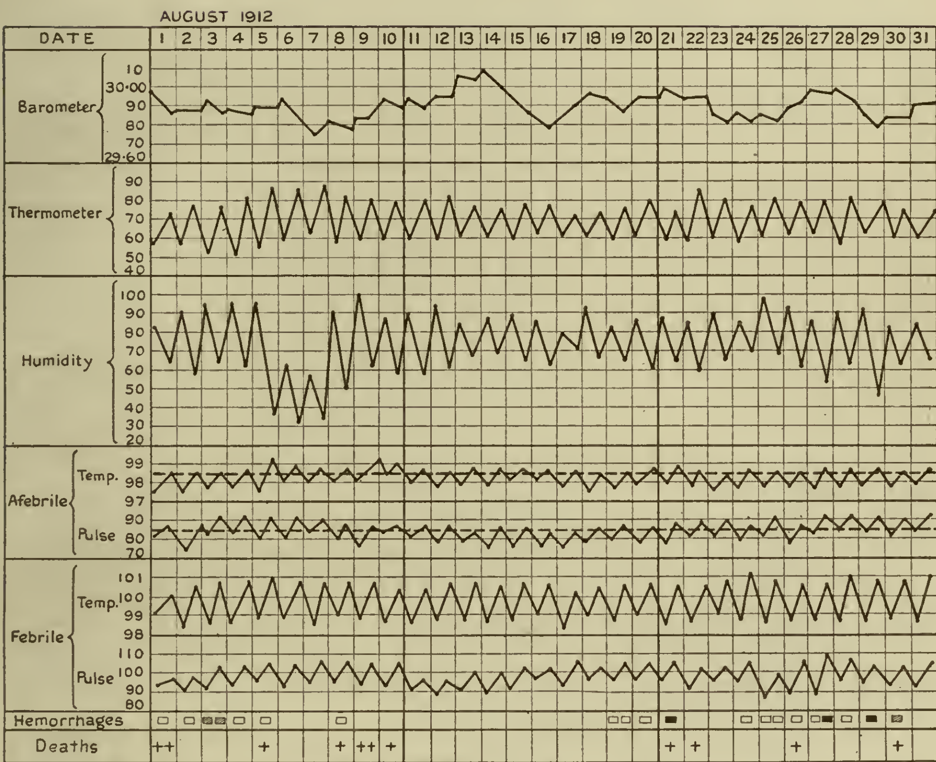
As the barometric pressure in any given place falls the cloudiness usually increases, the temperature rises, the wind increases, and precipitation is liable to occur; as the pressure rises the skies clear, the temperature falls and the winds shift to the west or northwest. The spirits and general morale of all patients usually improve with a rising barometer unless prolonged wind storms accompany such a change. Whatever improvement accompanies a rising barometer is due to the stimulus of cold or the return of sunshine and dryer air.

Dr. Charles C. Browning, of Los Angeles, has studied the effect of some atmospheric conditions on tuberculous patients.[3] In his first report it appeared that unseasonable or very sudden changes in temperature influenced temperature of patients, while equal or greater changes occurring slowly did not. Of hemorrhages occurring in groups about four times the number occurred when there

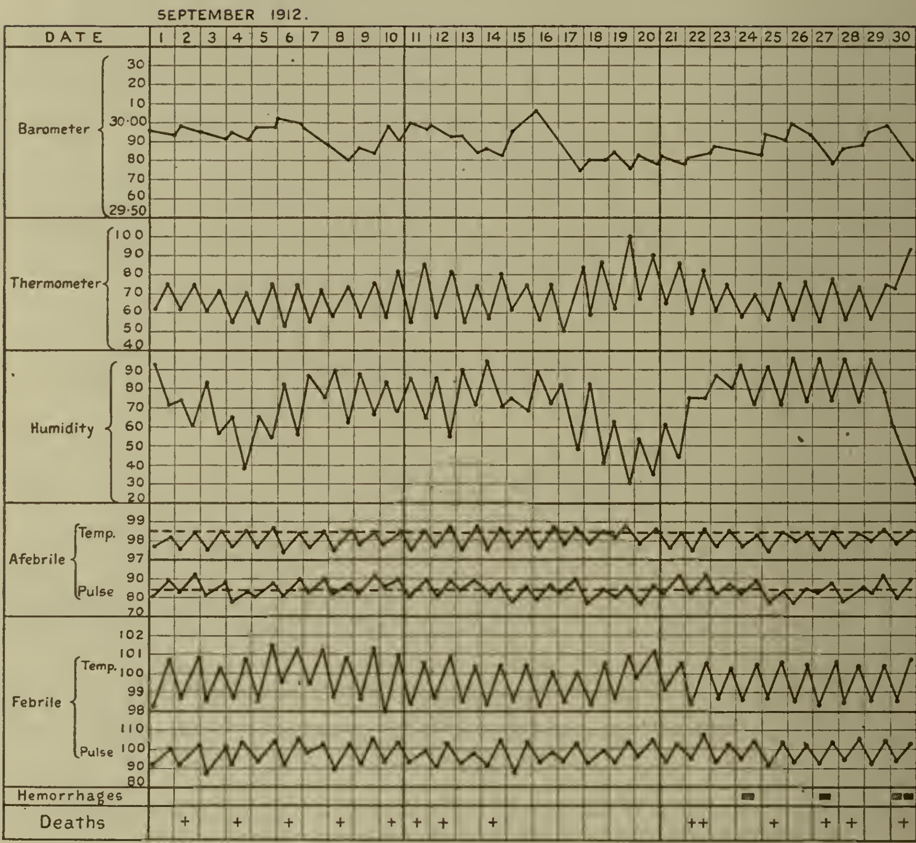
[1] Julius Hann: Handbook of Climatology, Macmillan, 1903, p. 71.

[2] Thomas, in Beiträge zur Allgemeinen Klimatologie, Erlangen, 1872.

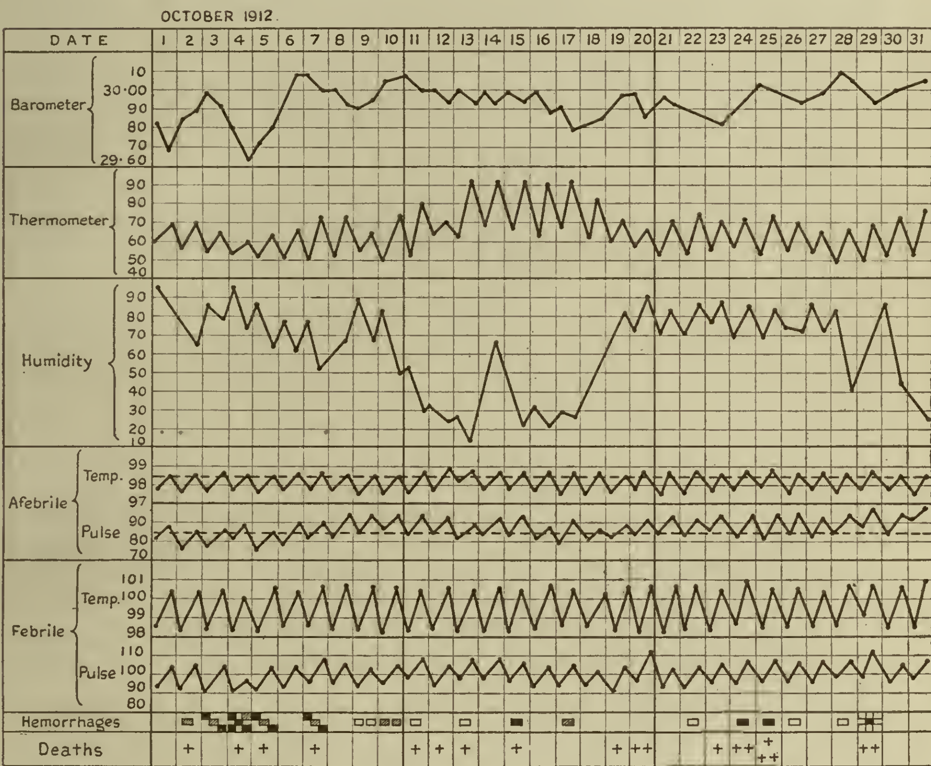
[3] Trans. American Climatological Ass., 1908; *idem,* 1913, p. 189.



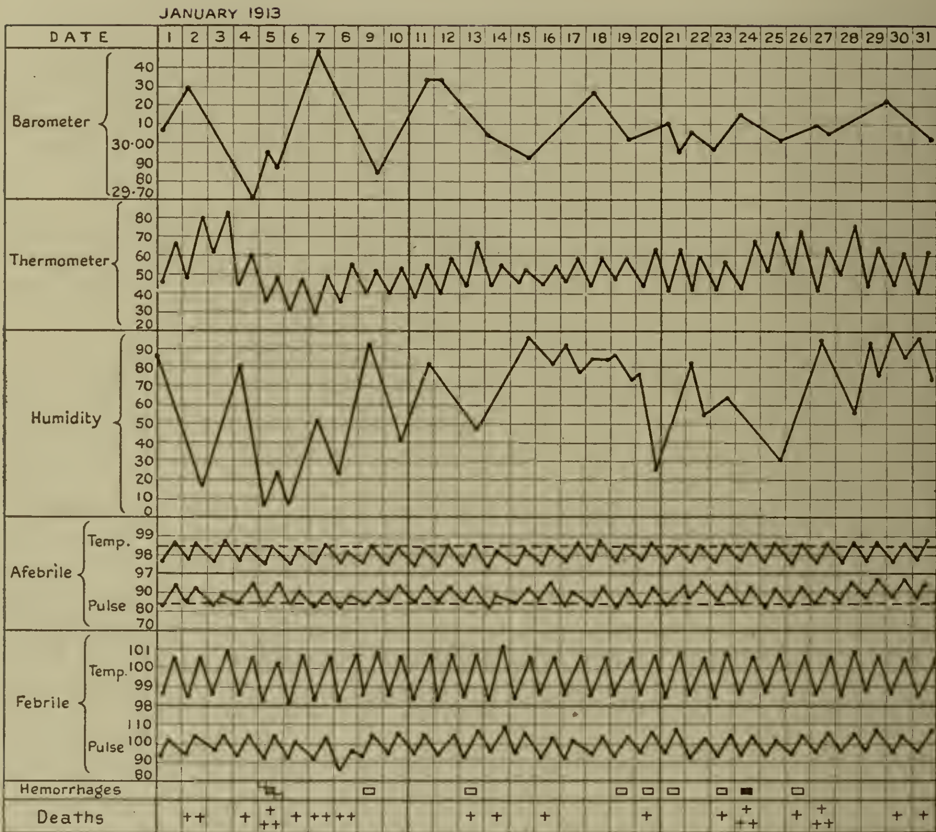
Relation of pulmonary hemorrhages and deaths from tuberculosis to barometric pressure, temperature and humidity. Courtesy of Dr. C. C. Browning, Los Angeles, Cal.



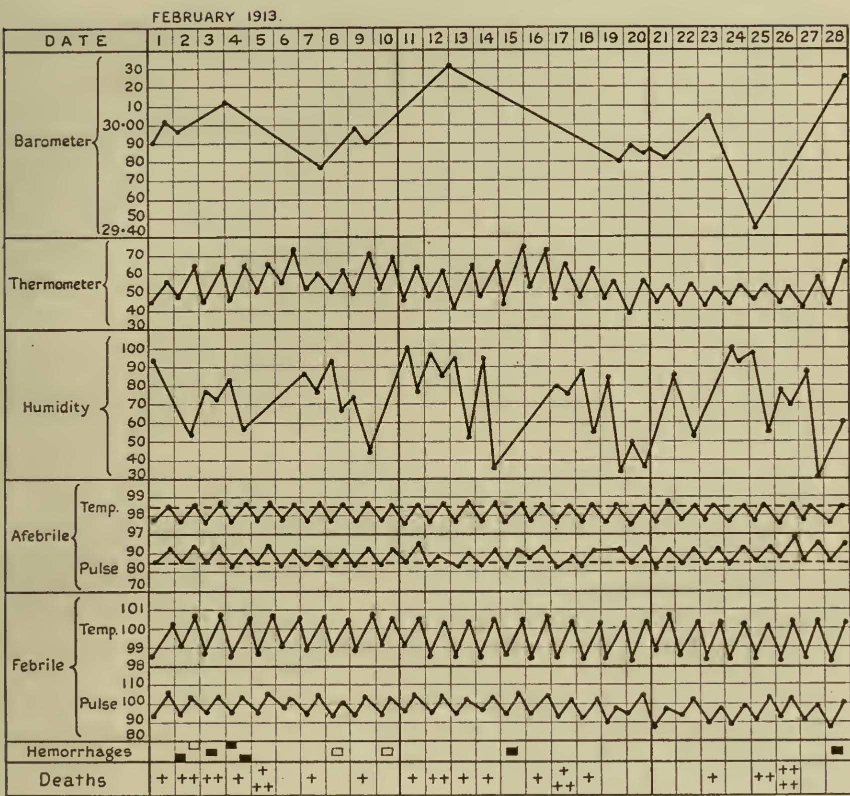
Relation of pulmonary hemorrhages and deaths from tuberculosis to barometric pressure, temperature and humidity. Courtesy of Dr. C. C. Browning, Los Angeles, Cal.



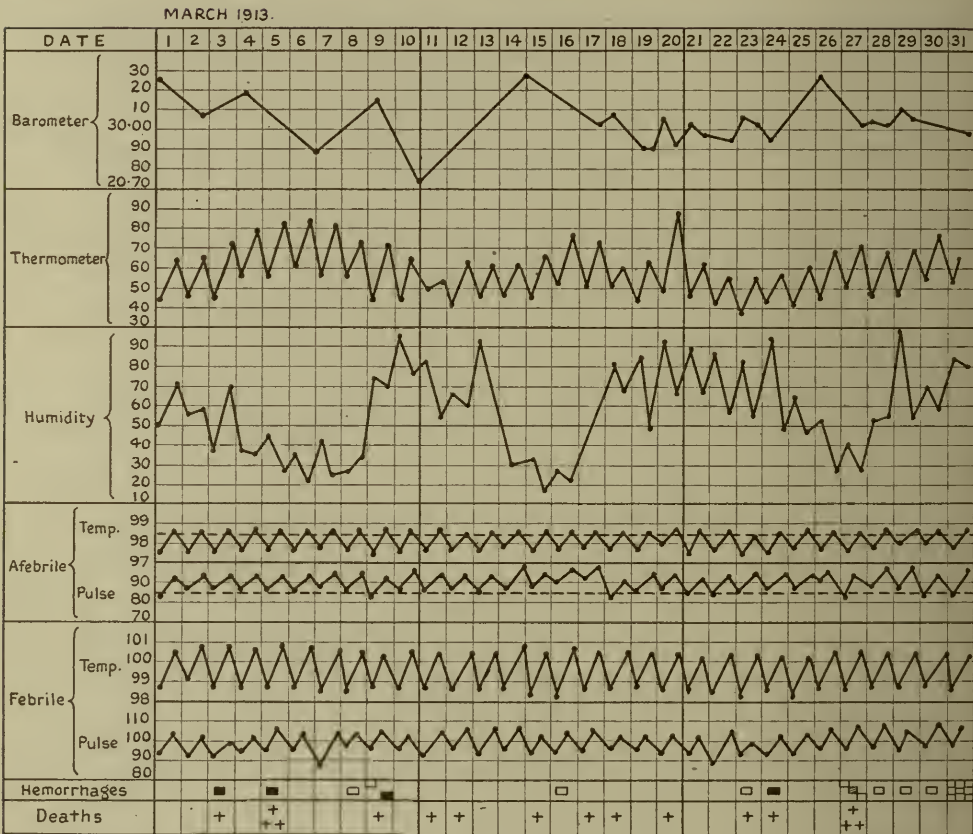
Relation of pulmonary hemorrhages and deaths from tuberculosis to barometric pressure, temperature and humidity. Courtesy of Dr. C. C. Browning, Los Angeles, Cal.



Relation of pulmonary hemorrhages and deaths from tuberculosis to barometric pressure, temperature and humidity. Courtesy of Dr. C. C. Browning, Los Angeles, Cal.



Relation of pulmonary hemorrhages and deaths from tuberculosis to barometric pressure, temperature and humidity. Courtesy of Dr. C. C. Browning, Los Angeles, Cal.



Relation of pulmonary hemorrhages and deaths from tuberculosis to barometric pressure, temperature and humidity. Courtesy of Dr. C. C. Browning, Los Angeles, Cal.

was a barometric pressure change exceeding .3 of an inch within twenty-four hours than when the change was less. The hemorrhages appeared to be more frequent if there had been a change in the opposite direction—a sudden fall. The cases observed were all in the advanced stage. The conditions which appear to influence groups of hemorrhages and deaths are barometric pressure, humidity and cloudiness, each in turn appearing to be the most prominent

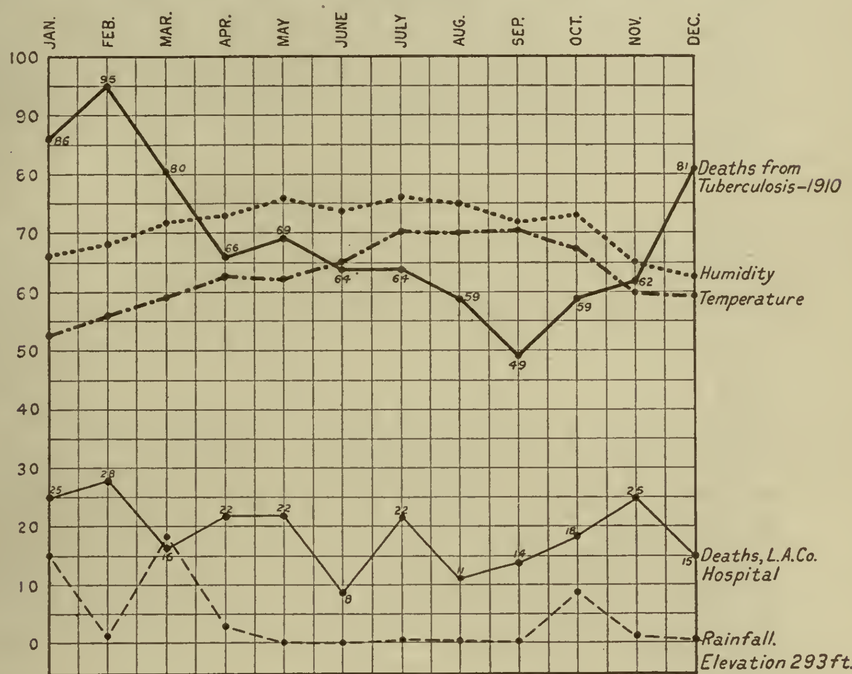


Chart showing deaths from tuberculosis in the Los Angeles County Hospital and in the city of Los Angeles in 1910. Rainfall, mean monthly temperature and relative humidity are also shown. Courtesy of Dr. C. C. Browning.

index in exerting a limited determining influence. This is shown in the two charts for November and December, 1912. Dr. Browning's paper contains charts for six other months.

Dr. Browning notes the influence of fog and remarks that the "high fog" is regarded by many as one of the most desirable factors of the Southern California climatic condition. It is not fog in the generally accepted meaning, for this "light veil" is neither cold nor excessively moisture laden; neither is it high, for its altitude is less than a thousand feet.

When the barometer is gradually rising and the humidity slowly falling and the sky clear or clearing, patients are pleasant, in some cases jovial and inclined to be optimistic as to the future.

When the barometer is either gradually or rapidly falling and the humidity rising and becoming more oppressive as the hours go by, and the day is foggy with little or no sunshine, the effect on patients is entirely different. They become pessimistic, cross and very irritable. During the so-called "northers," when the barometer falls, then rises rapidly with clear weather and a quick drop in the humidity as from 75 per cent to 20 per cent in twenty-four hours, there is a marked drying of the mucous membrane, causing great discomfort in some and comfort in others.

ARTIFICIALLY COMPRESSED AIR

Artificially compressed air has been used by Oertel, Simonoff and Charles Theodore Williams in pulmonary tuberculosis. The first two claimed great improvement resulting from its use; but Williams did not find such favorable effects.[1] In nine cases submitted to the compressed air bath, hemorrhage was brought on in two while in the bath; in four others hemorrhage occurred but could not be distinctly connected with this form of treatment. There was usually some gain in weight and diminished cough and expectoration, and apparently the respiration became freer in the unaffected portions of the lungs. Beyond the opening up or aeration of portions of the lung which had not been brought into play for some time, there seemed to be no special change for the better. Compressed air in Williams's experience did not facilitate the absorption of lung consolidation or infiltration.

At the Brompton Hospital a large wrought iron chamber was constructed about ten feet in diameter by eight feet in height, and accommodated four patients. It had thick glass windows and a closely fitting door. By means of inlet and outlet pipes compressed air was introduced and allowed to escape. The outer air from a pure source was filtered through cotton and pumped into the receiver. The pressure was gradually increased after the patients were inside the tank until it reached ten pounds or two-thirds of an atmosphere above the normal. Half an hour was spent in increasing the pressure, one hour in maintaining it at the highest point required, and half an hour in

[1] Charles Theodore Williams: Compressed Air Bath and Its Uses in the Treatment of Disease, London; Smith, Elder & Co., 1885, and Aerotherapeutics, Macmillan, London, 1894, p. 106.

reducing it; so that two hours were consumed in its application therapeutically.

A practical difficulty was encountered in keeping the compressed air sufficiently cool to be comfortable, owing to the fact that air invariably rises in temperature during compression and cools during rarefaction; so that in warm days ice had to be used about the reservoir.

Von Vivenot, in a careful series of experiments, showed that the influence of compressed air on the respiratory capacity was to permanently raise it. When used for two hours every day it is found to increase daily from 20 ccm. to 30 ccm. above the previous day's record. Von Vivenot took 122 compressed air baths during 143 days and his respiratory capacity was raised from 3051 ccm. to 3794 ccm. and, in compressed air, to 3981 ccm. This increased capacity was reached in three and a half months, after 91 baths and was afterward maintained at practically the same level.[1]

An increase in respiratory capacity has been noted by other observers, but the respiration rate is always lowered and in almost all cases there is a similar lowering of the pulse rate.

PNEUMATIC CABINET

These experimental results naturally appealed to phthisiologists and patients were treated at Brompton, as we have mentioned, and in the United States by means of Ketchum's pneumatic cabinet or similar devices. There is no doubt but that the method was given a fair trial, but it has been found wanting. The pneumatic cabinets installed at considerable expense at the Loomis Sanitarium at Liberty, at the Rush Hospital in Philadelphia and at Saranac, are rusting away or consigned to the scrap heap. The simpler and more natural method of outdoor life is found much more safe, rational and effective.[2]

See J. Solis Cohen: The Use of Compressed and Rarefied Air as a Substitute for Change of Climate in the Treatment of Pulmonary Phthisis. (Trans. Amer. Climat. Ass., Vol. 1, 1885).

V. Y. Bowditch: Ten Months Experience with Pneumatic Differentiation, *ibid.*, 1886, 47.

A. S. Houghton, Journ. Amer. Med. Ass., Nov. 7, 1885.

C. E. Quimby, Trans. Amer. Climat. Ass., Vol. 9, p. 33.

Isaac Hull Platt, Trans. Amer. Climat. Ass., Vol. 3, p. 76.

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[1] Paul Bert, *op. cit.*, p. 439.

Huggard, W. R.: Handbook of Climatic Treatment, p. 109.

[2] At Sharon Sanatorium it is still used in some cases as a means of calisthenics for the chest and is thought to be of value.

Tiegel, New Yorker Medicinische Presse, April, 1887.
E. L. Trudeau, Trans. Amer. Climat. Ass., 1886, p. 41.
Ketchum: Physics of Pneumatic Differentiation (Medical Record, Jan. 9, 1886).
Waldenburg, Pneumatische Behandlung, Berlin.
J. T. Whittaker, Gaillard's Med. Journ., August 1885, p. 208.
Herbert F. Williams, Journ. Amer. Med. Ass., Aug. 14, 1885.
Herbert F. Williams, Trans. Amer. Climat. Ass., 1886, p. 17.
B. F. Westbrook, Trans. Amer. Climat. Ass., 1887, p. 102.

ARTIFICIAL HYPERÆMIA

We must here refer to an important advance in the treatment of surgical tuberculosis in which artificial changes in the atmospheric pressure play a prominent part. Prof. Bier, of Bonn, first used his famous method in treating tuberculosis of joints; he used the "Stauungsbinde." He also uses cupping glasses of various shapes so that they may be applied to various parts. The rarefaction of the air is accomplished by a rubber ball, or a pump, according to the size of the glass. After opening tuberculous lymphatic glands and tuberculous abscesses in connection with joints, the cupping glasses are applied and the claim is made that this process avoids mixed infections. Tampons and drains, also, are found to be unnecessary.

In treating a member, for instance the hand, Bier uses a glass cylinder provided with a cuff and a rubber band, so that the whole hand is hermetically sealed and by means of the pump the air is partially exhausted. By similar apparatus Prof. Bier, Dr. V. Schmieden, Dr. Willy Meyer, Ewart, and others all over the world have treated successfully cases of surgical tuberculosis so that the method has an established place in tuberculo-therapy.[1]

CHAPTER VI. ARTIFICIAL PRESSURE; BREATHING EXERCISES

Radical differences of opinion exist as to the use of artificial variations of pressure, or pneumatic differentiation, in pulmonary tuberculosis and also as to the larger question as to whether the diseased lung should be set at rest or invited to expand.

The respiration of artificially compressed or rarefied air for limited periods, such as half an hour or two hours, has been considered, but this form of pulmonary gymnastics has given way to

[1] August Bier: Hyperæmie als Heilmittel, 5th edition. Prof. Bier advises a long continued residence at the seashore in cases of surgical tuberculosis.

more natural methods of accomplishing the results aimed at. The judicious use of exercises has been advocated for centuries and this plan of treatment has passed through most interesting phases, long advocated, then condemned and later revived. Some of the recent advocates of exercise by graduated labor invoke the very latest knowledge of the pathology of tuberculosis in support of this method.

The bad effects of exercise on tuberculous patients at the well-known climatic stations have been widely commented on and numberless histories of patients going to their death when caution might have saved them are on record. Patients going from the lower elevations to altitudes of five and six thousand feet do not seem to realize at first how necessary are rest and thorough acclimatization for their safety during the earlier weeks or months of treatment. The higher stations are natural gymnasia where diseased lungs may be trained or overtrained; where accidents may happen to the inexperienced and rash, or even to the old time expert if he neglects to exercise proper judgment. No fall from the trapeze is more fatal in its effect than some mountain expedition or other adventure by the tuberculous patient. Dr. Solly was wont to say that nowhere is the invalid fool more quickly punished for his folly than in Colorado.

We are concerned, at present, with exercise as it relates to the breathing habit and the aeration of the diseased lung. Exercises and improved breathing habits can be carried out and acquired at the sea-level or at higher elevations. We believe that at the moderate or higher altitudes breathing exercises are more effective for good and tend more fully to develop the thoracic movements and capacity than at the lower levels (see page 62). Minor has recently reviewed this subject in a paper or the "Use and Abuse of Pulmonary Gymnastics in the Treatment of Tuberculosis" and holds that they are beneficial in properly selected cases. That such measures are abused by those who use them indiscriminately and unintelligently we all know.

ATMOSPHERIC COMPRESSION OF LUNG

Fifteen years ago Cornet came out strongly against exercises and others of experience take even more radical ground. The principle of rest has been carried to such an extreme that surgical measures, such as strapping the affected side to insure complete immobilization, have been adoped.[1] The most radical measure was the introduction

[1] Charles Denison, Trans. Amer. Climat. Ass., Vol. 21, 1905.

into the pleural cavity of nitrogen gas, or atmospheric air, so as to compress the lung and prevent as nearly as possible all motion. The credit for devising this operation and first performing it, belongs to Forlanini, but it was first practiced in America by Dr. John B. Murphy,[1] of Chicago, and has been repeatedly used by many others in Europe and America, including the late Dr. Henry P. Loomis,[2] Dr. Cleaveland Floyd and Dr. Samuel Robinson, of Boston, Dr. L. Brauer, Prof. T. Beneke, of Hamburg, Dr. H. L. Barnes and Dr. F. T. Fulton, of Rhode Island.

ARTIFICIAL PNEUMOTHORAX

Prof. Theodore Beneke, of Hamburg, says[3] that Forlanini conceived the idea of placing the affected lung at rest by artificial pneumothorax as early as 1882; he put it in practice in 1888; Brauer and Ad. Schmidt performed it in 1906. Murphy seems to have developed his operation without any knowledge of Forlanini's work. The operation has been performed in Germany, according to Beneke, by hundreds of physicians on several thousand patients. The operation is meeting with great favor in America.[4]

The clinical observation that the occurrence of pleuritic effusion in tuberculous cases was followed by an arrest of the symptoms of the primary disease if the effusion were left undisturbed; and, further, the unfavorable results which follow tapping in other cases, or when later adopted in cases of quiescent during the presence of the effusion led to this method of artificially producing immobility. Pleuritic effusion is intimately connected with pulmonary tuberculosis in a majority of cases and, if not purulent, should probably be left undisturbed.

Loomis followed Murphy's technique, using a special apparatus for the injection of pure nitrogen gas by means of which from fifty

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[1] John B. Murphy: The Surgery of the Lungs (Journ. Amer. Med. Ass., 1898). Also Surgical Clinics of Dr. John B. Murphy, December, 1913. W. B. Saunders Co., Phila.; also Interstate Medical Journ., March, 1914.

[2] Henry P. Loomis: Some Personal Observations on the Effects of Intrapleural Injections of Nitrogen Gas in Tuberculosis (Trans. Amer. Climat. Ass., 1900; Med. Record, Sept. 29, 1900).

This method was first proposed by Prof. Carlo Forlanini, of Pavia, Italy, at the International Medical Congress, Rome, 1894.

[3] Ueber den kunstlichen Pneumothorax, "Tuberculosis." Berlin, Nov., 1913.

[4] See article by Dunham and Rockhill, with discussion by C. L. Minor, Journ. Amer. Med. Ass., Sept. 13, 1913.

to two hundred cubic inches were introduced into the pleural cavity on the affected side[1]

The nitrogen gas introduced into the pleural cavity does not remain long without being absorbed, and in order to keep the lung immobilized for six months or more, repeated injections are required. When ordinary atmospheric air gains entrance to the pleural cavity it constitutes the condition known as pneumothorax, and if the pneumothorax becomes closed, the oxygen steadily diminishes and finally disappears, the carbon dioxide decreases and the last element to disappear is the nitrogen. This fact has been determined by chemical analysis by Dory, Bouveret, LeConte, Ewald (Loomis). The respirations are always increased after the injections and the pulse rate is lowered. A notable effect in Dr. Loomis' cases was the absolute control of pulmonary hemorrhage in cases where all other measures failed.

Dr. Loomis' experience in eighteen cases treated by injections of nitrogen gas was uniformly favorable, although not curative. Probably the fact that pulmonary hemorrhage is controlled is the chief value of the method, though gain in weight followed the adoption of this measure in all the cases.

SONG CURE

One method of pulmonary exercise lately advocated for tuberculous patients is by singing.[2] Singing invokes correct nasal breathing and a maintenance of the elasticity and proper expansion of the chest. The necessary breathing exercises promote an increased functional activity of all parts of the lungs, including the apices where tuberculosis usually first becomes evident. It is here that expansion is most limited and the prevalent opinion is that this comparative inactivity is a strong factor in the tendency of the disease.

The "song cure" may be suitable in some cases of pulmonary

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[1] For a good description of the latest apparatus and a discussion of the most approved methods see articles by Harry Lee Barnes and Frank Taylor Fulton, and by Samuel Robinson and Cleaveland Floyd, Transactions of the American Climatological Association, 1913, pp. 160-188, and 1911, pp. 289-383. A bibliography is given in Transactions, 1913, p. 170.

See also Trans. American Sanatorium Association, 8th spring meeting, p. 16. Discussion by H. D. Chadwick, W. A. Griffin, E. S. Bullock, G. W. Holden, J. J. Lloyd, Jr., L. Brown, J. Roddick Byers.

See also Samuel Robinson, "Practical Treatment," edited by Musser and Kelly, W. B. Saunders Co., Philadelphia, 1911, Vol. 3, p. 254.

[2] Drs. Leslie and Horsford, The Hospital, London, Jan. 25, 1908.

tuberculosis, but in laryngeal cases it would be counter-indicated. Its practice in pulmonary cases has not been adopted to any very great extent; but it would seem to have some advantages as it does not involve great muscular fatigue.

It is well known that public speakers with pulmonary tuberculosis cannot continue this practice with impunity. Their tendency to attempt to increase their weakening vocal powers by forcing the air outward has a bad influence on the lungs. Bad habits of speaking and lack of training are probably accountable for these bad results. Artistic breathing should be cultivated and all public speaking in crowded and badly ventilated halls should be avoided.[1] Knopf refers to cases of phthisis[1] which had even passed the incipient stage and were cured after following the occupation of street singer or speaker. He cites the case of an English lady who became an evangelist, addressing crowds of people every night in open air meetings and who was actually cured of her tuberculous disease after following this calling for a year.

Our own experience leads us to believe this to be an exceptional result. Having had some experience in treating members of the Salvation Army in various grades of the service, the impression gained was that tubercular disease was quite common among them and that their life of exposure, unhygienic quarters, insufficient food and excessive use of the voice rendered them an easy prey to consumption. The voice is almost always over-strained and hoarse and the open air life the members lead is accompanied by hardships which over-balance any favorable features in their nomadic existence.

Open air singing, properly employed, as in the German Army, is, no doubt, beneficial. This should be encouraged by all military authorities. It relieves the tedium of the march and invigorates the soldier. Barth, of Koslin, has made a thorough study of the effects of singing on the action of the lungs and heart, on diseases of the heart, on the pulmonary circulation, on the blood, the vocal apparatus, the upper air passages, the general health, the development of

[1] George Hudson Makuen: Artistic Breathing (Philadelphia Medical Journal, Sept. 3, 1898).

[2] S. A. Knopf: Respiratory Exercises in the Prevention and Treatment of Pulmonary Diseases (Johns Hopkins Medical Bulletin, Sept. 1901).

See also John H. Pryor, Deep Breathing as a Therapeutic and Preventive Measure in Certain Diseases of the Lungs (Trans. Amer. Climat. Ass., Vol. 22, 1906, p. 251).

the chest, on metabolism and on the activity of the digestive organs, and has come to the conclusion that singing is one of the exercises most conducive to health. (Knopf.)

CHAPTER VII. FRESH AIR SCHOOLS FOR THE TUBERCULOUS; VENTILATION

Under the name of "Waldschule" these have recently been established in Germany. The first was opened at Charlottenburg, Berlin, August 1, 1904, and closed its first term October 29th of the same year with 120 scholars. The results of the first year were very encouraging, the average increase in the weight of the children was five pounds, and the Forest School has been regularly opened each year.

The credit of its establishment belongs to the "Vaterländischer Frauenverein" of Charlottenburg. This patriotic association of women selected children either suspected of tuberculosis or with the disease already established for the Forest School. In this way educational facilities are provided for children whose condition renders them unsuitable for the public schools and at the same time avoids the necessity of sending them to sanatoria where there is little or no provision for teaching.

At Charlottenburg they put up so-called "Doecker barracks" or transportable buildings of light construction. There was one school barrack, containing two class-rooms and one teachers' room. The second barrack was used for household purposes. There was also an open "liege-halle" towards the south where the children may remain during bad weather. A light frame structure contains wash rooms and a bath-room with tub and douche. Three schoolmasters and one schoolmistress give instruction. The children were distributed in six classes of about twenty each. This is smaller than in the public schools where there are from forty-five to sixty in a class. The sessions never lasted over two hours continuously.[1]

This school has now grown so as to accommodate 240 children.

A second school is located in M.-Gladbach in the Rheinprovinz. It was opened in 1906 for sixty children between eight and fourteen years of age.

A third one is in Muhlhausen, Reichslande, Elsass-Lothringen, Southwest Germany. It was opened in 1906 and the physician in charge is Dr. Bienstock.

[1] For further particulars of this school, see article by Dr. J. Nietner, Tuberculosis, May, 1905.

A fourth is the Forest School in the Victoria Louise Children's Sanatorium at Hohenlychen. It was established August 1, 1903. Pastor Mickley is in charge. These are the pioneer schools and many others have since been established.

The most successful private open air schools in Germany are conducted by Prof. Dr. Gustav Pannwitz, the honorary secretary of the International Association for the Prevention of Tuberculosis. They are situated at Hohenlychen, about two hours by rail from Berlin, near Templin, on the hilly plateau which is called the "Mecklenburgisch—Pommersche—Seenplatte," between the East Sea and Spree Rivers. There are extensive forests of fir, a large lake with an island of 240 acres belonging to the school. It is conducted on the most modern hygienic principles.

An open air school was established at Bostall-Heath, near Woolwich, England, in 1907; in France, at Lyons, Vincennes and Boulogne; in Switzerland, at Lausanne, open from June 5 to September 23, at Zurich and Geneva. The "Rayon de Soleil" at Geneva, is for very young children; so also "Les Oisillons" at Lausanne.

In the United States the first fresh air school for tuberculous children was established in Providence, Rhode Island. Dr. Ellen A. Stone and Dr. Mary S. Packard had a small day camp during the summer of 1907 for children suspected of having tuberculosis. They soon became convinced that a fresh air school ought to be started for the benefit of the tuberculous children of Providence and they asked the help of Dr. Jay Perkins, Chairman of the Providence League for the Suppression of Tuberculosis in getting a single small school, necessarily ungraded, for those children, arranged so as to approximate an out of door school. At the camp which these physicians had been conducting there were about ten children who would soon have to go back to the ordinary schools or else would be at home in close rooms.

In response to this appeal Dr. Perkins enlisted the sympathy of the Superintendent of Schools, Mr. Walter H. Small, and with Judge Rueckert and Dr. Charles V. Chapin, the school committee established the first fresh air public school in America.

A school house not then in use and centrally located was requested for use and granted, and the necessary changes were made. The result was that they had to begin with a room on the second floor the full size of the building, about 40 by 25 feet, with windows on three sides. The brick wall on one-half of the southerly side was removed and windows substituted, these windows extending from near the floor to the ceiling, with hinges at the top and pulleys ar-

LONDON COUNTY COUNCIL'S OPEN AIR SCHOOL AT SHOOTER'S HILL. PAVILIONS
Courtesy of D. Walter Lindley

LONDON COUNTY COUNCIL'S OPEN AIR SCHOOL AT HORNIMAN PARK, LORDSHIP LANE. REST HOUR
Courtesy of D. Walter Lindley

ranged so that the lower end can be raised to the ceiling, thus leaving this half of the room completely open to the south. Each school desk and its accompanying seat is arranged on an individual wooden support so that, while stationary as regards each other, each desk and seat can be moved as desired, and thus any arrangement of seats may be made. The school is an ungraded one (the ages running from 7 to 13 years), and as such limited to 25 pupils. The school hours are from 9 to 11.45 a. m., and from 1.45 to 3.30 p. m., with a recess from 10.15 to 10.45. Towards the end of this recess each pupil is served a cup of hot soup. Each pupil has a sitting-out bag of the standard type and in very cold weather has a hot soapstone in the bottom of the bag. In the end of the room not open to the south a good fire is kept going, thus partially warming the air and keeping that end of the room moderately warm, the pupils' seats all being in the other end.

One interesting feature in connection with the school is that, though these children come from poor homes and there has been an extensive epidemic of "colds" in winter, especially affecting the nose and throat, no child in the school has had even a "cold in the head." On being enrolled, each child is weighed, measured, and the hemoglobin tested. The League furnishes the sitting-out bags and soapstones and some clothing, the city paying all other expenses.

Thus the credit for suggesting the school belongs to Drs. Packard and Stone, but the work was developed and carried on through the efforts of the League. Most of the children for the school are selected in the first instance by the head tuberculosis nurse and secondly by the physicians on the League Committee. All of them are from within walking distance of the school. Dr. Stone is one of the Medical Inspectors of the Public Schools and the other Medical Inspector, Dr. Charles E. Hawkes, was added to the committee.

Providence was the first city in the country to establish special schools for the mentally deficient and the school department is to be highly complimented because of the enthusiasm and energy with which they took up the establishment of a special school for the physically deficient as soon as the matter was presented to them.

This Fresh Air School in Providence was opened on January 27, 1908, with ten pupils, and soon twenty were enrolled. Hot soapstones, sitting-out bags, hot drinks at recess, frequent trips to the stove, breathing exercises, marching, bending movements, and uniform work in singing are prominent features of the pioneer fresh-air school in America.[1]

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[1] Ellen A. Stone, M. D., Journal of the Outdoor Life, May, 1908.

The instruction of children at the Sea Breeze Hospital for Tuberculous Children at Coney Island is provided by the Board of Public Education of Brooklyn, New York, and the Board deserves credit for thus cooperating with the Sanatorium. Provision is now made in the larger cities for the regular and systematic education out of doors of tuberculous children in the community at large and the success of this movement is attested by the fact that on May 1, 1913, there were 177 open air schools in the United States, five of these are in Rhode Island; thirty in Manhattan; twenty in Brooklyn.

See also Jay Perkins, M. D.: Fresh Air Schools—How They Accomplish Their Result (Journal of the Outdoor Life, New York, June, 1912).

Les EColes de Plein Air, leur valeur prophylatique dans la Lutte Anti-Tuberculose, "Tuberculosis," Berlin, Nov., 1911.

The Open-Air School, Anna Garlin Spencer, Trans. Sixth International Congress, Washington, 1908, Vol. 2, p. 612.

Open Air Schools, Thomas Wray Grayson, M. D., Therapeutic Gazette, Nov., 1913, p. 27. Also John V. Van Pelt, Interstate Med. Journ., April, 1914.

In order to control tuberculosis effectively we shall have to make more determined efforts to reach the school children and even those of earlier years. Tuberculosis is latent in thousands of children in every large city; sooner or later it becomes manifest as vital resistance becomes lowered. A recent view, prevailing in France and Germany, is that all tuberculous infections are made in infancy and childhood, the disease lying latent, from one cause or another, until the individual resistance, weakened by successive colds, pneumonia, grippe or other infections, or exposure to reinfection, finally yields and tuberculosis is actively established. Both laboratory and clinical experience point to a much earlier primary infection than we have been accustomed to believe and hence too much stress cannot be laid on the importance of better ventilated schools and the establishment of more "fresh-air schools" in every city of the country. These should be located near parks, if possible, or at least have extensive play grounds.[1] They should be conducted also for the benefit of children who may be anemic, nervous, and not necessarily tuberculous; and also for apparently healthy children. The best example of the outdoor school for normal children has been opened at Bryn Mawr College, Pennsylvania, as the Phebe Anna Thorne Model School.

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[1] Henry Barton Jacobs, M. D., Journal of the Outdoor Life, April, 1908.

J. H. Lowman, M. D., Trans. Nat. Ass. for the Study and Prevention of Tuberculosis, 1907.

The three Elizabeth McCormick Schools, in Chicago, are admirable examples of the open air school.

FIG. 1. "RAYON DE SOLEIL," GENEVA, SWITZERLAND. DAY CAMP FOR ANEMIC AND DELICATE CHILDREN

FIG. 2. FOREST SCHOOL, GENEVA, SWITZERLAND

FIG. 1. OPEN AIR SCHOOL ESTABLISHED BY THE CIVIC CLUB, PITTSBURGH, PENNA. STUDY HOUR; WARM WEATHER

FIG. 2. OPEN AIR SCHOOL ESTABLISHED BY THE CIVIC CLUB, PITTSBURGH. STUDY HOUR; COLD WEATHER

OPEN AIR SCHOOL ESTABLISHED BY THE CIVIC CLUB, PITTSBURGH, PENNA. RESTING HOUR

OPEN AIR SCHOOL ESTABLISHED BY THE CIVIC CLUB, PITTSBURGH, PENNA. LUNCH HOUR

FIG. 1. FRESH AIR SCHOOL ESTABLISHED BY THE CIVIC CLUB, PITTSBURGH PENNA

FIG. 2. OPEN AIR CLASS FOR ANEMIC CHILDREN AT PUBLIC SCHOOL NO. 21, NEW YORK CITY
Courtesy of Dr. J. W. Brannan

OPEN AIR CLASS, ROYAL VICTORIA HOSPITAL, EDINBURGH, SCOTLAND
Courtesy of Sir Robert Philip

Other private schools are advertising open air classrooms, *e. g.*, the Horace Mann School, the Packer Institute of Brooklyn and the Brooklyn High School.

All measures to preserve the purity of air and its freedom from dust should be rigidly enforced in schools. Bad ventilation is the rule except in the most modern school buildings. After two hours the air is depressing and carbonic acid is usually found in excess. The problem of how to deal with dust is a difficult one in schools, owing to the expense of really efficient methods. The floors should not have open crevices and dry sweeping should not be allowed. Sweeping with wet saw dust is probably the most effective, and at the end of each term a thorough bacteriological dust disinfection should be carried out by the Department of Health. Dr. J. H. Lowman, of Cleveland, who has instituted great reforms in the hygiene of the schools of that city, recommends not formaldehyde, but that the walls should be cleaned or painted, the furniture washed and the floors treated with dilute solutions of chloride of lime.

We recognize tuberculosis to be one of the greatest dangers to school children, for at the tenth year the Prussian statistics show that out of 100 boys who die, 9.26 die of tuberculosis, and out of 100 girls, 12.02 die of tuberculosis; hence the importance of all hygienic safeguards against this malady.

Tracheo-bronchial tuberculosis and tuberculosis of the lymphatic system are the forms most commonly encountered and strict medical inspection will reveal large numbers of children for whom fresh air schools or sanatorium schools should be provided. In New York City, out of about one hundred thousand children examined in 1905-1906, over one thousand were found to have pulmonary disease, and in almost every case it was the first intimation to the mother that her child had pulmonary tuberculosis.

Besides the Waldschule of Germany there are specially constructed sanatorium schools in Milan, Italy, and vacation colonies have been established near Geneva, the Swiss Government supplying the teacher while philanthropy supports the schools. In Denmark, where the outing vacations are so thoroughly systematized, the teachers are supplied by the state. The United States show promise of carrying out this enlightened method of dealing with the tuberculous problem. Outdoor schools are conducted successfully in connection with private camps for boys and girls. Many of these are in New Hampshire and Maine, in the vicinity of the Rangeley Lakes, and in Oxford County.

IMPORTANCE OF VENTILATION

The first desideratum in tuberculo-therapy and in the prevention of tuberculosis is abundant and free ventilation. The dwelling, the bedroom, the workshop, the office, the church, the schoolroom, the theatre, the modern subway are one and all dangerous in proportion, as their atmosphere is composed of dead or rebreathed air. Not only is tuberculosis favored by unhygienic surroundings and vitiated atmosphere in particular, but no other agent, not excepting alcohol and bad food, so surely undermines the constitution and renders it unable to resist disease. Air that has once been breathed, ought not to be breathed again. Out of doors the danger is minimized; indoors we usually breathe and rebreathe the contained air again and again. To some extent, of course, this cannot be avoided, but we should endeavor to reduce it to a minimum. This subject has been recently investigated by Dr. Thomas R. Crowder, who studied by ingenious methods the effect of such factors as change of position, body motion, different types of breathing and different temperatures and, in addition, has determined the conditions that obtain on the sleeping porch and in the open air. Nasal breathing was the type examined, since in mouth breathing there is, under favorable circumstances, little reinspiration.[1]

The conclusions that may fairly be drawn from Crowder's work are that (1) a person remaining quiet and indoors will immediately rebreathe from 1 to 2 per cent of his own expired air; (2) when lying in bed the percentage is higher, rising to from 4 to 10 per cent, depending on the position assumed while sleeping. "Nor does sleeping in the open insure pure air for breathing. The same influences here produce the same relative results that they do inside. When one buries his head between pillow and bed clothes for the sake of warmth, reinspiration is inevitable, and it is not necessarily small in amount." In addition, it must be noted that at each inspiration we reinhale not only some of the air just exhaled, but also the air contained in the nose and larger bronchi—the so-called "dead-space" air. This may amount to one-third of the whole volume in quiet inspiration and not less than one-tenth in deep breathing.

The significance of this study in connection with questions of ventilation is obvious. Since even under the most favorable conditions we cannot avoid drawing back into the lungs some of the air that has just passed out of them, not much importance can be attached to the slight variations in carbon dioxide content which occur in the air of rooms.

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[1] The Reinspiration of Expired Air. Archives of Internal Medicine, Chicago, October, 1913, p. 1936. Journ. Amer. Med. Ass., Editorial, Nov. 29, 1913, p. 1986.

PORTABLE OPEN AIR SANATORIUM FOR CONSUMPTIVES ON THE GRABOWSEE, NEAR ORANIENBURG. DOECKER CONSTRUCTION
Courtesy of Christoph and Unmack

THE OPEN AIR CHAPEL, KING EDWARD VII SANATORIUM, MIDHURST, ENGLAND

OPEN AIR CHAPELS AND THEATRES

It is remarkable how inconsistent we all are in matters of hygiene. Medical men are often among the worst offenders. Their offices are commonly stuffy, their conventions and social gatherings are often held in inadequate halls in which vitiated air, sometimes reeking with smoke, is perfectly abominable.

> If to do were as easy as to know what 'twere well to do
> Then chapels had been churches and poor men's cottages princes' palaces.

We cannot go back to the time of the Druids or worship in groves after the manner of the Greeks, but it seems fitting here to call attention to one chapel that has been specially constructed for out-of-door worship and that is destined to be a model for many a sanatorium at least. This has been constructed for the famous King Edward VII Sanatorium near Midhurst, in Sussex, England. The accompanying illustration of this unique chapel marks a step in advance in sanatorium construction. It is in the Moorish style, shaped like a broad letter V. The double rows of columns of the cloister are on the southerly side, the pulpit and chancel are in the apex and the northerly sides forming the inner walls are provided with arched apertures so that the patients may sit absolutely in the open air but with sufficient protection from the weather at all seasons. In fair weather services are held under the sky in the open space in front of the building between its extended arms. The illustration shows this very beautifully.

Open air theatres were built by the Greeks and Romans and the remains of these structures are among the most interesting of ancient ruins. In Europe the Passion Play at Bayreuth is enacted wholly out of doors, but is entirely apart from our subject except so far as it demonstrates the possibilities of out-of-door representation. The low theatre and concert hall are invariably hot and stuffy and undoubtedly foster tuberculosis by inadequate ventilation. It would be better if we could have some theatres or assembly halls with perfectly free circulation of air.

The Groton School in Massachusetts has lately undertaken to build an outdoor gymnasium, so that the boys shall have the advantage of the open air rather than in an enclosed building. This is the first school we know of to adopt this admirable plan.

VENTILATION OF DWELLINGS

Ordinary dwellings are terribly deficient as regards ventilation. The country dwellings of the poor are strangely defective in this respect. It has been said that the reason why the air in rural districts is so pure is that the poor country people have all the bad air shut up in their houses. There is a great deal of truth in this. Doctors are constantly struggling with the strange aversion that the rural population has regarding sufficient air in the bedrooms. As soon as night falls the windows and doors are tightly closed and the kerosene lamp adds to the pollution of the air. It is a common experience to find the doors and windows kept closely shut owing to the deeply rooted fear of catching cold. In European countries the windows of many of the older dwellings were originally intended for light and not for air, and are merely panes of glass built into the wall and not intended to be opened. Others are so badly constructed that the upper sash cannot be lowered and the lower sash is scarcely ever raised more than a few inches.

The children in many country cottages instead of being rosy and robust, as they should be with healthy surroundings, are frequently pale and bloodless on account of this bad air. This deficient ventilation of country houses and the bad food so common, where milk and eggs ought to be so plentiful and good, conspire to give to some country populations a bad start in the earlier years. No better example can be cited than that of the "poor whites" of the Southern United States. Indolence, ignorance, general helplessness and inertia are their characteristics. Their children are pale and gaunt, and their living quarters are horrible beyond description. It is a wonder the death rate among them is not greater than it is.[1]

It seems very strange, but it is a fact, that about seventy years ago a proposition was made to use the Mammoth Cave in Kentucky as a winter resort for invalids. Sixteen consumptives were sent there to gain the reputed benefit from the equable temperature and asserted purity of the air in that cavern. Five of these patients died and the others were injured as a result of the darkness and dampness combined. That such an irrational and cruel experiment should have been tried seems incomprehensible at the present day.[2]

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[1] The death rate from pulmonary tuberculosis for Virginia during the year ending June 30, 1913, was for whites 98.4, and for colored 256 per 100,000. The state rate was estimated at 148.

[2] See Croghan: The Mammoth Cave as a Winter Resort for Invalids (Boston Medical and Surgical Journal, 1843, Vol. 28, p. 188).

Daniel Drake, M. D.: Western Journal of Medicine and Surgery, Louisville, Kentucky, 1843, Vol. 7, p. 78.

OPEN AIR DINING HALL. DR. WALTHER'S SANATORIUM, NORDRACH-COLONIE, BLACK FOREST, GERMANY

LAWN CUTTING. GRADUATED LABOR IN PULMONARY TUBERCULOSIS. SANATORIUM OF THE BROMPTON HOSPITAL, FRIMLEY, ENGLAND

ROYAL VICTORIA HOSPITAL FARM COLONY. PLANTING POTATOES. GRADUATED LABOR
Courtesy of Sir Robert Philip

CHAPTER VIII. EXERCISE IN TUBERCULOSIS; GRADUATED LABOR

The Nordrach system of treatment of pulmonary tuberculosis carried out by Dr. Walther and that of his predecessor, Dr. Brehmer, at Goebersdorf, in Silesia, involves much exercise in addition to fresh air and alimentation; the Dettweiler system enjoins rest in the open air with superalimentation. McLean's dictum is: "If the phthisical patient would live, he must work for it."[1] Probably this advice should not be taken too literally, at least by every tuberculous patient; but graduated physical exercise has a very important and useful place in the treatment of most patients. Brehmer advocated hill-climbing, while Walther advises graduated walking exercises, in some cases to the extent of walking twenty miles a day. Whether one practices walking, or hill-climbing or graduated labor, we cannot dissociate from these measures the effect of atmospheric air, in its various qualities, upon the lungs and the accompanying stimulation of the pulmonary and general circulation. Two recent papers by London practitioners are full of such suggestive thoughts on this subject that we call special attention to them. They are considered by some as marking an epoch in the treatment of pulmonary tuberculosis.

At a meeting of the Medical Society of London, January 13, 1908, Dr. Marcus S. Paterson, the Medical Superintendent of the Brompton Hospital Sanatorium, at Frimley, read a paper on "Graduated Labor in Pulmonary Tuberculosis" which was supplemented by another on the "Effect of Exercise on the Opsonic Index of Patients Suffering from Pulmonary Tuberculosis," by Dr. A. C. Inman, Superintendent of the Laboratories, Brompton Hospital.[2]

The patients for whom Paterson instituted graduated labor were selected cases sent from the Brompton Hospital in London to its Sanatorium at Frimley, at an elevation of 380 feet in the country.

He was induced to carry out this plan of treatment after seeing tuberculous patients who did well while working under unfavorable surroundings; but he believed that under careful regulation of labor and with very careful observation of the temperature records, he might safely proceed. The exercises adopted involved all the muscles of the trunk and extremities and this was thought to be better than walking exercises in which the lower limbs were chiefly employed. The use of the upper limbs seemed more likely to favor

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[1] McLean: Personal Observation in Phthisis Pulmonalis (Journal Amer. Med. Ass., February, 1898).

[2] The Lancet, January 25, 1908.

the expansion of the lungs. It was not forgotten that the common objections to this plan of treatment are, (1) that the disease would become active again under the strain; and (2) that the exertion would tend to produce hemoptysis. Considerable tact and personal influence must have been exerted to get the patients to carry out a plan which involved increasing labor and measures that are generally considered positively harmful.

The first exercise ordered was walking, the distance being gradually increased up to ten miles a day. When a patient had reached this stage he was given a basket in which to carry mould for spreading on the lawns. No case of hemoptysis or of pyrexia occurred among these patients. When they had been on this grade with nothing but beneficial results for from three weeks to a month, they were given boys' spades with which to dig for five minutes followed by an interval of five minutes for a rest. After a few weeks, several of the patients on this work, who were doing well, were allowed to work as hard as possible with their small spades without any intervals for rest. As they had all improved on this labor larger shovels were obtained, and it was found that the patients were able to use them without the occurrence of hemoptysis or a rise of temperature. About this time many of the patients were feeling so well that it became necessary to restrain them from doing too much.

These results in a few cases creates a most favorable sentiment among the other patients so that the system was extended generally, with great care and minute supervision. Harder work was prescribed for patients who could be trusted even to the use of spades, shovels and five pound pick-axes. The patients all expressed the opinion that the work did them good and that the harder they worked the better they felt. Many patients have written to Dr. Paterson to say that they date their improvement from the commencement of the labor, and that they think the hardest work did them the most good. It certainly speaks well for the strict supervision of these patients that no accidents occurred of a serious nature, though several developed fever and, subsequently, pleurisy. One patient was laid up for two months and was much worse at the end of that time, though eventually he did well and returned to work, though the extent of his disease was increased through overexertion.

The suitability of cases for graduated labor rests on a very careful physical examination, importance being laid on the general muscular and physical development. Marked wasting and poor development is, naturally, a bar to this method of treatment. The resisting power

ROYAL VICTORIA HOSPITAL FOR CONSUMPTION, EDINBURGH. GRADUATED LABOR; ROAD MAKING BY THE PATIENTS ON HEAVY GRADE WORK. THERAPEUTIC AUTO-INOCULATION ARTIFICIALLY CONTROLLED BY MANUAL LABOR

Courtesy of Sir Robert Philip

THERAPEUTIC AUTO-INOCULATION ARTIFICIALLY CONTROLLED BY MANUAL LABOR. LOOMIS SANATORIUM, NEW YORK.
LIGHT GRADE WORK IN THE GARDENS

of a patient with a very limited lesion is an unknown quantity and has to be determined, whereas a patient with a lesion involving four lobes may remain at work for some time and exhibit a good initial resisting power.

Dr. Paterson lays very great stress on the temperature taken in the mouth. If this is or has been 99° F. or over during the week preceding admission to the sanatorium, the patient is put to bed after the journey. So long as the temperature remains at 99° F. in the case of men or 99.6° F. in the case of women, the patient is not allowed up for any purpose. So long as the temperature is unaffected by exertion the patient is gradually allowed up for longer and longer periods. Patients with apparently limited disease, but who are in poor general condition and without fever, are allowed to be up all day, but are not permitted to take further exercise than is entailed by walking to and from the dining hall for their meals. The remainder of the day is spent in resting. As their condition improves they are allowed to walk half a mile a day, and so on, until a distance of six miles a day is reached. The rate of increase in the amount of exercise depends upon such factors as the patient's disposition, weight and appetite.

The grades of work are briefly as follows:

(A 1) Walking from one-half to ten miles daily.
(1) Carrying baskets of mould or other material.
(2) Using a small shovel.
(3) Using a large shovel.
(4) Using a five-pound pick-axe.
(5) Using a pick-axe for six hours a day.

Patients in grades 1, 2, 3, and 4, work four hours a day.

The basket work in which about eight pounds of earth are carried is considered the most important and, as a rule, patients spend far more time in this work than in any other. It brings into use all the muscles.

Work has a wholesome effect on the mind. If the patient is at first sullen and apathetic, the improvement in physical condition quickly begets a lively and cheerful mental attitude, and one that seeks work rather than to shirk it.

During 1905 and 1906 the number of patients discharged from this sanatorium was 164, and they all returned to their previous occupations, whatever they happened to be, and not to light, outdoor work. They were fitted by the line of treatment which we have described for effective wage earning.

We have dwelt quite fully on this innovation in tuberculo-therapy because it gives promise of good, practical results and, further, because it is so radically different from the prevailing methods adopted in most sanatoria. But, the most interesting feature is the explanation which is offered to account for the benefits which has accrued. This explanation is set forth in an elaborate study made by A. C. Inman, M. B., the superintendent of the laboratories of the Brompton Hospital, on the "Effect of Exercise on the Opsonic Index of Patients Suffering from Pulmonary Tuberculosis."[1]

This study of Inman's was prompted and made possible by the brilliant work of Sir Almroth Wright. Wright showed in his Harveian Lecture in New York, that there are three great agencies by which immunizing responses can be evoked in the organism:

(1) By the inoculation of bacterial vaccines.

(2) By artificially induced auto-inoculations.

(3) By spontaneous auto-inoculations.

Wright had previously elucidated the subject of vaccine therapy by constructing curves from the opsonic indices of patients vaccinated against their infection and in this manner traced a definite train of events which follow upon a single inoculation. The successive phases were termed the negative phase, the positive phase and the phase of maintained high level. Freeman, working in Wright's laboratory, then took up the subject of massage in its effect on gonococcal joints showing that "*Auto-inoculations follow upon all active and passive movements which affect a focus of infection and upon all vascular changes which activate the lymph-stream in such a focus.*"

Wright's dictum was that "where in association with a bacterial invasion of the organism bacteria or bacterial products pass into the general lymph, and blood-stream, intoxication effects and immunizing responses, similar to those which follow upon the inoculation of bacterial vaccines, must inevitably supervene." It is a perfectly logical conclusion, then, that nature cures bacterial infections through such auto-inoculations. Inman set himself to find out what the body is doing of itself and what value extraneous circumstances, such as physical exercise, have in aiding these attempts on the part of the body. Inman's work was conducted on a carefully planned technique, controlled and checked at all points, using forty-three patients in the sanatorium treated by the System of Graduated Labor.

Inman found that in 41 out of 43 cases the opsonic index was at

[1] Read before the Medical Society of London, January 13, 1908.

THERAPEUTIC AUTO-INOCULATION ARTIFICIALLY CONTROLLED BY MANUAL LABOR. LOOMIS SANATORIUM, NEW YORK.
HEAVY GRADE WORK; ROAD MAKING

THERAPEUTIC AUTO-INOCULATION ARTIFICIALLY CONTROLLED BY MANUAL LABOR. LOOMIS SANATORIUM, NEW YORK.
HEAVY GRADE WORK; ROAD MAKING

some time of the day well above the normal, and what is of even more importance, in no case did the exercise, even though severe, lower the index below the normal line—that is, the auto-inoculation was never so great as to produce a negative phase and, therefore, never in excess.

It was observed during these investigations that in some bloods examined, tuberculo-agglutinins appeared in association with the immune tuberculo-opsonins. This must be taken as another evidence of an immunizing response on the part of the organism. When the difficulties of such a method of treatment and the danger of the weapon employed are taken into consideration it will be readily understood that every now and then, in spite of the most careful supervision, an excessive auto-inoculation must take place. Such an over-dose is readily recognized clinically. A patient doing well on the grade of work prescribed for him and with no abnormality of temperature suddenly complains of feeling tired, of loss of appetite and of headache; and the temperature chart registers an elevation to 99° or 100° F. These are precisely the symptoms which are found during the negative phase after an excessive dose of bacterial vaccine.

Thus we have a new scientific test by which the effect of physical exercise on the blood of patients has been traced. As Inman says:

The opsonic index has shown that the exercise has supplied the stimulus needed to induce artificial auto-inoculation, and that this systematic graduation has regulated this in point of time and amount. This co-operation with the natural efforts of the blood has enabled Dr. Paterson to send his patients back to their accustomed work, however hard it may be. But the investigation has done more than explain a successful mode of treatment. Dr. Paterson agrees with me that with the aid of the opsonic index he can regulate the stimulus with scientific accuracy and obtain his results more certainly and more rapidly. This, of course, involves work in the laboratory. But it also means a more rapid and a more certain discharge of the patient which is the main object of the sanatorium.

Fresh air, exercise, and proper food seem then to constitute the foundation of successful treatment of tuberculosis. The improvement of the general condition of the patient and life in the open air evidently needs to be supplemented by certain exercise so as to produce a series of auto-inoculations and probably the best method yet devised is by the system of graduated labor just described.

All sorts of exercises such as horseback riding, golfing, light dumb-bell exercises and other calisthenics have been practiced for many years in treating tuberculosis; walking exercises have been the feature of some of the German sanatoria referred to; patients sent to the western states and territories almost invariably practiced outdoor exercises, some with great harm and some with benefit. Neither physician nor patient in most instances regulated these exercises intelligently, but groped in the dark, never dreaming of the underlying principles as explained by laboratory studies of Sir Almroth Wright, Paterson, Inman, and others. We trust that further studies and the application of the same method in Europe and America will fix the value of exercise in tuberculosis.

A somewhat similar system of graduated labor has been adopted in the King Edward VII Sanatorium near Midhurst, England. Light work in the gardens and grounds is prescribed in lieu of some of the walking exercise and forms part of the regular treatment. Practical gardening in the grounds and flower beds is utilized. The lightest labor consists of weeding, hoeing and edging paths and borders, gathering seeds, plucking dead flowers, pruning, etc. Somewhat harder exercise consists in wheeling soil to the lawns and spreading it, clearing ground of stones and taking them away in barrows, and in leveling new ground after being broken up. The heaviest work is that of digging and trenching unbroken ground, moving, rolling, etc. Paths through the pine woods have also been constructed. In this particular work the breaking up of the ground with picks and clearing away the roots from neighboring trees was allotted to the first division of patients. The second division cleared away the broken ground and roughly leveled it. The third division finished the leveling of the paths with rakes and tidied up the edges.[1]

Free patients at the King's Sanatorium have made a cinder tennis court; they have cut down and sawed fire wood; they have an open air carpenter shop and an instructor in carpentry, who is himself a patient; they care for the poultry and make the runs for the fowls. In this way patients are constantly occupied.

Although the system of graduated exercises, or labor, adopted at the sanatoria referred to, has attracted wide notice and its principles were there first placed on a highly scientific basis, there were previous attempts to do this in an intelligent and rational manner. Sir Robert Philip, at Edinburgh, over twenty years ago, before the bacteriology of tuberculosis had been so well developed, prescribed practically the same thing as a therapeutic measure of definite dosage. He had had classes of selected patients who came at fixed hours to take regular training with regard to posture and healthy respiratory movement. More especially the young were taught the value of a healthy form of chest, the principles of nose-breathing and full diaphragmatic movement. "In addition to this, measured walks of varying amount and gradient were prescribed exactly

[1] Noel Dean Bardswell, Tuberculosis, Berlin, May, 1908.

as we prescribe medicines. Thus we had walks radiating from the dispensary round the meadows, walks over the Bruntsfield Links and walks in various directions on the slopes of Arthur's Seat. The patients reported, at successive visits, their experience in carrying out such instructions and notes were made of the effects produced." Here we see the germ of the class method so well developed and practiced by Pratt, of Boston, although he is an apostle of rest rather than labor.

The results in Philip's hands were eminently satisfactory. "The patients did remarkably well and no accident was traced to the adoption of active movement instead of rest. The experience led to a change in my outlook in relation to the meaning of treatment in tuberculosis." Philip came to the conclusion that by the establishment of hospitals or sanatoria for patients in the earlier stages of tuberculosis "we might hope to achieve permanent cures to a degree not dreamt of, by elaboration of the principle of regulated exercises and graded activity of all kinds." These conclusions were justified by the results obtained "in the home treatment undertaken for so many years at the Victoria Dispensary and in the systematized *régime* of work at the Royal Victoria Hospital and the recently opened Farm Colony."

Sir Robert Philip lays great stress on the well-known fact that there is a progressive intoxication in tuberculosis and the toxins produced by the tubercle bacillus appear to exert their vicious influence particularly on the neuromuscular apparatus. The toxin is especially a muscle poison.[1] There is a visible and palpable progressive wasting of the muscles, both of the trunk and the extremities, with advancing flaccidity and increased myotatic irritability. It is an expression of malnutrition, a muscular dystrophy dependent on intoxication. The obvious conclusion is that by the institution of natural movements the physiologic cure of "recreation" is assisted and health gradually returns.

Sir Robert's scheme of physical treatment at the Royal Victoria Hospital is worthy of mention. On admission each patient is placed at complete rest. During this stage, in addition to minute examination of every organ, the patients general condition is carefully observed. According to the estimate which is made the length of the resting period is fixed. Thereafter, in the absence of counter-indication, the patient is gradually advanced through the other stages.

[1] R. W. Philip, Trans. International Med. Congress, Washington, 1887, Vol. 1, p. 205.

The dose of exercise is increased or diminished as the temperature chart, pulse rate and other indications suggest. A colored badge is given to the patient to denote the stage he has reached.

I. Resting Stage, as noted above. (White Badge.)

II. Stage of Regulated Exercises. (Yellow Badge.) This includes (1) walking ¼ to 5 miles; (a) on the level; (b) on sloping ground. (2) Various respiratory exercises once or twice a day. (3) Other forms of movements to improve carriage of shoulders, head, chest, etc.

III. Stage of Regulated Work. (Pale Blue Badge.)

IIIA. Picking up papers, leaves and other light rubbish on the grounds; knitting; sewing; drawing.

IIIB. (Green Badge.) Emptying waste garden boxes and assisting to carry away rubbish. Carrying light baskets for various garden purposes. Light painting work, wiping shelters; setting tables and laying cloth in patients' dining room; cleaning silver, brasses, taps, etc.

IIIC. (Deep Blue Badge.) Raking, hoeing; mowing; sweeping leaves; light wheel-barrow; heavier painting work; sweeping shelters; scrubbing floors; cleaning knives; assisting in laundry; washing dishes.

IIID. (Red Badge.) Digging; sawing; carrying heavy baskets for various gardening purposes; wheeling and drawing full wheel-barrow and other heavy gardening work. Window cleaning and polishing floors; sweeping and cleaning court yard. Carpentering; joinering; engineering; attending boiler; errands.

An institution providing diversified occupations has a great advantage over one whose patients are restricted to walking exercises and where the women are employed in kitchen work and the men as laboratory orderlies, assistants in the drug rooms, clerks and so on. It is well to vary the walking exercise with manual labor. Patients welcome it and take a great interest in the various occupations they are put to. They acquire confidence in themselves as they see their muscular tone improving and some prospect of resuming useful occupations.

With various modifications suggested by local conditions the system of graduated labor described above is now adopted at various institutions in America; in many cases, however, the economic aspect of the plan of treatment apparently overshadows the therapeutic features; probably the best examples of the method are at the Loomis Sanatorium, New York, Otisville State Sanatorium, New York, The Adirondack Cottage Sanitarium, New York, The North Reading State Sanatorium, Massachusetts, and The Barlow Sanatorium, Los Angeles, California. Dr. Barlow has kindly sent me the following description of the method he has carried out:

This institution is semi-charitable and receives cases in all stages.

You ask me to send you a statement of our use of graduated labor. I will give you the facts as we handle the matter, which is somewhat modified to

TENT HOUSES. BARLOW SANATORIUM, LOS ANGELES, CALIFORNIA

BARLOW SANATORIUM, LOS ANGELES, CALIFORNIA meet the needs of our institution. It seems to me that every institution must modify this according to the facilities at command. Our working plan is as follows:

All the patients without any fever are kept absolutely quiet for the first two or three weeks, except that they are allowed to go to the dining room for meals. If, during this time, there is no elevation of temperature, no marked acceleration of pulse, and no loss of weight, they are started on exercise, beginning with ten minutes' walking twice a day. If they continue to do well, gain weight, temperature remains normal, and progress of physical signs is favorable, then exercise is increased every two weeks. The amount of exercise is charted for each patient; one copy posted on the bulletin board, and one copy retained by the nurse in charge of the order, to check up the allowance for each patient. Patients who have more than ten minutes' exercise twice a day make their own beds and keep their rooms in order, except the heavy cleaning. After patients have reached an allowance of thirty minutes twice a day, they are assigned to more practical work about the place or grounds. In making these assignments, the patient's physical condition and progress, former, and probably future, occupation are considered. Most of these assignments are changed each month, the effort being to try to increase the work each month. The work done includes the setting of tables in the dining room, removing and washing dishes, work in the diet kitchen, looking after books and pamphlets in the library, cataloguing books, statistical work, stenography and typewriting, carrying mail, light repairs about buildings, care of paths and summer-houses, sprinkling during dry weather, and operating the incinerator. Many patients are assigned to flower beds of their own, or to doing light work in caring for the sanatorium grounds. In carrying out this exercise or labor, careful watch is kept over patients, and if any elevation of temperature, acceleration of pulse, or extension of physical signs are observed, they are put back to rest. The purposes that this exercise and labor seem to serve are, recreation, stimulating the appetite and digestion, building up healthy tissue, inducing healthy sleep, and testing the patients against relapses when they resume their normal way of living after being discharged. We find that patients who accept the occupation cheerfully make better progress mentally and physically than those who resent being assigned to duties.

For patients with an elevation of temperature 99° or over, acceleration of pulse, either loss or no gain in weight, or who do not show improvement in other ways, rest is continued, and exercise or assigned work is deferred.

At the present time (December 11, 1913), there are 43 patients in the sanatorium. Ten are in the infirmary; thirty-three in open-air cottages; of the latter twenty-seven are doing their own work, and twenty-five additional assigned work. Of the six in open air cottages not doing their own work, three are new patients who have been recently admitted and not under observation a sufficient time for report.

REFERENCES TO WORKS ON EXERCISE AND WORK

Sir Robert W. Philip: Rest and Movement in Tuberculosis (British Medical Journal, December 24, 1910).

Albert Robin: How Consumption is Cured by Work (Therapeutic Gazette, December, 1911, p. 854-865).

Lawrason Brown and F. H. Heise: Properly Regulated Rest and Exercise in Pulmonary Tuberculosis (Journal of the Out-Door Life, August, 1912).

J. W. Flinn: Rest and Repair in Pulmonary Tuberculosis (Journ. Amer. Med. Ass., Aug. 16, 1913, p. 466).

L. Teleky: Choice of Occupation with Regard to Tuberculosis (Wien. klin. Wochnschr., March 13, 1913; abstr., Journal Amer. Med. Ass., April 26, 1913, p. 1336).

S. R. C. Halcomb: Graduated Labor in Pulmonary Tuberculosis (Military Surgeon, February, 1913; abstr., Journ. Amer. Med. Ass., Oct. 26, 1912, p. 1564).

J. W. Allan: Graduated Labor at Bellefield Sanatorium (Glasgow Med. Journ., January, 1911; abstr., Journ. Amer. Med. Ass., Feb. 4, 1911, p. 384).

A. P. Francine: Rest, Exercise and Food in the Management of Tuberculosis (New York Med. Jour., Dec. 31, 1910; abstr., Journ. Amer. Med. Ass., Oct. 29, 1910).

M. Paterson: Treatment of Pulmonary Tuberculosis by Graduated Rest and Exercise (Practitioner, January, 1913).

C. C. MacCorison and N. B. Burns: Method of Recording Exercise Data in Sanatorium for Consumptives (Boston Med. and Surg. Journ., May 9, 1912).

CHAPTER IX. ACCESSORIES FOR THE FRESH AIR TREATMENT OF TUBERCULOSIS

It would be impossible to carry out the fresh air treatment of tuberculosis without some special facilities or accessories. These vary somewhat in accordance with the plan of treatment, whether singly or collectively; or in cities, forests, or plains. Among these accessories we include: (1) Tents; pavilion tents. (2) Tent houses; shacks, "lean-tos." (3) Disused trolley cars. (4) Balconies or leigeterrasse for day use. (5) Day camps. (6) Sleeping porches or balconies. (7) Wooden pavilions. (8) Glass pavilions. (9) Hospital roof wards. (10) Detached Cottages. (11) Sleeping canopies.

Tents.—Tents have the advantage of low cost, portability, and the fact that they are adapted for almost any locality, whether in the city, the forest, or the plains. In the city a tent for the use of a tuberculous patient usually attracts too much notice and unfavorable comment unless placed in a rural district. It is possible, however, to erect tents in the heart of a great city, hundreds of feet above the ground where an abundance of pure air and sunlight are obtained. The modern hotel or office building can furnish a far better site, in these particulars, than many rural districts. The author is not aware of any extensive use of tall buildings for the treatment of pulmonary tuberculosis, but it would seem to be an entirely feasible proposition.

TENTS FOR TUBERCULOUS PATIENTS, SUNNYREST, WHITE HAVEN, PENNA.

ESTES PARK, COLORADO. CHEAP BUT COMFORTABLE TENT FOR SUMMER USE
Courtesy of Dr. S. G. Bonney

Anyone who will read the interesting story by Van Tassel Sutphen entitled "The Negative Pole,"[1] will find the history of an interesting case of pulmonary tuberculosis cured by residence of eighteen months on the top of a modern "skyscraper." The patient had been advised to remove to Arizona, but circumstances made this advice impossible to follow; as an alternative measure he isolated himself almost entirely from the world in the midst of a metropolis, and was rewarded by a complete cure. The imaginative author of this original story assigns to the patient a much more difficult rôle than need be assumed by anyone who may follow the general line of treatment and perhaps we may hear of many who may be encouraged to carry out the plan suggested.

In the forest during the warmer season tents are almost indispensable. A substantial tent properly erected, protected with a "fly" and with a surrounding trench to provide for excessive rainfall, can be made a comfortable and healthful habitation during a large part of the year.

The ventilation of tents, and their heating in cold weather, have received a great deal of study, and as they are perfected in these respects their suitability for a continuous residence throughout the year has been proved. Tents can be made storm proof and almost as comfortable in stormy weather as an ordinary building. On Blackwell's Island and on Ward's Island, New York City, tents are in constant use, with astonishing success for tuberculous patients.

At the Manhattan State Hospital East, for the insane, Ward's Island, New York City, the late Dr. A. E. Macdonald instituted, in 1901, a tent colony for the tuberculous patients.

This experiment resulted most favorably and led to the extension of the outdoor treatment to other classes of the insane besides the consumptives. For thirteen years the consumptive insane on Ward's Island have been treated in tents and pavilions. Tuberculous infection has been removed from the wards and 11.39 per cent of patients are reported to have had their tubercular disease arrested. They almost invariably gained flesh; one is reported to have gained 79.5 lbs. (Eighth Annual Report, Manhattan State Hosp., New York.) In the Eighth Annual Report the following comment is made: "In our experience the winter months have proven to be the most favorable for these patients, despite popular opinion to the contrary, and likewise it is seen that the summer month of July was in a decided manner proven to be the least favorable of the year."

[1] Harper's Magazine, July, 1908.

The accompanying illustrations show fully the initial stage of this experiment in a portion of New York City having many natural beauties. But in the course of time it was apparently realized that the same results might be obtained with other structures of a more permanent character and I am informed by Dr. William Mabon, the superintendent and medical director, that the tents have been replaced by wooden and glass camps. The reason for this change is that the tents were found to be very close and unsatisfactory in wet weather, whereas the wooden camps can be opened and ventilated under all conditions of weather.

Pavilion Tents.—On Blackwell's Island, New York, the Metropolitan Hospital makes use of twelve pavilion tents with a capacity for 142 patients. Steam pipes are arranged in a double circuit and in some cases stoves render these pavilion tents comfortable in winter and were preferred by the majority of the patients, in the coldest weather, to the ordinary quarters in the main building of the hospital. These pavilion tents were devised by Dr. A. M. Holmes, of Denver.

The tent devised by Dr. Charles Fox Gardiner, of Colorado Springs, is largely used in western sanatoria and has some notable advantages. It is of conical shape, like the Sibley army tent, with a ventilator at the apex of the cone which may be opened or shut. The board floor has an air space beneath and air inlets opening at the floor between the interior wainscoting and the tent wall supplying air at the height of three or four feet above the floor. This is an improvement over the method of allowing air to enter at the floor. These inlets are controlled by hinged lids. This tent avoids the use of a center pole, pegs, or guy-ropes, as it is supported by two-by-four-inch timbers reinforced by angle irons and plates. This tent costs from $90 to $100 and is thoroughly practical. It is not unlike the Nordrach tent. (See plate 55.)

The tent devised by Dr. H. L. Ulrich, of Minneapolis, is simpler and less expensive. It consists of a wall tent with ridge pole for the tent, and another 12 inches clear above it for the "fly." There are ventilating openings on either side of the tent ridge. The tent and "fly" are secured by guy-ropes and pegs and all four sides may be rolled up and lowered as required. A stove may be used in cold weather. A tent 10 by 12 feet costs $22.50.

Other excellent tents have been devised by Prof. Irving Fisher, of New Haven, Dr. Mary Lapham, of Highland, N. C.,[1] and Dr. James A. Hart, of Geneva, New York, and Colorado Springs.

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[1] American Medicine, Phila., 1905, Vol. 9, 517.

UNITED STATES PUBLIC HEALTH SANATORIUM, FORT STANTON, NEW MEXICO. SHOWING TENTS OCCUPIED BY CONSUMPTIVE EMPLOYEES

FIG. 1. MANHATTAN STATE HOSPITAL, EAST, WARD'S ISLAND, NEW YORK CITY. TENTS FOR THE TUBERCULOUS INSANE

FIG. 2. MANHATTAN STATE HOSPITAL, EAST, WARD'S ISLAND, NEW YORK CITY. CAMP C, FOR DEMENTED AND UNCLEANLY TUBERCULOSIS INSANE PATIENTS

FIG. 1. MANHATTAN STATE HOSPITAL, EAST, WARD'S ISLAND, NEW YORK CITY. TENTS FOR THE TUBERCULOUS INSANE. SUMMER LOCATION

FIG. 2. MANHATTAN STATE HOSPITAL, EAST, WARD'S ISLAND, NEW YORK CITY. CAMP A, FOR THE TUBERCULOUS INSANE. SUMMER LOCATION

FIG. 1. TENT DEVISED BY DR. CHARLES F. GARDINER, COLORADO SPRINGS. SEE PAGE 122

FIG. 2. MANHATTAN STATE HOSPITAL, EAST CAMP A. INSANE TUBERCULOUS PATIENTS. REVOLVING TENT CONSTRUCTED SO AS TO BE EASILY TURNED IN ACCORDANCE WITH THE DIRECTION OF SUN AND WIND.

ROYAL VICTORIA HOSPITAL FOR CONSUMPTION, EDINBURGH. SHELTERS ARRANGED FOR NIGHT USE. THESE ARE USED ALL THE YEAR ROUND

Courtesy of Sir Robert Philip

FIG. 1. MANHATTAN STATE HOSPITAL, EAST, WARD'S ISLAND, NEW YORK CITY. NEW OPEN SHELTER FOR THE TUBERCULOUS INSANE

FIG. 2. LOOMIS SANATORIUM, SULLIVAN COUNTY, NEW YORK. SLEEPING GALLERY IN GUILD LEAN-TO

INTERIOR VIEW OF OPEN AIR COTTAGE USED BY STATE HOSPITAL FOR CRIPPLED AND DEFORMED CHILDREN, AT ST. PAUL, MINNESOTA
A PERFECT OPEN AIR TREATMENT. PATIENTS PROTECTED FROM SUN, FLIES AND MOSQUITOS
Courtesy of the Metal Screened Cottage Company, St. Paul

BED SHELTER, UNITED STATES PUBLIC HEALTH SERVICE SANATORIUM FORT STANTON, NEW MEXICO, 1912

TENT HOUSE, TYPE B UNITED STATES PUBLIC HEALTH SERVICE SANATORIUM, FORT STANTON NEW MEXICO, 1912

MODEL OF TENT HOUSE, TYPE A, USED AT THE UNITED STATES PUBLIC HEALTH SERVICE SANATORIUM, FORT STANTON, NEW MEXICO, 1912

TENT HOUSES, TYPE A, UNITED STATES PUBLIC HEALTH SERVICE SANATORIUM. FORT STANTON, NEW MEXICO, FOR MASTERS, PILOTS AND ENGINEERS

TENT HOUSES, TYPE B, UNITED STATES PUBLIC HEALTH SERVICE SANATORIUM, FORT STANTON, NEW MEXICO

TUBERCULOSIS SANATORIUM OF THE UNITED STATES PUBLIC HEALTH SERVICE AT FORT STANTON, NEW MEXICO

SCENE IN NEW MEXICO, NEAR FORT STANTON. THIS HERD BELONGS TO THE SANATORIUM OF THE UNITED STATES PUBLIC HEALTH SERVICE

A "ROUND-UP" OF THE HERD BELONGING TO THE SANATORIUM FOR TUBERCULOSIS, UNITED STATES PUBLIC HEALTH SERVICE, FORT STANTON. A CHARACTERISTIC SCENE IN NORTHERN NEW MEXICO

DISUSED TROLLEY CARS WERE FIRST USED FOR CONSUMPTIVE PATIENTS BY DR. WILLIAM H. PETERS, OF PROVIDENCE, AT THE PINE RIDGE CAMP, RHODE ISLAND. THE CAMP CONSISTED OF SHACKS. PHOTOGRAPH SHOWS THE EFFORTS MADE TO PROVIDE THE OPEN AIR CURE BEFORE THE STATE SANATORIUM WAS BUILT

The evolution of the tent and open air shelter into the tent house, shack, and cottage, is an interesting feature of the open air treatment of tuberculosis.

"Lean-to."—The open air shelter and "lean-to" are somewhat alike. The latter has been long used by sportsmen and others in our northern forests, and has been greatly amplified for sanatorium purposes. The roof of the "lean-to" slopes directly back from its front or there may be a ridge placed close to the front or southerly side of the structure. The roof slopes well toward the back, but is short in front and allows free access of air and light. Canvass or screens are arranged to hang in front as a protection from wind or rain, and to insure privacy. For a full description of a "lean-to" the reader is referred to Dr. H. M. King's description with plans in "Some Methods of Housing," Charity Organization Society, New York.

Excellent "lean-tos" or open air shelters are in use all the year at the Royal Victoria Hospital, Edinburgh, Scotland, as seen in the illustration kindly supplied by Sir Robert Philip. (See plate 56.)

Pavilion tents are amplifications of the tent cottage, and are adapted for ten or twelve beds. As described by Mr. Homer Folks, they are sixteen by thirty-two feet long; the walls are eight feet high; the roof is fifteen feet high at the ridge and the floor of the tent is sixteen inches above the ground with free circulation of air underneath.

Tent Houses adapted for use in the New England and Middle States are naturally different from those in use in New Mexico and Arizona, where rain and snow are uncommon. The accompanying illustrations show a row of six tent houses and a single tent house at the U. S. Public Health Sanatorium at Fort Stanton, New Mexico, for consumptive sailors, under the care of the United States Public Health Service. The roof has a slight incline and the sides are arranged to give free ventilation as well as shelter when required.

Trolley Cars.—Superannuated and disused trolley cars were first used for tuberculosis patients by Dr. W. H. Peters, of Providence, Rhode Island, at the Pine Ridge Camp near that city. With slight alterations and at very little expense these cars may serve a useful purpose in connection with the outdoor treatment of tuberculosis at all seasons. Once located on a convenient site they have many advantages over the ordinary shack, affording a maximum of light and air and good protection against storms with their adjustable windows and doors. The author visited Pine Ridge Camp and can testify to their efficiency; the camp itself was discontinued after the erection of the fine State Sanatorium for tuberculosis at Wallum Lake. Trolley cars were also used at the Camp Auxiliary, Montefiore Home, Bedford, New York. (See plates 67 and 68.)

The Balcony, or Liege-terrasse as it is known in Germany, is a necessary adjunct of any sanatorium for tuberculosis. Plate 71 shows a covered or partly sheltered balcony in use at a large private sanatorium in St. Blasien in the Black Forest, Germany. Plate 89 shows an open or uncovered balcony at the Sharon Sanatorium, Massachusetts. In June, 1908, the author visited the latter sanatorium with the Medical Director, Dr. Vincent Y. Bowditch, and can bear witness to the excellent arrangements for the outdoor treatment of tuberculosis carried out at this institution.

The records, now extending over 22 years, show that about 50 per cent of all cases, and 72 per cent of all incipient cases have been arrested or cured.[1] Of the 160 arrested cases treated between 1891 and 1906, 133 or 83 per cent were still living and well in 1908, most of them house-keepers and wage earners; in addition, 3.7 per cent were doing well at last accounts, but were not recently heard from.

We have given the particulars of these cases treated at Sharon Sanatorium because the results are remarkably good being obtained at an elevation of 250 feet above sea level, about 15 miles from Massachusetts Bay, and about 20 miles from Boston. Sharon is near enough to the ocean to be affected by the sea breeze during the hot weather.

Day Camps; Walderholungstätten.—The daily care of consumptives at a day camp for the outpatients of a general hospital had its origin about the same time in both Boston and Berlin. It was proposed by Dr. A. K. Stone and Dr. E. P. Joslin in 1905 in Boston, and provision was made at the Mattapan Day Camps and at the House of the Good Samaritan for ambulatory patients. Plates 72-74 show how this is carried out. In July, 1908, fifty consumptives too ill to be benefited by treatment at the Massachusetts General Hospital were transferred to the new home of the Boston Consumptives' Hospital on the Conness estate, Mattapan, and entered on treatment which it was hoped would culminate in their improvement to an extent that should warrant their entrance into the state institution. They went to the camp in the morning and returned to their homes

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[1] See V. Y. Bowditch, Boston Medical and Surg. Journ., June 22, 1899.
See V. Y. Bowditch, Journ. Amer. Med. Ass., Nov. 14, 1903.
See V. Y. Bowditch, Trans. Amer. Climatological Ass., 1907, p. 168.

FIG. 1. OLD TROLLEY CAR THAT WAS USED BY MOTHER AND CHILD AT THE PINE RIDGE CAMP FOR CONSUMPTIVES, NEAR PROVIDENCE, RHODE ISLAND
Photograph by Courtesy of Dr. W. H. Peters, Providence

FIG. 2. ESTES PARK, COLORADO. IDEAL SUMMER RESIDENCE, WITH SPACIOUS PORCHES FOR PULMONARY INVALIDS. SLOPING GROUND, SANDY SOIL, MOUNTAINOUS BACK-GROUND AFFORDING PROTECTION FROM WIND AND DUST.
Courtesy of Dr. S. G. Bonney

SHARON SANATORIUM, MASSACHUSETTS. PATIENTS TAKING THE SUN BATH IN WINTER
Courtesy of Dr. Vincent Y. Bowditch

at night. Those given preference in treatment were patients whose dependents, circumstances, and health most demanded it. The new hospital and its location are picturesque as well as healthful, and patients are able to remain throughout the winter. The main building is 125 feet long and contains dining-room, kitchen, examination and rest rooms, and has a spacious veranda facing the south. It is designed to accommodate 150 patients, in the two pavilions, two cottages, and children's building. The Day Camp has proved to be a great success.

Day camps, when properly conducted, have an immense value on educational lines. In addition they remove for a time the sources of infection from the community and from the homes. These patients cannot always go to a sanatorium but in this way receive proper care during a large part of the day and may eventually avoid the necessity of going to a sanatorium; others who need sanatorium care are provided for, pending admission; and after discharge from the sanatorium the camp helps to complete the cure. Dr. Otis does not believe that these camps are destined to become a permanent therapeutic measure in conducting the cure.

The best location for day camps is in the forest. In Germany they are known as Walderholungstätte and there are over eighty of them scattered throughout the Empire. Those who are only slightly affected with tuberculosis, or are convalescent from it, pass the day in camp and return at night to their homes. The accompanying illustration (pl. 76) shows these camps for adults and children at Kuhfelde, Germany. These forest convalescent homes are greatly favored by the German insurance societies and sick lodges. Their benefits are extended to the children of patients.

Germany must be given credit for making the greatest discoveries and for instituting the most rational methods of treatment in connection with tuberculosis. The most thorough measures are adopted by the Imperial Government, the industrial insurance companies and by the medical profession of Germany.

According to the business report of the German Central Committee for the campaign against tuberculosis, there were in Germany in 1908 99 popular sanatoria for adults affected with disease of the lungs. These have 10,539 beds, 6,500 for men and 4,039 for women; in addition there are 36 private sanatoria with 2,175 beds, so that in all, 12,714 beds for adult tuberculosis patients are available. For children with pronounced tuberculosis there are 18 sanatoria with 875 beds; besides there are 73 institutions, with 6,348 beds, in which are received only "scrofulous" children and those who are threatened with tuberculosis. During the last five years these facilities have been greatly increased; 31,022 insured persons were treated in the sanatoria during a total of 2,312,850 days of care, at a cost of 11,483,033 marks ($2,755,928). On an average, each person treated received 75 days of care at a cost of 370.16 marks ($88.84) or 4.96 marks ($1.19) per person for each day of care.

Night Camps.—These afford open air conditions of sleeping, either for patients with arrested tuberculosis who pursue their occupation by day in the nearby city, or with disease still unarrested but who are able, or from necessity are compelled to work by day.[1]

Sleeping porches and balconies.—Sleeping out of doors requires special arrangements which are not usually found in cities. The ordinary dwelling, apartment house, or tenement has no provision for this innovation in tuberculo-therapy. Suburban and country houses or those in the less crowded cities are better adapted for the conversion of an upper porch or balcony into a sleeping apartment. In Denver, for instance, the practice is common enough to excite little comment. Detached houses are usually easily fitted with the necessary screened enclosures.[2]

Pavilions are more substantial and permanent than the forms of shelter previously referred to. Where large numbers of patients must be cared for at a minimum of expense the pavilion system has distinct advantages, especially for night use. At the Metropolitan Hospital, Blackwell's Island, New York City, about one-third of all consumptives under hospital care in New York are there provided for in the tent pavilions referred to on page 123; these tent pavilions cost about $12.00 per bed or $144.00 for a tent pavilion with a capacity of 12 beds.

At the Manhattan State Hospital for the Insane, Ward's Island, New York, more substantial and permanent pavilions have been constructed of wood and glass and have displaced the cloth tents. These pavilions are heated by steam, lighted by electricity, and have removable glass sides permitting a free circulation of air and light all the time. Their per capita cost is about $100.

In addition, there are camps for both the men and the women with a total capacity of 175 patients. In summer some canvas tents

[1] E. O. Otis: Institutions for the Prevention and Cure of Tuberculosis, Boston Med. and Surg. Journ., Aug. 1, 1912.

[2] See "Directions for Living and Sleeping in the Open Air," National Ass. Tuberculosis, 1910. See T. S. Carrington: Interstate Med. Journ., April, 1914.

OPEN AIR LIFE AT THE ADIRONDACK COTTAGE SANITARIUM; WINTER

SANATORIUM ST. BLASIEN IN THE BADEN BLACK FOREST. THIS "REST HALL" IS CLOSE TO THE WOODS, HAS A PERMANENT ROOF AND FLOOR AND AWNINGS WHICH ARE ROLLED UP OUT OF SIGHT

Courtesy of Dr. A. Sander

FIG. 1. DAY CAMP FOR TUBERCULOSIS PATIENTS, HOUSE OF THE GOOD SAMARITAN, BOSTON

FIG. 2. A DAY CAMP FOR TUBERCULOUS PATIENTS AT THE HOUSE OF THE GOOD SAMARITAN, BOSTON, NEAR THE HARVARD MEDICAL SCHOOL

DAY CAMP FOR TUBERCULOUS PATIENTS, HOLYOKE MASSACHUSETTS

BOSTON CONSUMPTIVES' HOSPITAL AT MATTAPAN. DAY CAMP. PATIENTS REPORT AT 9 A. M. AND RETURN HOME BETWEEN 5 AND 6 P. M.

BOSTON CONSUMPTIVES' HOSPITAL AT MATTAPAN. COTTAGE WARD; LENGTH 150 FEET; CAPACITY 26 BEDS. IT AFFORDS CARE AT NIGHT FOR AMBULATORY CASES

DOECKER PORTABLE BARRACKS, USED AS A RECOVERY STATION, AT KUHFELDE IN THE ALTMARK, GERMANY
Courtesy of Christoph and Unmack

FIG. 1. DIET KITCHEN. DAY CAMP AT PARKER HILL, BOSTON, MASSACHUSETTS

FIG. 2. SLEEPING BALCONY USED BY A PATIENT IN HAVERHILL, MASSACHUSETTS

SLEEPING PORCH IN A CROWDED DISTRICT OF PHILADELPHIA

DOUBLE SLEEPING PORCH WITH EASTERN AND SOUTHERN EXPOSURES. THIS SUMMER RESIDENCE IN ESTES PARK, COLORADO, IS PROVIDED WITH PORCHES ON ALL SIDES SAVE THE NORTH, WHICH IS PROTECTED BY THE ROCKY FORMATION IN THE BACKGROUND. THE PORCH IS COVERED WITH A PERMANENT ROOF.

Courtesy of Dr. S. G. Bonney

CITY RESIDENCE WITH IDEAL UPPER DOUBLE SLEEPING PORCH CONNECTED WITH BEDROOM. SHEATHING AT THE BASE, WIRE SCREENING, AWNINGS, ELECTRIC LIGHT.

Courtesy of Dr. S. G. Bonney, Denver

PAVILIONS AT THE ROYAL VICTORIA HOSPITAL FOR CONSUMPTION, EDINBURGH, SCOTLAND
Courtesy of Sir Robert Philip

CANTON, MASSACHUSETTS, STATE HOSPITAL SCHOOL FOR CRIPPLED (TUBERCULOUS) CHILDREN, SHOWING UNIT

FIG. 1. MANHATTAN STATE HOSPITAL, EAST, WARD'S ISLAND, NEW YORK CITY. NEW PAVILIONS FOR THE TUBERCULOUS INSANE.
Courtesy of Dr. William Mabon

FIG. 2. MANHATTAN STATE HOSPITAL, EAST, WARD'S ISLAND, NEW YORK CITY. NEW GLASS PAVILION FOR THE TUBERCULOUS INSANE. WINTER
Courtesy of Dr William Mabon

INTERIOR OF ONE OF THE PAVILIONS, ROYAL VICTORIA HOSPITAL, EDINBURGH

Courtesy of Sir Robert Philip

FIG. 1. KIOSK AND OPEN DECK ADJOINING WARDS FOR EARLY CASES OF TUBERCULOSIS PHIPPS INSTITUTE, IN A VERY OLD AND CROWDED PART OF PHILADELPHIA

Courtesy of Dr. C. J. Hatfield, Director

FIG. 2. BELLEVUE HOSPITAL, NEW YORK CITY. ROOF WARD FOR CHILDREN

Courtesy of Dr. J. W. Brannan

are used. The accompanying photograph (pl. 83), kindly furnished by Dr. Wm. Mabon, the superintendent, shows the character of the pavilion.

In the Royal Victoria Hospital for Consumptives, Edinburgh, Scotland, still more substantial and expensive pavilions are in use as seen from the illustrations (pl. 84) kindly furnished by Dr. R. W. Philip.

Roof Gardens.—At the Philadelphia Hospital the first attempt to segregate tuberculous patients for the fresh air cure was by means of a roof garden ward. This was a vast improvement over the previous method of indoor confinement and was greatly appreciated by the patients. The roof garden ward was in use winter and summer, but later gave way to the six glass pavilions erected at an expense of over $112,000.

Each pavilion is intended to accommodate eighteen patients, usually in an advanced stage of tuberculosis. Each is separate in itself with walls and roof of glass and only sufficient metal work to give proper support. The floors are of cement so as to be as smooth and non-absorbent as possible. Including the porches, which are also enclosed in glass, each pavilion measures 39 by 70 feet. The glass is arranged in frames in both walls and porches and by means of automatic devices one side of the building or all three sides may be thrown open. Screens or shades are arranged to prevent too much access of the sun. The system of ventilation and heating is considered ample.

Detached Cottages.—At the Nordrach Ranch Sanatorium, three miles from Colorado Springs, independent cottages resembling tents are used. These are economical and insure privacy and sufficient protection. The system is adopted from that in use in Nordrach, Germany.

The highest development of housing for the tuberculous patient is undoubtedly the independent cottage. It is necessarily expensive, but the patient fortunate enough to be its inmate has a maximum of comfort and at the same time is in the enjoyment of the best atmospheric conditions night and day. At the Loomis Sanatorium where the snow lies on the ground more than four months in the year, and at Saranac Lake, in the Adirondack Mountains, where the winters are even longer and more severe, the independent cottage is a distinctive feature.

Sleeping Canopies.—Detachable windows may be applied to tents, pavilions, or ordinary dwellings, so as to allow patients to breathe by day and night the outer air uncontaminated by others occupying the same room or dwelling. Devices suitable for any window may be obtained. It is thus possible in a hospital ward to have half a dozen patients breathe the outer air while the ward is kept warm. The tent can come over the end of the regular hospital bed so that patients sleeping in wards where miscellaneous cases are received, may nevertheless have the full benefit of the outer air. By means of thick celluloid the patient may be readily seen. The celluloid window may be raised to give the patient drink and nourishment.

Plate 93 shows the Walsh Window Tent applied to the window of an ordinary dwelling.[1]

CHAPTER X. CONCLUSIONS.

There are some people, especially those of a skeptical or combative tendency, who refuse to admit that climate plays any important rôle in the cure of tuberculosis. One of these who was formerly in charge of a widely known institution for the study and treatment of tuberculosis has said: "I desire to go on record as believing that there is no therapeutic value in climate." This same physician probably owes his life to the fact that thirty-five years or more ago he left the city and removed to the mountains of Pennsylvania for the relief of a pulmonary disease and recovered. Such an attitude is a study for the psychologists and would hardly seem deserving of serious attention, except that we hear such statements as this: "If a case of consumption cannot be cured in its home climate it cannot be cured anywhere."

I think there is no doubt that if any of us were told that he is in the incipient stage of tuberculosis he would immediately take steps to familiarize himself with the line of treatment which would, before much time had elasped, involve leaving Boston, New York, Philadelphia, or Chicago, as the case might be, and so live as to enjoy what air and sunshine and other atmospheric features might afford.

One reason why home climates, if such a term may be permissible, have grown in favor is that it has been found necessary to establish a large number of State sanatoria, or at least to seek aid for private sanatoria from some of our State legislatures. It is a matter of expediency to have such sanatoria and legislators must be convinced that good results or, if necessary, the best results, can be obtained close at hand. We are all heartily in favor of such institu-

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[1] For the history of this tent see Knopf and McLaughlin, N. Y. Med. Journ., 1905, Vol. 81, 425.

tions whether or not we should wish to stake our chances of recovery in any of them.

Of course we do not claim that there is any specific climate for tuberculosis and the long search for such climate, a search lasting for nearly two thousand years, is apparently at an end.

Now what is there left to us, and what do we understand by a climatic change?

We all know that the New England climate is changeable, that is, the meteorological conditions are constantly varying just as they also vary in the Mississippi Valley and along the Atlantic seaboard. But the New England climate is peculiarly unstable and, as Charles Dudley Warner has said, "New England is the battle-ground of the weather."

We have a change of climate when we leave the hot city in summer and go a few miles to the shore. We have floating hospitals so that this climatic change may stimulate a sick child to recovery. A so-called "home-climate" may work a cure or aid in a cure because we leave the climate of our homes, often too dry with furnace heat, too poorly ventilated, too damp from lack of sun, and remove to more hygienic dwellings in the same locality where sun and air and cleanliness abound.

But, to take up the principal question at issue, the first thing usually asked is whether one should go to the Adirondacks, Colorado, New Mexico, Arizona, California, or elsewhere, in order to get what is so frequently claimed to be the greatest climatic advantages. No one who has visited these localities can fail to be impressed with the living examples of recovery from tuberculosis. Denver, Colorado Springs, and innumerable towns in southern California abound in doctors who have practically recovered from this disease and are earning a living that is the envy of their eastern confrères.

Would they have recovered in their eastern homes? Almost to a man they answer "No." I have never heard of an exception. But the case is hard to prove from such *ex parte* evidence. However, it is interesting to note Dr. H. B. Dunham's conclusion. He stated in 1904, after visiting discharged Massachusetts State Sanatorium patients in the west, and after comparing Massachusetts Sanatorium statistics with those of the U. S. Army Sanatorium at Fort Bayard, New Mexico, that "the results corroborate our beliefs in the efficacy of residence in dry climates, but with a smaller margin in its favor than was anticipated." The proportion of people adapted for treatment in these extremes of climate must be more equal than thought possible by climatologists generally. That is to say, a small majority of the patients at Rutland, Mass., would probably do better at Fort Bayard, New Mexico, and a large minority might do better at Rutland. But no one can say positively, in any given case, what would have been the outcome had he chosen differently.

We need not discuss the bearing of what to do for the poor or what to do for the rich, or the question of food, or the physician's management; these are important and may govern the choice, but what we want is an answer to the abstract question of the influence of climate.

We believe that climate may be *utilized as an adjuvant* of great value for carrying out the hygienic, dietetic treatment of all forms of tuberculosis and of many other diseases. There are some elements of climate that have a more positive influence in hastening cure than others. The first place must be assigned to an abundance of air, which is as nearly as possible bacteriologically and chemically pure. It goes without saying that city air is polluted by smoke and dust and all dwellings, whether in the city or the country, are far below the standard of purity desirable. Only on the sea or at the highest elevations do we find air really pure, but we can approximate it by living out of doors. There is a climate of the city, a suburban climate, a climate of the country, woods, and plains, all differing as regards purity of air. We are all probably agreed on this point.

Next comes the subject of sunshine. We admit that good results are obtained in cloudy regions as, for instance, in the Adirondacks and at Rutland; but there is at least no objection to sunshine, and I believe that the moral effect of bright sunny days and plenty of them is very great. Invalids always welcome the sun. We can protect ourselves from too much sun if need be, and I, for one, believe that sunlight does a vast amount of good and sunny regions are much to be preferred, other things being equal. That is the great asset of our western plains and mountains; and it is a real asset that counts. Of course there are exceptions. Tastes differ. Dr. Solly used to relate the story of one of his countrymen who had been sojourning in Colorado and finally returned to England. As he landed in a fog and found himself home again, he exclaimed, "Thank God! I am out of that beastly sunshine." I do not suppose he intended to be irrational or ungrateful for the greatest of all natural gifts.

Now, what other climatic conditions besides pure air and abundant sunshine have we to help us? Is a cool climate or a warm climate the best? Is a dry or humid climate to be preferred? These quali-

FIG. 1. SHACK WITH SCREENED PORCH. ESTES PARK, COLORADO
Courtesy of Dr. S. G. Bonney

FIG. 2. WELCH'S RESORT, FIVE MILES FROM LYONS, COLORADO. SIX ROOM COTTAGE SOMEWHAT PRIMITIVE BUT WITH AMPLE SCREENED PORCH. SHELTERED FROM NORTH AND WEST WINDS.

Courtesy of Dr. S. G. Bonney

VIEW OF THE ROCKY MOUNTAIN RANGE FROM THE PORCHES OF SUMMER COTTAGES, ESTES PARK, COLORADO
Courtesy of Dr. S. G. Bonney

COTTAGE AT THE ADIRONDACK COTTAGE SANITARIUM, NEW YORK

FIG. 1. ANNE M. LOOMIS MEMORIAL COTTAGE—(NEW INDEPENDENT UNIT) LOOMIS SANATORIUM SULLIVAN COUNTY, NEW YORK

FIG. 2. LOOMIS SANATORIUM, SULLIVAN COUNTY, NEW YORK. ONE OF THE EAST PORCHES OF THE MARY LEWIS RECEPTION HOSPITAL

ties of temperature and humidity may as well be considered together. Undoubtedly for the majority of cases in the first stage the climate should be dry and the temperature comfortable—not warm enough to be relaxing, but not so cold as to be repellent and restrict exercise or out-of-door life. It is true that in special localities better results are obtained during the cold months than during the summer. This is true of the Adirondack Cottage Sanitarium in the State of New York. One reason for this is that in winter the lakes and ponds are frozen and covered with dry snow; the air is drier. It is far enough north and at a sufficient altitude to escape the alternate freezing and thawing that is experienced in New York City, where unquestionably it is less favorable for the consumptive during the cold season than during the warm months. Take Florida and South Carolina: Undoubtedly the best season there is during the winter months, as the summers are oppressively warm and wet. The winter is the dry season and the temperature is comfortable. The interior of Florida forty or fifty miles from either coast is reasonably dry. As far as Arizona and New Mexico are concerned, the summers are too hot at all the lower elevations for any invalid, but at the higher elevations, 5,000 or 6,000 or 7,000 feet, the summer heat is not oppressive. Along the southern coast of California and at many of the resorts somewhat inland, as good results are obtained in summer as in winter, although the latter is the more fashionable season for eastern visitors. The southern California resorts which have been most frequented by consumptives vary greatly between themselves as regards the important question of humidity. That a place is frequented by consumptives does not prove that it is a desirable place for them. Many of them are misguided, wandering invalids, sent out from the east with little or no judgment as to their individual needs and with no proper knowledge on the part of their medical advisers as to the humidity or local character of the places to which they are destined. A man, for instance, will go to Los Angeles. It does not take him long to find out that while the air is fairly dry from 11 a. m. to 5 p. m., it is always damp at night. Six hours out of twenty-four are dry, the remaining eighteen are decidedly damp. The physicians of Los Angeles do not claim that their climate is a suitable one for cases of tuberculosis and usually send these cases to the interior stations, such as Redlands or Riverside, Monrovia or Altadena. Many are sent to Arizona. Experience shows that consumptives do better if they avoid the coast region. Or, if near the coast, as at Santa Barbara, they are better if they find a site at some elevation on the hillside or in the mountain valleys beyond the reach of the morning fog and the excessive humidity at the shore.[1] The records of the Weather Bureau show that these places on the coast or within reach of the fogs which penetrate inland have a greater humidity than Boston or New York, the mean annual absolute humidity for Santa Barbara, Los Angeles, and San Diego being given at 4.20, 4.42 and 4.34 grains, more than one-third more than that of New York and Boston, 3.19 grains and 2.84 grains. The mean annual relative humidity of all these places mentioned is from 72 to 73 per cent. But the advantage of places like Santa Barbara, San Diego, Redlands, and Riverside, lies in the fact that the mean annual humidity shows a remarkable variation during the twenty-four hours compared with places like Boston, New York, or Philadelphia, where the daily range is much less. At Redlands, fifty miles inland from the Pacific Ocean, one of the best known stations, the hygrometer has been known to indicate in fair weather 55 per cent at 4.30 p. m., and 80 per cent at 6.00 p. m. The relative humidity is sometimes as low as 30 per cent for a limited time during the day, and 70 to 80 per cent at night when the temperature is from 44° to 60° F.

It may as well be stated that the government records of humidity are quite misleading when we use them to judge of the climate of any given place. The observations are made at 8 a. m. and 8 p. m., but in the invalid's day, made up of the intervening hours, the relative humidity reaches a much lower mark than the records show. I often observe a relative humidity in Virginia of 25 or 30 per cent at 2 p. m., and 95 or 98 per cent at night or in the early morning, especially when dew falls after a bright, invigorating day. I think that people, whether sick or well, adjust themselves to these natural changes of humidity if properly clothed and constantly in the open air; but when subject to rapid changes in humidity, as in going back and forth from the excessively dry air of a house in winter to the damp air outside, the demands upon the mucous membranes are very great and such frequent and violent changes certainly do harm to susceptible people. Such rapid variations or alterations of the humidity of the inspired air I think are as bad as would be rapid alternations of altitude involving variations of several thousand feet.

Some patients, however, seem to do better with a humidity greater than that chosen for others. If we have a low relative humidity

[1] See W. Jarvis Barlow, M. D.: Climate in the Treatment of Pulmonary Tuberculosis (Journ. Amer. Medical Association, October 28, 1911).

and at the same time a moderately low temperature the general effect is tonic and it is beneficial in conditions of irritability of the respiratory mucous membrane; but if the temperature is very low this may be rather irritating. We find atmospheric conditions like this from Minnesota to the Rockies and through Manitoba and Alberta.

The combination of high relative humidity and low temperature certainly favors catarrh and we have such conditions all winter long in the region of the Great Lakes and in New York and New England. Probably the best combination is a low humidity and a moderately cool temperature; the average tuberculous patient makes his best gains after August first and in subsequent cold, dry weather when such conditions prevail. But of course there are exceptions and some do better with a high relative humidity and a warm temperature; these are not numerous and probably include more of the patients in later stages when expectoration is profuse and vitality is low.

The old idea about equability of temperature, at least between the temperature of midday and midnight, is not of great importance; all mountainous stations show great variations in this respect. Some variability tends to stimulate the vital activities, but in older people and those who are feeble great variability is a disadvantage.

As far as altitude is concerned it probably has not, *per se,* any great influence; certainly to my mind not so much as we used to think. However, altitude is incidentally associated with mountain life or life on the plains, with more sun, less moisture, and scattered population. We should not forget that surgical tuberculosis is always favorably influenced by a seashore residence suitably chosen.

I never shall forget the wonderful impression made on visiting the Sea Breeze Hospital for Tuberculous Children on Long Island, New York. Constant outdoor life in all weather works miraculous cures after the most formidable operations for bone tuberculosis and in many cases renders them wholly unnecessary in patients whose physical condition on admission was most unpromising. All the great French and Italian sanatoria for tuberculous children are located on the seashore.

Among the numberless histories of the climatic cure I will give only one and I think I may safely let it stand as a good example by which to let the argument rest. The history is that of a physician whom we all love and respect. It was published, together with twenty other carefully recorded histories, by that prince of clinicians, the late Dr. Alfred L. Loomis, in the Medical Record and formed a part of a paper read before the Medical Society of the State of New York in 1879, a paper which we commend to your attention. Dr. Loomis says:

At the age of twenty-five this patient, being of good family history, began to lose his health in the winter of 1872. His symptoms were rapidly becoming urgent; he was examined by several physicians. Extensive consolidation at the left apex was found, extending posteriorly nearly to the angle of the scapula; on the right side nothing was discovered save slight pleuritic adhesions at the apex.

He was ordered south, but returned in the spring in no way benefited. On the contrary, night-sweating had set in, and his fever was higher. In the latter part of May he started for the Adirondacks, the ride in the stage being accomplished on an improvised bed. His condition at this time was most unpromising; he had daily fever, night sweats, profuse and purulent expectoration, had lost his appetite and was obliged constantly to have recourse to stimulants. Weight about 134 pounds. He began to improve at once, his appetite returned, all his symptoms decreased in severity, and after a stay of more than three months he returned to New York weighing 146 pounds, with only slight morning cough, presenting the appearance of a man in good health. A few days after his arrival in New York he had a chill, all his old symptoms returned and he was advised to leave for St. Paul, Minnesota, where he spent the entire winter. He did badly there; was sick the greater portion of the winter. In the spring of 1873 he again went to the Adirondacks. At this time he was in a most debilitated state, was anemic, emaciated, had daily hectic fever, constant cough, and profuse purulent expectoration.

The marked improvement did not commence at once as it did the previous summer, and the first of September found him in a wretched condition. I then examined him for the first time and found complete consolidation of the left lung over the scapula and suprascapular space, with pleuritic thickenings and adhesions over the infraclavicular space. On coughing, bronchial rales of large and small size were heard over the consolidated portion of the lung. Over the right infraclavicular region the respiratory murmur was feeble, and on full inspiration pleuritic friction sounds were heard. I advised him to remain at St. Regis Lake during the winter, and although he was repeatedly warned that such a step would prove fatal, he followed my advice.

From this time he began slowly to improve. Since that time he has lived in this region. At the present time his weight is 158 pounds, gain of 22 pounds since he first went to the Adirondacks in 1873, and ten pounds more than was his weight in health. He has slight morning cough and expectoration, his pulse is from 72 to 85 and he presents the appearance of a person in good health. In his lungs evidences still remain of the disease he has so many years combated.

Although he has made three attempts to live in New York, at intervals of two years, each time his removal from the mountains has been followed within ten days by a chill, and a return of pneumonic symptoms—symptoms so ominous that he has become convinced that it will be necessary for him to remain in the Adirondack region for some time to come.

FIG. 1. LOOMIS SANATORIUM, SULLIVAN COUNTY, NEW YORK

FIG. 2. LOOMIS SANATORIUM, SULLIVAN COUNTY, NEW YORK. PORCH OF OLD INFIRMARY

FIG. 1. PARTIAL VIEW OF PENNSYLVANIA'S STATE SANATORIUM FOR TUBERCULOSIS NUMBER 1, MONT ALTO, FRANKLIN COUNTY

FIG. 2. PENNSYLVANIA'S STATE SANATORIUM FOR TUBERCULOSIS, NUMBER 3, HAMBURG, BERKS COUNTY

PARTIAL VIEW OF PENNSYLVANIA'S STATE SANATORIUM FOR TUBERCULOSIS, NUMBER 2, CRESSON, CAMBRIA COUNTY

This property, formerly a popular summer resort hotel, was presented to the State by Mr. Andrew Carnegie for sanatorium purposes

THE WALSH WINDOW TENT. ALTHOUGH LYING IN THE BEDROOM THE SLEEPER HAS FREE ACCESS TO THE OUTER AIR

We all know the after history of this patient. Thank God, he is still living, still working, and there are thousands living to-day who owe their lives to the example which he has set them. He seized the principles of climatic treatment and adapted it to the individual.

I recently sent the following question to the deans of medical colleges in Boston, Chicago, New Orleans, Los Angeles, and Montreal. I knew nothing of the views of these men on this subject except one; of course we all know that every one from California has decided views on climate. The question was:

What would you do for yourself climatically if you were told for the first time that you had incipient pulmonary tuberculosis?

Here are the answers:

I would strike for the wild pine woods of northern Michigan or Wisconsin and stay there.—A. R. Edwards, Chicago.

In answer to your question I may say that if I had incipient tuberculosis I should either go to Saranac or St. Agathe in Canada and employ the open air treatment.—F. J. Shepherd, McGill University, Montreal.

In answer to your question of December 26, I would say that I would treat myself as I do patients on whom I make the diagnosis of incipient pulmonary tuberculosis, that is, refer them to a local man who specializes in this disease, and ask him to look them over and refer them for climatic treatment in accordance with his knowledge of climatic conditions suitable to the individual case. Were I to start out to select a climate for myself, I would be much more influenced by the physician under whose care I would come in the new place than by the actual climate, and would probably select either Saranac Lake or Asheville, N. C., as I know and have confidence in physicians in each place. Were they to decide that I was better suited to some other climate, I would move on under their advice. If it were possible, I believe that I would undoubtedly leave Boston, had I incipient tuberculosis.

Very truly yours,

Henry A. Christian,
Boston.

If I had to answer your question categorically I would say that I would ask the advice of one or two men living in my own community as to what I should do for myself climatically if I were told for the first time that I had incipient pulmonary tuberculosis.

The practice among the profession in New Orleans is to send patients to St. Tammany Parish, in Louisiana, where the growth of piney woods is thick and ozone plentiful. When the particular case justifies, the patient is sent to the plains of Arizona or New Mexico, and, rarely, to El Paso, Texas. A few patients go to Colorado.—Isadore Dyer, Tulane University, New Orleans, La.

Perhaps I can best answer this personally by telling you what I did when I was told this very thing fifteen years ago. Having contracted tuberculosis in New York city I sought a better climate for an outdoor life, spending the first summer in the Adirondack Mountains and in November of that year going to California, where I lived for one year in the foothill region near the coast at an elevation of 1,000 feet, free from responsibility and work. After the first year I never had any return of my pulmonary tuberculosis.

I believe a change of climate is more a question of finances than anything else. If one has not the necessary means to have what is right in a different climate his chances for a cure are much better with home treatment, but when a better climate can conveniently be added to other measures of treatment for pulmonary tuberculosis it should be advised.—W. Jarvis Barlow, Univ. of Southern California, Los Angeles, Cal.

NOTE.—For the bibliography of tuberculosis in its various relations the reader is referred to the Index Catalogue of the Surgeon-General's Library, U. S. Army, Volume 18, Second Series, Washington, 1913. This bibliography embraces 412 pages in double columns, an invaluable contribution to the history and literature of this subject.

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