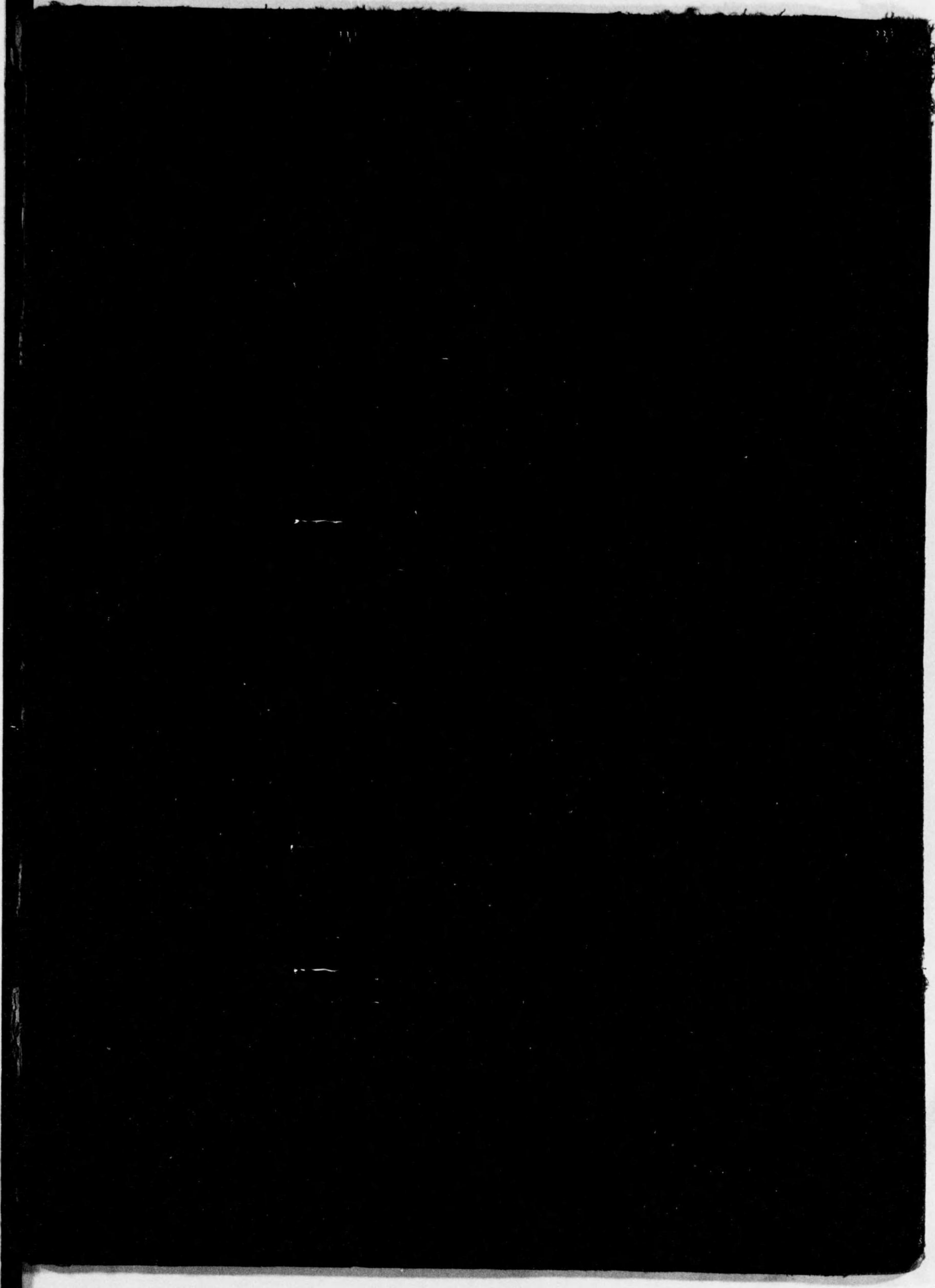


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*Editor*

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ment of the Roentgenologic study of the intrathoracic organs and because of the upward increase of the cases following surgical operations, which of late has been popularized and widely applied to various forms of diseases, especially on conditions of upper respiratory tract.

Rankin (4), Manges (5), Goodman (6), Lehmann (7), Green (8), Hartwell (9), Achard (10), Peters (11), Meis (12), Bengnot (13), McKenzie (14), they all reported interesting cases; Norris (15), Chalver (16), de Vernejoul (17), discussed on the diagnosis; Glowacki (18), reported on his study of ninety cases, while Bevan (19), and Towneux (20), Kinghorn (21), Robert (22), Lihenthal (23), Shere (24), and Meyer (25), discussed the lung abscess from the surgical standpoint, each presenting of cases of surgical interest.

Furthermore, Roch (26) recommended medical treatment from his experiences, while (27) gives a brilliant result obtained at bronchoscopic treatment in a case of diffuse pulmonary suppuration.

While the condition is dreadful, and despite the fact that so much has been written on this subject of Lung Suppuration, as for the treatment it has not yet been settled on a definite basis of dealing with this malady. Even the present advancement in the surgery gives us no better encouragement with its high surgical risk.

There have been alternate periods of active surgical treatment and of a return to more palliative measures. A decisive advance was first made in 1885 when Gluck, Schmidt, Block, and BIODI (28) showed that partial section of the lungs was possible in animals. In 1894, for the first time, pneumothorax was employed for the treatment of a tubercular abscess, by FORALANINI (29), Tuffier, Garri and Quincke did a great deal toward stimulating the more logical study of the condition. McKewan's total expiration of a lung, and chloroform anaesthesia, should have marked an epoch in the thoracic surgery. Murphy (30), in his address on thoracic surgery in Denver, in 1898, was twenty years ahead of his time.

Sauerbruch (31), Meyer (32), Lilienthal (33), Robinson (34), and many others (35-40) made most valuable contributions to the subject from their surgical standpoint.

Meyer (41) recently reported forty-nine cases of various types of subacute and chronic lung suppuration treated by the author's method of lung lip-fistula. Funk (42) discusses the value of bronchoscopy in the treatment of lung suppuration; Imperatori (43), in 1922, reported his result of treatment by Endobronchial Irrigation in pulmonary suppurations, in which he included tubercular abscesses also; and Carmody (44) in 1922, reported six cases of lung abscess which he treated by aspiration through the bronchoscope by means of a motor driven aspirating pump or by use of the tube with a closed end to prevent injury to the mucosa. Again, Lukens (45) 1923 published his remarkable result obtained by bronchoscopic drainage of pulmonary abscess, and he

concluded that surgical treatment, with its high mortality and uncertainty as to cure should be considered only as a last resort.

Thus far according to these methods mentioned above such as pneumonectomy, lobectomy and artificial pneumothorax and finally most recent development in the use of bronchoscopic treatment seems to have given us apparent encouragement in handling this condition, but when we come to the question which method shall we select for treating a particular case, we cannot but pause.

A correct interpretation of the pathology of the case and the diagnosis in its early stage will lead us to better judgment in applying any one of the methods enumerated. Careful Roentgenologic study and proper interpretation of the film is here indispensable.

Acute lung abscess may result fatally within a short time during the stage of extensive necrosis and cavitation, when, on the other hand, the patients survive for months or years, as they frequently do, the inflammatory process undergoes an evolution which is reflected in a constant changing clinical picture.

In the portrayal of these changes the Roentgen examination can render us invaluable service. It faithfully depicts the extension or recession of the diseased area, it notes the existence of and growth of cavities in situations inaccessible to physical examination and provides the only certain information as to the cure of the patient. Finally, by an accurate localization of the disease it guides the surgeon in the precise application of his operative procedures.

## CHAPTER II. — ETIOLOGY

Wessler and Jackes (46) State:

"It will be evident that in the diagnosis of a disease which has so protean a clinical picture and Roentgen appearance as chronic indurative pneumonia, a knowledge of the chronology of the symptoms and their sequence is of the greatest moment to the examiner? The definite history of a Pneumonia or an antecedent pleural disease or of the aspiration of a foreign body may point clearly to the true nature of the disease."

In the Roentgen interpretation a correct knowledge as to the Etiology of lung abscess is often of a greater help and many times Roentgenologist is led astray by not being properly informed regarding the clinical history of the case. Jackson (47) states that he had at the Bronchopneumonia Clinic over two hundred cases of lung suppuration in which a foreign body was the cause. The foreign body had been present from a period

varying from a few weeks to thirty-six years, and a number of the cases the presence of a foreign body was unsuspected. One of the most striking things in these overlooked cases is the inevitable conclusion that countless thousands of patients with lung suppuration had in past years been buried without the foreign body origin, ever having been suspected, and the further conclusion that many of the cases was supposed to have died of pulmonary tuberculosis. This is evidenced by the fact that in all the older text books the statement was made that foreign body in the lung ended in "phthisis pulmonaris."

Jackson further states that Roentgen-ray examination should always be made whether there are signs of bronchial obstruction or not, and an X-Ray examination should always precede Bronchoscopy whether the foreign body in question be of a kind opaque to the ray or not.

In fact, in cases of peanut kernel and similar radio-transparent foreign bodies the ray signs of obstructive emphysema discovered by Iglauer and developed and applied by Manges with a high degree of skill are absolutely diagnostic. It is interesting to note that even a metallic foreign body may be visible in a good ray plate. The foreign body though of metal, may be very thin and overlay the heart shadow and an area of pathology. Jackson (47) has demonstrated Roentgenogram which showed pulmonary abscess, fibrosis, displacement, and extensive pathologic changes due to the overlooked presence of a safety pin in the lung for thirty-six years. Removed bloodlessly through the mouth, and a local anaesthesia, in ninety minutes and seven seconds. In cases of recent aspirated foreign bodies there have been recoveries in 98.3 per cent.

Morgan (48), in 1922, reported four cases of lung abscess, which were sent to Metropolitan Life Insurance Sanatorium for pulmonary tuberculosis. The first case gave a history of choking on a piece of food, X-Ray showed a lung abscess, and this was treated by postural drain, and cured. His second case gave history of nearly drowning while bathing three months previous to the onset of the disease. The third case followed an operation of diseased appendix two months previous to the onset of the lung suppuration. In the fourth case in which the etiology was unknown, the patient started with sudden expectoration of copious pus and blood. In all these cases X-Ray gave positive informations confirming the diagnosis. Then the author concludes that Cardinal lessons emphasized by these cases is that with the symptoms here described, every effort should be made to discover apparently insignificant etiologic factors in the history, which will frequently establish the diagnosis of lung abscess. Regarding various etiological factors involved in the causation of lung abscess analytical tabulations by various authors are given herewith, in the hope that it will contribute to a clear understanding of the manifold causes of lung abscess and their probable mechanism.

Heuer and MacGready (49), in 1923 studied sixty two cases in Johns Hopkins Hospital, and their result was as follows:

31 followed pneumonia, complicated with or without empyema; 16 followed post-operative pneumonia or P. O. Bronchopneumonia, of which the nature of the operations and occurrence in each are tonsillectomy four, intraabdominal operations 7, mastoid operations 2, Hernia 1, open reduction of fracture 1, breast operation 1; 7 cases followed acute abdominal infection, 4 of which were liver abscess secondary to acute abdominal infection, 1 of pelvic peritonitis, and 2 of sub-phrenic abscess, secondary to appendicitis; 8 cases are tabulated under miscellaneous group,—they are, aspiration of tooth in 2, perforation into lung of an esophageal carcinoma in 2, abortion and septicemia in 1, septicemia from osteomyelitis, multiple arthritis and umbilical cord infection, 1 each.

In 1919, Lord of Boston (50), carefully analyzed one hundred cases which were collected in Massachusetts General Hospital with the follow-up in 90 percent of the cases, covering the period of from 1 to 10 years. Of his series, he found that 25 percent followed operation about the upper respiratory tracts which included operation for carcinoma of jaw, lip and tongue in 4 percent each, the number of tonsils and adenoids in 50 percent, incision of peritonsillar abscess in 4 percent, and removal of teeth in 36 percent.

It is remarkable that such apparently simple operation as the removal of teeth may bring about sequele so serious and in such high percentage. Lord says that aspiration of blood, tissue or infected material is the cause, and this is followed by pulmonary manifestations usually from one to four days after the operation.

Prosser (51) reviewed 18 cases from the University of Penn Hospital, in which 5 followed pneumonia, 2 extraction of teeth, 2 repeated convulsions, 2 tonsillectomy, 1 suppurative appendicitis, 1 ing. herniorrhaphy, 5 in which etiology undetermined. The author calls special attention to the cases following convulsive seizures, as he states that it is not generally known that lung abscess may be ascribed to this cause. It is probable that in such cases the patient inhales a foreign body or some infectious material. The possibility of lung abscess following tooth extraction should also be more widely recognized.

In one of the cases following tooth extraction, the first symptoms were noticed on the fifth day after the extraction, but the treatment was not instituted for four weeks when a successful two stage thoracotomy was done.

Williams (52) reviewed of his 18 cases, including 2 cases which followed the extraction of teeth under gas anaesthesia and these patients were suffering from bad pyorrhea.

Homans (53) analysed 23 cases from the Bent Brigham Hospital, Boston, as follows:—

Post-operative,—	
Post-tonsillectomy ... ..	7
Teeth Extraction ... ..	3
Abdominal Operations ... ..	3
Pneumonia ... ..	4
Influenza... ..	1
Exposure to fumes of fire ... ..	1
Etiology unknown ... ..	3

Etiological findings of Wessler and Jaches (46) in their one hundred cases from Mount Sini Hospital are as follows:

Aspiration Abscess—

Post-operative:	
Tonsillectomy ... ..	21
Other operations ... ..	6
Following Unconscious States:	
Submersion ... ..	2
Morphine ... ..	1
Alcoholic ... ..	1
Foreign Body ... ..	2
Acute Pneumonic Gangrene ... ..	16

Non-aspiration Abscess—

Chronic Pneumonia ... ..	21
So-called Grippe ... ..	21
Empyemic ... ..	1

Miscellaneous—

Embolic (Suppurative Thrombophlebitis) ... ..	1
Tubercular ... ..	2
Secondary to Carcinoma of Lung ... ..	1
"    "    "    "    Esophagus... ..	1
Actinomycosis ... ..	1
Diabetic ... ..	1
Syphilitic ... ..	1

It is to be noted here that these authors classified the etiological factors into two large groups—Aspiratory and Non-aspiratory. Is lung abscess following operations in upper respiratory tract or administration of anaesthesia due to direct aspiration of infective material or is it caused by embolic or metastatic infection of the lung tissue?

This is a very important question yet to be solved, for if it is established that aspiration is the cause, the grave consequences following operations can be prevented in many occasions. While some authorities, such as Fisher and Cohen (89), still hold metastatic or embolic view, the writer believes more in the direct aspiration as a cause in these cases, and to prove the latter view from the Roentgenologic standpoint is one important object of this paper.

Lyman (54) assumes that the causes may be intrapulmonary, or extra-pulmonary. The first may arise from inflammation of the lung tissue after bronchial pneumonia, lobar pneumonia, influenza, pleurisy, asthma, colds, typhoid, measles, scarlet fever.

Inflammation of the lung tissue may also occur from inspiration or penetration of foreign bodies.

The extra-pulmonary causes are direct extension from abscesses of adjacent structures, as in empyema, suppurating bronchial glands, mediastinal abscesses, echinococcus cysts, abscesses of the liver, or malignant growths. There may be infective emboli from distant parts.

It is accepted that tuberculosis, diabetes, and chronic alcoholism increased the liability to a complication of lung abscess.

Others consider syphilis, acute infection, advanced cardiovascular changes, delayed coagulation time, and high blood pressure, chronic bronchitis, and bronchiectasis causes for this complication, especially in operations.

Lemon (55) analysed 81 cases in the Mayo Clinic, where the cases were as follows:

Pneumonia ... ..	31
Cold, grippe, pleurisy, asthma, typhoid, measles and scarlet fever ... ..	19
Tooth extraction (general anaesthesia)... ..	7
Tonsillectomy (general anaesthesia) ... ..	5
Appendectomy ... ..	2
Gastro-enterostomy ... ..	1
Gall-bladder ... ..	1
Excision of gastric ulcer ... ..	1
Trauma ... ..	2
Unknown ... ..	12

In the writer's series of one Hundred cases which occurred in the New York Hospital and in this private practice during past ten years the initiation of the disease was found to be as follows:

- 20 Lobar Pneumonia.
- 15 Broncho-pneumonia, influenza (epidemic and non-epidemic).

- 1 "Severe cold."
  - 4 Foreign body inhalation.
  - 1 History of choking.
  - 9 Tonsillectomy,
  - 4 State of coma (alcoholic, diabetic, 1 unknown).
  - 15 Operations in abdominal viscera.\*
    - \* Gastric ulcer, liver abscess, appendectomy, haemorrhoidectomy, dilatation and curette, cholelithiasis, herniotomy, pns tube, gastric carcinoma, etc.
  - 8 Septicemia.\*
    - \* Pyelonephritis with impacted ureteral stone, boil, subacute bacterial endocarditis, perturition, infarct due to unknown cause, drawing with fracture and gas bacillus infection, 2 unknowns.
  - 6 Miscellaneous.\*
    - \* Sinusitis, operation on the eye, fractured jaw, perforating gastric ulcer, stretching of sciatica under general anaesthesia, mastoiditis with cellulitis of the neck.
- Undetermined:
- 6 Chronic bronchitis.
  - 7 Pleurisy.
  - 1 Suppurative pleurisy.
  - 1 Old (latent) abscess of the lung.
  - 2 Idiopathic.

100 Total.

The mortality in the pneumonia group was 50%. In one case of this group developed tuberculosis, and in its later stage only showed tubercle bacilli in the sputum, although there were suspicious Roentgen shadows from the beginning.

The mortality in the influenza of epidemic type was very high, being 100%. Severe cold was only possible initial symptom in one. The one with "history of choking" had only mild secondary symptom, the X-ray showed a characteristic lesion.

Only one death occurred from tonsillectomy group.

Post operative group showed high mortality, being 60%. Some of this group developed septicemic infection, the lesion in the lung being apparently embolic.

Chronic bronchitis as a cause was placed under "Undetermined" the history given by the patient in this group could not be otherwise, although there may be something else that would have led to the symptoms of bronchitis.

Pleurisy, in the same sense, has been placed under this heading, because there might have been something behind that led to the development of pleurisy. "latent abscess of the lung" developed acute multiple abscesses and acute endocarditis; at post mortem a thick walled old abscess was found at the base, from which streptococcus haemolyticus was discovered, there was no history referable to previous lung involvement.

Extreme difficulties were encountered in classifying the causes of the disease in this group, because number of the cases began insidiously without definite histories, from which the best was made out in the foregoing analysis.

Frequency of Lung abscess:

The frequency of lung abscess accordingly to Osler (56), clinically occurred in 76 cases of 12,030 cases (or 0.63%), and this condition were found in 28 of 1,294 cases at necropsy (or 2.1%). The above quotation roughly indicates that many cases were missed during life.

Sex: Most authorities agree in that that more number occur in men than among women. According to Stewart (80) it is seven times more frequent in man than woman. Lockwood (2) states that it is three times as common in males as in females.

Age: It occurs in any age, but more frequent during middle age.

Schwartz and Wessler (57) reported in 1919, one hundred and fifteen cases from Mount Sini Hospital, in which series they found 16 cases occurred in children between 4 to 14 years of age.

Bharucha (58) reported a case in a new born baby of seven months old. According to Lockwood (2) it occurs more often between the ages of 25 and 40.

The foregoing general review on the etiological factors in the causation of lung abscess has revealed many interesting points, and it is not amiss to comment at this point on some of these factors in details in order to approach, if possible, a fundamental etiopathology or pathogenesis in the causation of the lung abscesses, especially when we find that a great number of such cases occur after operations under the use of general anaesthesia.

These etiological factors may be summarized as follows:

I. Acute Infectious Diseases—

- a. Influenza.
- b. Simple "Colds."
- c. Lobar and broncho-pneumonia.
- d. Pleurisy and suppurative pleurisy.
- e. Acute contagious disease.
- f. Acute and subacute endocarditis.
- g. Septicemia.

II. Chronic Infectious Diseases—

- a. Chronic bronchitis.
- b. Chronic bronchiectasis.
- c. Asthma.
- d. Chronic pneumonitis.



- III. Due to Aspiration—of foreign bodies.
- IV. Operations on the upper respiratory tract—
  - a. Extraction of teeth.
  - b. Tonsillectomy, adenoidectomy and other intra-oral operations.
- V. Use of general anaesthesia.
- VI. State of Coma or semi-comatous state—
- VII. Miscellaneous—
  - a. Secondary to abdominal diseases.
  - b. Perforating gastric ulcer.
  - c. By direct extension of diseases of adjacent structures of upper respiratory tracts.
  - d. Diseases of the skin.
  - e. Mastoiditis.
- VIII. Unknown group or idiopathic.

We are now in the position to consider the details of some of the important headings as quoted above.

## I. Acute Infectious Diseases.

### (a) INFLUENZA.

Influenza, grippe and even simple colds are looked upon as responsible for causing acute abscess of lung.

Influenza, particularly, is a strongly disposing factor. This is emphasized by many writers in their recent treatise on the subject. Gabbi (59), Curschmann (60), Hilbrandt and Geulen (61), and Frank (62), they all state that pulmonary abscesses are more frequently observed since the Flue epidemic of recent years. Hocver (63), however, states that although a lung abscess is thought to be particularly frequent after Influenza pneumonia, the experiences of our recent epidemic do not bear out this impression.

At any rate, in the case following the epidemic form of influenza, the prognosis was very poor. In the writer's series there was almost 100% of mortality.

### (b) SIMPLE "COLDS."

That simple colds could be looked upon as the only cause is mentioned by Sante (64), Whitmore (65), Lyman (53) and others. One case of Sante's series is of interest and will well serve here as an example.

This patient, in apparently good health, boarded a freight train a hundred miles or so away from St. Louis, with intention of stealing a ride to his destination. While

on the train he was exposed for several hours to a piercing cold rain, which drenched him to the skin. On his arrival in St. Louis he had to be removed at once to the hospital, and on X-Ray examination made the next morning disclosed a consolidated area in the hilus region, which, on subsequent examination, rapidly extended to the periphery. That the process was primarily a lung abscess is evidenced by the fact that on the sixth day after the onset a definite lockjaw occurred, and pus was evacuated in large quantities. The very foul odor of his breath suggested a gangrenous process and a rather refractory hiccup led to the suspicion of subphrenic involvement. Pneumo-peritoneal examination, however, disclosed the subphrenic space free from involvement. The condition ended in spontaneous recovery.

The rapid onset of consolidation after exposure to cold reminds the possibility of an intercurrent Influenza infection unlikely, and it is quite probable that in this instance the exposure to cold was all that was necessary to bring about the condition favorable to abscess formation.

In the case above quoted it might possibly be conjectured that the lobar pneumonia was a preceding condition of the lung, although there was no definite statement made throughout the history as regard to the signs and the symptoms suggestive of lobar pneumonia in this patient. That this is a possibility, however, must not be overlooked. In the writer's series, one had initial "severe cold" while few others described it—the onset as "cold."

### (c) LOBAR AND BRONCHIAL PNEUMONIA.

That Lobar Pneumonia or Bronchial Pneumonia are followed by formation of lung abscess is rather of a frequent occurrence. In the writer's series 20% of the cases were due to these causes, with 50% of mortality.

Instances: Case IV, IX, XIII, XIV, XX, XXV, XXXII.

From Lockwood's (2) series, however, it may be concluded that contrary to the opinion of early writers that abscess of the lung is a common sequel to lobar pneumonia, a survey of the reported cases of the last century would lead one to conclude that it is a rare sequel.

The manner of onset of abscess formation varies somewhat in lobar and bronchial pneumonia: but at present it can be considered together for the sake of convenience.

According to Oxford Medicine "Broncho-pneumonia is more frequently followed by abscess and gangrene than lobar pneumonia. It is probable that broncho-pneumonia is more commonly a forerunner of an abscess than is generally recognized, for patches of broncho-pneumonia no doubt precede abscess formation in all cases of aspiration abscess.

Post-pneumonic gangrene is rare clinically in lobar pneumonia. Aubrecht in

1,501 cases of Lobar Pneumonia observed no instance of gangrene.—Oxford L. L. Medicine, Vol. II. P. 102.

In Lobar Pneumonia there is a consolidation characteristic of this disease accompanied by typical clinical symptoms and signs, plus the X-Ray characteristics, usually limited to one or more lobes.

The disease progresses, and either the temperature falls with crisis, only to be followed shortly after, by another rise, or the temperature may never fall by crisis, but may gradually assume septic form. In either event the consolidated area persists at least in its central portion and later an abscess cavity appears in its midst. When once established such an abscess cavity progresses much the same as the other forms.

There may be a rupture into a bronchus with discharge of pus, or rupture into the pleural cavity with empyema formation may occur; spontaneous recovery may result or the process may pass into chronic state with formation of numerous abscesses, and an Interstitial pneumonia which can only be cured by surgical intervention. Such as illustrated by Case XIII.

Beyond the chronic stage of fibrosis, there may be sudden spread of the lesion into acute bronchial pneumonia as illustrated by Case XIV.

Or there may be sudden spread to acute pneumonitis complicated by empyema, and death ensues—Case XXV.

Meyer (66), offers an explanation that it is also possible, and appears plausible, that the sputum discharged along from the alveoli during the course of the inflammation and the convalescence from typical pneumonia, is reabsorbed from the bronchial tree with a paroxysmal deep inspiration following the coughing spells, and produces post-pneumonic suppuration. Such sputum may also be aspirated into hitherto unaffected parts of the lung in the act of expectoration and subsequent inspiration. This was possibly the cause in the Case XXXV.

Again, Exudates due to pneumonia per se may not be responsible, but such expectoration mixed with sputum is more virulent, especially when the patient is suffering from severe pyorrhea.

#### (d) PLEURISY AND SUPPURATIVE PLEURISY (EMPYEMA)

Pleurisy as a forerunner of lung abscess is quoted by many writers, such as Villar (67), Baxton (69), Lyman (54) and others. It is reasonable to consider that intra-pleural infection may spontaneously spread into most proximal tissue—the lung and may form an isolated lesion.

According to Norris and Landis (68), in many instances what were believed to be a pulmonary abscess were in reality an encapsulated Empyema which has ruptured into a bronchus. On the other hand, a pulmonary abscess may perforate the visceral layer of the pleura. The pus may become then encysted and form an encapsulated

empyema. But in view of Gill's (76), investigation which is later to be quoted, foreign bodies entering the bronchus may easily find a way into the pleural cavity; such circumstances, may occur oftener than it is thought. Sante (64), states that at certain stage rupture of the abscess and evacuation of the pus into the bronchus may occur or a rupture into the pleural cavity. Furthermore, it is stated that most of the abscesses recognized clinically follow rupture into the lung of an empyema—Oxford Medicine Vol. II, Page 102.

In the writer's series at least 7 per cent of the cases could be considered as pleural origin, in most of these cases Thoracentesis was performed in the early stage of a pleural involvement, and it may not be too hastening a statement of blame for the performance of Thoracentesis as responsible to cause the infection of the deeper tissue, or setting up more complicating circumstance, which would have been otherwise a simple process.

So far as the writer's knowledge goes, no attention has been drawn to this matter. Refer to case illustrations: Case XIX, XXIX, XXX (?).

When performing a thoracentesis, it should always be kept in mind that some virulent material of the intrapleural content may be carried into the parenchyma of the lung, either directly or by way of blood or lymph stream. In a number of the cases of the present series, in the early course of the disease, the history showed that the pleural cavity was explored by needle for the existence of fluid or pus. In case XXIX, such needling of the lung might have been responsible for setting up more important infection in the lung. In another case of the series, exploration of sub-pleural space showed an inflammation of this region which was apparently caused by previous thoracentesis for exploring the pleural cavity.

#### (e) ACUTE CONTAGIOUS DISEASES.

Such as Typhoid fever, Measles, Scarlet fever are sometimes responsible for causing the lung abscess. To this matter, Baxton (69), Lyman (54) and others have drawn attention.

#### (f) ACUTE AND SUBACUTE ENDOCARDITIS (BACTERIAL).

Such was evidently a cause in one of the writer's series. Being this an embolic process, the lesions are usually multiple, and they are associated with embolic lesions in other parts of the body.

In one case in which was found a chronic lung abscess at left base at autopsy, besides many new small lesions in the lung and acute endocarditis, which was the original focus could not be differentiated.

## (g) SEPTICEMIA

Presents similar picture as caused by foresaid disease.

Usually multiple abscesses are found in the lung tissue coincident with lesions in the other organs of the body. Such septic emboli may come from distant organs following operations due to latent foci. In the author's series, at least four cases could be attributed to this cause; one was due to septicemia following pyelonephritis with impacted ureteral stone, one due to simple boil, one from puerperal infection, and one from latent foci in the lung. Seven cases were due to spontaneous infarct from unknown causes.

**II. Chronic Infectious Disease.**

## (a) CHRONIC BRONCHITIS.

Twelve per cent of the present series give history of insidious onset, in which chronic bronchitis revealed to be the only existing condition, otherwise the history was entirely negative. These were grouped under unknown causes. In looking over articles written by various authors I failed to find chronic bronchitis as an etiological factor. Some of the cases grouped as "unknown" etiology may have been possibly due to this condition.

Admitting the possibility of pulmonary infection takes place by way of direct spread of focal infection in the bronchial wall—as this is more often the fact—than by way of blood stream or otherwise, it can be easily assumed that chronically inflamed and localized catarrhal lesion in the bronchi, under a certain favorable circumstance or by invasion of some pyogenic organisms, may break through the wall of the bronchi, thus causing a localized suppuration of lung tissue. Case XXVIII will illustrate such an instance, in which the patient had chronic Bronchitis lasting for thirty-two years, previous to the onset of the terminal suppuration of the lung, and in which multiple lung abscesses were found at autopsy and no bronchiectasis.

## (b) CHRONIC BRONCHIECTASIS.

The same thing happens with bronchiectasis, and here even the so-called "Idiopathic" or "congenital" bronchiectasis is not an exception. The lung parenchyma is always more or less involved in these conditions.

Lord (70) states that to raise bronchiectasis often to the position of an independent disease is to fail to appreciate the pathology of the condition. Aside from its occurrence in the rare cases of bronchial asthma without secondary infection it is never found at autopsy unassociated with pulmonary changes of much greater importance than the bronchiectasis itself. Chronic infection of the bronchi is not likely long to

exist without extension to the neighboring pulmonary tissue, and a more accurate term is then a "chronic bronchopulmonary infection."

Definite clinical differentiation between chronic Bronchitis, Bronchiectasis and the so-called bronchiectatic lung abscess is difficult. This can be done only by referring to X-Ray study of the disease progress. There is a certain pathological differences between bronchiectasis and its idiopathic form, for which the reader is referred to the Pathological Section and X-Ray differentiation.

## (c) ASTHMA.

Baxton (69) and Lyman (54) may be again quoted as stating that asthma is a predisposing factor, but I doubt that if a true asthma could be counted as a cause for producing a lung suppuration.

Secondary infection of a bronchus or chronic bronchitis following asthma, however, appears more reasonable to be a direct cause. In fact a number of cases of so-called asthma are in reality cases of chronic bronchitis.

## (d) CHRONIC PNEUMONITIS.

This is included among the etiological factors by Wessler and Jaches (46). This is rather a new term adapted to a certain chronic lung infection with recurrent febrile attacks associated with symptoms resembling Tuberculosis, and changes in the Roentgenograms. Full descriptions of the condition with case illustrations and characteristic X-Ray findings are given by Niles (71).

**III. Due to Aspiration—Of Foreign Bodies.**

The importance of aspiration as a cause of lung suppuration has been dwelt upon in previous pages quoting Jackson (47) and Morgan (48) Heuer (49) and others. The Etio-pathological feature of aspiration lung abscess, may be most comprehensively expressed by borrowing Willy Meyer's discussion in the following lines.

Willy Meyer (66) said: "The etiology of suppurative inflammation of the lung is similar to that of pus formation in other parts of the body. That is to say it is due to traumatism inclusive of the entrance of a foreign body; to the invasion of the pulmonary tissue by pus forming microbes, the products of which are not absorbed but form an abscess.... If, in the term "foreign body," we include also liquids, or in other words, if we substitute the word "substance" for "body," we may be right in ascertaining that the great majority of pulmonary suppurations, excepting, of course, Tuberculosis and Syphilis, are due to the entrance of a "foreign substance" into the bronchial tree and lung tissue.

Then bullet, piece of clothing, bone-splinters, etc., that enter the organ in violent traumatism from without, through the chest wall, as well as "foreign substances" that enter the bronchial tree and lung tissue by aspiration through the mouth and the trachea, all tend to produce inflammation and suppuration.

After some time has elapsed, the suppuration invariably involves the alveolar tissue of the lung, plus the communicating bronchi, the two structures within the lung which always represent a unit in a pathologic sense."

It may be stated still further that lung abscesses are due to the introduction of foreign substance, in its broad sense, into the lung tissue. The mode of introduction may be divided into endogenous and exogenous. Considering that the lung tissue itself as a host, the meaning of the endogenous origin becomes greatly limited in that it is represented by blood and lymph streams.

The rest of the causes may be considered as exogenous, which can be conveniently sub-divided into consecutive invasion and aspiration. By consecutive invasion it is meant tissue destruction in its continuity, such as lung suppuration caused by direct extension of the destructive lesion in the neighboring tissue; and by aspiration it is meant the introduction of a foreign substances by way of the air tube.

In classifying the pathogenic factor of a given case, especially for statistical purpose, it is desirous to ascertain as nearly as possible from which portal the suppuration has begun. This can be done only by careful analysis of the case referring to early and serial Roentgenographic investigations.

In the case of consecutive invasion, it is rather easily diagnosed, but in the case of endogenous origin, most care is here required to exclude the other sources.

Emboic sources are to be suspected where patients are deprived of much of their vitality by the presence of pre-existing diseases such as tuberculosis, syphilis, diabetes, chronic alcoholism, Bright's disease, and advanced cardiovascular changes. From a general survey of literature one is impressed by how important a role aspiration plays in the production of pulmonary suppuration. This will become the more evident if we glance over a few of the reported interesting cases in the following pages.

As it has been referred to in page 7 and 8, a simple history relative to the etiology is often of great assistance both to Clinician, Roentgenologist and to the surgeon.

In the writers series there were three cases which followed a definite introduction of foreign bodies, in one of which the bronchoscopy was negative, but patient later expectorated out a piece of bone on which she had choked. One case in which no etiological factor could be ascertained excepting a history of choking on food on one occasion, the roentgenogram represented a characteristic rootlesion. At times the foreign body may be introduced without the knowledge of the individual and it may be suddenly followed by acute formation of pus cavity, or it may be possible for the

foreign body to remain imbedded for many years without causing apparent discomfort to the patient.

Kaempfer (72) reported a case in a woman of 51, who had a cough, profuse foul expectoration and in whom the X-Ray showed a foreign body and lung abscess. Post Mortem in this case revealed the lower lobe of the right lung as gangrenous and showed many abscesses on the rest of the lung. In the right lower lobe, near the vertebral column beneath the pleura was a longitudinal cavity about five inches in length and three-eighths of an inch in width, which contained a slate pencil. No scars in either pleura or esophagus no knowledge of inhalation, but may have swallowed it in her childhood.

Hirsh (73) reported foreign body in bronchus stayed in for fifteen years. Huber (74) reported a case of lung abscess in a child due to a wire two inches long in the right bronchus. The child was operated and made an uneventful recovery. Many of these cases could only be properly diagnosed by proper Roentgenological investigations.

#### IV. Operation on the Upper Respiratory Tract.

This is one of the most important factors which deserves attention of every surgeon and clinician because lung complications occur so frequently after operations, chiefly done under general anaesthesia. With patients in a sub- or unconscious state, aspiration of infective material will take place deep into the bronchi whose mucous membrane has already been devitalized by irritative action of anaesthetics and such aspirated is far more virulent than solid foreign substance. There is no doubt that post operative lung complications are more often due to this aspiration than is generally thought and so long as it is due to aspiration, there is no reason why this cannot be prevented in the majority of cases.

##### (a) EXTRACTION OF TEETH.

Lung abscesses are frequently caused by aspiration of teeth or teeth fillings. This subject may be properly considered under the section of foreign body, but since it is involved with narcosis and infected oral cavity, it deserves separate consideration.

Gill (76) recently reviewed 117 reported cases of foreign body of dental origin in the lung from the literature including two of his own. According to his findings: Ratio of occurrence in right and left bronchus, 2:1. Nature of accident: general anaesthesia—gas 19, ether 2, chloroform 3, rectal anaesthesia 1. The remaining accidents occurred in the following order: aspirated, time not stated, four; during sleep, two; while eating, one; while in a fit of coughing, two; while in the dental chair, nine;

when kicked by a horse, one; when making a cast for the mouth, two; while in petit mal, two; while in intoxicated stupor, one.

Thirty-two patients developed lung abscesses of which seventeen recovered and thirteen died, the result uncertain in the remaining two.

The sojourn in the lungs of the foreign bodies presented in this series varied from four to thirteen years.

Post mortem findings in some of the cases were: Fistula of lung opened into large empyema cavity containing pus; lung collapsed dentine with four teeth found in the pleural cavity. In another post mortem it showed cavitation in left lung; fragment of the tooth in pleural cavity.

Thus it shows that the foreign body does migrate from the lung tissue into the pleural cavity accompanied by empyema, or not.

X-Ray studies must be done from various points of view in such cases and bronchoscopy must be resorted to without hesitation. Jackson recognizes no absolute contra-indications to bronchoscopy.

Moltz (75) reported in 1921 a case in a boy of four following extraction of teeth, with review on the literature.

The chief lesson we obtain from these reports lies in that such a simple procedure as tooth extraction may bring about grave sequences and that aspirated foreign bodies may easily sojourn in the pleural cavity.

#### (b) TONSILLECTOMY, ADENOIDECTOMY AND OTHER INTRAORAL OPERATIONS.

Since Richardson (77), as late as in 1922, reported the first case of lung abscess following operations on the tonsils, recorded cases have steadily increased and many writers, such as Clark (78), Meyers (66), Lockwood (2), Heuert (79), Stewart (80), and Whitmore (81), discussed this subject with increasing enthusiasm, some reviewing on complete Bibliography, some analysing many interesting reported cases, while others strove to reach to its pathogenesis as far as tonsillectomy and adenoidectomy are concerned.

Pottenger (82) met twenty cases of lung abscess complicating tonsil operations during a period of eighteen months. At the Mayo Clinics they found 16% of post-tonsillectomy lung abscess out of a total of 54 lung abscess cases and they had all together 25,000 tonsillectomies performed under local anaesthesia (83).

In New York Hospital in all 2,620 tonsillectomies were done under general anaesthesia during past ten years, and 4 lung abscess cases occurred. The rest of the cases of tonsillar origin in the present series were from other sources, (5 cases).

Bassin (84) met 16 lung abscesses following tonsillectomy done under general anaesthesia during the year of 1913, while Manges (85) met nine such cases in a year.

Lockwood (2) collected 208 reported cases for analysis in 1923 and found that only seven of these were done under local anaesthesia.

Whitmore, quoted above, reported 100 cases of lung abscess in 1923, of which 60 were operated on the upper respiratory tract. He thought that these were aspiratory in origin and that a large percentage could be avoided by the use of more careful technic.

Stewart (80) places responsibility to the aspiration of blood and infected material for post-tonsillectomy lung abscess. Clard also favors aspiration theory, and emphasizes careful toilet before and after operation on the upper respiratory tract. Heuer's series (79) indicated that out of 76 cases, 74 had general anaesthesia.

Daland (86), who is well known for his treatise on "Focal Infection," in 1924, presented three fatal cases of lung abscess following tonsillectomies, at the meeting of the New York Physicians Association, and brought up a few important points—(1) definite presence of focal infection requires extrication: (2) Is there any justification in doing the operation in the presence of apparent danger (complication of lung abscess) in these patients who are handicapped by various conditions such as old age, myocardial weakness or the state of lack of resistance due to the presence of the focal infection? (3) How can we guard against the occurrence of serious consequences in these patients if such operations are justifiable, in other words, is there any logical method of prophylaxis?

The presentation of such a timely subject was naturally followed by active debate regarding the pathogenesis of Lung abscess in its relation to tonsillectomy.

Meyers of Brooklyn (87) bronchoscoped 100 patients immediately after tonsillectomy and he found blood in the trachea in 78% of the cases.

Some still hold that lung involvement following tonsillectomy, takes place by embolic process or lymphatic infection which may be caused by inserting the needle too deeply into the peritonsillar tissue.

Slueder (88) used to operate on tonsils using local anaesthesia only, and many accidents occurred. He now uses only general anaesthesia and seldom has mishaps.

Although this is not the place to discuss methods of operation, may it be said that whichever method is used, the success depends on careful technique and not on the method alone. Only a few unusual case demonstrations do not decisively affect the pathogenesis. Although it is certain that some cases are caused by embolism, there are a few cases on record with post mortem pathology, showing that the lymphoid tissue of peritonsillar space is first infected and then carried down to mediastinum in the vascular sheath, then transmitted to pericardium and lung. Only one case of post-tonsillectomy lung abscess from the Mayo Clinics' series in 1922 showed the jugular vein infection possibly indicating embolic infection.

Even if the jugular vein is previously infected, it is not always necessary for the infection to spread onward by way of the blood stream. Instead, extra-vascular tissue become involved first and then the infection may spread downward destroying consecutive tissue until intrathoracic organs become finally involved. Such an instance is illustrated by case X, in which it began with mastoiditis, from basis of external jugular vein, then localized cellulitis of the neck which continued to spread until it destroyed the pulmonary tissue. This case will illustrate that consecutive spread of the lesion through the devitalized neighboring tissue takes place more rapidly than embolic process from distant foci. The majority of post-tonsillar lung abscess cases are chiefly due to aspiration of infected blood or infective substance whose virulence depends on amount of the infective matter and the virulence of the organism, and, on the other hand, individual resistance. Aspirated infective material works its poisonous effect on devitalized bronchial mucosa, and with this initiation there is production of peri-bronchial inflammation and abscess formation, or bronchial obstruction may lead into inflammation of the deeper components of pulmonary tissue, producing localized broncho-pneumonia.

Tonsils are situated in the triangular recesses between the pillars of the fauces and the base of the tongue. The floor of this recess is formed by the pharyngeal aponeurosis and the superior constrictor muscle on which each tonsil rests, and which it is separated from the pharyngomaxillary space. This space lies between the lateral wall of the pharynx internally, the internal pterygoid externally and the upper cervical vertebrae posteriorly, and contains fat and loose cellular tissue. Zuckerkandel (231) showed that it was divided by the styloglossus and stylopharyngeous muscles into an anterior chamber, contiguous to the tonsil, and a posterior chamber containing in its hindermost part the internal carotid artery, the internal jugular vein and their accompanying nerves.

From the above anatomy of the tonsils, if the infection of peri-tonsillar tissue takes place primarily, the downward extension will take place along the space in which the internal carotid lies. The lymphatics of the tonsil enter the deep cervical nodes beneath the posterior belly of the digastric. These are situated near the angle of the jaw, and may be readily felt when enlarged. The venous blood is drained from pharyngeal venous plexus into internal jugular vein. Whichever route the infection may spread, there is always a characteristic display in the pathological anatomy, presenting a clinical picture, which in each case, may be depicted by Roentgenogram.

Fisher and Cohens (89) simple conception is convenient, but such a hurried conclusion could not be made unless a larger group of cases and more extensive literature are considered. Fetteroff's (90) assertion, as well, concerning metastatic infection taking place from retro-tonsillar tissue can not be generally accepted.

When it is established that the majority of cases of post-operative lung complica-

tions are due to aspiration, at the least following precautions should minimize occurrence of accidents:

1. Pre-operative administration of calcium salts and increase of milk intake at least for two weeks before operation as a prophylaxis for checking hemorrhage.
2. Pre-operative oral hygiene for the same period before operation and especially careful treatment for pyorrhea, if present.
3. Careful preparation of locality for asepsis, such as the application of tincture of iodine or mercurio-chrome solution.
4. Minimum use of anaesthesia, if it is to be used and minimum time should be consumed.
5. Use of suction during operation such as the suction cup of Wider (91).
6. Careful management of the patient after operation. Rest in bed before and after operation, and by taking every precaution just as for a major operation.
7. Adequate term work between surgeon, clinician and nurses.

Alway (92), Prens (93) and Lyman (54) all favor aspiration as responsible pathogenic factor and mishaps are chiefly due to faulty technic and therefore they can be prevented.

Cullom (94) is impressed by the fact that lung involvement after nose and throat operation occurs exclusively in patients operated under general anaesthesia. Porter (95) has the same opinion.

Moore (96) found, in a study of 202 cases of pulmonary abscess following operation on upper respiratory tract reported to him by 508 laryngologists in the United States and Canada, that 15 cases occurred after a lapse of considerable time, 22—100—150 days. Excluding these, the average time of onset of symptoms after the operation was six days; for those complicated with previously diagnosed tuberculosis, five days. In 60% of reported cases, the abscess was located in either the right or left lower lobe (Right lower, 41% and Left Lower, 19%). The question of location will be considered in the section "X-Ray."

Pulmonary abscess occurs once in from 2500 to 3000 tonsillectomies. From the time of development of post-operative lung abscess and their localization, which is very similar to that of in case of inspired foreign bodies, Moore concludes that this type of abscess of inspiratory origin in the majority of cases. Blood stream transmission of infected material may occur, but in a small number of cases, while lymphatic extension is very rare.

Peabody (97) in discussing Moore's paper, believes that the removal of reflex innervation is responsible. Botsford (98) after discussing metastatic and aspiration theories, favors the latter theory even in those cases operated under local anaesthesia. As a preventative means he believes in not abolishing all lung and throat reflexes, quoting Jackson's "The Watchdog of the Lungs" in which the latter demonstrated

that 8% solution of cocain applied to the lower part of the pharynx abolishes all reflexes in the vocal cords and thus inhibits the coughing reflex.

Bigelow (99) offers three possible routes by which infection may reach the lung in operations in upper respiratory tract, i.e. (1) by way of the lymphatic channels, (2) the blood stream, or (3) by direct inhalation. That the last named is the more usual route, Bigelow says, is indicated by the fact that the majority of these abscess occur in the lower lobe of the right lung, the right bronchus leading almost directly downward from the trachea.

The writer, however, thinks that the last stated anatomical reasoning is apt to mislead one to too hasty conclusions. Other possibilities such as the movement of the lung, active reflex in the lower part of the lung tissue, the activity of cilia, and the position of the patient must also be considered in such localization of the lesion. In fact the right upper lobe and root region of the lung are more frequently involved. Early Roentgenological examinations in these cases would indicate that the lesions tend the gravitay downwards so as to occupy lower lung fields in the later period.

Voorhees (100) reports a case following removal of tonsils under other anaesthesia by the Slueder's method and suggests as a possible explanation the inspiration of cheesy masses squeezed out of the tonsillar crypts by the evagination. Slueder believes that this infectious material is more responsible for post-operative trouble than any other things and that it is just possible that the alleged increase of lung abscesses following tonsillectomy of late years is due to the fact that nearly all operators disregard these cheesy particles and go right ahead with the enucleation. Refer to case XXXI.

According to Chipman (101) in a large hospital 30% of all operations are done on the nose and throat. It would be very convenient if we could feel as sure as Fisher and Cohen (89) that lung abscess following nose and throat surgery is of embolic origin, for then it would make little difference if local or anyone of the various forms of general anaesthesia should be used. It is difficult to see how the cause can frequently be other than aspiration, when we consider that out of 33 cases, the right lung was involved near the hilum 27 times. Embolic abscess is most frequently found near the edges rather than the center of the lung. When all facts are taken into consideration, we must conclude that lung abscess is caused both by aspiration and by the infective embolus, carried to the lung by the blood stream or lymphatic system.

Meyer (41) believes that the dreaded lung suppuration following tonsillectomy and the removal of adenoids are almost all due to aspiration of blood, mucus, particles of infected glandular tissue or tonsillar plugs during the operation. The theory of lung infection subsequent to tonsillectomy by way of the blood stream seems far fetched and less plausible, although one occasional case may perhaps develop in this way.

Regarding the Roentgenological evidence in favor of the aspiration theory and and direct extension of the lesion, the writer wishes to discuss the matter fully in the Roentgenographic section. At this point we must proceed to the consideration of other pathogenic factors which are closely related to the operations in the upper respiratory tract, supplying further evidence to the possible inhalatory theory.

## V. Use of General Anaesthesia.

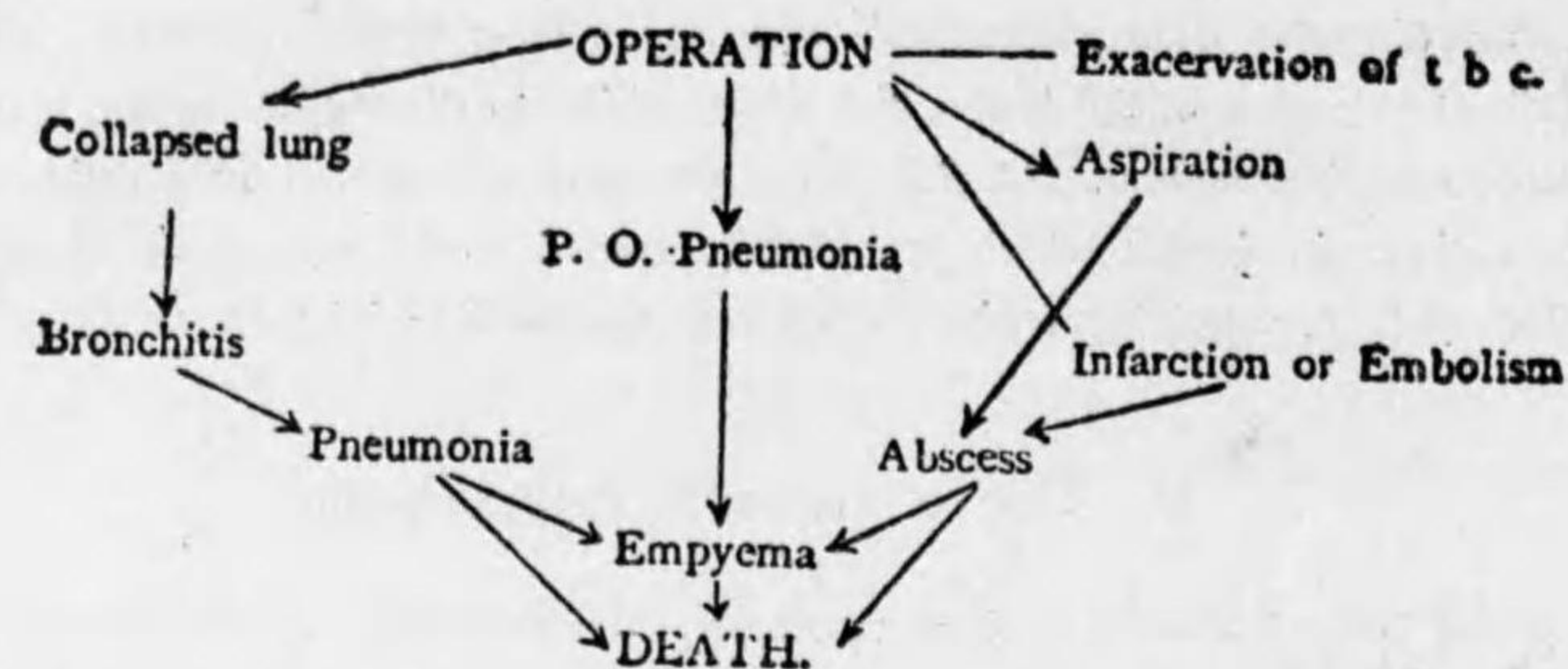
It has been inferred elsewhere that lungsuppuration more often follows Broncho-pneumonia and the latter is said to arise or happen on the area of collapsed lung during the course of operation under deep anaesthesia. Post-operative pneumonia has a certain bearing on the subject of lung abscess.

Elwyn (102) reported the occurrence of post-operative pneumonia in 2.76% out of a total of 2932 patients operated on during the period from March 8, 1921 to September 1st, 1922. Types of anaesthesia used were, ether, alone, ether plus nitrous oxide, nitrous oxide plus oxygen. Frequently massive collapsing of lung occurred which was mistaken for pneumonia of lower lobe. Anaesthesia causes collapse of the lung, if it is not early re-expanded there follows congestion and infection. Elwyn offers other factors as causing post-operative pneumonia—(1) previous acute or chronic inflammation of the respiratory tract, (2) irritation of the respiratory tract by the anaesthetic, (3) hypostatic congestion in weakened old persons. Out of 2932 operations, 1080 on gastro-intestinal tracts, P.O. pneumonia in 6.29%; 1852 on other parts of the body, in 0.7%.

White (103) found 148 embolic (?) abscesses including gangrene of the lung out of 6,000 autopsies, and 76 abscess cases of which 74 followed general anaesthesia. His findings strongly indicate that lung abscesses are due to chiefly aspiration under deep anaesthesia. White offers for prophylaxis lowering the head during and for some time after operation, use of local anaesthesia whenever possible, and cleansing mouth prior to patient sent to operation.

Pepper (104) quoting Pasteur and Briscoe emphasizes collapse of one or both lungs as an initial cause for post operative pulmonary complications. Embolism most frequently occurs in laparotomy and operations on female genital system, usually after two to three weeks.

The graphic expression regarding post operative complications by Pepper, modified by the writer, serves for visualizing the possible post-operative sequelæ:



That a collapsed lung is not always an initial condition of post-operative pneumonitis leading into lung abscess, but such conditions may exist independently in the same patient almost synchronously, is illustrated by our case No. VII. In this case, following operation for perforating gastric ulcer, there were signs at the right lower region suggesting consolidation and the radiographic findings were: very high diaphragm, aloudyness at cardiohepatic region and hazyness at lower axillary region. These latter X-ray findings did not suggest ordinary pneumonia. The mediastinum was also displaced to the right. This picture more suggested atelectasis of the lung or collapsed lung. Much later on we had a large abscess cavity in the right upper region appeared, which evidently followed aspiration and destructive process at the root area.

The presence of oral sepsis as an etiological factor in producing post-operative lung complications especially after prolonged general anaesthesia should be born in mind, aside from the simple collapsing of lung. Not only operations in the upper respiratory tract, but in all operations in which prolonged anaesthesia is used the aspiration of septic matter from the upper air tract is a strong etiological factor in bringing about lung complications, as is indicated by the accumulated evidence. In the writer's series more than 25% of the lung abscess had advanced degree of pyorrhea. Post-operative lung complication is almost all broncho-pneumonia, and the fact that broncho-pneumonia is frequently followed by abscess formation (page 19) is another point which favors primary aspiration of infected material.

Lambert and Miller (105) made experiments with monkeys in an endeavor to produce lung lesions by intratracheal injection of these anaerobic organisms, and in one monkey this was done in conjunction with tonsillectomy. The result published in 1924 was not yet satisfactory. In their series Lambert and Miller found various types of anaerobic organisms, and they expressed on opinion that the fact that some of these anaerobes correspond to the type found in the mouth and throat in such conditions as pyorrhea and Vincent's angina raises the further interesting query as to whether the well recognized relationship between pulmonary abscess and operation on the upper

air passages may not, in part at least, be due to the pathogenic possibilities of these anaerobic bacteria in producing abscess when they reach the lung under the varying conditions of the inspiration of foreign infected material at the time of operation.

## VI. State of Coma and Semiconscious Condition.

The conditions produced by alcoholism, morphinism, epileptic fits, and diabetic coma may be considered similar to conditions produced by general anaesthesia.

Prosser (51) among his 18 cases of lung abscess found two cases in which lung abscess followed repeated convulsions. The writer calls especial attention to the cases following convulsive seizures, saying that it is not generally known that lung abscess may be ascribed to this cause. It is possible that in such cases the patient inhales a foreign body or some infectious material.

In my present series there were five cases (5%) in which comatous state existed just previous to the development of lung abscess; in these cases the inhaling of foreign substances was probably the cause. Two are due to alcoholism, two to diabetes and other had unknown convulsive attacks possibly epileptic. Cases on record ascribing alcoholism as a cause of lung complication seem to be very scarce and the writer wishes to call especial attention to this point in recording cases. Diabetes as a cause is frequently given in the literature, but no explanations were made as to the mechanism of producing lung abscess, whether directly by direct inhalation or due to the lowered physical condition. It may be possible that in such a patient during the state of coma or semicomatous condition, he may inhale infective material causing direct damage to the lung, or it may be possible that metastatic infection from distant foci takes place on top of such a lowered physical condition. If the infection takes place, however, through inhalation, the Roentgenographic investigation done under proper periods ought to reveal the characteristic pathological process. If the region is metastatic, it is apt to be periphery situated and multiple, besides one may find infectious foci in other parts of the body.

Morphinism as a cause was mentioned by Wesser and Jaches (46).

Aspiration pneumonia, especially of the insane, is often the predisposing factor causing lung abscess. This is mentioned by Carr (106).

## VII. Miscellaneous.

### (a) SECONDARY TO ABDOMINAL DISEASES.

Cases on record regarding pulmonary abscess secondary to suppurative abdominal diseases are many. Most of them are metastatic and multiple. Hall (107) in 1915 reviewed such cases and Morgan (108) reported a case secondary to abscess of liver.



Among their present series, one case originated in impacted and infected renal stone, one case followed the operation for pus tube. Instead of embolic transmission, the infection of the lung may take place by direct spread through the diaphragm.

(b) PERFORATING GASTRIC ULCER.

Cases occurring secondary to perforating gastric ulcer are rare. In these cases the infection takes place by direct spreading in its continuity. The diagnosis in this type of lung abscess is difficult in the early stage because it is mistaken for subphrenic abscess, clinically, and the X-ray shadow is overridden by the diaphragm. One such case is illustrated in case No. XVI.

The case of Beever (109) has its historical interest and therefore it is quoted as follows:

Case: Female, age 20, domestic servant.

Past History: Anaemia, Dyspepsia, Constipation with occasional vomiting during past two years.

On Feb. 24th, 1905 the patient came for pain in left anterior axillary line at about 9th rib.

Physical examination: chest and abdomen were negative.

Medication: Bismuth mixture were given.

On the 29th after a full and injudicious meal patient had been seized with very severe pain in the abdomen; pulse collapsed and cold extremities. Morphine given, Pain localized to splenic region with general abdominal tenderness.

March 1st, pulse recovered much, temperature 100 F Abdomen not distended, marked hypogastric tenderness and appearance of menses.

March 2nd and 3rd, temperature rose slightly; W.B. C. 14,000.

March 2nd admitted to the Hospital, then temp. 99.2 pulse 120, small. Severe pain in left iliac region. Abdomen slightly but uniformly distended. with rigidity of abdominal muscles. Abdomen did not move on respiration; great tenderness more at left iliac region; absence of liver dullness. Some vomiting, absolute constipation for a time. Since there was no localizing no operation was attempted.

March 6th, thoracic signs consisted of dullness on left base of lung to 4th rib in axillary line, over which loss of breath sounds, vocal resonance and tactile fremitus were present. W.B. C. 18,000.

March 9th, exploration on left chest showed 2 ounces of bloody stained serous fluid.

March 11th and on, temperature always rose Pulse 112, respiration, 36.

March 16th, temp. 104.4 W. B. C. 32,600. The pain increased, localized at the left side of the chest and left shoulder.

Physical signs remained same as before, except mobility of abdomen improved. There were no cough and no expectoration.

The second exploration gave small amount of bloody stained serous fluid, few cells and was sterile.

X-ray: slight depression and flattening of the left dome of the diaphragm, and area above the diaphragm showed a little opacity as if pleural effusion.

March 18th, over the former dull area there appeared tubular breathing and bronchophony.

Next few days her condition became worse; temperature 102-104, increased pain in the left shoulder.

March 22nd, cough appeared, but no expectoration. P. 140, resp 40.

March 23rd, patient suddenly brought up by combined cough and vomiting over a pint of fluid, foul pus with some stomach contents intermixed. At the same time the temperature came down to 102-97 and to 94 patient collapsed, rapid thready pulse 130 and respiration 52.

Cough and expectoration continued for next few days.

March 25, signs of pneumonia at right base.

March 29th, patient became slowly better, the lung condition on the right base improved; thrombosis of femoral vein occurred later on.

May 1st patient left hospital practically quite well.

Chief interest in this case lies in the speed and the roughness of recovery where the abscess was long in penetrating to a bronchus, where secondary pneumonia developed in the other lung and where the patient was of poor physique.

Similar to the perforating gastric ulcer causing pulmonary abscess, abscess of liver or subdiaphragmatic abscess or perforating appendicitis may cause abscess at the base of lung by direct extension and not to by metastasis. Frank (62) referred to cases following septic process in the subphrenic space, liver or retroperitoneal area extending through the diaphragm.

(c)

Abscess of lung may be caused by direct extension from foci existing in mediastinal structures and esophagus. Secondary infection of esophageal carcinoma breaking into the lung tissue is not of infrequent occurrence. Frank (62) referred to a case following rupture of mediastinal abscess.

(d) DISEASES OF THE SKIN.

One of the writer's cases was due to metastasis from skin-boil, in which it was of course multiple type.

Lung abscess following external injury may occur, such as by entrance of bullet,

but one caused by subcutaneous injury of the thorax is very rare, such instance was reported by Hofman (110) in 1922. This was in a man of 35, injured breast and back by fall, breast was painful, breathing was painful but no other symptoms. Five weeks after the injury, spitting of blood, pain, dyspnea, fever and swelling on right scapular region developed. X-ray showed a cavitation in right upper lobe and a fracture of the 3rd rib. On operation, found skin abscess communicated with lung abscess; resection of rib and drain leading to complete recovery. The author's comment on this case was that originally there was probably a haematoma of the softer parts and a contusion or rupture of the lung. The lesion of the lung might have been a secondary phenomenon and was caused by an infection transmitted from the opened bronchial tube. The abscess then encroached upon the haematoma at the point of fracture, where both places probably were adherent.

(e) MASTOIDITIS.

Few instances are given with mastoiditis as an etiological factor indicating that such instances are not frequent. Heuer (49) reported two cases following mastoid operation, but he did not give any explanation to the pathogenesis, whether metastatic or by direct extension from mediastinal structure as in case No. X.

### VIII. Unknown Group or Idiopathic.

These cases tabulated under unknown group in the writer's series gave the history of bronchitis or a few of them history of pleurisy of shorter duration. Whether they started from chronic bronchitis or pleurisy could not be definitely stated. That some of the cases of so called incidious or idiopathic origin may be sequelae of an influenza infection is also quite possible.

Lambert and Miller (105) — their experience with the cases that occurred in their services at the Bellevue Hospital led them to surmise that the abscess of the lung may occur without any evidence of preceding pneumonia. Such a condition may be supposed to be an abscess from the start, the interstitial tissue of the alveoli being infected and the inflammatory products breaking down promptly without any definite stage of an exudative pneumonia into the air vesicles. In their series, such primary abscesses would appear from the history to have been a probability in twenty-two out of the sixty cases. The history in such cases was of a rather short and not very acute prodromal period, which developed in a short time, usually within a week, into the definite symptoms of an abscess discharging into a bronchus quantities of pus. In favor of such an hypothesis of primary abscess formation, they believed in the fact that secondary abscesses in the same or the opposite lung not infrequently occur; (Case No. XXXV may be an instance of this particular type); that these secondary

abscesses have the same character as the original lesion without signs or symptoms of a preceding pneumonia and that, following the inhalation of foreign bodies, such abscesses are well recognized independent of any intermediate pneumonia stage. This primary abscess formation may occur either because of local favoring factors in the lung itself or because of the nature of the infecting agent. Among these local factors in the lung itself, the irritant action of ether vapor should be considered as one. The writer wishes to add that the above quoted Lambert and Miller's cases included lung abscesses which occurred post-operatively. In the writer's series these were considered in post-operative group. Some of these cases at least indicate that lung abscess occurs independent of post-operative pneumonitis.

### CHAPTER III—BACTERIOLOGY.

Besides various other factors that are concerned in the causation of lung abscesses, it has been intimated on many occasions in the previous chapter that bacterial organisms have a significant bearing on the subject, and, that a certain form of micro-organism seems to produce a particular pathological change is suggested by the presence of so called idiopathic lung abscess to which Lambert and Miller (105) have drawn attention.

Differences in the gross pathology produced by various organisms may be depicted under the Roentgenogram for comparison, if a large number of cases are grouped together accompanied by careful bacteriological study. In our present survey, however, no special organism can be incriminated for causing a particular lesion and we are merely informed by the usual statement that a variety of organisms are found in association with lung abscesses.

It is understood, of course, according to the statement made at the beginning of chapter I, that specific organisms, such as amoeba, actinomycosis, syphilis, tuberculosis, aspergillosis, blastomycosis and glanders are not considered here.

Lay (111) found in one case, streptococcus, staphylococcus and filaments of leptothrix. Some short thick bacteria, some fusiform bacteria; and in another case, streptococcus and diplococcus.

From the writer's series of 100 cases the following varieties of organisms were found, and from this no definite conclusions could be made in their relations to Roentgenographic findings. In many instances the culture was negative.

#### SPUTUM CULTURE

Staphylococcus aureus	Streptococcus salivarius
Streptococcus albus	„ haemolyticus

Green producing non-haemolytic streptococcus	
Micrococcus pharyngeus	Gram negative Bc. aerogenus
„ tetragenus	„ Freedländer
„ catarrhalis	„ lactis aerogenus
Pneumococcus	Large Gram positive diplococcus
Short Gram negative Bc.	

#### CULTURE FROM CHEST FLUID AND OF ABSCESS

Bc. capsulatus mucosus	Gram negative non-haemolytic and non-capsulated Bc.
„ subtilis	Streptococcus viridance
„ coli	„ haemolyticus
„ of colon group	„ non-haemolyticus (Green producing)
Staphylococcus albus	Diphtheroid Bc.
„ aureus	Gram negative Bc. of proteus group.

In the majority of cases these organisms were found associated with one or many others and not singly.

Haemolytic streptococcus were often obtained from lung abscess in cases following influenza, and they usually terminated fatally.

There was an epidemic of lung abscess following the recent influenza epidemic. There were more lung abscess during 1919 than during several years preceding the influenza epidemic. At that time, the haemolytic streptococcus was the prevailing organism found in the tonsils.

Nichols and Bryan (112) discovered haemolytic streptococci from the crypts of 75% of 100 pairs of extirpated tonsils.

Cajigas (113) in 1919, found haemolytic streptococci present before operation in 170 out of 200 cases, or in the tonsils of 85 percent of the patients examined.

Streptococcus haemolyticus is a virulent organism and it may be present in a chronic foci or in a latent foci, giving rise to fulminating spread of the lesion at certain periods.

In one case the disease began suddenly with severe abdominal pain, pain on left side, in the right arm, septic fever, expectoration of bloody sputum. There followed a rapid development of dyspnea, jaundice, abscesses of leg and arm and blood culture showed streptococcus haemolyticus septicemia. Patient died within four weeks after the onset of the disease. The post-mortem findings were; acute ulcerative endocarditis, sub-acute bronchiectasis, atelectatic left lung, and at the base of the right lung an old abscess with a thick wall was found. From the abscess streptococcus haemolyticus

was obtained. Apparently the patient had latent foci in the lung which spread into various parts of the body. In another case, it began with lobar pneumonia, in which the chest fluid showed streptococcus haemolyticus. The patient died from sudden spread from the lesion to the other lung. Case No. XVI finally died of streptococcus haemolyticus septicemia which apparently resulted from a chronic lung abscess. In a number of cases which followed aspiration of sea water, bc. of Colongroup were found. Lynor (137) asserts that lung abscess following the aspiration of sea water in the vicinity of New York were usually fatal. One of writer's cases began with sudden chill and fever, rapid development of lung abscess. Aspirated fluid culture showed Bc. aerogenus, Bc. Freedlaender, Bc. lactis aerogenus, and no other organisms. This case ended fatally within short time after exploratory thoracotomy. In another case, it began with acute amygdalitis (Influenza?) which ended fatally within a short period.

Bullowa (114) reported a case of lung abscess following the aspiration of seawater, in which colon Bc. was the chief infecting organism. One of Lynah's cases (137) showed a pure culture of Freedlaender bacteria—most virulent of cases which we see in summer, caused by swimming about in New York harbor.

Steward (80) says that influenza bacteria in large numbers, are found in bronchiectasis.

Lavastine (115) reported a case in 1921 which was due to pneumococcus infection. This was in a woman 23 years of age, who, after pneumonia, developed multiple abscesses of the left lung. None of these abscesses ever ruptured into the bronchi. Operation was considered, but due to the great number of lesions, it was not thought to be advisable. The patient was then given anti-pneumococcus serum and promptly recovered.

Paissean (142) reported that in one case streptococcus was discovered from cavity, had only mild fever, while in another found pneumococcus patient who had a high fever.

Pilot (116) stated that in pulmonary lesions, particularly abscesses, gangrene and bronchiectasis with the production of foul sputum, the putrid character is usually the result of infection with fusiform bacilli and spirochaetes; these organisms resemble in their morphology those found about normal teeth and tonsils and in Vincent's angina. Salvarsan has an influence on the fuso-spirochaetal infection of Vincent's angina and gangrenous balanitis, due presumably to the spirochaeticidal action of the drug. In several lung cases the results with neosalvarsan therapy were so striking that one may assume a specific effect of the arsenicals upon fuso-spirochaetal pulmonary infection. Four cases out of a series of 40 are cited as illustrating the different types of lesion.

According to Peemöller (117) purely internal treatment of pulmonary abscess or gangrene is followed by death in at least four-fifths of all cases, according to the earlier statistics. Salvarsan treatment, instituted in 1914, has furnished a number of

prompt and favorable results. Its occasional failure is due to the fact that not all cases of pulmonary gangrene are due to fuso-spirillary symbiosis, but that streptococcus putridus must often be regarded as a principal agent, especially in the embolic form of the disease. It follows that this form must be almost entirely excluded from salvarsan treatment, which, however, is especially adapted to those forms which are unfavorable for operative treatment on account of their progressive tendency—i.e. diffuse gangrene of the lung. The conditions for a successful outcome are the existence of a fuso-spirillary symbiosis and the absence of solid aspirated substances or foreign bodies which have been demonstrated; no time must be wasted with useless injections of salvarsan. A case of pulmonary gangrene which was successfully treated with salvarsan recently came under the authors observation.

Curschmann (118) reported a case of pulmonary gangrene following influenza pneumonia in which recovery followed the administration of neosalvarsan; also a case of fetid bronchiectasis in an old man aged 71 in which the effect of neosalvarsan was reported favorably. The author advocates the early employment of salvarsan or neosalvarsan in pulmonary gangrene.

Twenty-five per cent of the writer's series had suffered from marked pyorrhea; spirochaetal organisms are frequently associated with the pyorrhoeal disease; large number of cases of lung abscess, especially aspiratory type, may be of mixed infection including spirilla; and in this meaning the use of Salvarsan may bring about beneficial result.

Lambert and Miller (105) state that the usually accepted idea of the bacteriology of lung abscess is that of a mixed group of pyogenic organisms, on which may be engrafted the putrefactive organisms in the cases in which gangrene appears. Their studies of bacteriology were limited to only ten cases, in which the examinations were made directly from the abscesses at the time of operation. They did not include any studies of the sputum, for certain reasons. The striking feature of these bacterial examinations of the abscess pus in these ten cases, was the uniform presence of anaerobic bacteria, which were present in predominating numbers in all, and were the only type of organism found in eight of the ten cases. In the other two cases, streptococci were found, one a haemolytic and the other a non-haemolytic variety, in addition to the anaerobic bacteria. The anaerobic flora found were quite variable, being a streptothrix in six cases, a Gram-positive coccus in six, a Gram-positive bacillus in four, a Gram-negative bacillus in seven and a fusiform bacillus in two cases, and a spirillum, closely resembling that in Vincent's angina, in one case. It is interesting to note that in one of their cases in which the patient was successfully operated on for abscess in the right lower lobe, two anaerobic organisms, a streptothrix and a Gram-negative bacillus, were the only bacteria found, and that sixteen months later, after the patient was apparently well, another pulmonary abscess

developed in the right upper lobe, from which the identical two organisms were again the only ones isolated, at a second operation.

#### BLOOMFIELD: (118)

Experiments carried out by the author on volunteering healthy persons with *Bacillus Coli*, *Staphylococcus albus*, *Bacillus influenza*, Friedländer's bacillus, and *Streptococcus haemolyticus* showed that the micro-organisms were eliminated from the tongue, nasal septum, tonsil crypts and pharynx within at most forty-eight hours.

Further experiments with charcoal paste revealed the mechanism of this elimination: on entering the mouth, such particles were promptly anchored in the mucus overlying the epithelial surfaces; but their removal was effected by an orderly backward sweep (even past the tonsils, generally supposed to be a converging place for bacteria entering the mouth), evidently due to suction currents set up by the masses of the mouth and pharynx. A similar elimination takes place by way of the nasopharynx from the nasal passages, the sweep of the cilia being apparently the principal factor of this mechanism. In view of this facts and of other observations showing that saliva is an unfavorable medium of growth for most bacteria, how is it to be explained that an abundant normal flora does exist regularly and constantly in the mouth and throat, coming into being within the first 24 hours after birth?

Apparently, the answer is that these bacteria grow not on but in the mucosa, just as *Staphylococcus albus* has been recovered by drawing a silk thread through the epidermis after sterilizing the surface of the skin. Cultures of bacteria obtained before and after subjecting the tongue to scrubbing and sterilizing procedures bound to remove all or nearly all bacteria merely growing free in the mucus showed little or no difference in the number of bacteria obtained.

Which, then, are the factors that induce the eliminating mechanism to break down under certain conditions, permitting certain groups of micro-organisms to become localized in the tissues?

In answer to this question, Bloomfield offers the following considerations. (1) In the case of most bacteria, infection depends on the numbers entering the air passages, either in consequence of some subtle synergistic activity of the individual micro-organisms, or simply because a greater number offers a better chance for one or another of them to lodge on a vulnerable spot. But the author has shown in the test tube that a certain minimum number of bacteria must be introduced, before growth can be initiated, and Dudley advances a similar hypothesis on clinical grounds. (2) Infection is more likely when bacteria are introduced in a highly vegetative state (direct epidemic infection) than when they enter in a state of decline (from chronic carriers or outside sources such as dust).

In the latter state, it may be easier for the flushing mechanism to eliminate them.

(3) From time to time, some bacteria are bound to lodge in clefts or to be ground into tonsil crypts, or to be arrested in situations where a break in the mucosa may occur.

(4) Injuries of various sorts are probably the most important factors, such as reflex vasomotor changes in the upper air-passages following peripheral chilling or chemical injuries, as for example war gas poisoning, in which the invasion of the necrotic epithelium of the bronchial tree by bacteria has been actually observed.

Anaesthesia abolishes the protective mechanism, and in a case of balbar palsy, the bacteria placed on the tongue were observed to remain in situ. In infectious diseases such as measles and influenza, the "erythema" of the air passages is clearly associated with some impairment of the protective mechanism. On the whole, these considerations furnish encouragement for the antituberculosis campaign in the sense that a mere reduction in the number of bacilli in the environment may materially decrease the number of infections.

Bloomfield's experiments have significance to the lung abscess in relation with inhalation cause.

## CHAPTER IV. — PATHOLOGY.

### Morbid Anatomy.

As it has been made clear in the previous chapter on Etiology of Lung abscess, the inflammation and the destructive process of the lung tissue is similar to that of pus formation in other parts of the body, i.e. entrance of foreign body including an infectious material traumatizes the pulmonary tissue which is then followed by reactive inflammation and by re-infection of pyogenic organisms resulting in the formation of pus cavity.

The manner in which the above said principle manifests itself is somewhat different depending on etiological factors. These may be roughly divided into (1) those due to aspiration of foreign bodies and infected material into the bronchi, (2) post-pneumonic type, (3) blood stream infections which may again be divided into (a) general sepsis and (b) local septic processes.

#### (1) ASPIRATION OF INFECTIVE SUBSTANCE.

When infected material is aspirated into the bronchus, the material with the inflammatory exudate about it plugs the bronchus. The occlusion of the bronchus, together with the infection, produces a dilated bronchial sac, filled with infected

exudate. The infection rapidly spreads to the surrounding lung and the alveoli become filled with leukocytes and fibrin. This inflammatory exudate undergoes gangrenous liquefaction and a small cavity is formed. The pulmonary infiltration early shows a strong tendency to organize, and the production of scar tissue may compress neighboring bronchi, and numerous small abscesses may thus be formed. These small abscesses frequently coalesce, producing a large irregular cavity.

Aspirated solid foreign body causes the same inflammatory reaction in the surrounding tissue. The effect produced by the aspiration of solid foreign body and the inspiration of infective material is different however, in that the former tends to produce sub-acute or chronic localized process of less virulent degree, while in the latter case, it may produce rapidly disseminating disintegration of the pulmonary tissue.

It sometimes happens that aspirated foreign bodies may become completely inclosed by fibrous tissue and become deeply imbedded, or even displaced outside the visceral pleura, so that it is no longer directly concerned with formation of lung abscess. Kaempfer's (72) case was of this type.

In the early stage of foreign body introduction into the bronchus, emphysema of lung is produced due to the occlusion of bronchus, which phenomenon will aid Roentgenologist to make an early diagnosis, even if such foreign body is radio-transparent. There may also be a mediastinal emphysema with or without parenchymal emphysema, pressing the hilar structures outward, the Roentgenogram of which is characteristic.

#### (2) POST-PNEUMONIC LUNG ABSCESS.

Abscess of the lung resulting from pneumonia represents the result of the patient's failure to react effectively. It is the consequence of death of tissue and, instead of subsequent fibrosis necrosis is the pathologic picture.

The occurrence of an abscess in an area of preceding consolidation cannot be so clearly followed. It usually comes on insidiously, and perhaps the first stage is organization of the exudate followed by bronchial obstruction and the formation of cylindrical bronchiectasis. Or the exudate fails to be absorbed and in its central portion a direct destruction of pulmonary tissue may begin owing to the virulence of the infective organism and lack of the tissue resistance. In these cases, the interval is usually two weeks before the sputum or breath acquires the characteristic odor.

Meyer (66) states that in other instances the pneumococci or microbic infection of a different type (pyogenic bacteria) may directly produce a suppuration of the lung in the presence of non-resolution of the inflamed area.

Schwartz (57) studied pathology in 16 cases of lung abscess occurred in children and he classified the pathology in two types: (1) pneumonic type—usually chronic indurated pneumonic abscess; (2) post-operative—usually gangrenous due to anaerobic

infection, has bad odor, the first set up bronchitis, its wall broke through and formed pneumonic abscess.

In bronchopneumonia the small peribronchial infiltration becomes necrotic and forms small abscess and these coalesce and form large abscess in the middle portion of the lung. Their appearance is quite characteristic. Or according to the type of infective organism a rapid necrosis of tissue and by sluffing off of such tissue a large abscess cavity may be formed with irregular ragged outer wall.

### (3) BLOOD STREAM INFECTION.

Pulmonary emboli are particularly common in the heart disease associated with distension of the right side of the heart. Thrombosis of the systemic veins is also frequently followed by pulmonary embolism. Often the venous thrombosis is unsuspected until pulmonary embolism occurs. It may be caused from thrombosed uterine venous sinuses after child birth.

When a branch of the pulmonary artery is occluded, by embolus an infarct is produced, which is a firm dark red colored mass of a triangular or pyramidal shape. If the infarct becomes infected, abscess and gangrene follow. The later course of such infection is the same as that of post-pneumonic abscess.

Bacterial emboli may produce multiple small foci in terminal pulmonary arteries resulting in the formation of multiple small abscesses, imbedded in diffuse indurated lung tissue. These small cavities may coalesce and form one or more irregular large cavities.

In abscess due to metastatic or septic emboli, the lung on section shows the infected foci in all stages from that of purulent infiltration to the formation of the abscess and excavation. Occasionally the lung presents a honeycombed appearance due to the formation of numerous small cavities with productive fibrous tissue. Owing to the wide extent of the infection in the lungs and the serious constitutional disturbance, an individual suffering from multiple abscess formation rarely lives long enough to establish fibroid changes in walls of cavity. The condition is rarely chronic.

The gross appearance of pulmonary abscess depends upon the etiology and the stage of development. A typical acute abscess is usually rounded in shape and appears as gray yellowish or red areas of softening from which pus can be expressed. When cavities form, they may be single or multiple or communicating.

They vary greatly in size, ranging from the size of a small marble to one with a diameter of 10—12 cm. Their distribution also varies. In the series of Norris and Landis (Diseases of Chest, Page 459) the abscesses involve the right lung in 19 and the left 11 cases.

In an early stage the walls are ragged and soft, composed of soft necrotic tissue and not sharply marked off from the surrounding structure which consists of an area

of intense hyperaemic edema. Old abscess cavities may be smooth and surrounded by an area of fibrosis; the longer the abscess remains the thicker and the more dense the wall becomes. Bands containing branches of the pulmonary artery and thrombosed veins often run through the cavity. The lung tissue about the abscess is infiltrated and fibrosed. There is always marked induration about the abscess and sometimes widespread and diffuse induration occupies a lobe of the whole lung.

In the chronic type the pus either becomes completely walled off or is not effectively drained. In either case it acts as a foreign body and the lung in the vicinity of the abscess becomes fibroid. Even a relatively small abscess may lead to extensive fibroid changes with marked physical signs and symptoms.

Abscesses frequently lie beneath the pleura and the latter is often involved. The pleurisy may be dry or there may be a purulent or gangrenous pleural exudate.

Pulmonary abscesses may be found in any of the lobes, although the middle lobe is seldom involved. Aspiration abscesses, particularly post-operative, are more frequent in the upper lobes than in the lower, about two to one. They usually start from or near the hilar region, and actual cavity formation may take place in the peripheral region. Hence there is often a statement made that cavities are more commonly situated near the pleura than deep in the lung substance. Case No. II will illustrate this very well.

The healing of the abscess takes place by evacuation of debris, consisting of dead tissue, bacteria and the exudate, formation of fibrosis and its contraction and by re-spreading of surrounding normal alveolar tissue. It is remarkable, however, that even large amounts of fibrous production become eventually absorbed in a comparatively short period in many instances. This is demonstrated by our case No. I, IX, X, etc.

Again the contraction of fibrous product may divide the cavity into multiple chambers, or compress bronchi producing bronchiectasis and multiple small cavities, thus preventing drainage. If there is a rapid production of a large amount of fibrosis and if the subsequent contraction, the mediastinal structures, the heart and great vessels become displaced to the affected side on which side there may be a deformity of the thoracic wall.

### Evolution of Lung Abscess.

A single abscess may terminate in one of three ways according to Norris and Landis (Diseases of the Chest, Page 460): (1) It most frequently ruptures into a bronchus and thus empties itself. If the drainage is efficient, the process heals and unless the cavity is very large, nothing but a fibrous scar remains. (2) The abscess may rupture through the pleura. If this happens a pyo-pneumothorax sometimes results. The more usual cause, however, is the formation of an extrapulmonary

abscess. Under these circumstances, the pus may become encysted in an interlobar fissure, between the base of the lung and the diaphragm, or between the chest wall and the lung. When an abscess forms near the surface of the lung, the pleura becomes inflamed and the two surfaces adhere. This acts as a defensive barrier if the pus breaks through the pleura and prevents the occurrence of a pyo-pneumothorax.

Robinson (161) is of the opinion that the majority of instances of encapsulated empyemata have their origin in a pulmonary abscess which ruptures through the pleura.

(3) The abscess may become chronic and be the cause of extensive fibroid changes in the adjacent lung tissue.

The following case of Piery (119) will serve the best illustration of the evolution of the abscess and its accompanying clinical features. The patient had a chronic abscess of the lung which had been taken for apurulent interlobar pleurisy. This evolved in three distinct phases. In the first, after a beginning which made one think of a pulmonary tuberculosis or pulmonary syphilis, there was noted an evolution of temperature and an opacity in the radiogram of the whole upper  $\frac{1}{3}$  of the right lung. The diagnosis was probable purulent interlobar pleurisy, without accompanying casifying bacillary lesion. In the second period, which lasted five months, the temperature became normal, the physical signs became less and the X-ray shadow diminished considerably. In the third phase, the temperature became elevated and very irregular; in the right lung, in the region of the fissure, all the signs of an incipient pneumonia were noticed. There was hemoptysis, but the examination of the sputum always resulted negative. X-ray shadow became distinctly triangular. Signs of pleurisy soon set in; an exploratory puncture showed pus; and the patient died shortly afterward. The post-mortem examination revealed a pulmonary abscess.

Some cases in which there is not a single symptom that points to the diagnosis of pulmonary abscess, and in which it is very difficult to distinguish from tuberculosis, pulmonary syphilis or from a purulent interlobar pleurisy.

A pulmonary abscess can evolve in a chronic fashion. However, in the course of this latent period, incipient pneumonia can be observed. Some of these pneumonias of the periffissural region can perhaps determine the appearance of small multiple infarcts around which the pulmonary parenchyma becomes necrotic. From the confluence of these little abscesses, there result veritable pulmonary abscesses.

The border line between the sub-acute and chronic lung abscess and bronchiectasis can not be sharply drawn; where does the pathologic picture of lung abscess end and that of bronchiectasis begin?

Meyer (66) divides lung suppuration into three groups: (1) The typical lung abscess, (2) The typical bronchiectasis, (3) Bronchiectatic lung abscess.

The typical lung abscess has been described on page 58. In the typical bronchiectasis, the anatomic structure of the bronchial tree is primarily affected, but naturally

the surrounding lung tissue is also involved later on, the intensity depending on the extent to which a mixed infection with its deleterious results has invaded these cavities. Meyer is impressed that in the greatest number of cases of this type are of congenital origin.

The following pathological examination of the specimen which was obtained from a patient who was operated on for bronchiectasis will fully illustrate the pathology of bronchiectasis, and the possibility that it may break the boundary and easily become a bronchiectatic lung abscess. This patient had a long standing cough and profuse expectoration and recently developed fever. A lobectomy was performed.

Specimen consists of a portion of the lower lobe of right lung, about the size of a fist. Part of the pleural surface looks thickened and ragged, and on section a considerable area of scar-tissue-like formation is seen. The rest of the parenchyma appears normal. Microscopically, considerable atelectasis. Around bronchioles are many miliary abscesses. Both lungs are voluminous and do not collapse when thorax is opened. When the lung, in the upper part of the right lobe a firm mass is felt, and the rest of the lobe is firmer than normal, but not completely consolidated. The middle lobe is small and soft. The lower lobe is covered by red pleura. It is firm but fluctuated. The first incision was made in the upper lobe. On doing so a large amount of very foul, faintly green tinged pus flows from a large bronchus. When the lung is laid down flat on the table the pus continues to flow for several seconds. It is found to come from hugely dilated bronchi in the lower and middle lobes. These two lobes are completely riddled with large branching tubular cavities, which vary from  $\frac{1}{2}$  to 2 cm. in diameter. Each is lined by a dark brown membrane and has 2 fibrous tissue wall. Cartilage is found in the walls of some of them. They were slit open longitudinally and correspond to greatly dilated bronchi. The lung tissue among these bronchiectatic cavities is not consolidated, but soft and bright red. The lumen of these cavities is filled with the foul pus described above. This pus can be easily washed out of the cavities and the cavities are then found to have smooth linings. Post-operative diagnosis—Bronchiectasis and acute Broncho-pneumonia. The above case was a man of 59, development and nourishment both good. History of cough with shortness of breath for 2 and one half years, which followed a severe cold. The first diagnosis was asthma. Examination showed voluminous lung with shower of coarse rales over both sides. Temp. 100 W. B. C. 18000. Large quantities of purulent sputum. Sudden chill with high fever. Died within eight hours, p.o.

The so-called bronchiectatic abscess should embrace all the other non-specific and non-traumatic subacute and chronic lung suppurations which are so frequently found. On section of such a specimen, the observer perceives large and small open cavities which communicate with the visible central defect, the former bronchiectatic abscess. When its contents are removed, any portion of the interior of the cavity, under good

illumination, shows a picture not unlike that of the dilated pelvis of a kidney after removal of pus resulting from a pyonephrosis. If we take a plaster cast of a bunch of grapes of varying sizes, divide the cast lengthwise and remove the grapes, the cavity of such a half ("the negative," resembles the appearance of the cavity of what we have called "bronchiectatic lung abscess.")

Aschner (120) made a study in 24 specimens removed from cases of pulmonary abscess during a series of lobe resections by Lillienthal. Of these, 10 represented bronchiectasis, 10 bronchiectatic lung abscess and the remaining four suppurative pneumonia. According to his descriptions, the following definitions are made. (1) Bronchiectasis,—a more or less uniform dilation of the bronchi and bronchioles in one or more lobes of one lung, or involving both lungs extensively. (2) Bronchiectatic abscess,—a localized suppurative process in the course of a bronchus, occurring chiefly after tonsillectomy. (3) Suppurative pneumonitis,—a diffuse purulent process. (4) Extra-bronchial abscess,—a localized purulent process in the parenchyma of the lung. Among the most interesting histological changes found in this series are metaplasia in the bronchial epithelium; epithelial lining of bronchial epithelium; epithelial lining of bronchiectatic abscess and some smaller abscesses in pneumonitis; sometimes proliferation of the smaller bronchioles and air passage similar to the proliferation of bile passages in portal cirrhosis.

Microscopically, on section, the abscesses are found surrounded by firm fibrous induration which consist of round cells, plasma cells and fibroblasts, the alveoli being obliterated by organized exudate. Elastic fibres are often destroyed and the blood vessels show hyalin degeneration and endothelial thickenings.

Spontaneous cures must result from complete epithelization of the cavity or total necrosis of the lining membrane before fibrotic changes have appeared to prevent collapse of the cavity.

Cases of pneumonia show abscesses in the terminal bronchioles or in the parenchymas with secondary perforation into the bronchial tree.

Letulle (121) reported four cases in 1922 and discussed at length the pathology of dissecting necrotic pneumonia. The essential feature in this type is a gangrenous necrotic process attacking and destroying large areas of the lung parenchyma and with this a fibrous necrotic process; in some of his cases a defensive reaction of the lung in the form of pulmonary sclerosis was observed. The causative organisms is as yet undermined.

In conclusion of this chapter, pathological analysis in suppurative pulmonary diseases as described by Lemons (122) is quoted below in the hope that it may be of service in Roentgenographic interpretation of a later chapter.

According to the author, there are three main diseases that constitute the suppurative type of pulmonary diseases, namely, empyema, bronchiectasis and abscess. Acute pulmonary disease which proceeds into chronic disease may be classified into seven groups:

**GROUP ONE:** Acute fulminating inflammations that may be caused by irritating gases; these rapidly fuse with later groups unless death ensues.

**GROUP TWO:** Acute streptococcal broncho-pneumonia, common during the epidemic of influenza.

**GROUP THREE:** Less acute, but almost equally fatal, pseudolobar pneumonia, also of streptococcal or pneumo-streptococcal origin.

**GROUP FOUR:** Pneumonia, progressing to the formation of free or interlobar encysted empyema.

**GROUP FIVE:** Abscess of the unilocular or multiple type, or acute bronchiectasis. Included in this group are abscesses of embolic origin, and the aspiration type of the bronchiectatic abscess.

**GROUP SIX:** Residual inflammation which develops into chronic non-tubercular infection of the lung, or into frank bronchiectasis.

**GROUP SEVEN:** Resolving condition gradually reverting to normal.

## CHAPTER V.—CASE PRESENTATION.

In the presentation of the cases, they are roughly arranged, according to the Roentgenologic characters which they produced.

Section I, consists of five cases, each of which showed definite cavity shadow with fluid level.

Section II, includes six cases which showed characteristic X-ray shadows, but without fluid levels.

Section III, contains twelve cases whose Roentgenograms are characterized by localized mottling. Although they did not show definite cavity pictures, but the existence of lung abscess was proved either by operation, exploratory thoracentesis, autopsy or by definite clinical symptoms.

Section IV, includes twelve cases whose Roentgenologic findings were characterized by dense shadows occupying lower lung fields. The lesions were frequently multiple, complicated by pleural diseases. Even if large cavities were present they were hidden either behind the heart-shadow or diaphragmatic shadows. In these cases the presence of the cavity or cavities were proved either by exploratory thoracotomy, exploratory thoracentesis, autopsy or by definite clinical symptoms, although the X-rays were negative.

For the details of X-ray characteristics of each group refer the Chapter on the Roentgenologic Classifications.



The physical findings in the chest of each case are charted on the accompanying diagrams, which were made synchronously with the radiologic examinations, or at close period, in order to correlate both findings.

In order to make the presentation as simple and as concise as possible, minor daily changes in the physical findings are not recorded, but only when gross changes were noticed.

Each case are presented with six X-ray prints and diagrams from original negatives which were taken serially. Most of the cases were studied stereoscopically and fluoroscopically at daily or weekly intervals; but the presentation of all the films here are not only unnecessary, but would be too voluminous for the present consideration, so that only important ones are reproduced herewith.

Better readings are made direct from the original negatives; better still if stereoscopic views are studied, while fluoroscopic views are sometimes more helpful in doubtful cases. The latter can demonstrate moving fluid level in the cavity, movability of the cavity shadow within the lung tissue, with each respiration; it shows better the relation of the lesion to other intrathoracic structures such as the heart, great vessels and the diaphragm, presence of pulsation or not, and evacuability of the cavity or not. In fact, in some cases (case VII) positive cavitation was observed sooner than it appeared on the film. Films when printed (positive) lose the details and unfit for correct interpretations.

On account of the above said reasons, these photo-diagrams were prepared directly from the original films, and whenever necessary, incorporated by stereoscopic views and frequent fluoroscopic examinations of the patient, hence they are graphic analysis of the films whose prints are presented in Volume III.

The following abbreviations are used: a.p.t.—artificial pneumothorax; i.c.s.—intercostal space; tbc.—tuberculosis or tubercle bacilli; Br. S.—breath sounds; V.S. or—Res.—vocal resonance; V.F.—vocal fremitus; W.V.—whispered voice sounds; dim.—diminished; inc.—increased.

### Case I. S. V.

Austrian furrier, aged 52, admitted on September 23, 1921 with the chief complaint of cough and expectoration of fetid sputum in large quantities. His past history as well as the family history were negative.

Present illness dated back about five weeks, when patient had emergency operation at the Bellevue Hospital for obstructed hernia from which, the recovery was uneventful excepting that he began to have cough and expectoration of yellow-green sputum about four days after the operation. Remained in the hospital for three weeks, then he was up about at home, still coughing and expectorating. There was, however, no hemoptysis. He came to us on account of loss of weight. On examination he showed marked pyorrhea, congested pharynx, and some fever. Lungs: as shown in the chart,

the signs indicate that of dissolving pneumonia with much thickened pleura and no signs of cavitation. Remarkable thing is that breast sounds at right axilla were normal, and more acute signs at both bases posteriorly, contrary to X-ray findings, which may be due to diminished expansion with hypostatic congestion.

Extremities showed marked clubbing of fingers and thick atrophic toe-nails. W. B. C. 18,200, Polymorphonuclears 78%, Haemoglobin 80%; sputum, greenish-yellow, in large quantities, forming three layers, demonstrated elastic tissue; repeated examination resulted negative for tbc.

Course; during his residence his temperature varied from 100-103, pulse, 96-128 and respiration 20-30. Patient developed neuritis of right arm which became worse after the treatment by artificial pneumo-thorax. Possibly trauma to right brachial plexus caused at time of operation at Bellevue Hospital.

On September 28th, gave 350 cc of air by artificial pneumo-thorax (hereafter A. p. t.) and this was repeated many times, each time increasing the amount of the air given. During the course he had one or two insignificant hemoptysis. Patient made a gradual improvement and he was discharged on Nov. 14, 1921, although he still had occasional rise of temperature, ranging between 100 and 101.

Follow-up. On February 14, 1922, patient reported for examination; condition good, gained in weight, no cough and apparently entirely recovered from the lung condition.

May 16, 1922. Pulmonary condition satisfactory.

Nov. 15, 1922. Same as above except the presence of coarse rales and diminished breast sounds at right base.

### Roentgenological Interpretations.

Fig. 1. Taken on September 21, 1921, in upright position.

There is "fish tail" shaped density occupying the middle region of the right lung field, with its tip at the axilla. Above and periphery it is somewhat mottled and fibrous in appearance, while its lower margin is defined by a curved line which probably coincides with interlobar pleura. Above this shadow, an irregular hazy area is seen with clear cut straight line limiting its lower margin. This is probably a cavity formation with a fluid level. The root area is thickened. This film is apt to be irregularly interpreted as sacculated liquid and the hazy character of the shadow indicating early destructive lung tissue is frequently missed. The serial investigation will only demonstrate the importance of early recognition of such lesions.

Fig. 3, was taken about a week after the previous film, in erect position. Not only did the cavity increase in size, but it is defined more clearly and shows definite fluid level. A.p.t. is shown above, while there is much tendency of fibrosis at root and base causing numerous adhesions. Probably a slight thickened pleura also contributes to the general haziness of the lower half.

Fig. 5, taken on September 30, 1921 following another a.p.t. treatment presents similar picture as previous one, excepting that it appears more thickened at base, with small amount of fluid.

Fig. 7, taken in erect position on October 24, 1921. The cavity is still present, the outline is less distinct, but more ragged, much less induration outside, surrounded by more fibrous structure. The irregular "geographic mottling" below may represent

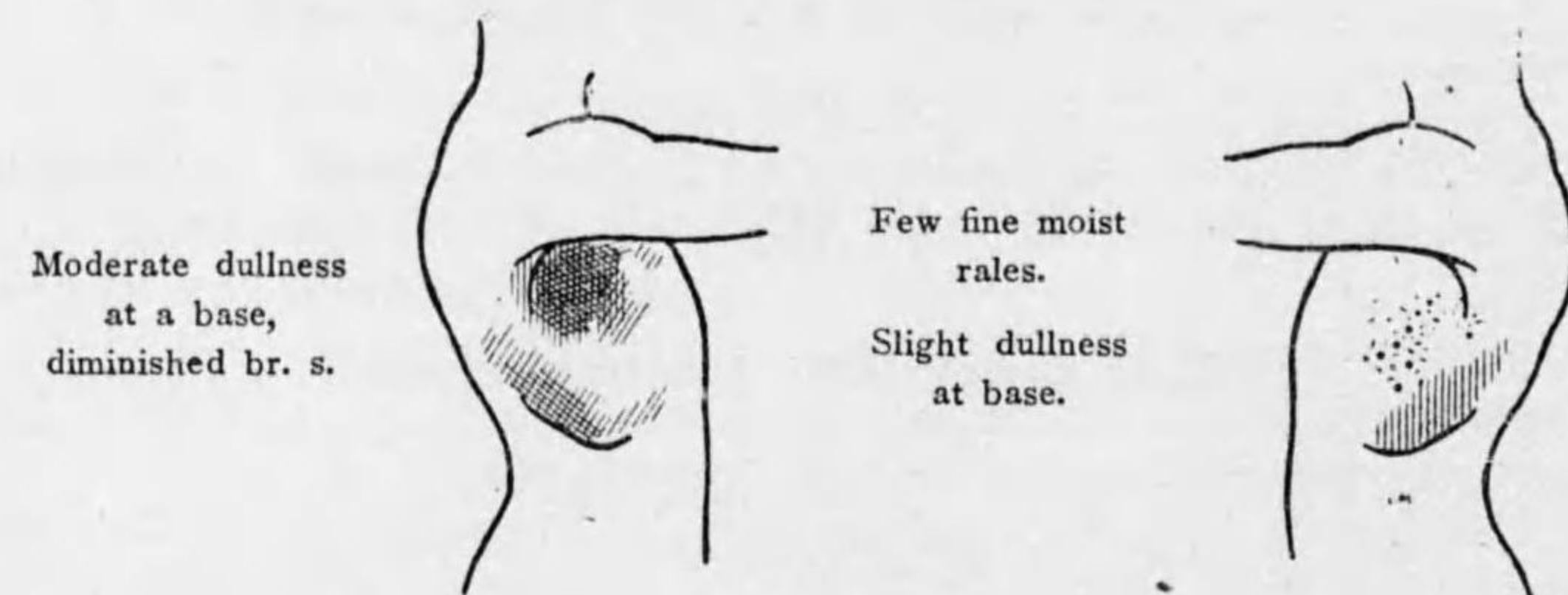
small cavitations. There is small amount of air and fluid at base. Notice the dense adhesions and the curved line of fluid and the fluid level at base.

Fig. 9, taken on November 15, 1922, about a year after the previous one. Remarkable improvement of the lung condition is here noticed. All signs of cavity have totally disappeared, the dense fibrous appearance is also gone and the lung has re-expanded satisfactorily. There is, however, more thickening at both roots. There is haziness at the right lower region with much increased lung markings. The diaphragm is flattened and its surface appears roughened, which is due to adhesion and thickened pleura.

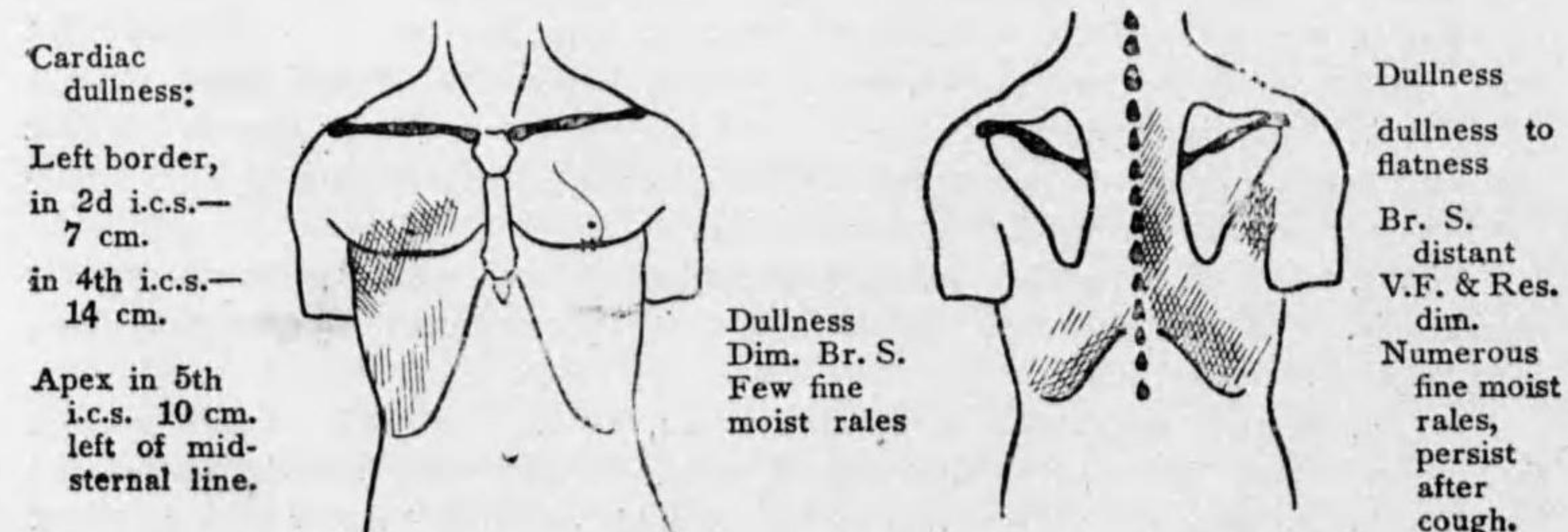
CASE I. S. V.

September 23, 1921.

Resonance flat at axilla to mid clavicular line;  
Br. S.—broncho-vesicular, only slight change;  
Vo. Res. and Fr.—moderately increased;  
Whisp. V.—harsh, increased and high pitched;  
Rales—many fine, of moist character.



Diag. Not typical pneumonia nor for effusion; no signs of cavitation. Thickened pleura and post-pneumonic condition is more probable. Similar signs persisted until pt. was treated by artificial pneumo-thorax, when the signs were interfered by the latter condition. Very later in the course the abnormality became much less marked, so that at the end of one year the signs were: generally diminished Br. S., of coarse quality, slight dullness at bases and a few coarse dry rales.



Case II. S. M.

Patient, man aged thirty, was first admitted to Ruptured and Crippled Hospital on August 13, 1924 and an operation for the relief of sciatica done under ether anaesthesia. He had a normal convalescence until August 2, when a cough and fever appeared. The blood count and blood culture were not significant, and he was transferred to the New York Hospital with a diagnosis of broncho-pneumonia, on August 29. On the day of admission, his temperature was 103.2 F. and a white count of 31,000. The physical signs of the chest were those of consolidation in the right upper and middle lobe. The X-ray picture suggested lung abscess, and under the fluoroscopy a definite walled off area could be seen close to the periphery of the upper right lung. There was a foul smelling sputum averaging from 250 to 350 cc per day. Repeated sputum examination for tbc. and the tuberculin tests were negative. Elastic fibres were found in the sputum and the culture of the sputum showed the presence of dominating organism to be micrococcus catarrhalis. 45 grams o urotropin per day seemed to control the odor of the sputum. The temperature was septic in type throughout. Vital capacity remained stationary at about 3,300 cc. During his stay X-ray plates have shown the progressive walling off and confinement of the abscess. Beside urotropin, postural drainage and the mercury vapor quartz lamp were used in treatment. An unsuccessful attempt was made on Oct. 10th and 11th to induce an a.p.t. Failure was due to adhesions. On Oct. 20th, the patient had hemoptysis of about 30 cc following slight coughing spell. He was transferred to the Lenox Hill Hospital for bronchoscopic treatment.

Follow-up. January 28, 1925. Patient coughs out 450 cc daily, receiving bronchoscopic drainage once a week. Has gained in weight and feeling well.

Summary of the clinical course: This case beautifully the negative signs in regard to the cavitation, while the patient was expectorating characteristic sputum in quantities and the Roentgenogram showed every step of cavitation. On Fig. 21 there was well localized large cavity shadow filled with pus. In comparing our physical signs with these Roentgenographical findings, we naturally wonder why, it is not brought out in the physical examinations. Careful anatomical and physiological examinations will however satisfy this interrogation. This matter is fully discussed in the section of physical signs.

X-ray Considerations. Fig. 9 and 10 taken August 30, 1924.

This was taken in prone position. There is some difficulty in the interpretation of the dense shadow occupying the middle two-thirds of the right lung, whether it is a pneumonia or lung abscess and it is more difficult to state whether this middle lobe is involved or not. According to Wessler and Jaches (46), an isolated pneumonia of the middle lobe is extremely rare. Its shadow in the dorso-ventral direction, which is best adapted to bring it out, is characteristic. (Figs. 158 and 132). It is not improbable that it occurs more often in association with disease of the lower lobe in which case it merges with the shadow of the lower lobe pneumonia and is correspondingly modified. However, on close observation, there is a large elongated central area with irregular indistinct edge, whose density is of a less degree than the rest of the shadow. The density suggests confluent broncho-pneumonia. At the axillary region it ends in homogeneous haziness, representing an indurative lung. There is a thickened interlobar pleura running across this density. This is probably a lung

abscess involving the upper lobe. Costo-phrenic angle is clear, both diaphragms are highly situated, this was taken before the patient took in a full breath. It is of interest to observe how the shadow evolves later in the course. Sometimes when the surrounding induration becomes less, and with the patient in erect position it may be possible to obtain a fluid level.

Fig. 11 and 12. September 3, 1924.

Stereoscopic films taken in prone position. Here the density is less than that of previous occasion and offers better situation for inspection. The rarefied central area amid the density observed in the previous film (Fig. 9 and 10), now appears to be honeycombed, which may represent many ill defined small cavities grouped together. One at the root and the other at right upper corner are more distinct. Periphery to this, the shadow is slightly more dense, and uniform indicating exudative inflammation. The lower portion appears to be mottled which may be caused by groups of broncho-pneumonic areas and bronchioles with thickened walls. The picture as a whole indicated that the reactive inflammation is becoming less, while sloughing has taken place in central area.

Fig. 13 and 14. September 11, 1924.

Taken stereoscopically a week after the previous film, in prone position. The shadow on the right is much less dense than previously and presents a similar picture as that of a resolving broncho-pneumonia. The honeycomb appearance here is not so clear. The rarefied areas with indefinite irregular edge noticed in previous film are not less distinct, although somewhat enlarged. These are not cavities, but groups of the broncho-pneumonia, because if they are cavities they ought to be more distinctly shown by this time, with perhaps more inflammatory surrounding areas. One at the root, between 6th and 7th rib, limited above with irregular line and ending in illdefined density below is more suggestive of a cavity. If this was taken in different positions and at different angles a fluid level would have been shown.

Fig. 15 and 16. September 26, 1924.

Taken stereoscopically two weeks later. The density at the axilla is somewhat more increased than in previous films. There is practically no change at the root. At the right lower corner of the shadow, however, there are many circular shadows, and as we go a little more carefully, we notice many small circular spot. These are evidently peribronchial infiltrations.

Fig. 17 and 18. October 2, 1924.

These were taken in three positions, one in ordinal prone position, one in lateral erect position, and one in antero-posterior erect position and the other in oblique erect position. The prone position, Fig. 17 and 18, shows similar picture, the irregular density or which I term "geographic mottling," and no evidence of actual cavity. Fig. 19 and 20 in erect position, shows a definite cavity near the root with a fluid level. The outline of the cavity is irregularly triangle and hazy. The small rounded shadow in the center of the cavity at the root of 6th and 7th rib as shown in prone position (Fig. 17) is not seen in Fig. 19, taken in erect position. Such shadow is produced by collection of exudate in the bottom of the cavity. Indistinct outline of the cavity and the general haziness are due to the presence of fluid intercepting the rays. The erect position also brought out hazy circular outline between 5th and 6th rib at the axilla, with probable fluid level. This may be interpreted as pleural shadow but it is indicative of cavity because in the next film it is shown as growing much

larger and increased in density. Because of the haziness of the shadow in prone position, it may easily be overlooked. Below the annular shadow described just above, there is a triangular shaped density indicating the lung tissue soaked with pus in its depending position. The cavity at the root is now smaller but more distinct, on account of the fact that the fluid contents of the cavity have settled at the base. There is a distinct fluid line at the lower portion of the whole mottling area with ill defined irregular cavity boundary above. Here again the dependent portion has triangular shaped density due to the sagging down of the pus.

No assistance given by lateral position, (Fig. 21), but left oblique erect position (Fig. 22) gives triangular shaped cavity with fluid level against the spine between 6th and 8th thoracic vertebra, with more marked density below. Its upper angle may be the communicating point with the bronchi. The cavity at the axilla observed in Fig. 19 is not seen in this film.

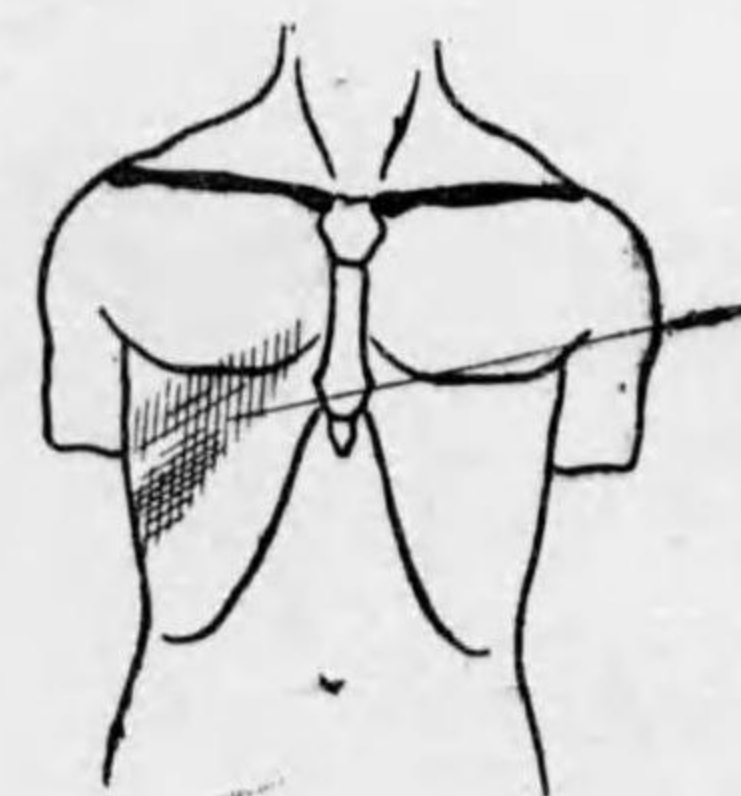
Fig. 23 and 24. Taken stereoscopically in prone position on October 16, 1924 or two weeks after the previous film, shows advancement of the cavity towards the axilla. It is a clear cut oval in shape and appears as if sacculated, although it is no. The cavity may become more distinct if taken in erect or in lateral recumbent position. The mottling at the root region is in much less degree, although there is still some honeycombed appearance. The cavity in the lower portion has cleared up, the rest of the region is that of resolving pneumonia.

#### Summary of radiography.

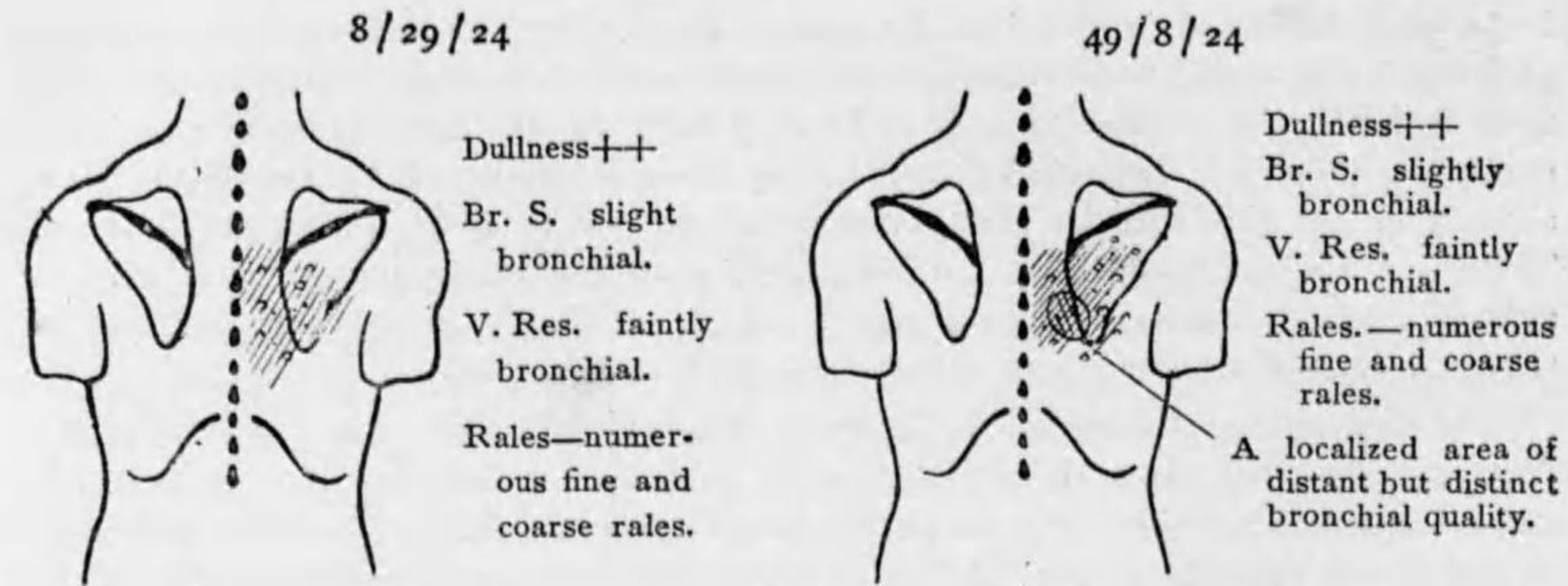
Early picture showed diffuse pneumonic process with increased density at the right root. Later, outer pneumonic area much diminished and here the root one could observe irregular cavity formation. Still later, outer area became more infiltrated and a few small cavities appeared. Finally a large filled isolated cavity at periphery, while there was tendency of healing in the medial portion.

Sam. Nathanson — I.

August 29, 1924.

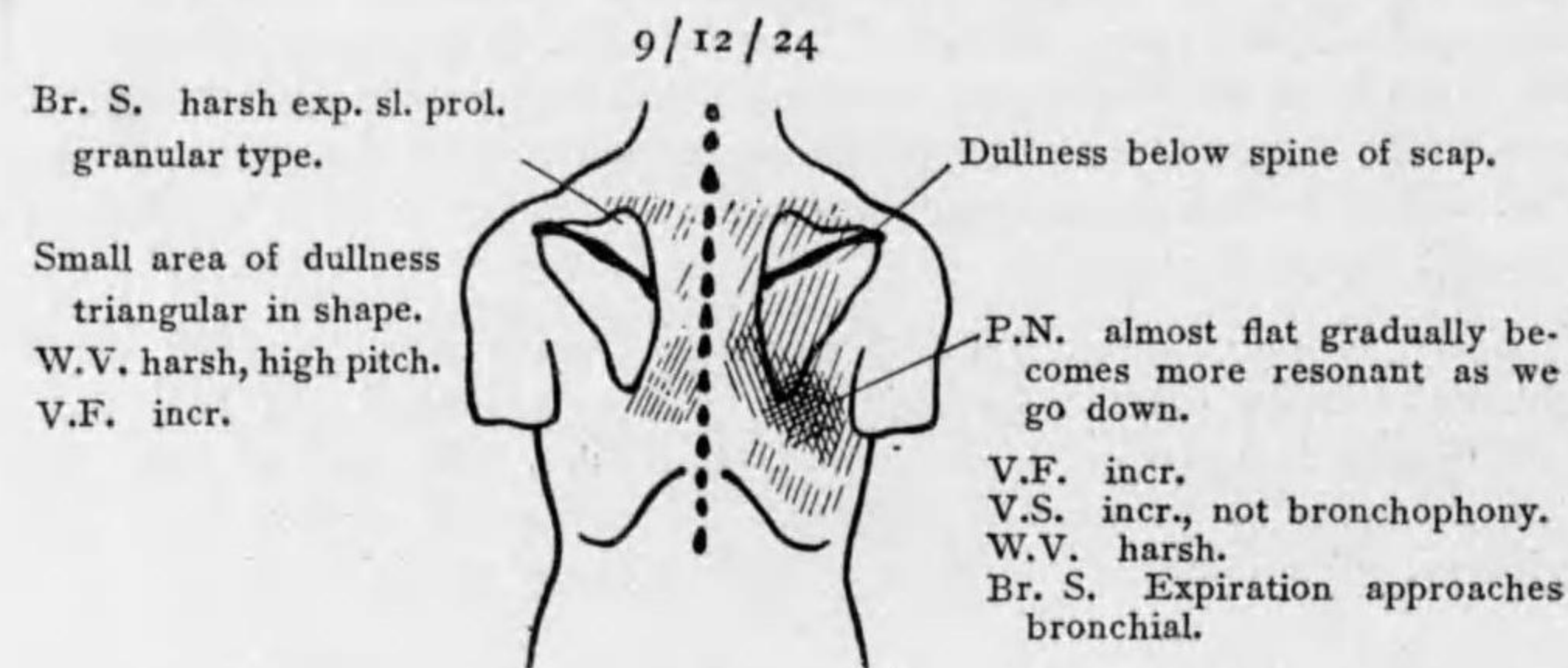


Dullness +  
Br. S. sl. dim.  
V. F. sl. nasal quality.  
V. Res.  
W. V. faint, high  
pitch.  
Rales few med.

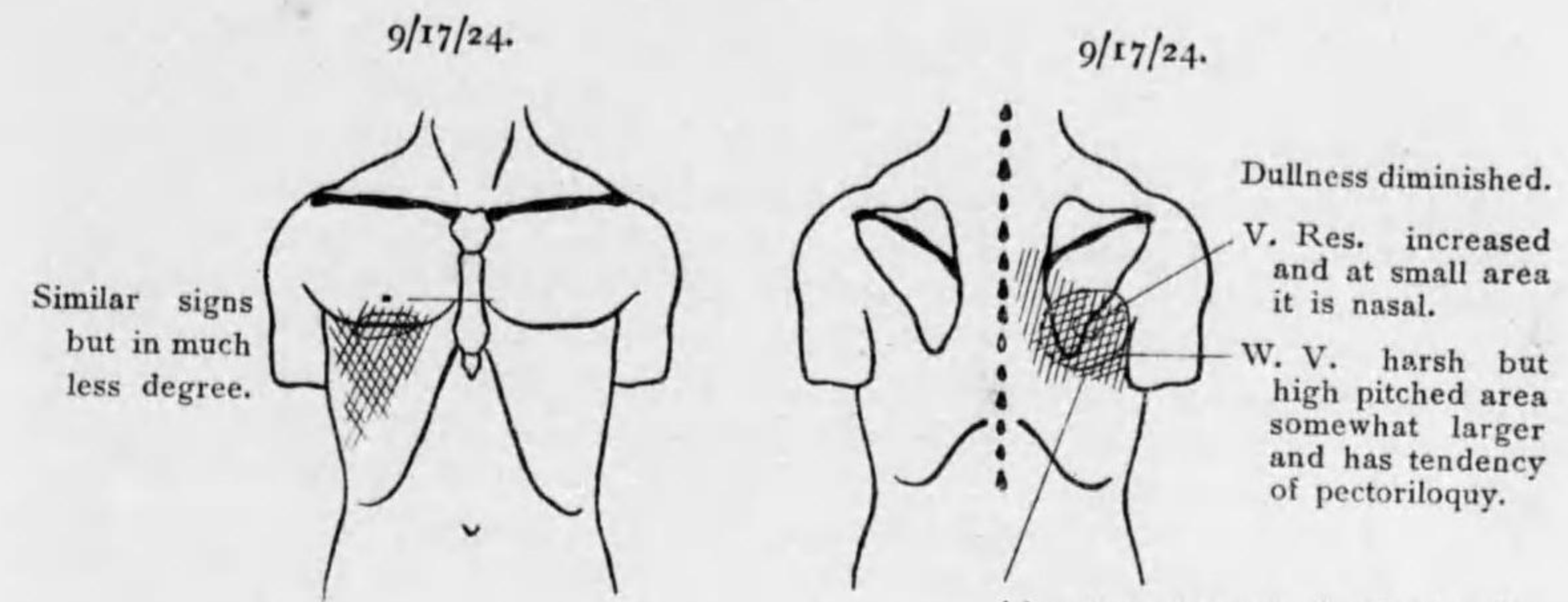
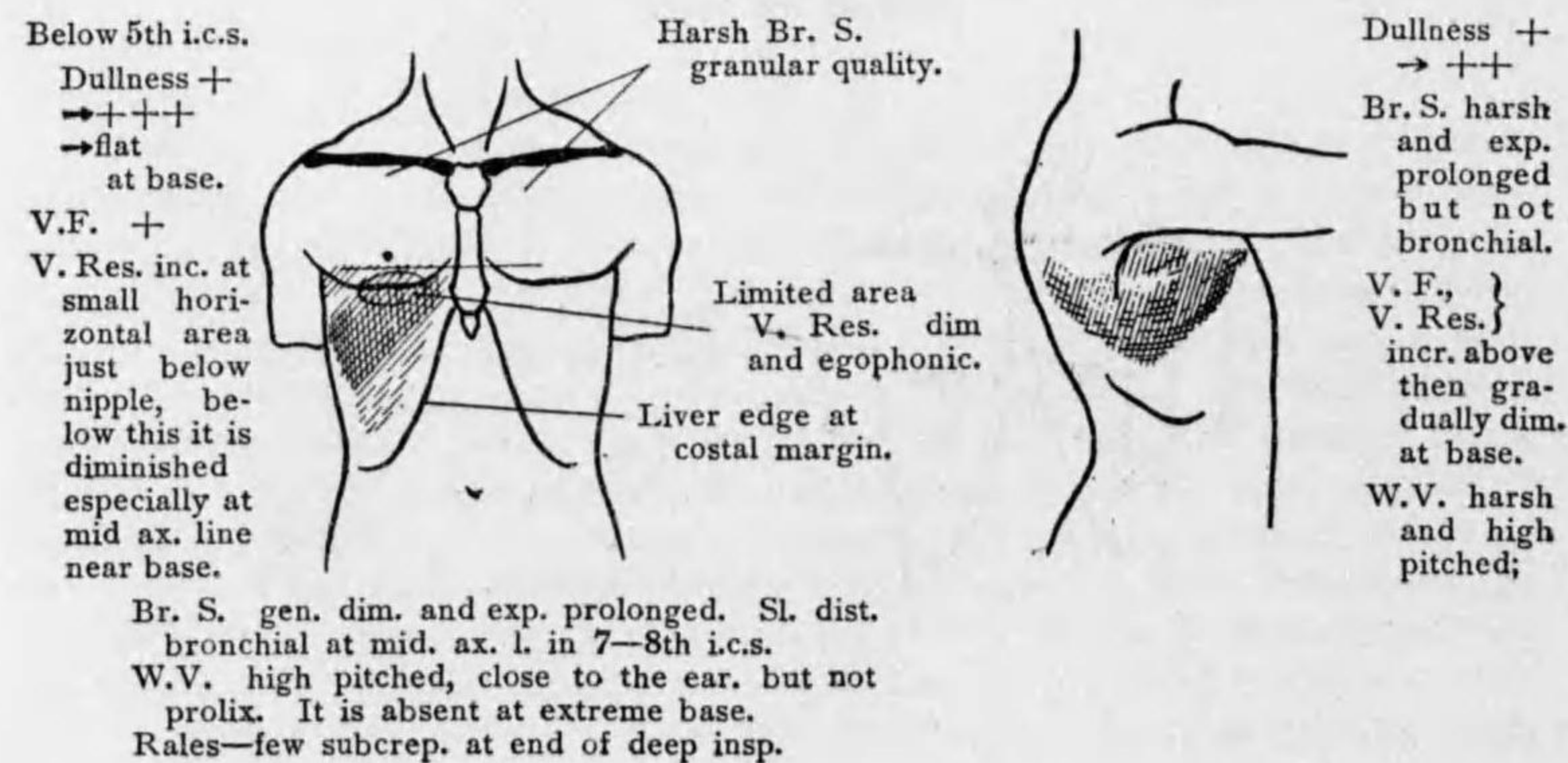


8/29/24  
 Gen. Cond. of Pt. good.  
 Large quantity of sputum,  
 fingers beginning to show  
 clubbing.

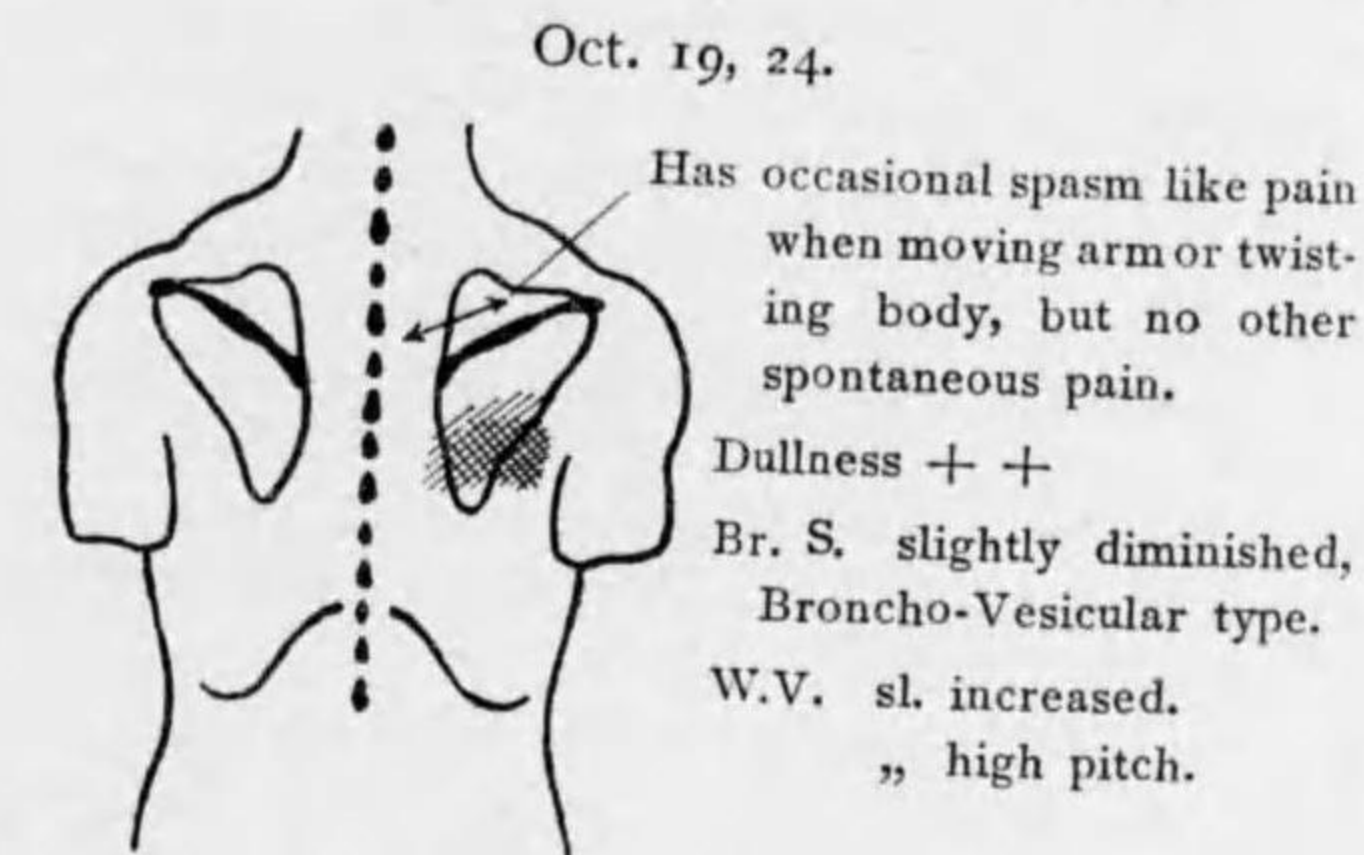
49/8/24  
 W.B.C. 35,750  
 Poly 84%  
 Sput. Cult. Micrococcus Catarrhalis  
 as predominating organism.



Sam. Nathanson—II.  
 Sept. 12.

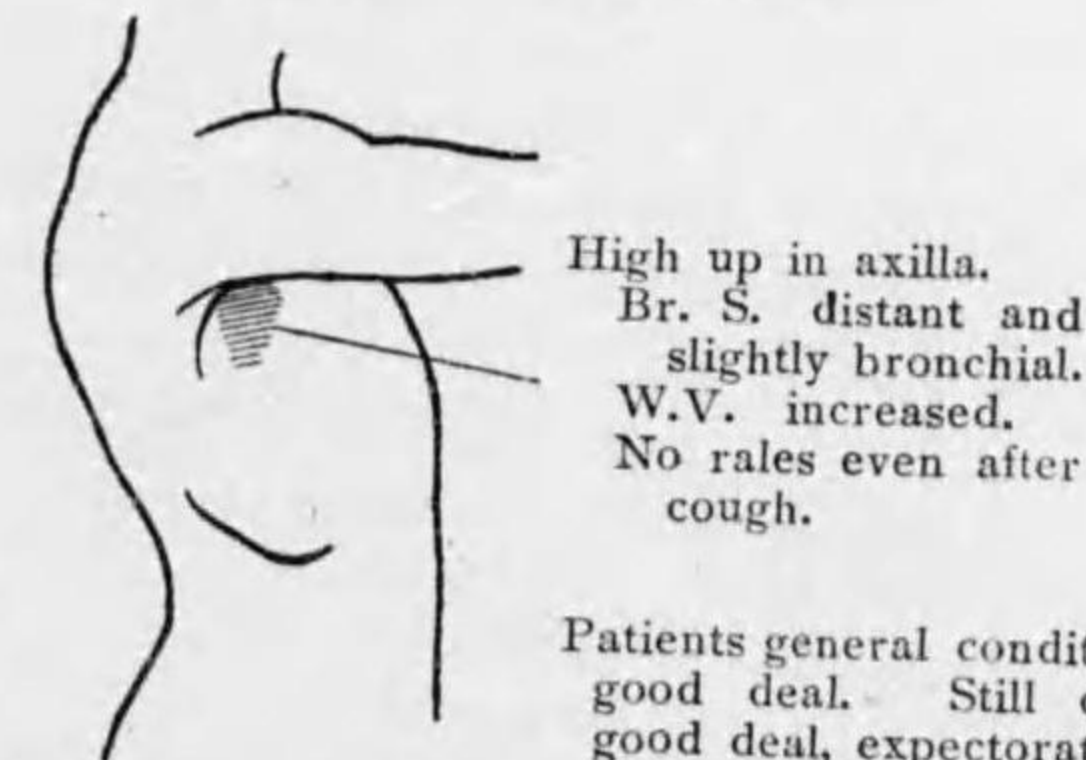


9/17/24.  
 After forced cough, Inspiration Br.  
 S. is more bronchial and some-  
 what shallow in quality. Only few  
 rales.



Oct. 19, 24.  
 Has occasional spasm like pain  
 when moving arm or twist-  
 ing body, but no other  
 spontaneous pain.  
 Dullness ++  
 Br. S. slightly diminished,  
 Broncho-Vesicular type.  
 W.V. sl. increased.  
 „ high pitch.

Sam. Nathanson—III.  
 10/19/24.

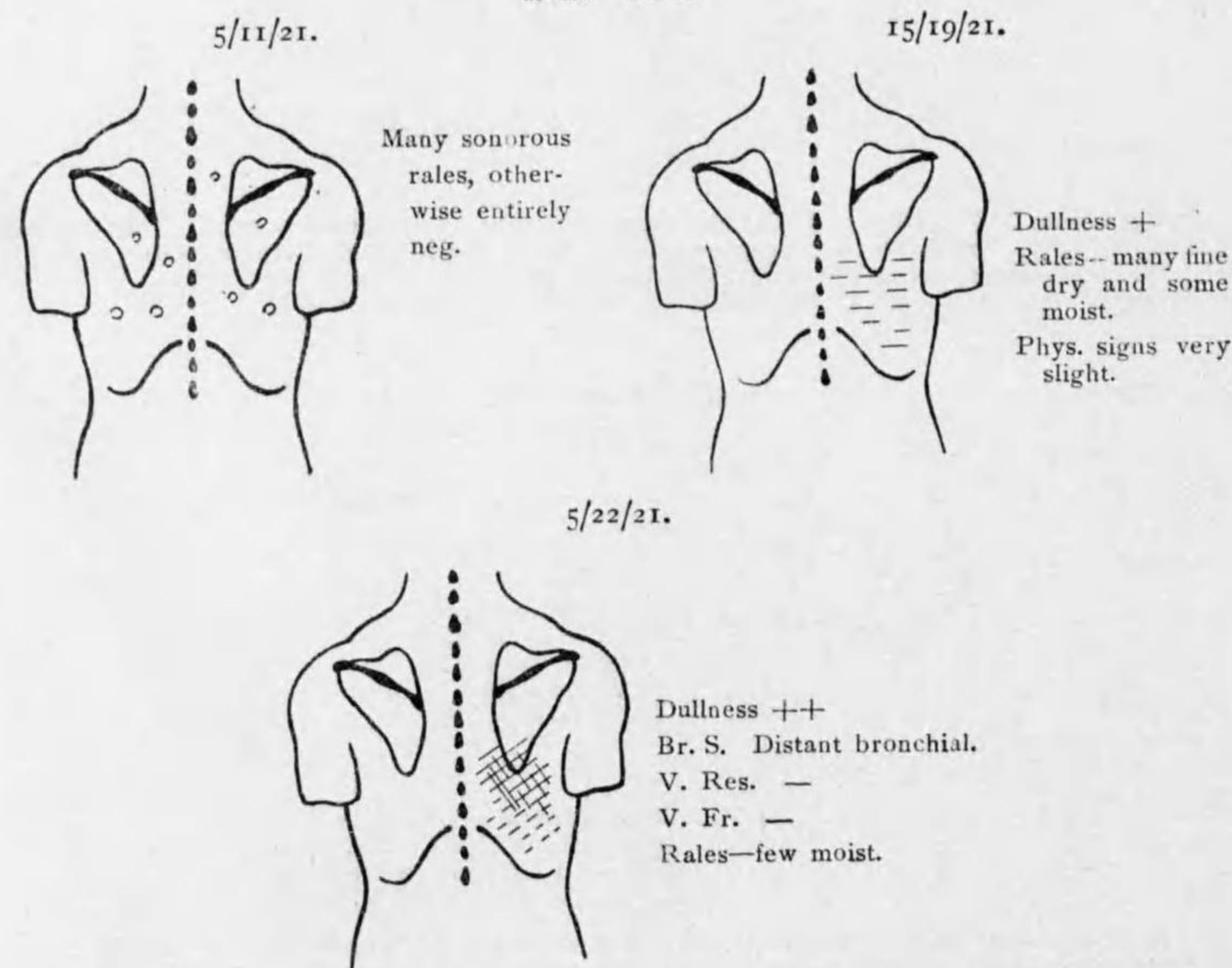


Patients general condition is very  
 good deal. Still coughing a  
 good deal, expectorate freely in  
 large amount, Pulse 108, T. 100 F.  
 Impression, Oct. 19th, No signs of cavitation whatsoever. Signs at high up in axilla, and  
 over the scapula indicate only presence of indurated area in the periphery of right upper lobe.

Case III. L. F.

Italian aged 45, stone mason for last thirty years. Admitted to the hospital on April 20, 1921 for pain in epigastrium and loss of weight. X-ray and fluoroscopic diagnosis established gastric carcinoma. His lungs signs on admission, were, slight dullness and slight high pitched harsh breathing over left apex with somewhat increased vocal resonance and a few mixed moist rales throughout both lungs. On April 30, 1921, he was operated on, gastro-jejunosomy being done; time one hour and 40 minutes; pathological finding was adeno-carcinoma. P.O. Course: wound of operation showed tendency of rapid healing, appetite increased and bowels were regular. Ten days after operation, however, there was a sudden rise in temperature associated by cough and pain on right side of his chest. On May 11, the lung signs were, many sonorous rales scattered on both sides, but no signs of consolidation. On May 19 temperature still elevated, wound was O.K., there was much cough and purulent sputum with offensive odor. On May 20 fluoroscopy showed a suspicious lesion of lung abscess, but the physical signs were very slight. On May 22, area of moderate dullness at angle of scapula with diminished breath sounds were obtained for the first time. The temperature at this period varied from 100 to 104 F. On May 27 patient received first a.p.t. treatment which was followed by expectoration of bloody mucus. After subsequent a.p.t. he had several bloody sputum; the cough was increasingly worse. Finally patient became very restless and ceased to breath.

Louis Fico.



Comment: This case of lung abscess appears to have originated on infarct. No metastasis in the lungs could be seen on the X-ray film. The a.p.t. seemed to work well on the cavity at first, the final cause of death may be attributed to infectious toxin and myocardial failure. Blood culture was sterile.

Fig. 25 and 26, taken in prone position on May 11, 1921, when patient having pain, cough and temperature. Notice there is very little to be seen here, except moderately thickened and suspicious area at the lower part of right hilum. There is also slight pneumonic shadow at periphery (atelectatic?) The "rainy" appearance is due to patient's breathing. There may be a little congestion at the base.

Fig. 27 and 28, about ten days afterwards, taken in erect position just after when patient commenced to expectorate a lot. At the side of lower hilar region, which was suspicious in previous film, there developed a large cavity, with fluid level and with mild induration around.

Fig. 29-30, taken on June 1st, 1921, after the first treatment of a.p.t. instituted. Notice the remarkably compressed cavity which is being divided by fibrous septum formation. The lung is very well compressed too, few adhesions on the thoracic wall and the diaphragm; heart is pushed toward the left. There is very slight induration around the cavity.

Fig. 31, erect, June 3, 1921, similar picture, the cavity is seen only as a narrow fissure.

Fig. 32-33 erect position, June 4, 1921, most part of the upper lung is compressed to a small rounded faint shadow, showing that there is very little fibrous adhesion. The lower lobe is somewhat fibrosed and several adhesions are seen. Within the central dense area a faint small cavity with smooth hazy outline is seen.

Fig. 34, erect June 6, 1921, after 6th a.p.t. Similar shadow as before. The lower lobe is more aerated. The cavity is not seen here. The left lung markings are not increased. The left border of the heart is displaced to the left, its conus region appears more bulging.

Fig. 35-36. June 7, 1921, same as before. A faint narrow shape of cavity is seen on top of the rounded shadow of the lower lung. Why the patient died in the next few days cannot be explained, while he seemed to be getting along very nicely as far as X-ray indicated. It might be possible that increased pressure on the vagus and aorta had some effect on the heart which was already suffering.

Summary of Roentgenogram. The abscess started in hilar region and later occupied lower lung field indicates aspiratory nature. These films also show remarkable compressibility of the lung by a.p.t. and its effect on the cavity. The latter physical signs were obstructed by the pneumo-thorax. It is to be greatly regretted that the patient did not respond well to the treatment. As a matter of fact the outlook for the patient from the beginning was very poor as the nature of the operation indicated.

Clinically it was suggested that the abscess started on infarct, but Roentgenologically it is more of aspirated character.

Case IV. V. L.

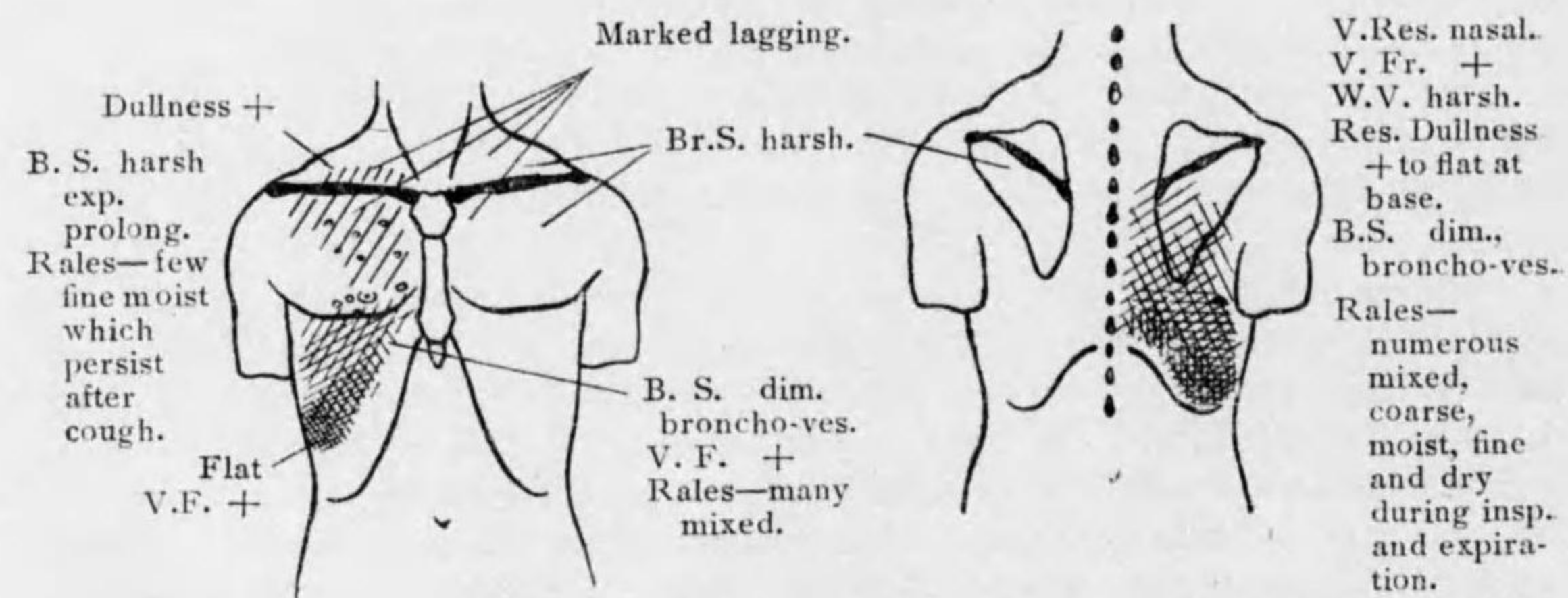
U.S. white porter aged 46, admitted to the hospital on December 14, 1921 with the chief complaint of cough and expectoration of foul sputum. Family history was negative as well as his past history. Present illness: five weeks previous to admis-

sion, he began to be very sick with "Pneumonia" and he had been in bed ever since. During past three days raised quantities of foul smelling sputum, but did not notice any blood in it, loss of weight, 15 pounds. On inspiration, patient appeared not acutely ill, had marked pyorrhea, unclean teeth, many caries, and congested enlarged, ragged tonsils. Lungs showed, as indicated in the diagram, impression of consolidation at right lower with diffuse bronchitis. But in view of clinical symptoms, lung abscess was considered. There was no clabbing on extremities. W.B.C., 20,000, poly. 90%, Wassermann neg. Sputum repeatedly negative for t.b.c.

Course: Patient was given treatment with a.p.t. which was repeated very few days controlled by radiologic findings. Patients general condition as well as his symptoms gradually and steadily got better and he was discharged as much improved on Jan. 3, 1922. Later observation of Feb. 27 showed still better improvement, signs in chest were also better. X-ray showed considerable improvement in general appearance. There was much less induration in the right lower lobe; no liquid level, no pneumo-thorax there was thickened pleura with slight adhesion at base. Patient was again seen on March 7th, when he showed a still better improvement; the X-ray showed as well a marked change. He was not coughing, felt well, gained in weight, although he still had some fetid odor of breath. He was working parting time.

Val. Leitschue.

Dec. 14, 1921.



The Roentgenogram taken on December 15 showed dense opacity in lower two-thirds of right lung with slight infiltration of left apex, but no cavity was evidenced—film missing.

Fig. 37-38 taken four days after the previous film in erect position, shows diffuse density below level of 6th dorsal vertebra in the right lung field. The upper border of the density is horizontal and sharply defined indicating a fluid level. Over the fluid line a faint irregular arch can be made out which indicated the upper border of the cavity. There is very little reaction beyond this margin. Bellow the fluid level there is tongue like downward extension of homogeneous density representing highly infiltrated area. On the adjacent area below this density and on its cardiac side, there is a hazy mottling appearance, suggesting infiltration in mid and lower lobes. The right border of the heart can be made out with little difficulty. There are some adhesions between the base of the lung and the diaphragm. There is

also small air in costo-phrenic angle indicating the result of a.p.t. There is also slight infiltration in left apex.

Fig. 39-40 taken on December 25, 1921 in lateral prone position, patient lying on his left side. The shadow is more fibrous and less dense. Two central rarefied areas are seen, the upper one is much fainter, no visible fluid content. The pneumo-thorax is a little larger than previous, and there are numerous basal adhesions. There is also evidence of pleural thickening and adhesion at left apex.

The later film taken on Feb. 27, 1922, which is missing, shows considerable improvement in appearance; right lower lobe less indurated no liquid level, no pneumo-thorax, there is some thickening of pleura at base.

Summary: Large cavity with fluid level; intense induration involving mid and lower lobes; rapid tendency to fibrosis and disappearance of induration. These pictures suggested that the abscess was more aspiratory type, while the pneumonia was not confirmed.

Case V. D. G.

Artist, Australian, aged 51 admitted to the hospital on Jan. 3, 1923. His family history as well as his past history were negative, except diabetic history for last three years during which period he never got free of sugar.

Present Illness: About for days before admission, he got some acute respiratory infection and seemed to have been very ill. On the morning of admission he became comatous, which was apparently due to diabetes, and from which he gradually came out. In the breath there was acetone odor. There was extensive pyorrhea and the pharynx was generally congested. The neck was slightly stiff. Laboratory findings: Urine showed sugar 2%, acetone 2 plus, diacetic acid, one plus; blood, W. B. C. 22,800, poly, 83%, hgb. 91%, Wassermann negative, CO<sub>2</sub> capacity, 32.8 volume, urea N. 11.5 mg per 100 cc blood; blood sugar .3%; temperature 101, R. 20 and pulse 96.

Course: Patient coughed persistently and expectorated large amount, treatment by dieting and Iletin 5 units every three hours. Complained of intense pain on the left side. The chest signes became increased and the condition became worse and died on January 19, 1923, or within 3 weeks since the onset of the disease.

His Roentgenographic findings:

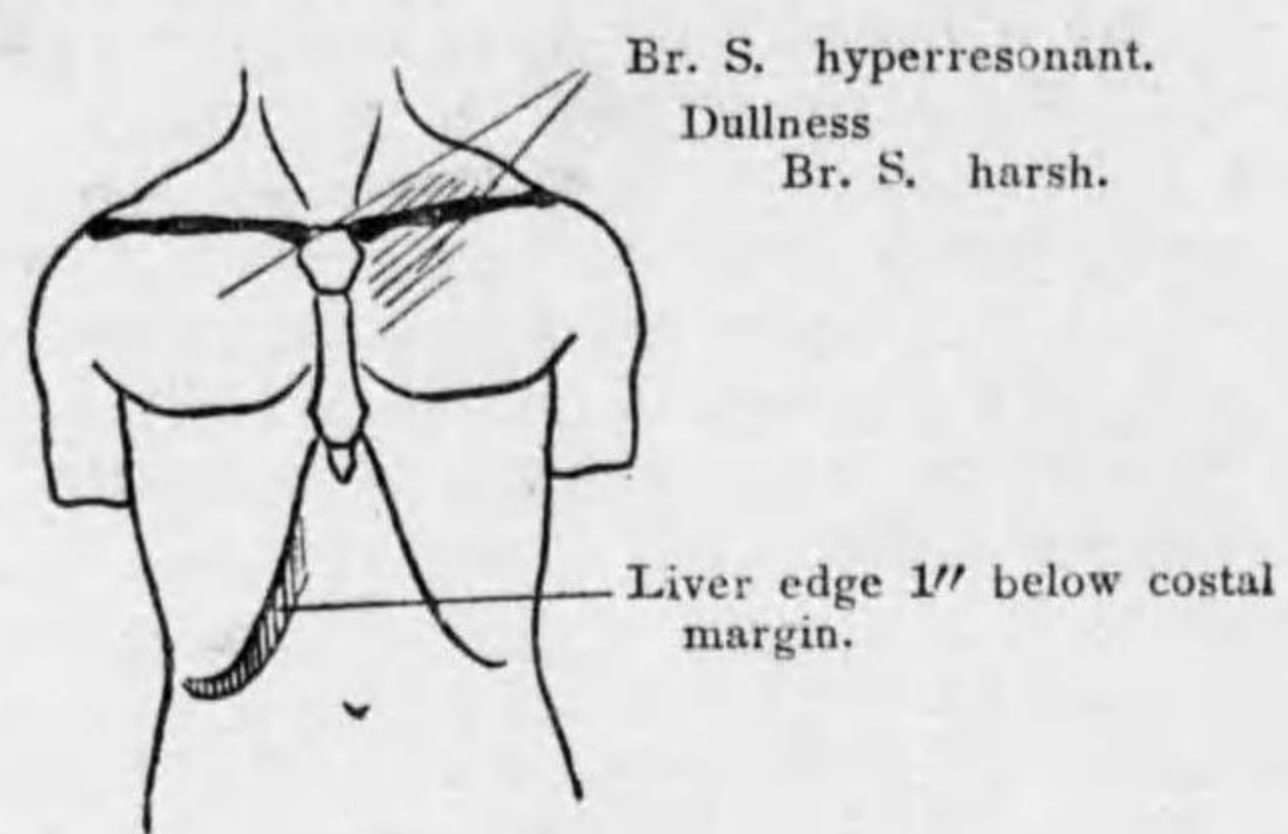
Fig. 41-42. January 5, 1923, in prone position. Left lung field shows increased lung markings with haziness at apex. Left diaphragm is high. The lung markings on the right side also increased more suggestive of engorgement. The shadow at the left apex suggests infiltration however no consolidation. The characteristic crescent appearance and the bulging outward of the left root shadow with the abnormal high position of the diaphragm suggests obstruction in the bronchus. Physical signs with hyperresonance emphysema.

Fig. 43: taken on January 11, 1923, prone position, or 6 days after the previous. Original film missing, only diagrammatic copy of the film is presented here. Left chest generally hazy slight infiltration in left apex. At mid-one-third, there is a liquid level, indicating gas or air and liquid, probably lung abscess. At its lower position, there is dense indurated area.

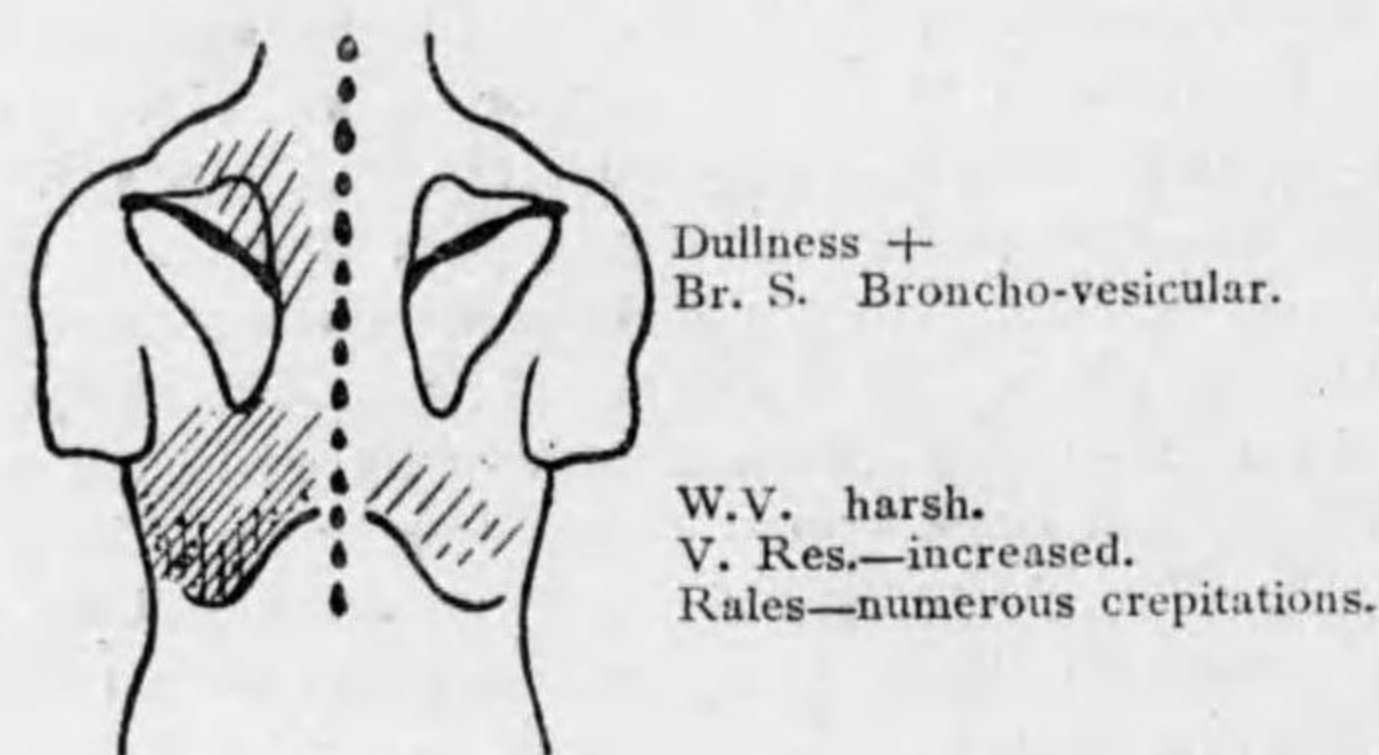
Comment: In comatous state patient is apt to aspirate infected material or foreign bodies. In this case, with early X-ray suggesting emphysema and appearance of destructive process at rather a characteristic position, it is plausible that this patient had lung abscess due to aspiration. In diabetics, the destruction takes place rapidly.

David Goodman.

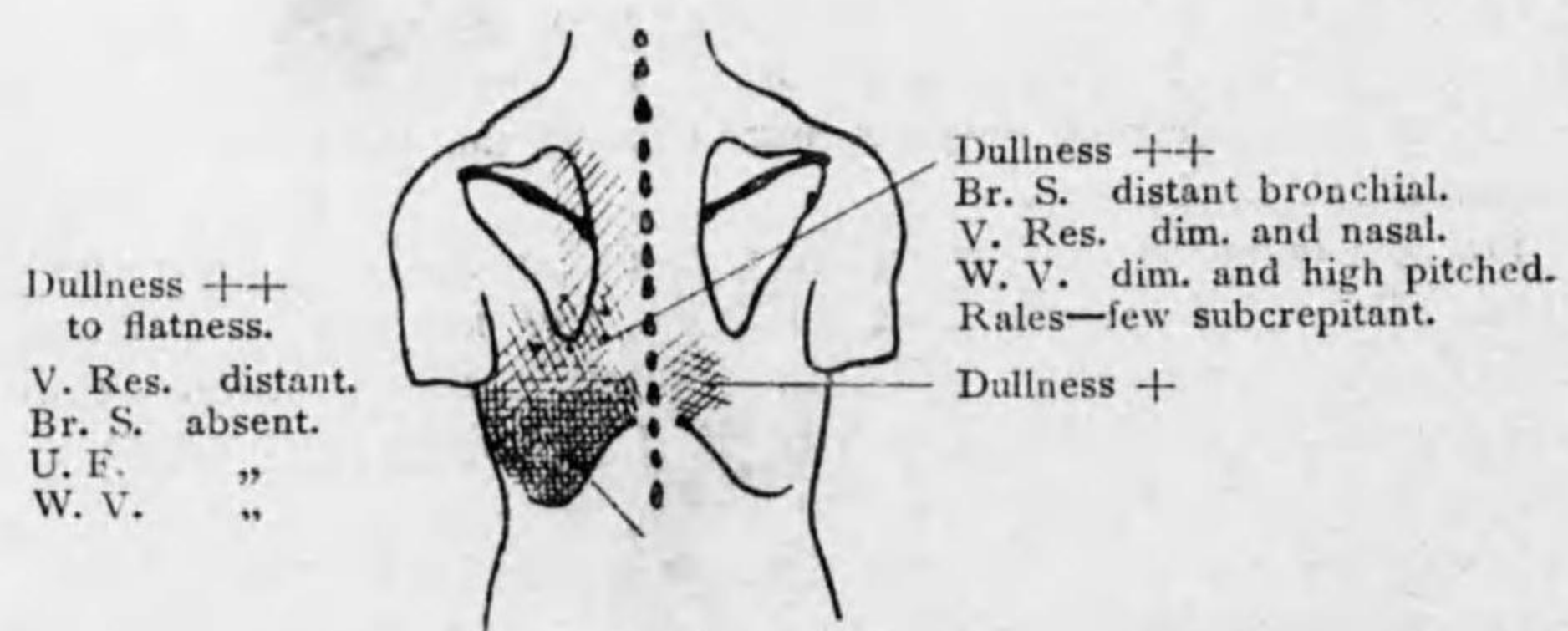
Jan. 3, 1923.



Jan. 3, 1923.



Jan. 10, 1923.



Thoracentesis—Sero-sang. fluid culture showed green producing streptococcus.

Case VI. E. K.

Hungarian laborer aged 31, admitted to the hospital for fractured tibia and fibula on Feb. 1st, 1921. His family history as well as past history negative.

Present Illness: While working on tow boat he has caught in tow line and thrown over board on the morning of admission. He swam in icy water for twenty minutes with loss of large amount of blood. The next day he was operated on, which consisted of amputation of leg for gas bacillus infection. He had rapidly declined due to toxemia, sudden rise of temperature, anxious expression and definite "mouse smell" from the wound. Fine crepitation was noted throughout the whole leg. Lung clear on admission, blood Wassermann 2 plus. Blood culture sterile for 9 days, specimen of amutated leg showed bacillus. On 9th day p.o. there was sudden rise of temperature, pain in the chest and coughed by bloody sputum. Most probably he had pulmonary embolism. Breath became foul, expectorated quite much. X-ray showed lung abscess. Patient died on March 3 or thirty days after accident and amputation of leg.

Summary of the history:

This is not a type of submersion lung abscess because it was rather late in appearance. Sudden pain in the chest, rise of temperature, associated with bloody sputum suggest more embolic nature.

Fig. 44-45, Feb. 14, 1921, in spine position. Hazy shadow in lower two-thirds of right lung, with circular rarefied area at base. Within this rarefied area, irregularly mottling dense area is seen, which suggests destructive lung area with much infiltration and some part already sloughing off. The outer and upper homogeneous haziness is due to re-active pneumonia. The rounded rarified area cannot be diagnosed at present as a cavity because it has no density below, no fluid level and no definite outline.

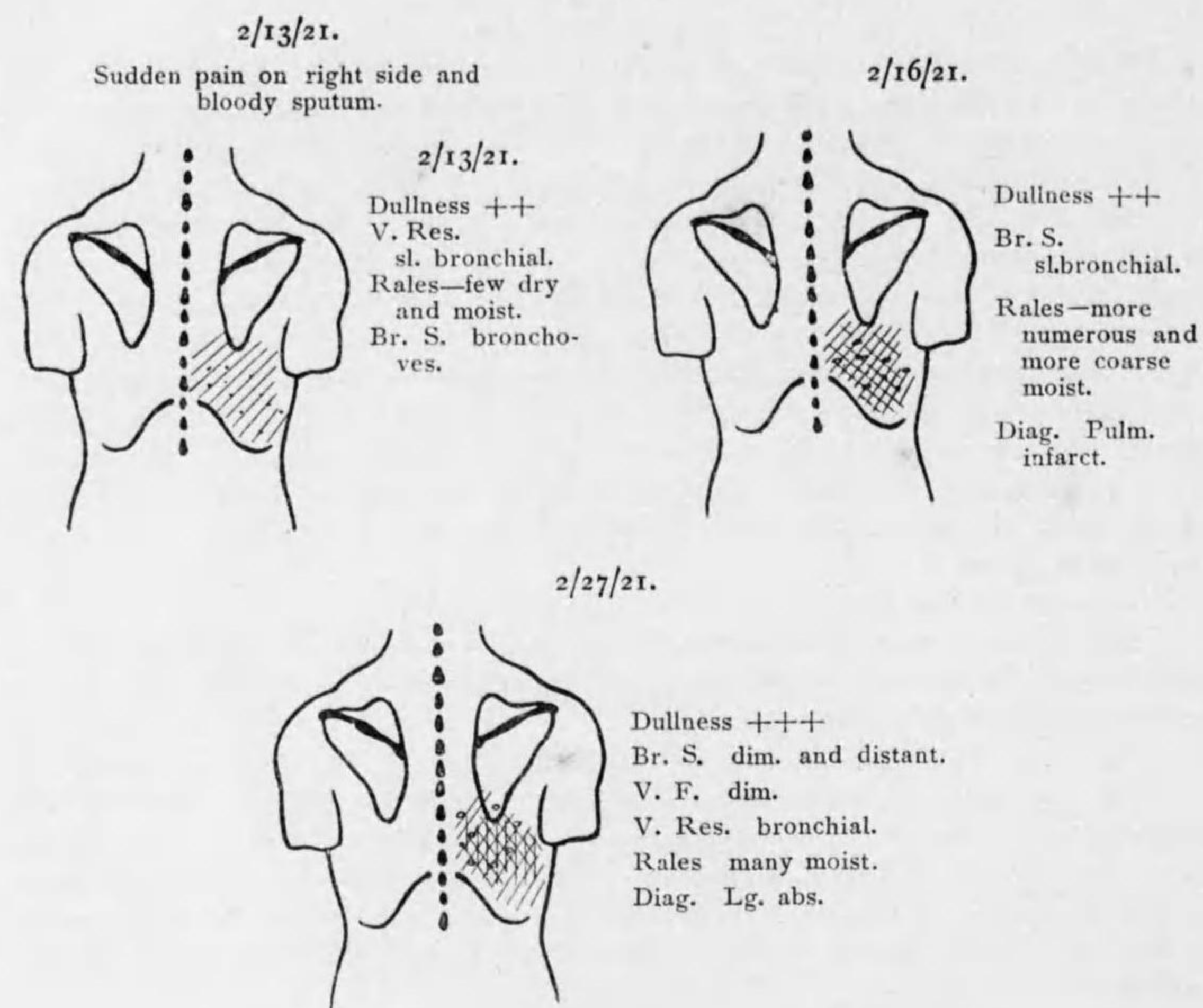
Fig. 46-47, taken nine days after the previous one. The general pneumonic shadow is increased in its density. There is some change in the rarefied and mottling area at base. Now we see a definite rounded cavity shadow at base and now nearer to the costal wall. Its basal portion is very dense, fluid level can be seen. The difference between the two films, taken nine days apart, and the one represented in figure 46, may be explained by (1) the mottling in the previous film was chiefly produced by irregular infiltration, (2) more diffuse induration in 2nd film obliterated some scattered "softened area" (3) a group of small cavitations became confluent in the latter picture (4) the latter picture suggests more cavity as it is definitely rounded, limited below by very dense area, and the shadow persists in the later films.

Fig. 48-49. Two films, one taken in full inspiration and the other taken in full expiration. These were taken on March 1, 1921 or six days after ths previous one. There is practically no change in the height of the diaphragm on either side or in the position of the cavity in these two pictures. This is probably due to inhibition on respiratory movement. In the film with full expiration, the cavity shadow is more distinctly shown.

Post mortem findings: There was a large cavity in right lower lobe. The mid and lower lobes presented many other small cavities. There was isolated pneumonitis in upper lobe.

Conclusion: The lung lesion was due to primary infarct and metastatic infection.

E. K.

**Case VII. B. N.**

Italian aged 26. Admitted on September 21, 1923 with the chief complaint of severe cough and expectoration. Family history and past history negative.

Present Illness: He had tonsillectomy in May, 1922, or sixteen months previous to admission. Ten days after the operation, he commenced to cough and raise foul smelling sputum. Ever since he had periodic attacks of cough and expectoration of large amount of such sputum. In all he had about 4 or 5 such attacks during past sixteen months. He would feel bad for one or two weeks preceding such coughing spells and would feel very much relieved after expectorating. He was treated for tuberculosis by local physician. The physical findings on admission, were as follows: he was under-nourished, fairly well developed, appearing chronically ill, voice was hoarse, breath foul, showed marked clubbing of fingers, moderate lagging on the left chest. Heart, apex not palpable, the left border in 5th i.c.s., 12 cm. left of medium line, first sound loud clear and regular, rate 80; temperature 99-100, respiration 22-24. Signs in chest, as indicated on the chart, showed definite cavitation. Sputum about 100-200 cc. every day, sometimes bloody. Culture showed pneumococcus type IV, and micrococcus catarrhalis. W. B. C. 7,800 and poly. 70%.

Course and treatment: Patient was given postural drain and several a.p.t. at three or four day intervals. After some of the treatments, he raised increased amount of sputum. Condition improved and patient was sent away to the country on November 7, 1923. Since patient left hospital he coughed very much and raised as much as before and he came back for treatment. On November 15, 500 cc. of air was given and he was sent home. On November 30 fluoroscopic examination showed abscess increasing in size, lung about half-way compressed and fluid in left lower pleural cavity. Patient continued to cough up great quantities of sputum and had a pain in the chest. He was re-admitted on December 4, 1923. Fingers much clubbed, nails were large and had "watch crystal" formation. Since last treatment by a.p.t. patient did not do well he developed pleural effusion, and therefore no more a.p.t. was given. December 10th succession splash obtained over left lung. Sputum 100-150 cc. p.d. Surgical interference was suggested but patient refused and went home. On March 30, 1924, patient reported that he was very ill. June 8, 1924 patient was operated on at Mt. Sinai Hospital, when thoracotomy with rib resection was done, after which there was some improvement for first five weeks, but cough was about the same.

It seems that a.p.t. had ill affects on this patient.

The Roentgenographic and the Fluoroscopic Findings:

Fig. 51-52, September 22, 1923. Dense shadow occupying upper  $\frac{2}{3}$  of the left lung. Its apical region is hazy, while its lower region has indefinite margin entering in normal lung shadow. The costo-phrenic angle is clear indicating there is no pleurisy or effusion in this locality. There are pleuro-diaphragmatic adhesions. The density is most marked at the root area. There are two ill defined less dense areas, one just below the clavicle and the other in 2nd intercostal space near the sternum. These may be cavities, the congested pleura and pneumonitis around interfere with the cavity shadow. Under Fluoroscopic examination, on the previous day (Fig. 50) a moderate sized round cavity could be observed under the clavicle. One at the sternum is most likely not a cavity. Right apex shines through normally. The root shadow is quite prominent and the linear markings are increased probably due to congestive vessels. Along 8th rib on middle clavicular line, there is a small but dense round shadow, which is seen in all the other films taken subsequently. A calcium deposit in the rib at the costocartilageneous junction often shows like picture, but in our present case this is a calcified spot of old healed tuberculous lesions, because in the other films, its position is changeable in respect to the rib shadows. The heart as well as the bronchus is moderately displaced to the right side, the shadow of the latter is clearly seen as a "fishing hook" linear shadow on the right side of the vertebra.

Fig. 54-55, taken two weeks after the previous picture and right after the a.p.t. introduction. Right lung same as before, except the bronchus and heart displaced more toward right due to pneumo-thorax. Left lung: shadow in upper lobe is now less dense than on the previous film. The cavity under the clavicle is now distinctly seen, the edge is not thickened. The atelectatic upper and lower lobes are well seen as well as the adhesions to the pleura and diaphragm. Fluoroscopy (Fig. 53) showed the cavity smaller than before.

Fig. 56-57, taken October 11, 1923, seven days later. The shadow here is that of smooth density and loss of mottling appearance indicating diminished exudate.



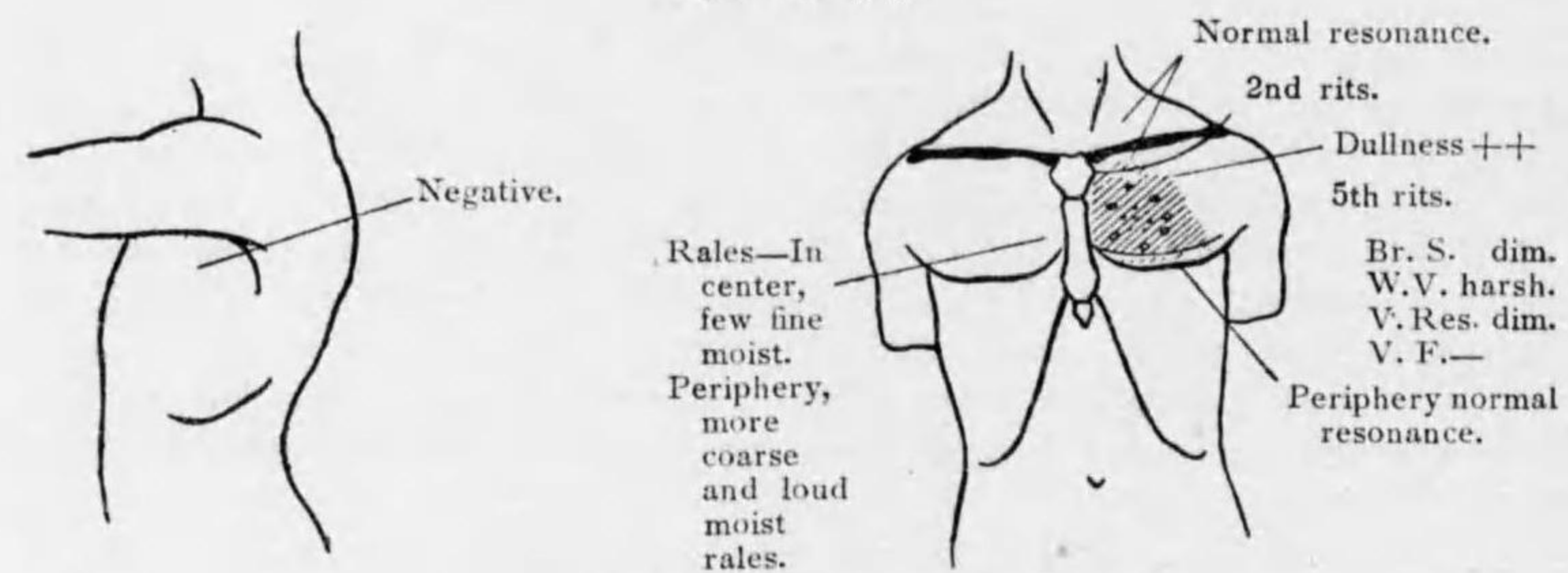
The lower portion shows a beautiful "rolled paper" with "Banian Tree" adhesions to the diaphragm. The upper lobe is not compressed due to the adhesions. The homogeneous character of the shadow indicating complete absence of the lung markings is at least the evidence that such lung markings are usually caused by pulmonary vessels.

Fig. 58-59-60, November 1, 1923, taken three weeks after previous film and after more a.p.t. Here the mediastinal structures and the heart are very much displaced to the right. The left lung is more compressed, the cavity is less distinct, but under fluoroscopy, (Fig. 58) it is observed in the same situation and smaller in size. The lower hazy irregular circular shadow is more likely to be a pleural adhesion, which is confirmed by subsequent film.

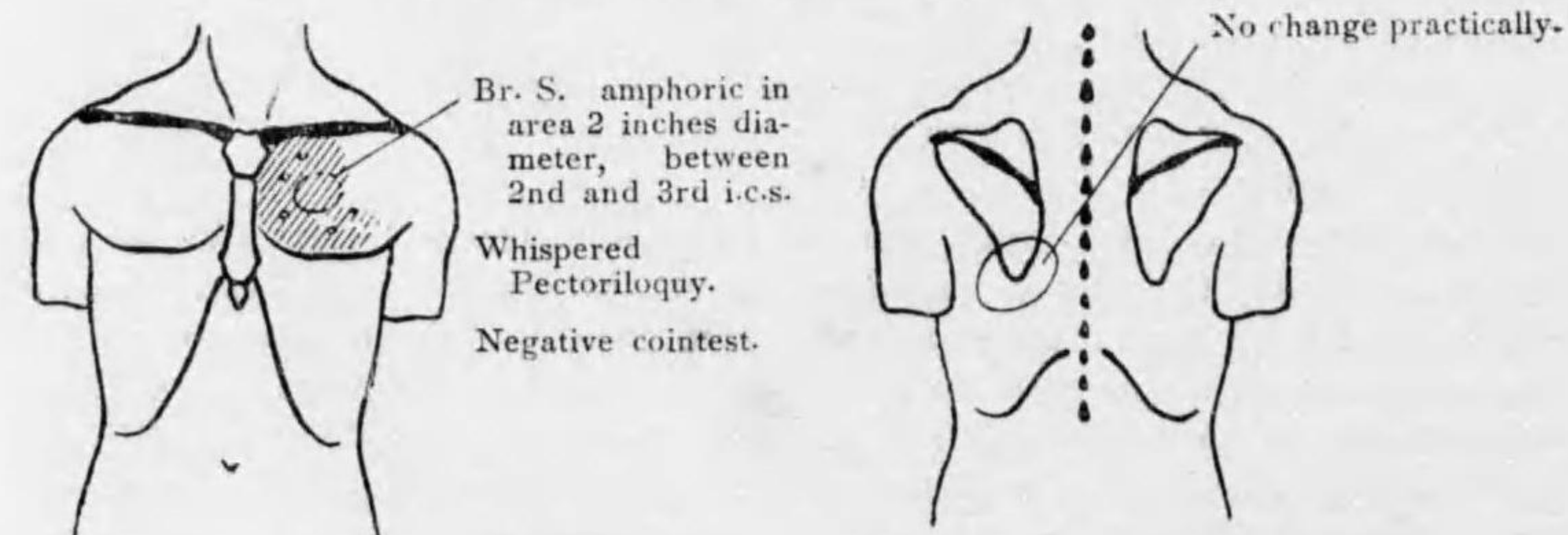
Fig. 62, 63, December 6, 1923. The left lung partially aerated. The shadow of upper lobe is shown as a triangular shape with the peak downward. The upper lobe is distended and appears thickened. At its mid portion there is a cavity with its ragged ill-defined boundary. The mediastinum, bronchus and the heart are still quite displaced to the right. The left base is horizontal indicating presence of small amount of fluid.

Bennie Nardi — I.

Sept. 21, 1923.



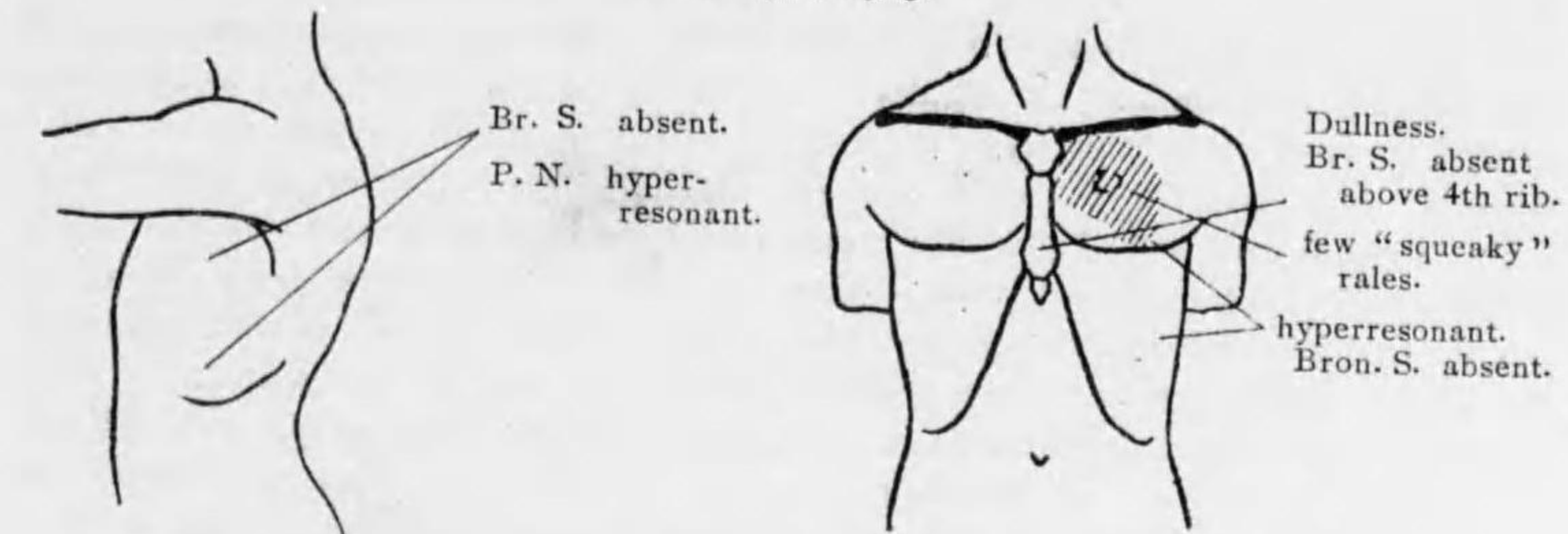
Sept. 28th.—Right after raising much sputum.



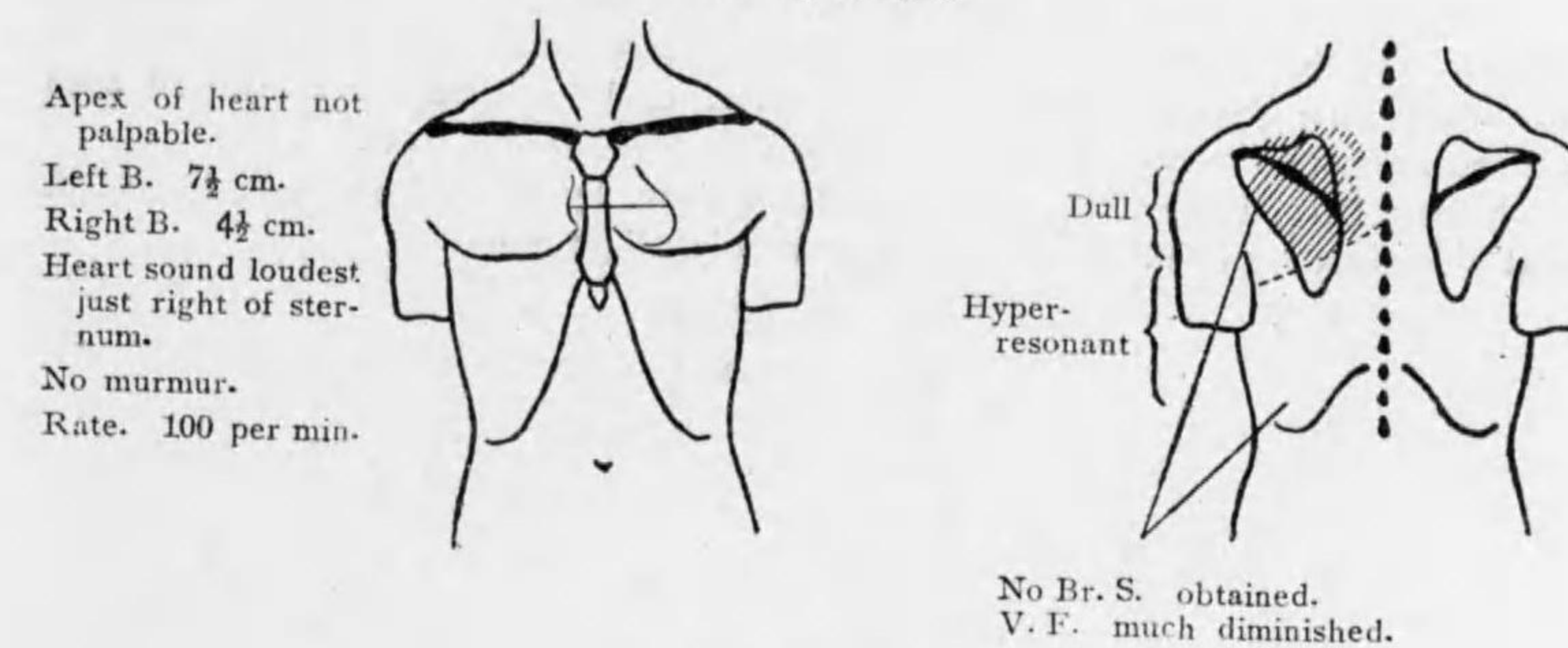
Oct. 2nd.—After active pneumo-thorax still amphoric Br. S. obtained, but only in front.

Bennie Nardi — II.

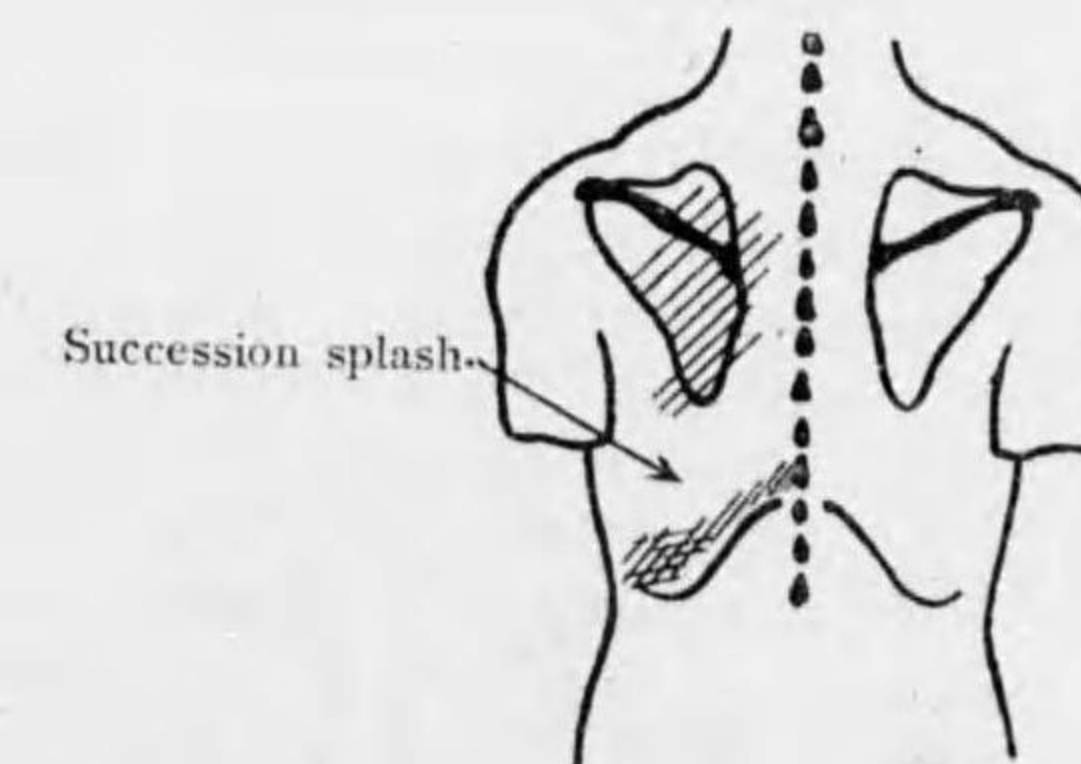
Nov. 15th, 1923.



Nov. 15th, 1923.



Dec. 10th.



The Fluoroscopic view (Fig. 61) made a few days previous to this film showed an increased shadow of the abscess, the lung was about one third compressed with fluid in lower cavity. The cavity and fluid signs were more definite under fluoroscopy.

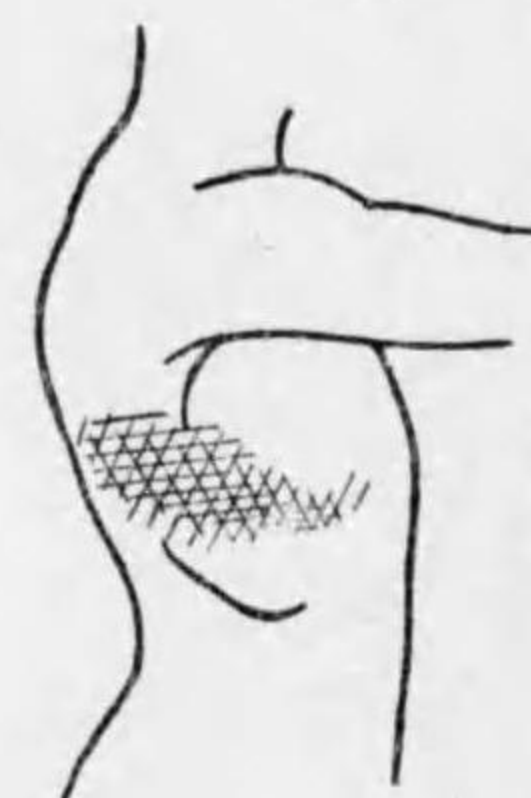
Conclusion: This was apparently an aspiration lung abscess. A.p.t. did not compress upper lobe due to the adhesion and accordingly there was not much beneficial affect on the cavity.

Case VIII. A. L.

Italian laborer, aged 36. Admitted to the hospital on September, 4, 1921 with acute seizure of a gastric pain. The diagnosis made was perforating duodenal ulcer and he was immediately operated on. The findings after the operation were: quantity of free gas, large amount of slightly yellowish turbid and viscid fluid in abdominal cavity, a round perforating ulcer in posterior aspect of the duodenum about 2mm in diameter from which there issued a steady stream of duodenal or gastric secretion. The operation consisted of closure of perforated prepyloric ulcer and posterior gastrojejunostomy. Post-operative course: There was rise of temperature from 102 to 104, but it came down to nearly normal within a week. With the rise of the temperature, there were certain changes in the physical signs of his lung as illustrated on the chart, and these were interpreted as due to lobar pneumonia. The patient was delirious and he was acutely ill indeed during the first week of his post-operative course. Then he made a gradual improvement and the temperature came down nearly to normal; the abdominal wound healed. Then on October 14, there was sudden rise of the temperature to 104, and he coughed considerably, sputum bloody. Persistent dullness, diminished breathing and appearance of moist rales plus X-ray findings, all indicated a lung abscess. The patient, however, made a steady improvement from this acute seizure and was sent to the country on November 3, 1921.

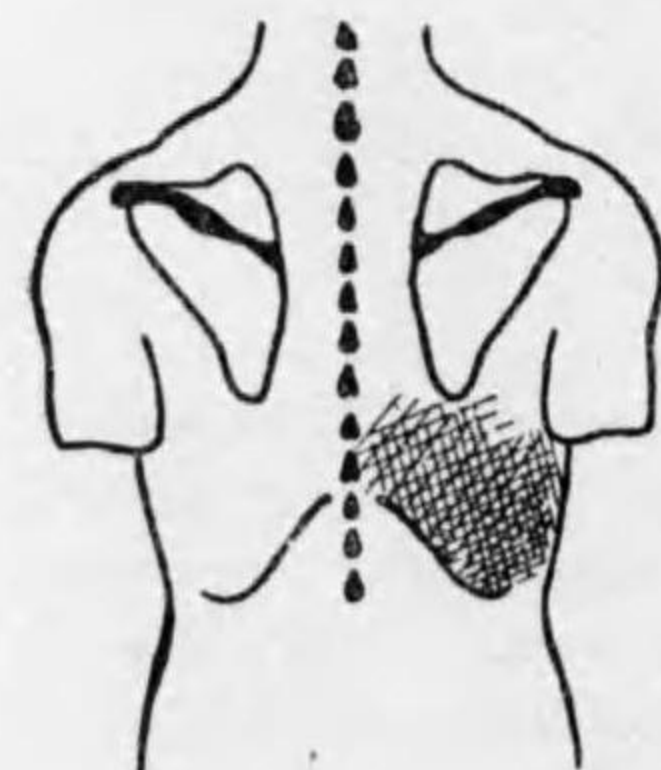
Follow Up: Patient was treated medically and by the end of 1922, his cough greatly decreased, gained in weight and now doing light work.

Ang. Licata — I.  
Sept. 26, 1921.



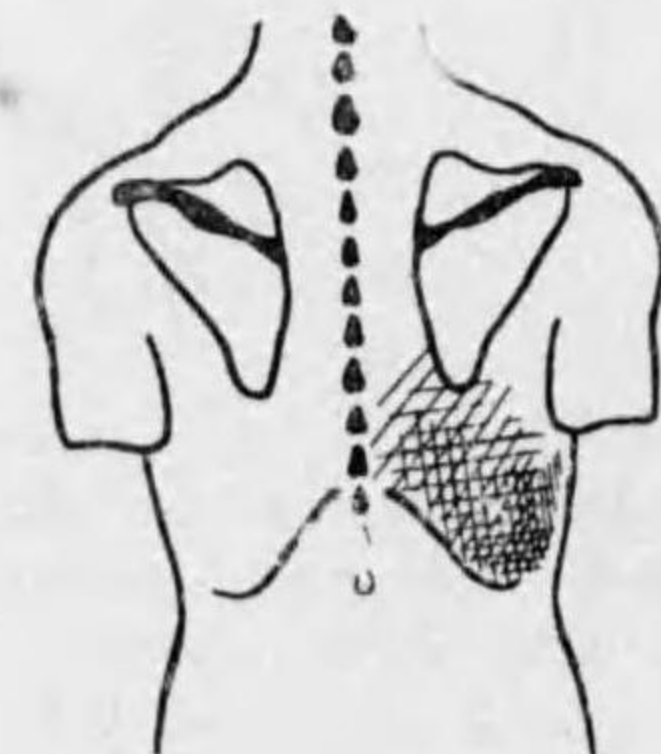
Res. Dullness to flat.  
Br. S. dim. and distant.  
V. Res. dim. sl. nasal.

Sept. 26, 1921.



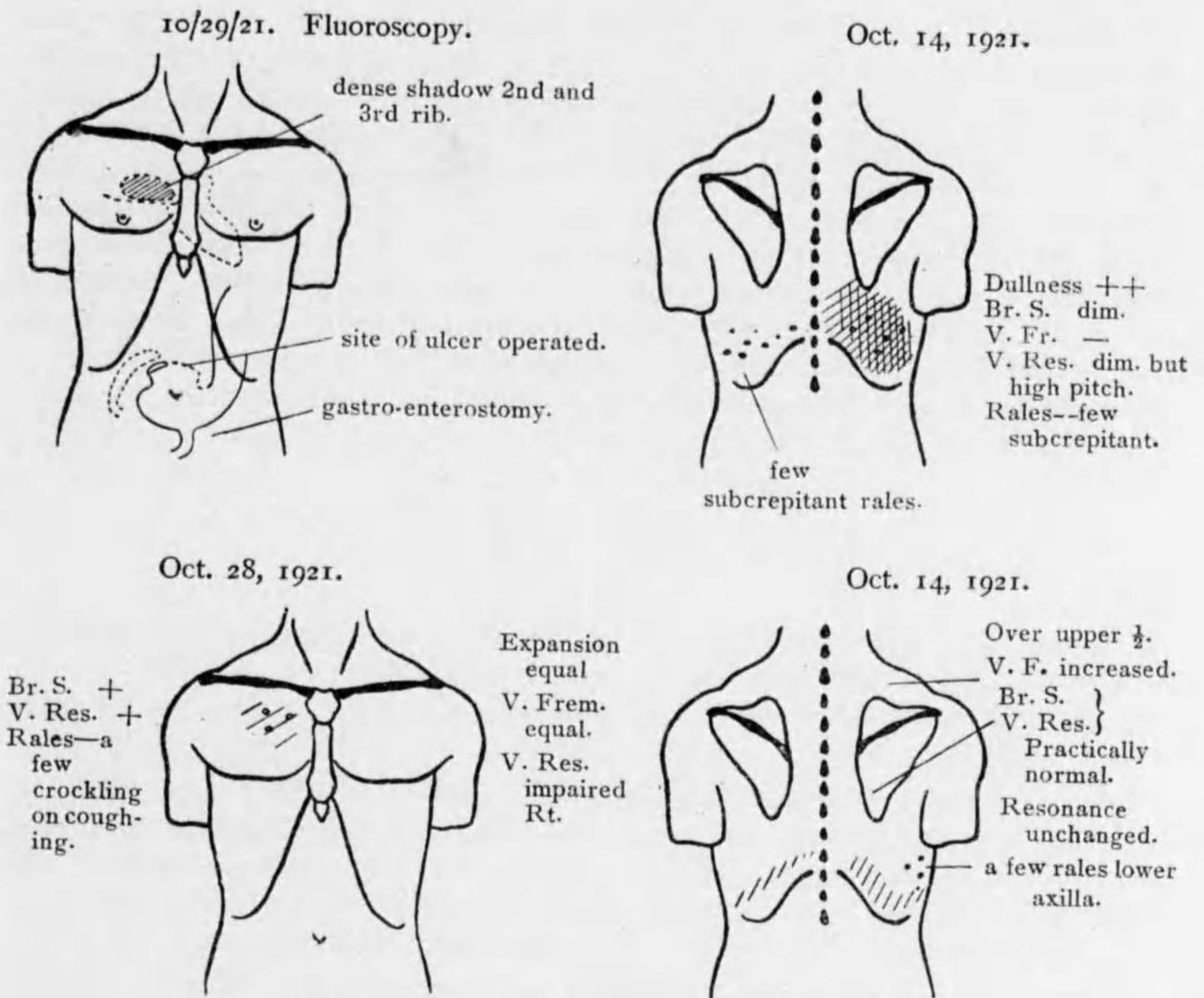
Resonance flat.  
V. Frem. greatly dim.  
Br. S. distant or almost absent.

Sept. 30, 1921.



Marked dullness to flat.  
Br. S. dim. and mod. bronchial.  
Rales. few crepitant and some friction.  
Diag. consolidation. rt. lower

Ang. Licata — II.



Signs do not suggest anything more than Bronchitis—

X-ray Findings: Fig. 64-65. Taken erect position September 27, 1921.

The hilar shadows increased on both sides. The mediastinal shadow thickened on the right. There is increased mottling density at cardio-hepatic angle; the right diaphragm is high; there is mild haziness at lower axillary region and upper hilar region. The former suggests hypostatic condition and the latter, probably inflammatory re-action, due to the presence of lesion in the hilar region. The whole picture, however, does not suggest lobar pneumonia or post-operative pneumonia, except an area at the root and cardio-diaphragmatic angle.

Fig. 66-67. October 5, 1921. In prone position. There is a definite widening of mediastinal shadow on the right side indicating displacement of the structure to the right. Whether this is due to atelectasis or not is difficult to say. Right diaphragm is quite high. There is a little mottling appearance at subclavical region near the spine; a small irregular shadow indicated by arrow, can not be interpreted with certainty because similar shadow is cast by thickened costocartilageneous junction.

Fig. 68-69, taken in erect position Oct. 29, 1921. This indicates clearly a circular

cavity with fluid level in upper lobe of the right lung, surrounded by more or less infiltrated area. The lower portion is triangular in shape and very dense. The diaphragm is in normal position.

Summary: The physical signs at first suggested pneumonia in the right base, which might have been due to collapse of the lung. Fluoroscopy confirmed the presence of the cavity in the right upper. The pneumonic shadow cleared up rapidly, and the right diaphragm was always highly situated, which may explain the persistence of signs at the right base posteriorly. The thickening of right mediastinal shadow, later appearance of density in the upper lung field, which was followed by a definite cavity shadow, suggest the pathology that there was at first an inflammatory peribronchial lesion at hilum causing artelectasis of lung followed by the extension of the process into the parenchyma forming a well localized cavity. This picture again indicates the nature of aspiratory lung abscess. The high position of diaphragm is sometimes due to the pressure exerting on the vagus, such pressure being again due to the inflammatory process at the root.

#### Case IX. E. L. C.

Italian leather goods handler, aged 42. Family history negative. Past history: two years previous to admission, no complication. Admitted on May 9, 1921 with the chief complaint of cough and expectoration of foul smelling sputum occasionally bloody in color.

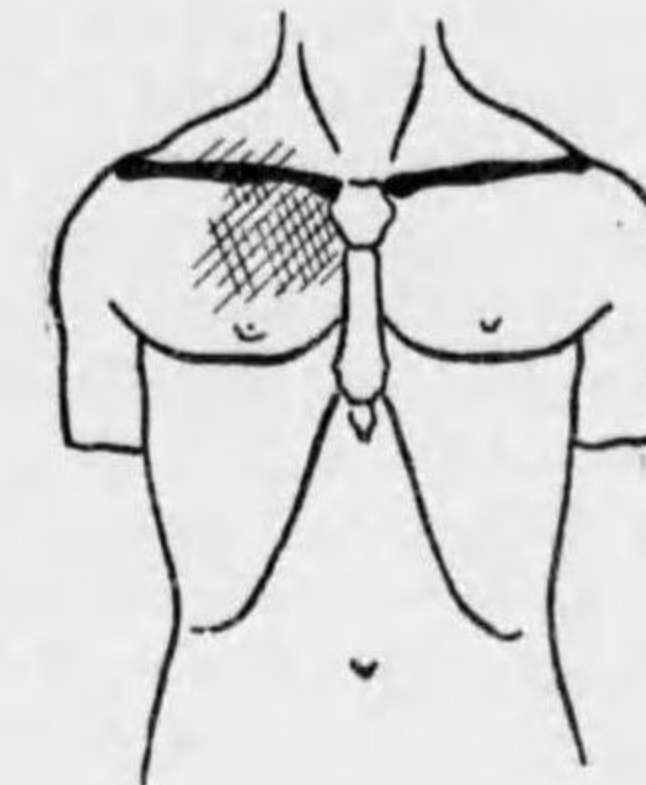
Present Illness: Six weeks previous to admission had sudden onset with chill and fever, continued to cough and expectorate. Sputum in large quantities, sometimes brownish and at other times purulent. Recently had lost appetite and weight. On inspection patient had marked pyorrhea, temp. 99-102, W. B. C., 20,000, poly. 79%. Repeated sputum exams. negative for tbc. occasionally demonstrated elastic fibers.

Course: Patient was given treatment of a.p.t. several times. On May 19, after one of the treatments, patient had hemoptysis about 10 cc and again on May 25. Otherwise his sputum had specks of blood at times. For his physical condition on admission, see chart. During the course of three weeks after starting the a.p.t. treatment, patient's general condition became very much better, although the signs in chest remained practically the same. At the time of discharge on June 18, cough, expectoration and pain in chest were all diminished, he gained in weight.

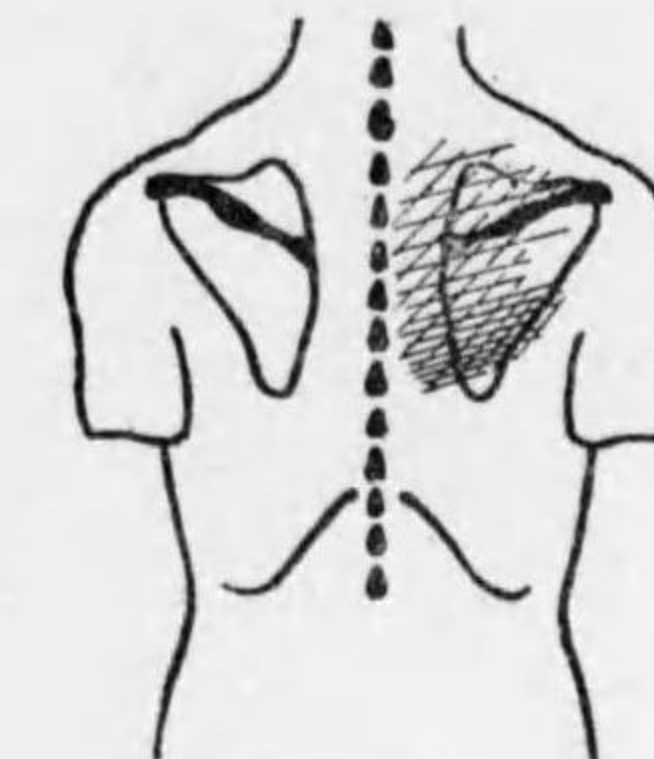
Follow Up: On August 24, 1921, when patient was seen, he said he still had night cough and sometimes he had stick pain in chest; but he gained 20 pounds since and there was no more odor to his sputum. On October 14, 1921 he had an attack of lobar pneumonia from which he recovered within two weeks, without complication. On December 28, he appeared again for "check-up" and reported he had blood streaked sputum three times, but otherwise he felt well, brought up very little sputum now and gained 15 pounds.

Emmanuel La Carrubs.

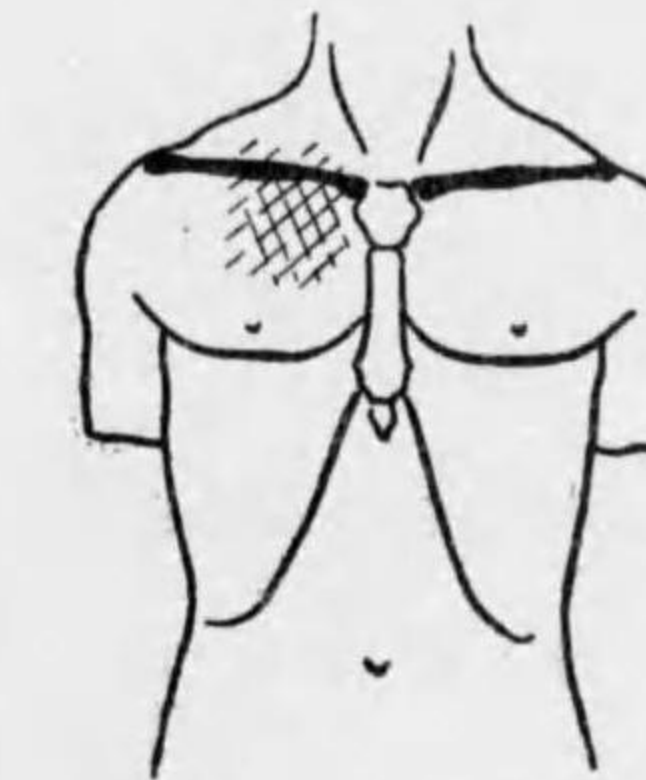
May 9th, 1921.



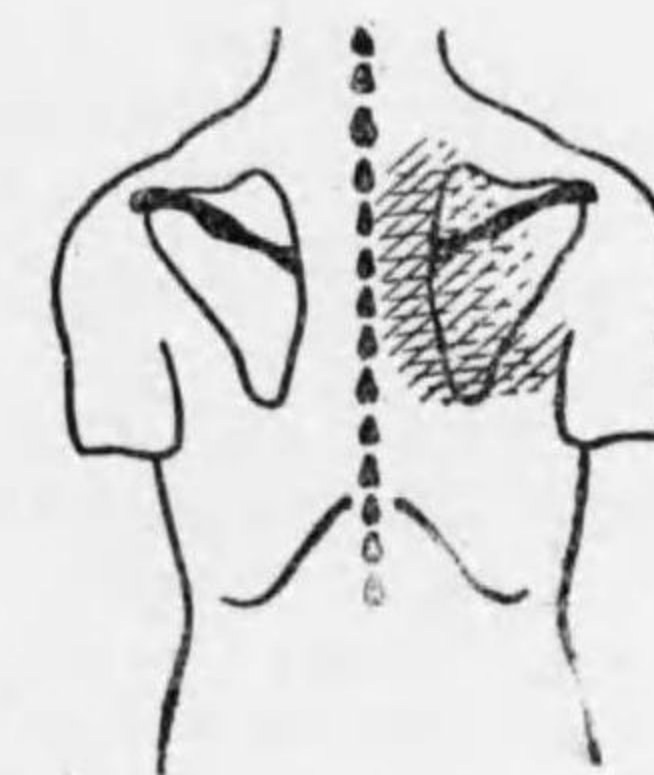
Res. Dull ++  
Br. S. Dim. Broncho-  
Ves.  
V. Res. sl. nasal.  
V. Fr. no change.  
W. V. dim. but sl.  
harsh and high pitch.  
Rales—many crepitant  
and subcrepitant.



June 17th, 1921.



Practically Similar to  
Previous Note.



#### Roentgenographic Findings:

Fig. 70-71, May 10, 1921, in erect position. "Geographic" mottling occupying upper two-thirds of right lung field. Two cavities are distinctly seen on level of 7th and 8th dorsal vertebra, respectively. The clear cut horizontal lower margin of the upper cavity may be a fluid level although the shadow is not dense enough for any large amount of fluid. Both cavities have otherwise faint irregular outlines. The lower region on the depending area below each cavity is more dense than elsewhere. The fibrous and somewhat mottling appearance in the peripheral region suggests dissolving pneumonia. Right apex is hazy indicating pleural thickening and a circular hazy shadow suggests pleural adhesions. The right mediastinal shadow is widened which is probably due to indurated mediastinal lymph nodes.

Fig. 72-73, May 11, 1921, taken the next day in erect position after the institution of a.p.t. presents the same picture as above, excepting that there is air in pleural cavity, lung is slightly compressed medially and heart is considerably displaced to the left, and also the mediastinal shadow somewhat. Rather small amount of air causing that amount of displacement may mean that interposed lung tissue is quite solid.

Fig. 74-75. Taken in erect position ten days after previous picture. The shadow here is somewhat perplexing. The cavity in the upper portion of the density is outlined by irregular indefinite shadow, appears to be run across by fibrous trabeculi, and its outer area is only slightly indurated. A short distance below this, there is a small rounded shadow nearly one cm. in diameter, with very thick wall, which may be a separated small cavity. The induration on medial portion has become much less and it is now replaced by fibrous production, while there is more increased induration on the lateral portion. There is a small amount of air in the pleural cavity. The irregular ring shadow in the right apex has very faint homogeneous outline with a little reaction around, its shape and size are not constant, thus strengthening the thought of this being a pleural adhesion and not a cavity.

Summary: Apparently from the history, cavitation followed a pneumonia. Radiography in this case, suggests that, in the beginning there were several areas of softening which later became coalesced forming into an irregular cavity; then trabeculi were formed, subdividing it into compartments. This became finally fused with normal lung tissue and thus cure was effected.

Such a spontaneous history without definite symptoms in the beginning, referable to lobar pneumonia, may strongly suggest an idiopathic type of Lung Abscess. Refer Section on Bacteriology and Etiology.

#### Case X. M. I. U. S.

White school girl aged 9.

Admitted to hospital on November 29, 1922. Her past history was negative as well as her family history.

Present Illness: Six weeks previous to admission, or on Oct. 21, she had operation for acute mastoiditis on right side, on October 25, she had resection of right jugular vein for infectious thrombosis; again on Nov. 16, she had a large abscess on the neck at the side of previous operation and this was opened for drain. Soon after this she developed high fever, cough and expectoration, and she was transferred to this hospital on November 29. She was poorly developed and in poor nutrition, appearing desperately ill; her respiration very shallow, rapid and grunting. Her right lung was hyper-resonant and there was amphoric breathing in upper third, both anteriorly and posteriorly. The physical findings indicated that in abscess in upper part of the right lung, suddenly ruptured causing a pyo-pneumothorax with marked and ever increasing dyspnea. This suggested a flap valve action in the pulmo-visceral pleura. For emergency, under local anaesthesia and intercostal incision in right 7th i.c.s. gave exit to a tremendous quantity of air under high pressure. Rubber tube drain inserted, no fluid evacuated, but there was bad smell to the imprisoned gas. Culture made from the pus showed staphylococcus aureus.

X-ray, Fig. 76-77, taken on December 1, 1922 or right after the operation is here indicated. There are many interesting points in this film. As we come down from above, there is a canal along the right side of the neck, bounded by indurated muscles. The canal disappears at apical region. In the right upper lung field, we have an irregular elongated shadow beginning just at or above the clavicular region, reaching as far down as to the level of the 8th dorsal vertebra. Its outline is more

distinct in its lower two-thirds, while its upper end is clouded out by hazy apex shadow. There is a marked density at the base of the lung and the diaphragmatic shadow is clouded out from view. The density at the base suggests indurated lung perhaps soaked with pus. At the site of the tube drain we have some air space and the atelectatic lung margin is well seen. The rest of the right lung field presents mild inflammation appearance. The heart is pushed to the left. Faint shadows of trachea and bronchi are seen. The point of its bi-furcation is visible at the level of the 4th and 5th dorsal vertebra. The right bronchi being connected with the dissecting cavity. In reference to the clinical history and from the nature of the radiogram, it is possible to assume that lung was infected directly from the pre-existed abscess on the neck in its downward continuity and not of aspiratory origin or metastatic from the previous operation. Again the lung complication appeared too late for aspiration or metastasis.

Course: On December 6, large amount of foul purulent discharge began. The wound was irrigated with Dakin's solution daily hereafter. December 12, operation, resecting of rib for lung abscess and empyema. Debris removed, wound gradually filling up, scant discharge, temperature down and patient was up about by the end of January. Discharged cured on Feb. 2, 1923.

Follow Up: May 13, 1923. No cough, gained 15 pounds. Wound healed, feeling well, and is now doing well.

#### Case XI. V. P.

Italian laborer aged 39, admitted to hospital on November 15, 1922 with the chief complain of cough and expectoration of large amount of yellowish sputum. Family history negative, as well as his past history.

Present Illness: On July 3rd, or a little more than four months to his admission to the hospital, the patient underwent an operation on the eye under general anaesthesia. Ten days after the operation he went to work, and that every morning he experienced rather a severe pain over right anterior of his chest and he had to stop work; the pain cleared up in a few days, but shortly afterwards he developed fever and sudden expectoration of large amount of yellowish foul sputum. This was in August or three months before admission and ever since he continued to cough and expectorate although he was not sick enough to be in bed. Tuberculosis was suspected, but every sputum examination was negative.

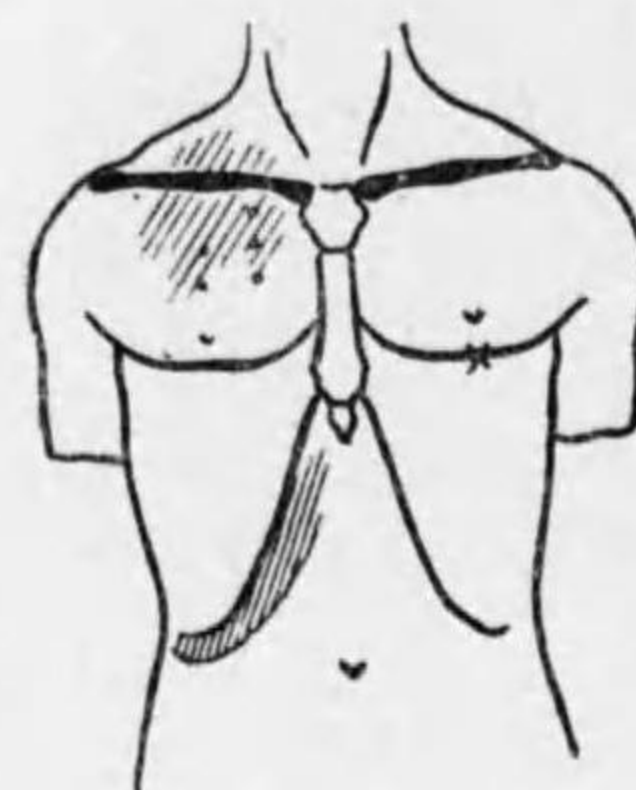
Physical Examination: He was well nourished and apparently a healthy individual. W. B. C. 13,400, poly. 79%, Hgl. 85% sputum in large quantities, but never succeeded in demonstrating tbc. No clubbing of fingers. For findings on the chest, observe the chart, it is most unsatisfactory.

X-ray Findings:

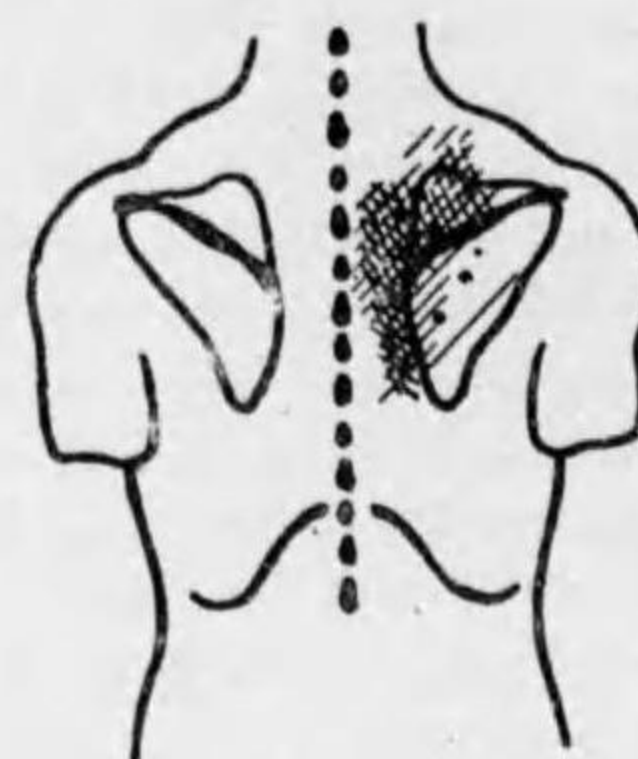
Fig. 78-79, November 16, 1922, in erect position. Narrow sagging ribs, drop heart, both root areas thickened, increased lung markings toward the base especially on the right lung. Above the level of the 7th dorsal vertebra, there is haziness, fan shaped spreading outward to the axilla. This area of moderate haziness with increased lung markings suggests post-pneumonic condition. Near the root there is ill defined circular density including slight rarefied area above, which appears to be the diseased center. The presence of cavity however, can not be definitely stated at this stage.

Case XI. — V. P.

Nov. 15th, 1922.



Slight dullness. Br. S. bronchoves. Vo. Res. sl. incr. W. V. incr. and sl. high pitch. Rales—few moist. Liver margin 4 cm. below c-m.

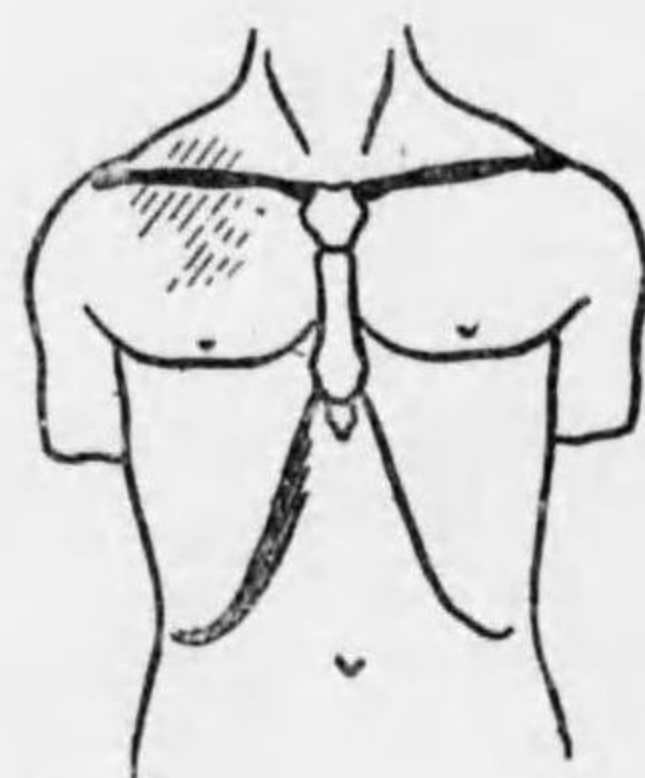


Moderate dullness. Many moist rales. Br. S. — bronchoves. dim. Vo. Res. dim. V. Fr. dim. W.V. inc. high p.

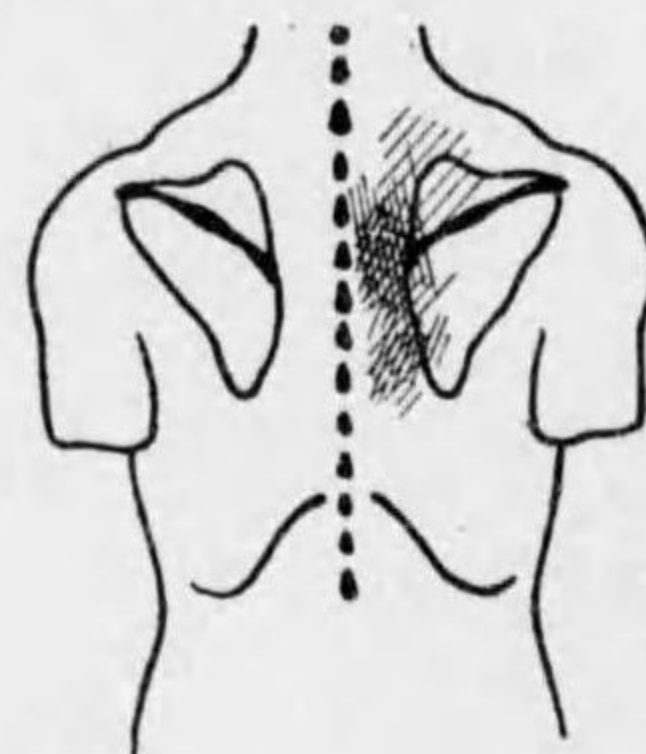
Diag. inconclusive, may be tbc. infiltration.

Nov. 22nd, 1922.

Physical signs similar to previous findings, except.



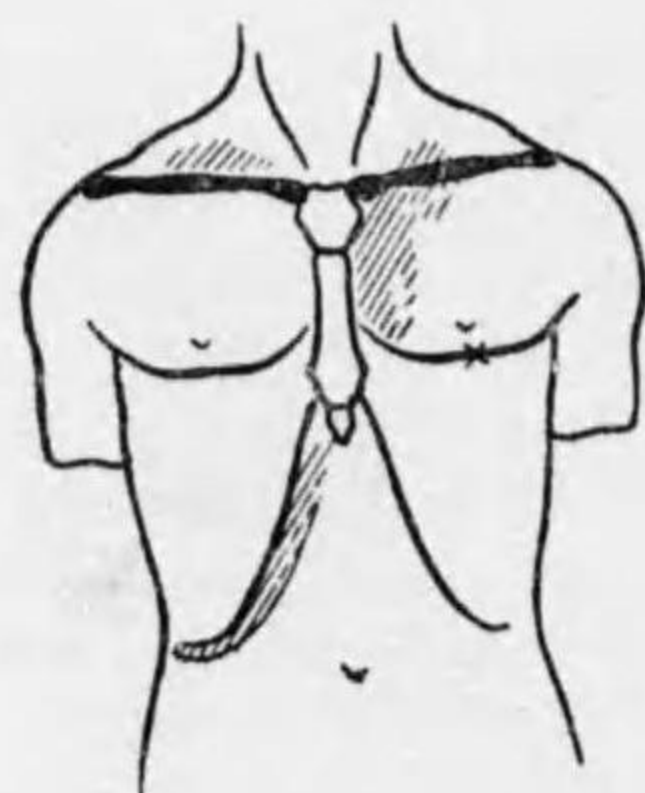
Sl. dullness etc., but no rales.



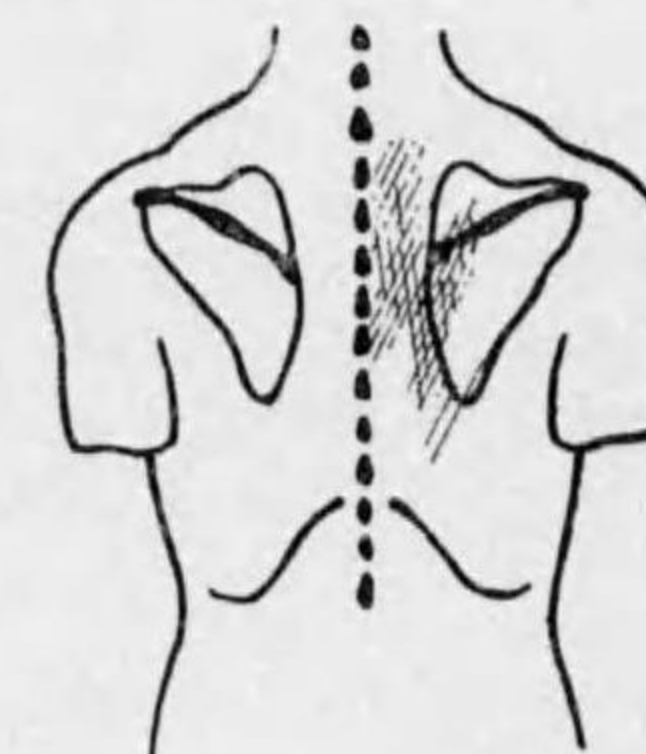
Moderate dullness more localized in interscapular region, where.

Br. S. distant bronchial. V. Res. sl. nasal. W. V. dim. but harsh. Only occasional rales. Other areas Br. S. some what coarse.

Nov. 24th, 1922.



Signs are modified by pneumo-thorax, cardiac dullness extending more to the left, Br. S. markedly diminished on the rt.



Limited area of dullness and distant bronchial B. S.

Signs indistinct due to pneumo-thorax.

Apices clear except mild homogeneous haziness indicating probable presence of thickened pleura in the right apex; tuberculosis can not be diagnosed.

Fig. 80-81, November 22, 1922 in erect position. Generally about the same as preceding figure excepting for a more thickened root shadow, appearance of faint

cavity shadow shaped like flattened out Figure 8, situating a little more periphery than the previous position and assuming more characteristic cavity shadow, and generally increased fibrous production.

Fig. 82-83 taken on November 24, 1922 in erect position, eight days after the first picture and after inducing a.p.t. There is marked lateral curvature of the spine with displacement of the heart of the left, and moderate amount of air in the pleural cavity. Here we have at least two small cavities piled up one on the other. Their outlines are hazy. A large dim ring like appearance far above cavities suggests pleural adhesion. The lower cavity seems to contain a fluid level; the dependent portion of the cavity is much indurated forming roughly a triangular shape with apex downward. The peripheral pneumonic shadow and haziness at the apex has cleared up to some extent. The base of the right lung is adherent to the diaphragm in its mid portion.

Summary: Began with destructive area at the root with reactive pneumonitis to its distal lung tissue. Clinical history does not suggest pre-existing pneumonia. General appearance of the thorax and mild cloudiness at apex with fibrous production may suggest tuberculosis, but their rapid clearance and absence of other Roentgenologic as well as laboratory evidences make it most unlikely for tbc. Such evolution of the lesion which followed ether anaesthesia again strongly suggests aspiration lung abscess.

Case XII. E. T.

Canadian white laborer aged 39, admitted on May 29, 1924 with the chief complaint of pain in the chest and weakness. His family history was negative. He had usual childhood diseases including scarlet fever and measles. In 1922 he had dysentery in China, from which he made rapid uneventful recovery. Otherwise he was always strong and athletic.

Present Illness: About three weeks previous to admission he had sudden severe pain in the left side of the chest accompanied by chills and fever, shortness of breath and prostration. A few days before admission he began to expectorate foul smelling sputum of yellowish color. On admission he was well nourished and well developed middle aged man, appearing acutely ill. His chest expansion was much diminished on the left side; heart was negative; and abdomen showed slight tenderness in upper right and left quadrants. W. B. C. 14,000 with poly. 84%, blood cultures repeatedly sterile. His chest signs on admission, as per illustration, suggested consolidation with beginning dissolution on the right side and pleural thickening and consolidation on the left. The peculiarity in the physical signs is, however, that they are more marked in upper 2/3 on both sides than at bases contrary to Roentgenologic findings. The exaggerated breath sounds with bronchial character in left interscapula region did not suggest any cavitation, but rather exaggerated transmission of tracheal sounds. Hyperresonance in left axilla is not directly due to air containing cavity but certain aerated lung conditions;—partially compressed lung due to sacculated cavity at base may well produce this condition. Rather scant signs on the right side compared with the X-ray which may be due to scattered consolidation (broncho-pneumonia).

Course: May 31, partial collapse of left lung indicated by a sudden paroxysms of dyspnea, cough, and jump in pulse to 160. Dullness was less marked at left base,

but definite signs of pneumo-thorax were not obtained. June 1st, 1924, severe cough, dyspnea raising foul swelling fluid and septic temperature, but general condition not alarming. Signs on right base has increased in extent bronchial breathing has disappeared, but obtained considerable dullness and numerous bronchials and rales throughout right base and axilla. June 2, patient continued to be dyspneic. Over right upper lobe there was deep tympanic note, but no evidence of fluid behind. Over left front and back there was marked dullness, many rales, but no frank signs of fluid or pneumo-thorax. Heart moderately displaced to the right. On the same day patient was operated on for suppurative pleurisy. The left pleural cavity contained very foul pus. June 4, the condition was worse; there was marked prostration and sweating. Large amount of foul drain from the wound. There was tympanic note all over front, coarse rales at bases. Otherwise signs on the left about the same. June 6, general condition better, respiration 40-60. Loud, vesicular murmur over entire left chest anteriorly. Dullness on right posterior. Diminished and bronchial breathing disappeared, numerous moderate coarse rales. In the afternoon there was sudden development of subcutaneous emphysema over left chest and neck, patient prostrated, profuse sweating and extremely dyspneic. June 7, sudden increase of emphysema on chest and neck and finally death followed.

Comment: Repeated examination of fluid failed to demonstrate entamoeba or echinococcus, culture sterile. Evidently there were multiple septic infarcts into the lung with resulting abscess involving pleura but no definite etiology could be established in this case. This might have been due to influenzal infection.

Fig. 84-85 erect position, May 29, 1924. In left lung below the 8th rib there is marked ebonization with a horizontal level above. From the central portion directing upward periphery there is arch-like dense shadow including below a lighted area which is a small pneumo-thorax. There is marked thickened pleura as evidenced by the homogeneous density. The said arch formation may be composed of condensing inflammatory lung. The left upper lung field is lighted up satisfactorily. The shadow on the right lung field is that of irregular density and of irregular shape, occupying lower 2/3 of the field, suggesting irregular consolidation, associated with thickened inflammatory pleura. Within the area, near the right border of the heart there is upright elongated rarefied space with thickened edge which is probably a dilated bronchus with peri-bronchial infiltration. The right apex lighted up fairly well.

Fig. 86-87, taken in erect position, May 31, 1924, presents similar picture except that the left side of pneumo-thorax is larger, the inflammatory process in the upper lobe is greater, and the fluid level is not seen due to exudate on thickened pleura. The bronchiectatic shadow in the right lung field is now more distinctly seen and there is more mottling appearance around showing increased broncho-pneumonia. Otherwise same as before.

Fig. 88-89. June 2, 1924. Increased mottling in the right lung field; small rarefied spots near the base may be a group of abscess cavities. The pneumo-thorax on the left side takes a rounded form and is much larger than before. There is also increased mottling appearance of the lung, the heart and the mediastinum are slightly displaced toward the left.

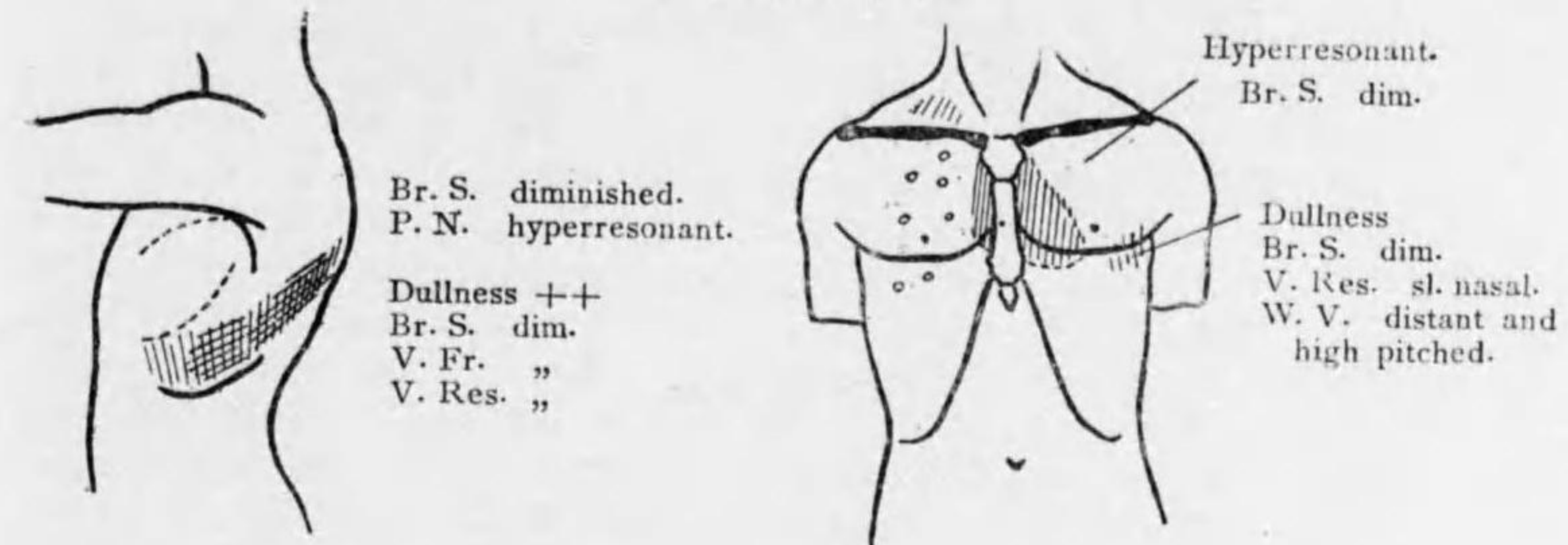
Fig. 90-91. June 6, 1924. Intense density occupying whole right lung field. There are few areas of less density which are probably degenerated lung areas. The homogeneous ebonization is probably due to thickened pleura with purulent exudate,

the similar condition as found on the other side. Left lung; thickened mottling appearance due to multiple abscesses and partial atelectasis of the lung.

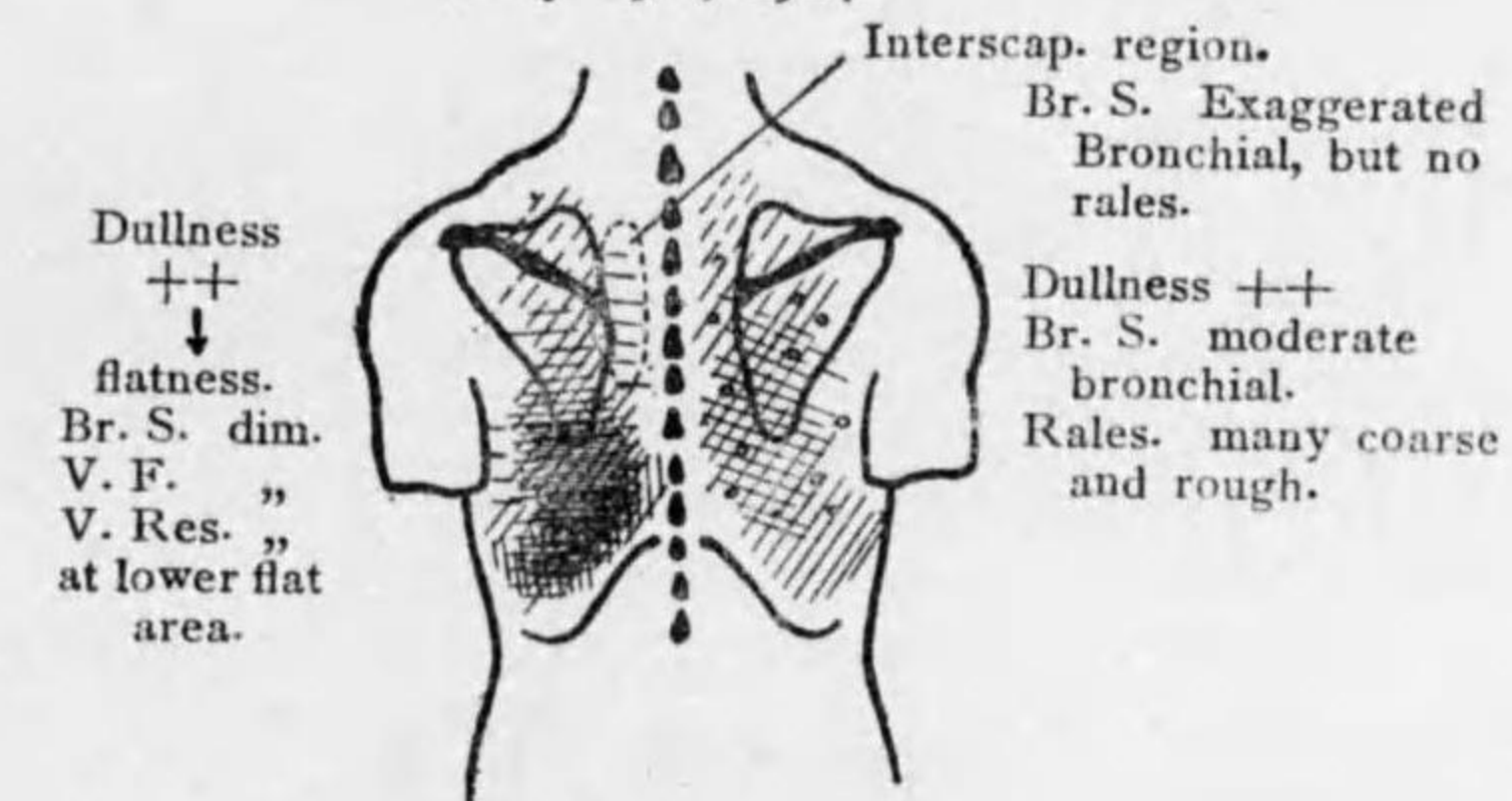
Summary: The arch and round shadow on left base represented Fig. 84-89 were apparently pyo-pneumo-thorax with infiltrated lung tissue above and pleural thickening. The right lung contained diffuse broncho-pneumonia with perhaps multiple abscesses. Roentgenologically and clinically, this case suggests influenza infection. At autopsy found bi-lateral diffused purulent pleurisy and multiple abscesses.

Edward Tuck.

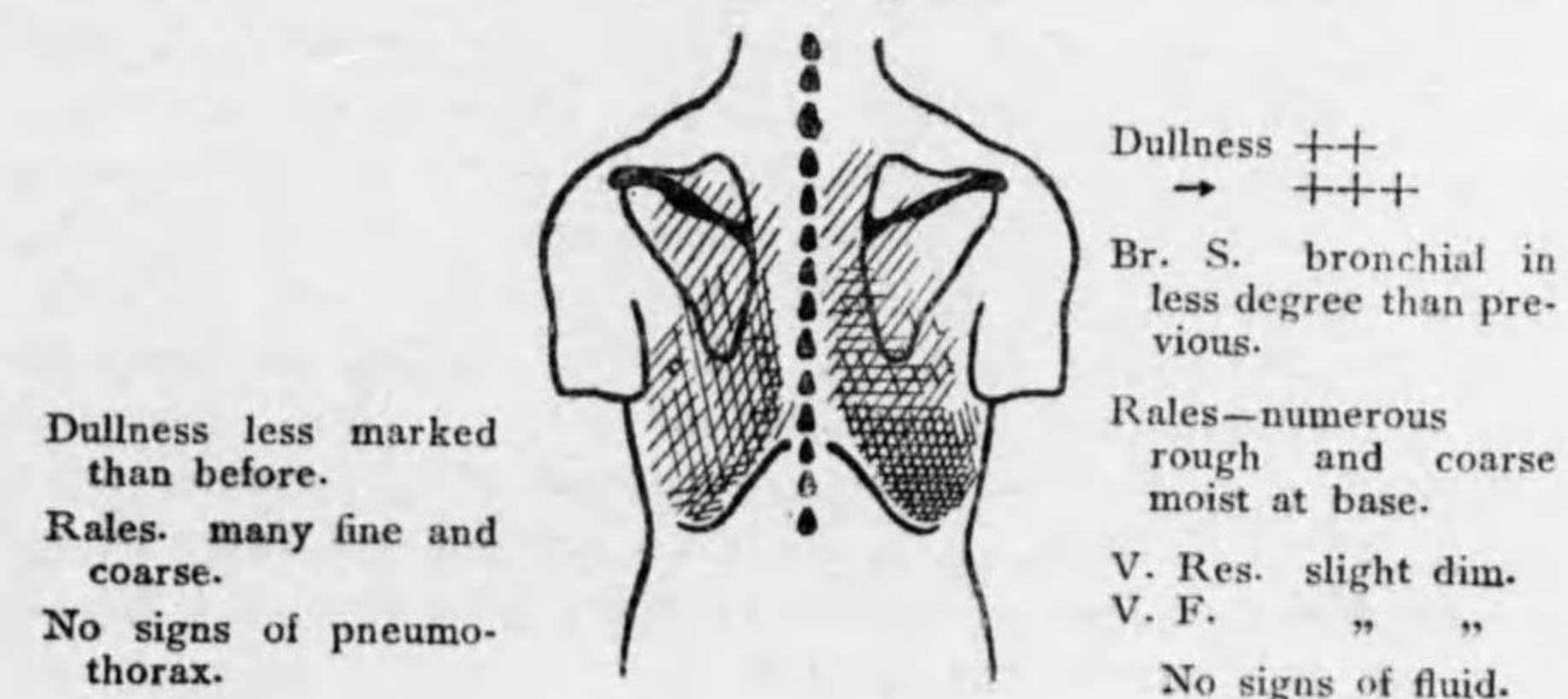
May 29th, 1924.



May 29th, 1924.



June 2nd, 1924.

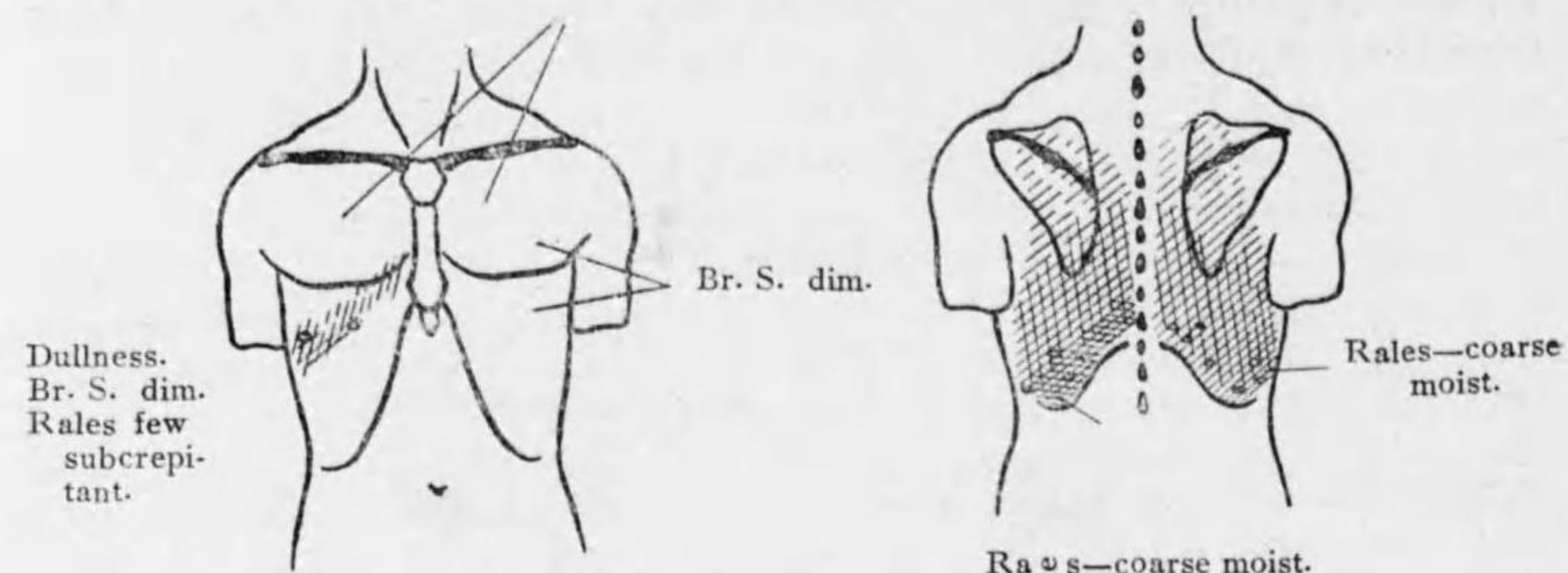


Edward Tuck.

June 4th, 1924.

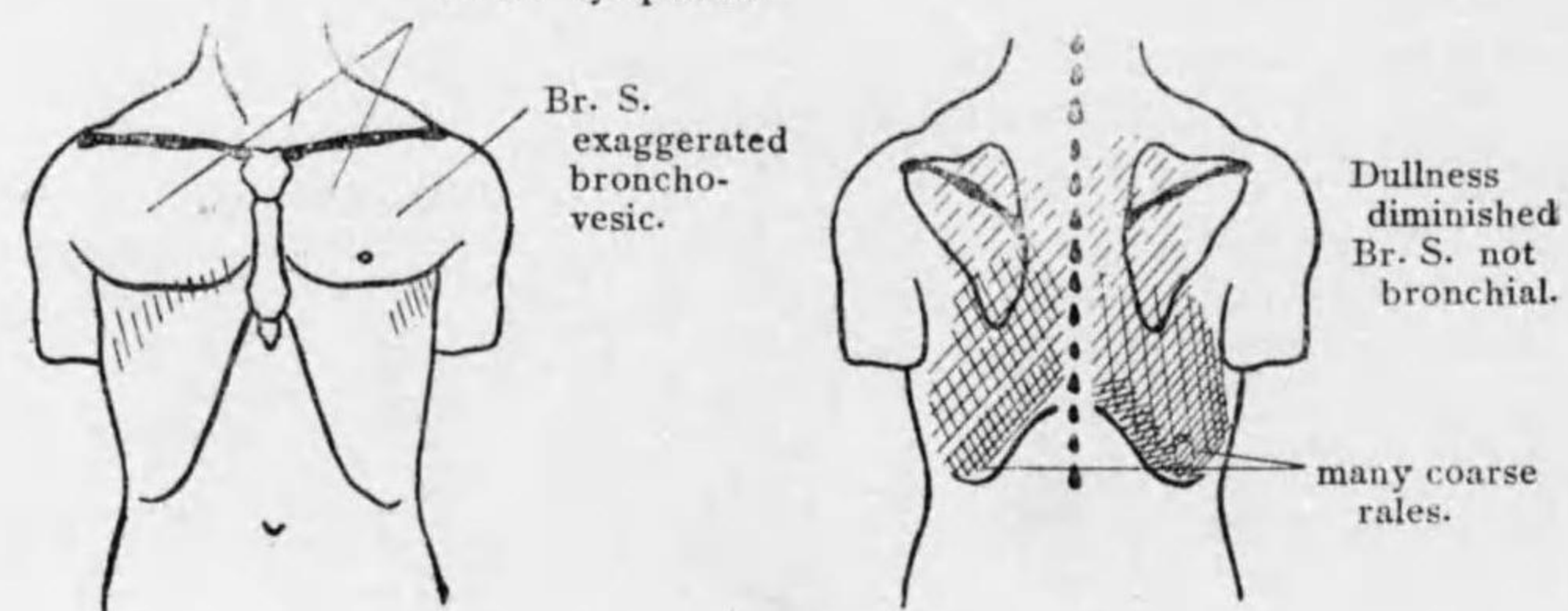
P. N. tympanic.

Signs practically same as before.



June 6th, 1924.

P. N. tympanic.



### Case XIII. E. B.

Girl of 17 previously admitted with lobar pneumonia of left lower lobe on Feb. 21, 1921. She had a complication of suppurative pleurisy for which she had thoracotomy and drain. She had also multiple skin abscesses on hand and abdomen. She was discharged greatly improved on April 11, 1921. Since then the sinus on the left side healed over several times, then to break down again. Her general condition had been fair, and practically had no fever. She came back on June 6th 1922 to straighten up the discharging sinus. At this time she had moderate cough and expectoration and at one time she coughed out piece of tissue. The pathological report of the tissue is as follows: Specimen consists of an irregular firm piece of tissue about 3 cm. in diameter. It is 1/2 to 1 cm. thick consisting of quite hard tissue, microscopically consists of connective tissue with foci of polynuclears and plasma cells. On June 8th she was operated on.

Thoracotomy revealed markedly thickened pleura, quite adherent lung to the pleura on the left lower. While this was freed with considerable difficulty, an abscess cavity was found well toward posterior surface of the lower lobe of the left lung between thickened pleura and thickened indurated lung. Diseased part of the lung and pleura was removed, the lung was freed from pericardium. At this stage the operation was stopped as the condition of the patient was bad. Blood transfusion was given. She made rather a rapid progress and was discharged much improved on August 29, 1922 and sent to the country. On Sept. 13, 1922, she came back with large abscess on left neck involving down to subclavicular region. The site of former thoracotomy presented several discharging sinuses with exuberant granulating tissue about them. The film taken at this time was unfortunately destroyed but presented considerable irregular density on lower left pleura with adhesions to the diaphragm. No visible evidence of liquid or abscess shown. She made fortunate recovery after the operation, but again came back on January 10th, 1923 with osteomyelitis of the rib. The diagnosis at this time was empyema sinus. Operation with rib resection was done. The discharging of sinus tracts in the left of chest was excised by a long skin incision which extended from the erector spinal muscles in the back down along the 8th rib to the costal margin in front. Throughout this area the 7th and 8th ribs were very markedly thickened and for about a distance of 20 cm. were the seat of a fairly marked osteomyelitis. The two ribs were excised through practically their entire course. A granulating piece in the soft parts was also trimmed away leaving a clean space with the thickened pleura on the under surface. There was no evidence at the operation that this sinus entered the chest and the whole process seemed to be an osteomyelitis of the two ribs immediately surrounding the previous operative scar. Patient discharged cured, three weeks post-operative.

Fig. 92-93. June 7, 1922. Taken in erect position, represents entirely negative picture so far as pulmonary lesion is concerned, excepting a slight haziness at the left lower. The heart looks larger than her normal. The mild haziness of homogeneous character at the left lower suggests only thickened pleura. No fluid is evidenced, the diaphragm is adherent at cardio-phrenic angle, and both root areas are thickened and appear fibrous. The patient has chronic discharging sinus at level of the 8th spine on the left posterior region, but nothing is shown in the X-ray, concerning the intrathoracic involvement; the lesion may be completely overridden by heart shadow.

Fig. 94-95. Taken in erect position nearly a month after the operation. Both apices are clear; right lung markings increased; the fine fibrous strands leading to periphery indicate engorged vessels. The lower half of the left lung field is clouded presenting a complexing picture. Its upper portion appears mottled and fibrous with a few calcified nodes, and there is a type of geographic mottling. The hazy looking flat-ring with dim smooth outline suggests a pleural adhesion, while the lower "island" with ragged irregular outline is most probably a cavity. This cavity shadow was made evident subsequent to the operation. (Refer to the description of operation). Still lower, homogeneous density suggesting thickened pleura and probably purulent exudate. A narrow band like shadow up along the thoracic wall should not be missed, it indicated fibro-purulent pleurisy.

Fig. 96-97. August 4, 1922. Erect position two months after lobectomy. The density at the base is due to chiefly very thickened pleura. Above this it appears quite fibrous, the irregular hazy looking "islands" or the residual cavities are undergoing fibrous change.

Summary: The first picture was entirely negative although a cavity was revealed at operation. Owing to the peculiar situation of the lesion, X-ray in lateral one position may not be visualized being interrupted by the shadow of the heart and spine. Later pictures showed rapid spreading of the infection and later slow healing process.

Case XVI. E. D.

Man 36 admitted to the hospital July 4, 1922 complaining of cough and expectoration. Past history: measles and pneumonia during childhood, operated on haemorrhoid one and one half years ago, Lues denied, otherwise negative.

Present illness: Began six weeks ago with sudden pain on right chest and fever, a week later cough and great deal of expectoration began, sputum somewhat tinged and bloody. Temperature septic, 98.5-104-F; P. 80-140; R. 20-28.

Physical Signs: Chiefly limited on right interscapular region consisting of dullness, bronchophony, bronchial breathing. At angle of right scapula it approaches a flatness, breath sounds diminished and has slight bronchial expiration with pleuritic rub and few median sized rales.

Course: July 10, a.p.t. was attempted but failed to obtain result as shown in Fig. 98. Another was tried on July 13 which is shown in Fig. 100. This was followed by moderated amount of haemoptysis. Patient began to have severe pain in the chest, became suddenly very septic. Signs on right chest were obscured by pneumothorax, while signs on the left now became more prominent indicating disseminating broncho-pneumonia. Patient finally died with lung enpyema.

Post Mortem: Right lung numerous cavities in middle lobe filled with pus; disseminating broncho-pneumonia on left lung with some fluid. Culture of sputum showed green producing non-haemolytic streptococcus.

Fluoroscopy on July 4 showed abscess in the region of right rib.

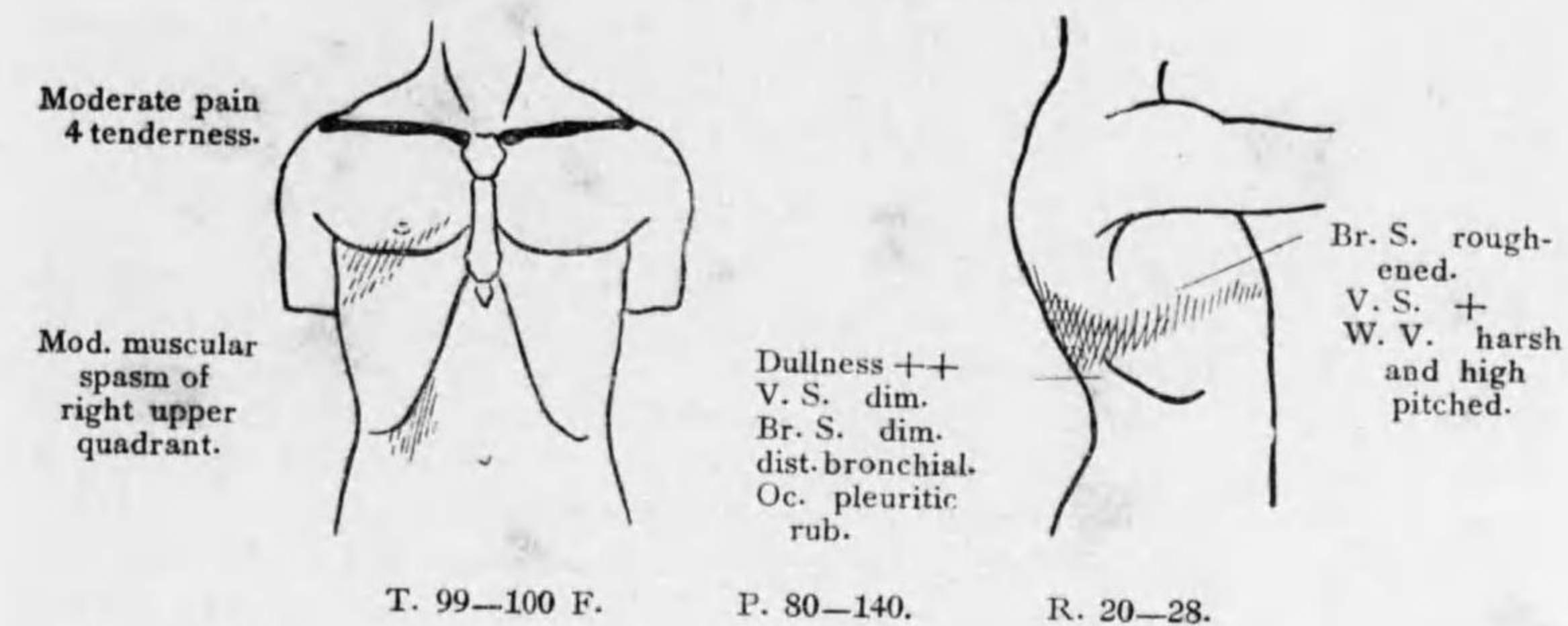
Fig. 98-99. July 11, erect position. Irregular circumscribed density in the region of right middle lobe. Root region quite thickened, near the upper margin of the shadow there is ovoid less dense area with ill-defined boundary, which may be a small cavity. Left lung clear. Both costal phrenic angles clear.

Fig. 100-101. Square shaped shadow in the region of right middle lobe, its lower margin is hazy, upper margin appears fibrous. The probable cavity observed in previous film is now more distinct and larger than before. Another hazy ovoid area is seen near 9th dorsal vertebra within the density. Partial pneumo-thorax on right base, left hilum appears also thickened.

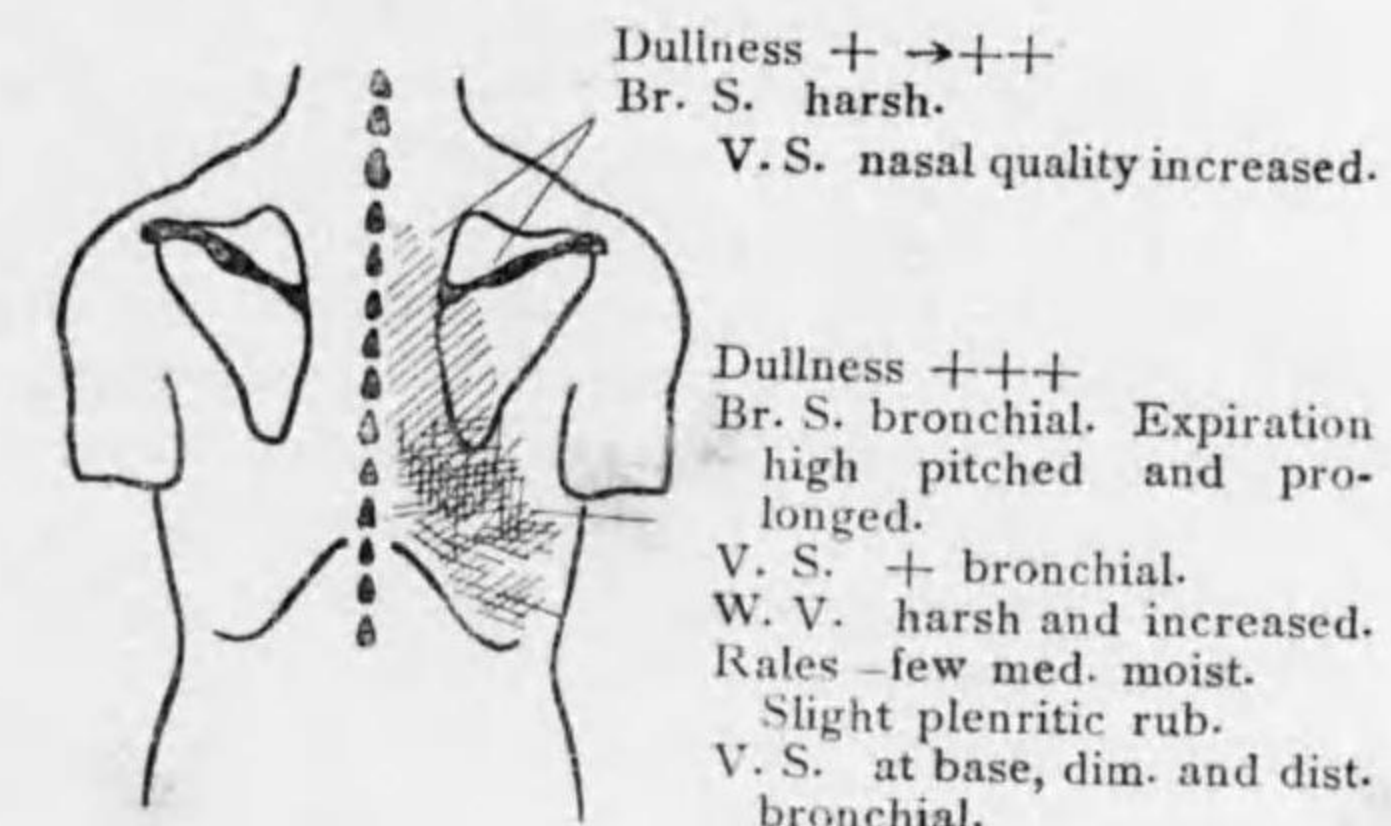
Summary: This case began as unresolved pneumonia in the right middle lobe, later patient died of disseminating broncho-pneumonia. Again, in this case, in absence of definite history referable to lobar pneumonia, the predisposing factor may be influenzal infection or "idiopathic infection."

Case XIV. — E. D.

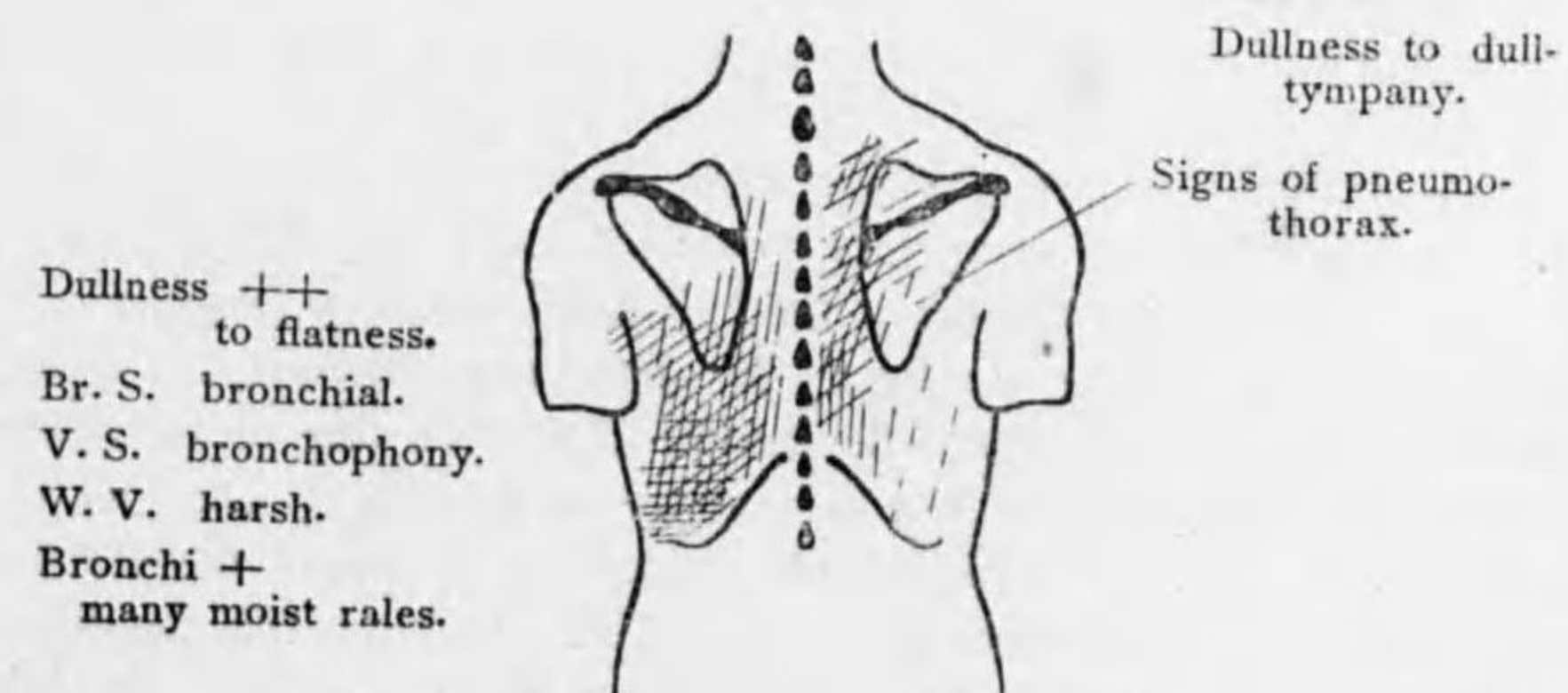
July, 4th, 1922.



July, 4th, 1922.



July, 19th, 1922.





Case XV. L. P.

Austrian woman aged 28, was admitted to the hospital on January 9, 1923. Former history negative. She passed usual childhood diseases, such as measles and chicken pox, otherwise had been quite healthy up to the present illness, excepting her last menstruation which was on August 5, 1922 and since which period she has had morning sickness.

Present Illness: Five days previous to admission, she caught a "cold" and developed a cough and pain in the right chest which was made worse by taking a deep breath. She was normally developed and a well nourished woman about four months pregnant. Her teeth mostly decayed and she had worn plate and bridge for 14 years. Her chest signs as illustrated, suggested pleurisy with effusion and complicating pneumonia on right upper lung. X-ray confirmed the physical findings; fluoroscopy also showed pneumonia above and pleural effusion below. Her blood showed W. B. C. 10,500 with 85% polymorphonuclears. There was much cough and expectoration, amount of sputum was not suggestive of lung abscess however. During her residence, her temperature was between 99-101 F, P. 120-128, and Resp. 36-40. On January 12, she was tapped and obtained about 400 cc. of creamy fluid of which guinea pig culture was negative. She continued to cough and expectorate and remained in the same condition. Her sputum became more increased and now became more suggestive of lung abscess. Fluoroscopy on Feb. 13 showed thickened pleura and cavity or pneumo-thorax with fluid below. On the same day, thoracotomy was done on the right chest where fluid was obtained by previous thoracentesis; revealed no pathology. On Feb. 20, another exploratory thoracotomy was done, and the following informations were obtained: Lung adherent to the chest wall, pleura was about 1 cm. thick, a large cavity in right lower lung located filled with much foul fluid.

Outcome: Patient died three days after the last operation from septic infection. No autopsy was done.

Summary: Patient developed a lung abscess following probable septic pleurisy and pneumonia. X-ray showed indefinite cavitation and possible fluid level in the pleural cavity. Fluoroscopy was more definite in this case. The first operation revealed no fluid or pus in the pleural cavity, while thoracentesis revealed pus. This discrepancy was due to the fact that the fluid was confined in lower portion of the pleural cavity and in small amount, and the fluid obtained by the needle came directly from pulmonary abscess. In the second operation a large abscess cavity was found.

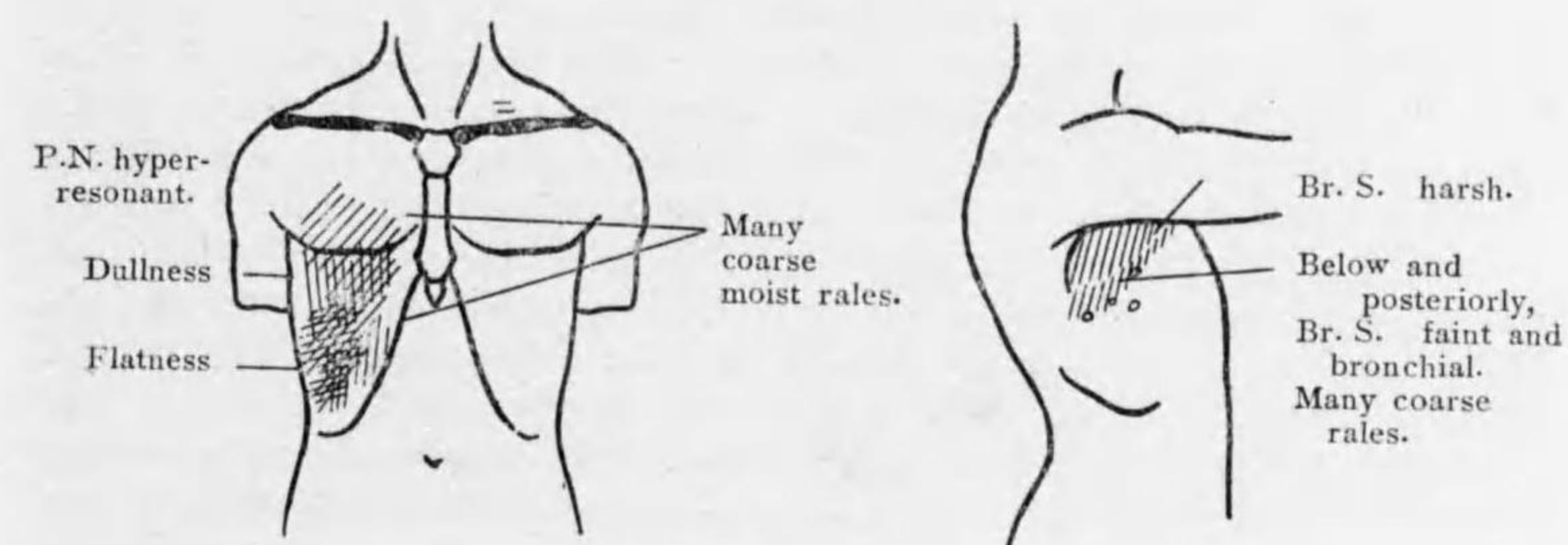
Fig. 105-106, January 10, 1923. The right lung field presents a complicated picture. No. 1, a dense shadow occupying lower third of lung with a straight horizontal upper margin which is evidently a fluid shadow, No. 2 a longitudinal shadow of homogeneous density up along the right side of the mediastinum, the outer margin of which reaches almost midway from the middle line, and has clear outline. This may be the result of enlarged lymph nodes at the root, and it may not be due to displaced mediastinum. No. 3, an ill defined shadow of irregular density occupying just above the fluid level and upward along the axilla. Through this density scattered aerated areas are seen, suggesting diffuse broncho-pneumonia. The remaining mid

portion and the apex is hazy and still normal lung markings are seen through. An inflamed pleura and scattered broncho-pneumonia may well present this picture. No abscess cavity is made out. The left lung field lights up normally and there are some congestive vessels. Fluoroscopic examination on January 9 indicated pneumonia on lower portion of upper lobe with pleural effusion. (Fig. 107).

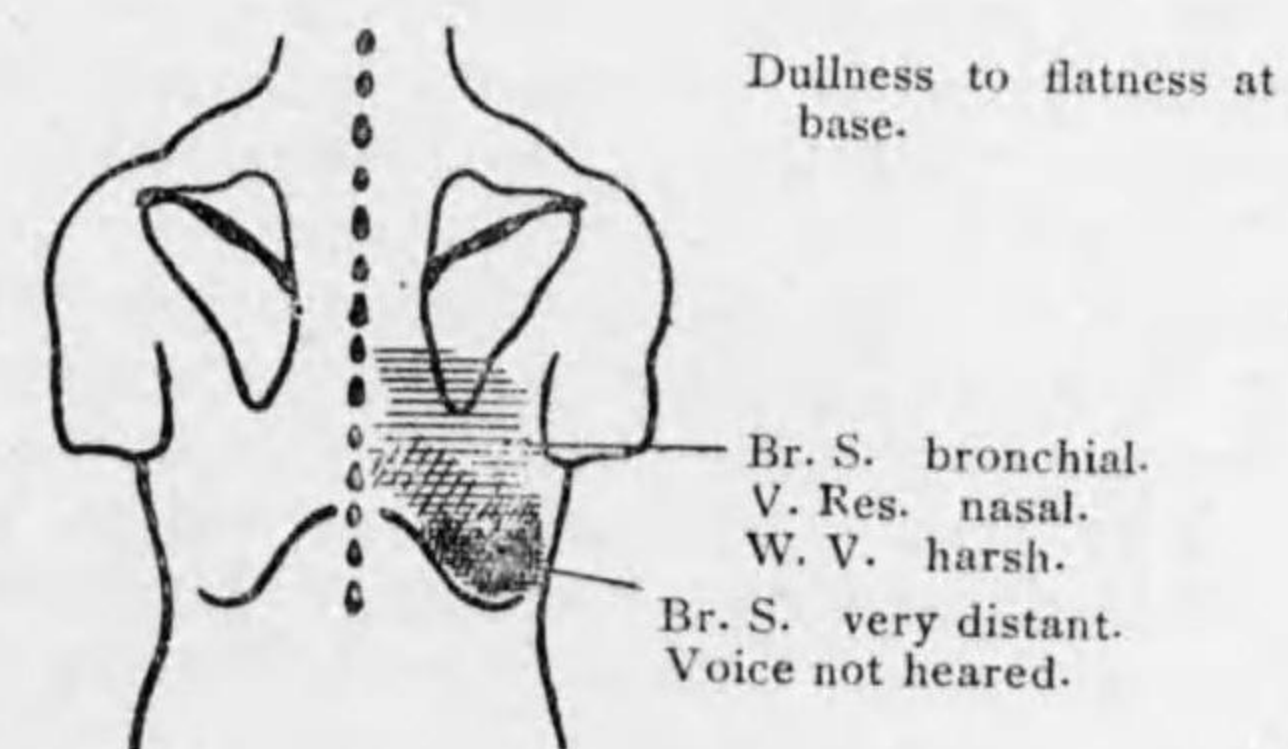
Fig. 108-109-110, taken on Feb. 16 and 17, represent exactly the same picture as before and the previous examination is confirmed. The only differences are, however, in these later pictures, the mediastinal shadow is narrowed, the upper lobe presents homogeneous haziness limited below by thickened interlobar pleura. Just above the fluid level, and to its right there is an irregular shaped rarified area, surrounded in its lower portion, by dense concave shadow. This is quite suggestive of abscess cavity. On Feb. 13, 1923 patient was fluoroscoped and showed much thickened pleura with a probable cavity and pleural fluid.

L. P.

Jan. 9th, 1923.



Jan. 9th, 1923.



**Case XVI. I. T.**

Japanese, age 36.

The patient was first seen in consultation at his home on April 10, 1923, and obtained the following history. His chief complaint was abdominal pain and progressive weakness. His family history as well as his past history was negative except that he had few attacks of epigastric pain in the past.

Present Illness: About two months before he was exposed to cold weather for two days, then he experienced sudden severe pain in the upper abdominal region, which made him double up. This was followed by prostration, and he vomited bitter yellowish fluid which did not contain any blood. His doctor was called in who made him take citrate of magnesia but the patient vomited out. Any substance by mouth gave him severe abdominal pain, and the doctor gave him hypodermically. Patient described his abdomen "stiff and hard as stone." The patient was seen by the doctor every day who told him that he had indigestion. This condition remained about the same although the abdominal pain got a little better, but he would have severe epigastric pain if he ate anything and so that the patient was nearly fasting for past 45 days losing most of his weight. Another doctor was called in who said he had constipation and he treated him accordingly. Patient thought he had mild fever. The pain was first at epigastrium, but later shifted more to the right and around the back, but not as far down as to the iliac regions. His abdomen continued to be tense, his stool was noticed tarry at first and later constipated and suffered from gas.

The Physical Findings: On April 10th or 45 days after the onset of his illness. Patient under developed, extremely emaciated, lying in bed on his left side, with thighs flexed on abdomen and apparently in pain. Temperature 100 F, Resp. 20, pulse 84. Thorax movement on the right side somewhat restricted. Signs in the lung practically negative except as charted. Abdomen: The right rectus muscle was held tight especially in upper half; tenderness at epigastrium, right subcostal region and posteriorly on the right side and at the level of the 10th dorsal vertebra; mild spasm of right lumbar muscles; both iliac regions were negative. With the tentative diagnosis of gastric ulcer, I prescribed a bismuth mixture and referred the patient at Bellevue Hospital for investigation of his gastro-intestinal tract. By the way, the patient stated that almost immediately after taking the bismuth mixture the pain became very much alleviated and he could eat soft meals without having pain. Patient was observed in Bellevue Hospital for 5 days, X-ray findings were said to be negative, and was discharged on April 16, with the diagnosis of "chronic constipation." Patient returned to me on the same day and about this time developed cough and began to raise some "cheezy smelling" sputum and foul smelling gaseous eructation. The signs in the chest became more distinct as pointed out in the chart. The sputum amounted to 150 cc. in 24 hours settled in three layers and repeatedly negative for tbc. The tentative diagnosis was lung abscess following perforating gastric ulcer. The case was further studied at the clinic of Cornell University and the following data were obtained.

X-ray of the lungs shows evidence of tuberculosis process in the right upper lobe. Toward the base, pleura thickened there seemed to be adhesions to the diaphragm.

Fluoroscopy of the right chest showed a marked shadow at the level of the 5th rib which indicated a shifting fluid level with the position of the patient and with respiration. Urine: specific gravity, 1017 and no pathological findings. Blood: Hemoglobin 60%, R. B.C. 4,382,000, W. B. C. 7,500, polys. 44%, Lymphos. 55% and Monos. 1%. It is probably that this patient has an abscess of the lung. Not findings to support a diagnosis of tuberculosis except the X-ray. Gastro-intestinal examinations were not account of the weakness of the patient, and he was admitted to the hospital on May 15, 1923 and once discharged on July 6th, 1923 with some improvement;

Summary during his first residence in the hospital: Urine, negative; Blood, hgl. 80%, W. B. C., 8,200, later 6,800, poly. 70%, trans. 4%, lymph. 25%, eos. 1%. Wassermann negative. Fluoroscope: perforated duodenal ulcer with extension through diaphragm—exploratory puncture at 4th inspace on nipple line, 1 cc. of pus obtained which was sterile on culture.

His second admission was from Oct. 16 to Nov. 23, 1923. Summary of second admission: General condition much improved. Laboratory findings: blood count normal, sputum negative for tbc. volume varied from 20-100 cc. per day.

Fluoroscopy—shadow at right lower chest; adhesions involving first and second portions of duodenum.

Course: Postural drainage, artificial pneumo-thorax a. 300 cc. b. 400 cc. Hemoptysis 8 oz. 3 hours after 2nd a.p.t. on Oct. 27th followed by several hemoptysis of 2-3 oz. each within next 12 hours. Has had daily small haemorrhages of 2-3 oz., last one on Nov. 2nd. Since then cough has diminished and temperature normal.

Physical exam.: Lungs, anteriorly, normal resonance and fremitus on both sides except on right side below level of nipple where percussion note is flat. Breast sounds are vesicular on both sides except over flat area where they are absent. Breath sounds in axilla extend to base of lung. Posteriorly, lungs are resonant throughout, breath sounds are faint but vesicular. Tactile fremitus normal. Rest of physical examination not important. Patient sent to the country (Burkes Foundation).

Summary of third admission:

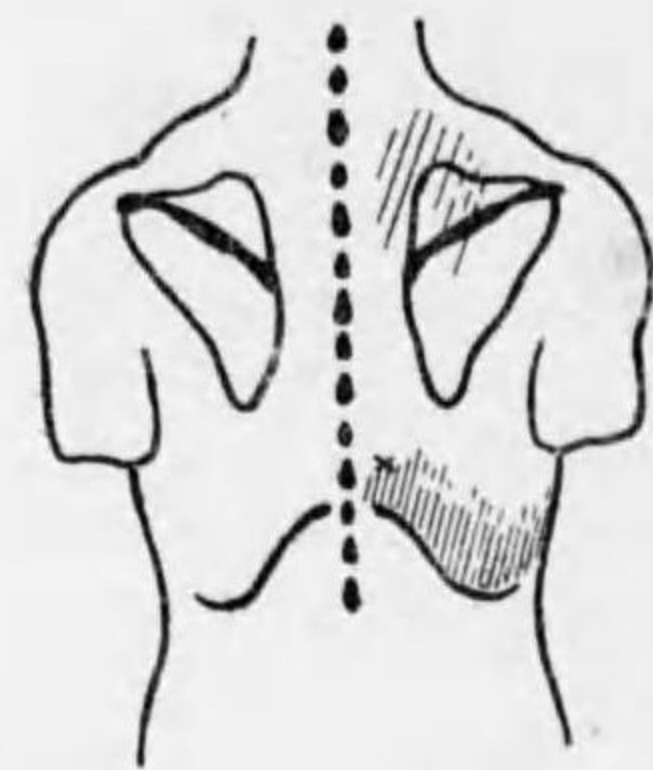
At Burkes Foundation until the time of admission (Nov. 23rd), general condition improved except for slight persistent cough. Laboratory findings: blood count normal. Sputum negative for tbc., sputum 1/2 to 1 cupful each night. X-ray showed area in right lower lobe unchanged with tbc. infiltration in right upper lobe.

Course: During stay had several hemoptysis. Operation was considered inadvisable by Dr. Hitzrot for the reason that the patient was up and about ward during last part of stay and had only slight cough. Temp. and pulse practically normal after December 24th.

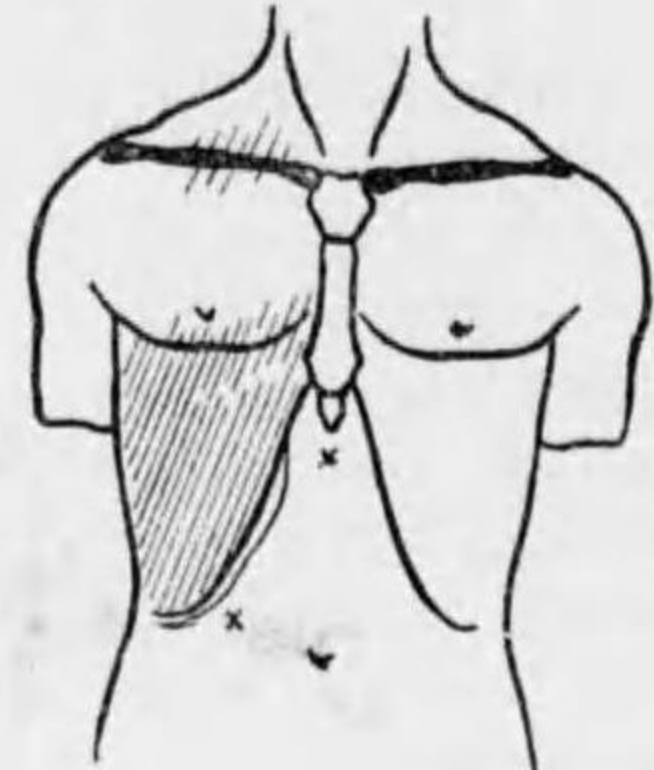
Physical Exam.: Positive findings include diminished resonance at right lower area, dull below 4th space. Breath sounds diminished and a few rales is in same area: signs posteriorly same as in front. Improved; but on Jan. 19th had several hemorrhages amounting to three cupfuls. On Jan. 20th had another of one cupful and says he had severe pain in the left chest. Came to hospital on Jan. 21st, 1924. Patient was transferred to Bellevue hospital on Feb. 19, 1924 and from that time on his case was a puzzle, one time he was thought to be tuberculous and at other times chronic lung abscess. On Feb. 26 he was needled under Fluoroscope at point just inside the right nipple, needle was pushed in until it was about 3 or 4 cm., and a very definite resistance was felt but no fluid obtained. On Feb. 27 a.p.t. 270 cc. of air, no reaction,

Case XVI.

April 7th, 1923.

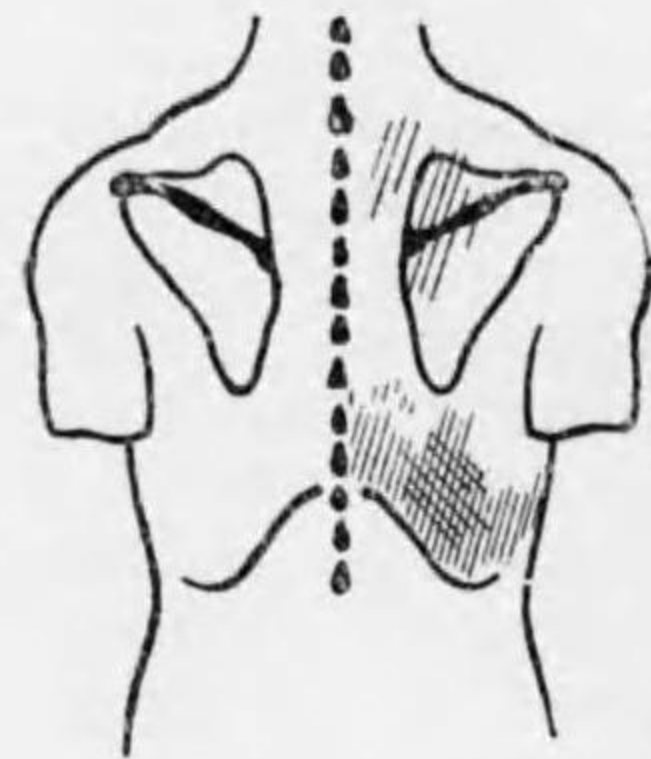


Br. S. dim.  
Tenderness.  
Dullness—slight.  
B. S. dim.  
V. F. and V. R. dim.  
Muscular spasm.

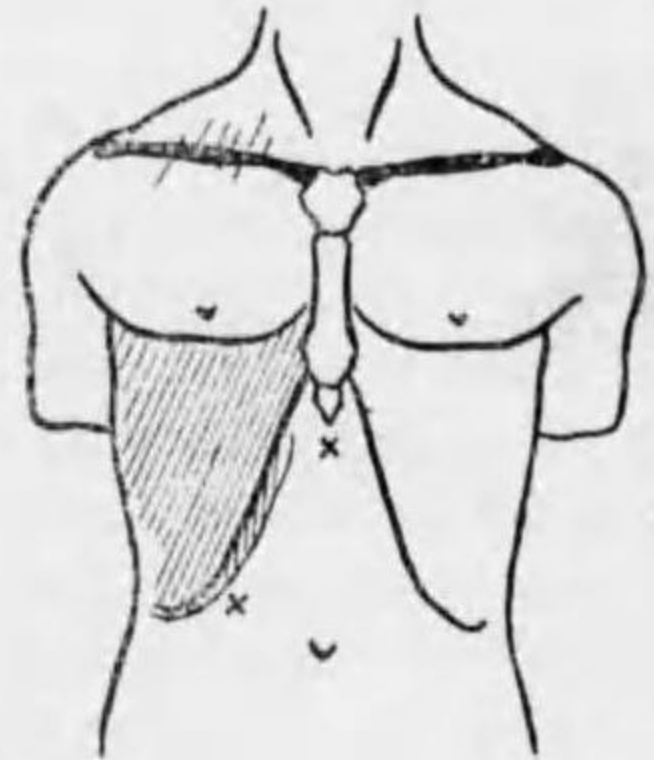


Tenderness.  
Muscular spasm.  
Hypersensitive.

April 16th, 1923.



Dullness.  
B. S. dim.  
V. F. and V. R. dim.  
Othersise same as above.  
Diag. Chronic gastric ulcer subdiaphragmatic abscess. Gall stone or chronic appendicitis.

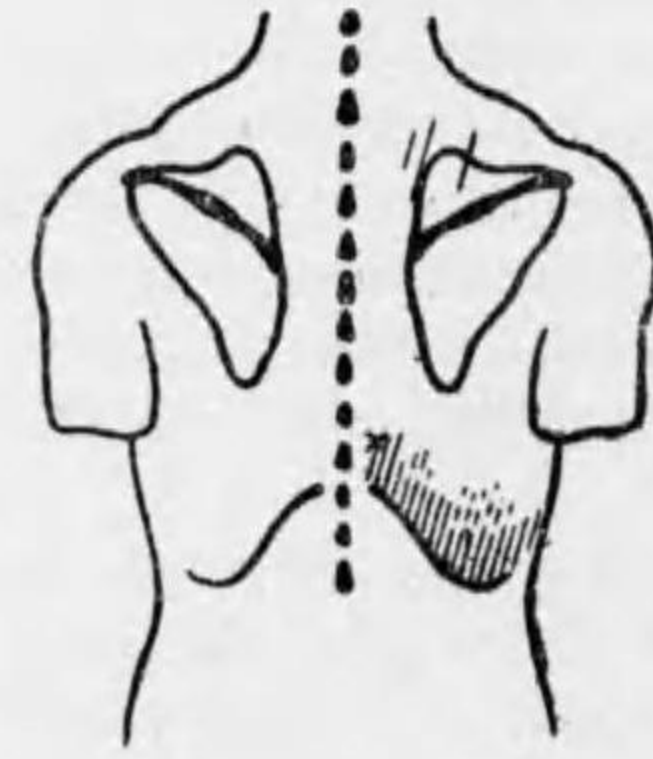


Tender and liver palpable, one finger below costal margin.

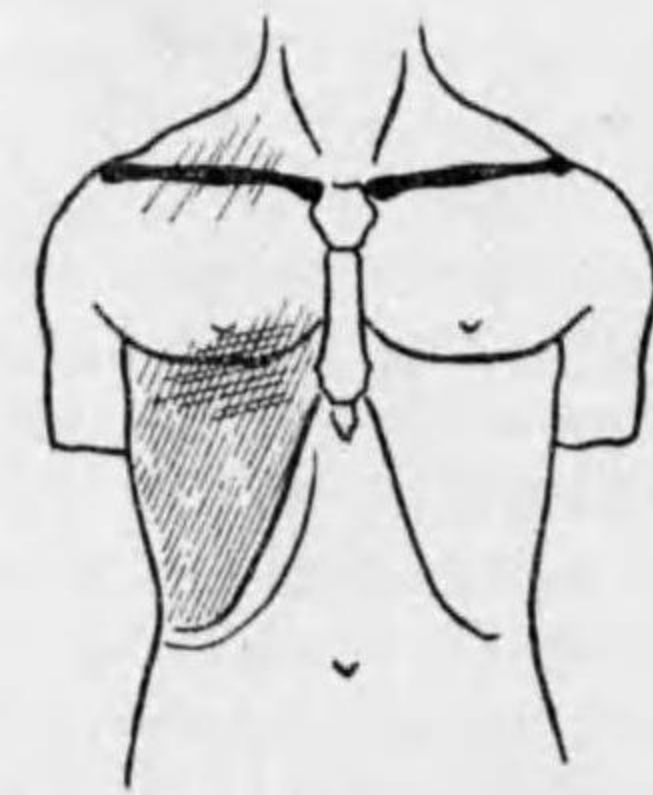
April 30th, 1923.



Pain and tenderness on below 9th rib. right side.



B.S. distant bronchophony.  
W. V. dim. but high p.

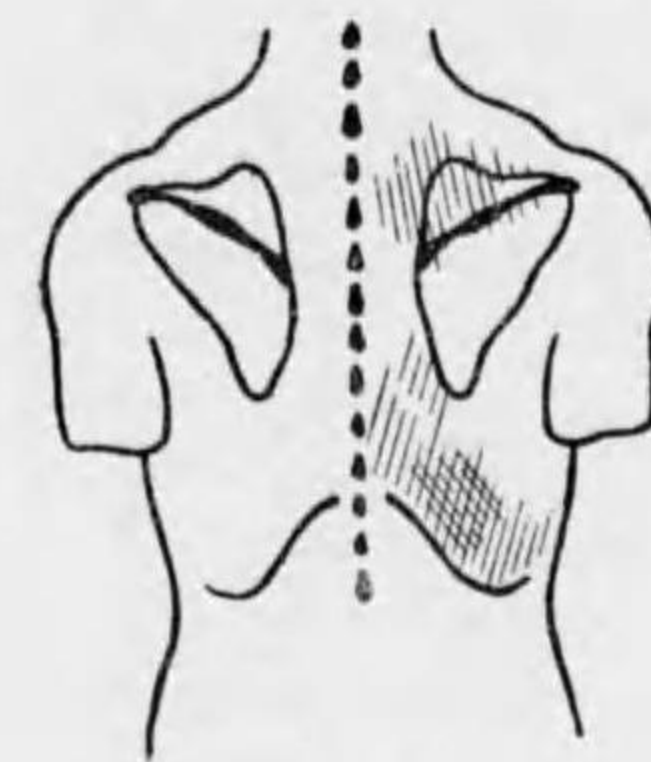


Below 5th rib.  
Increased dullness and distenderness and liver edge palpable.

Dullness increased and higher. where B. S. is absent.  
V. F. and V. S. present but dim. Rales none. W. V. very faint, but harsh quality.  
Diag. lung abscess (?).

Case XVI.

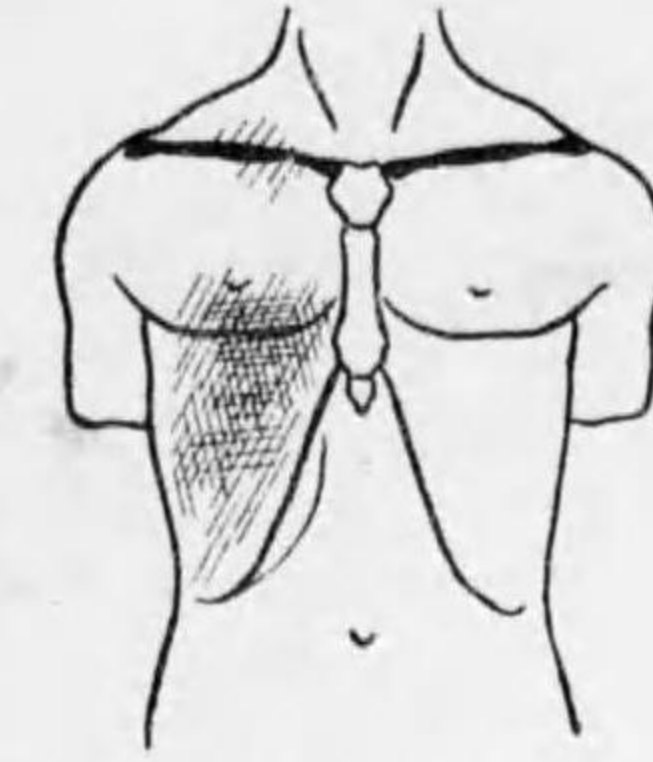
May 11th, 1923.



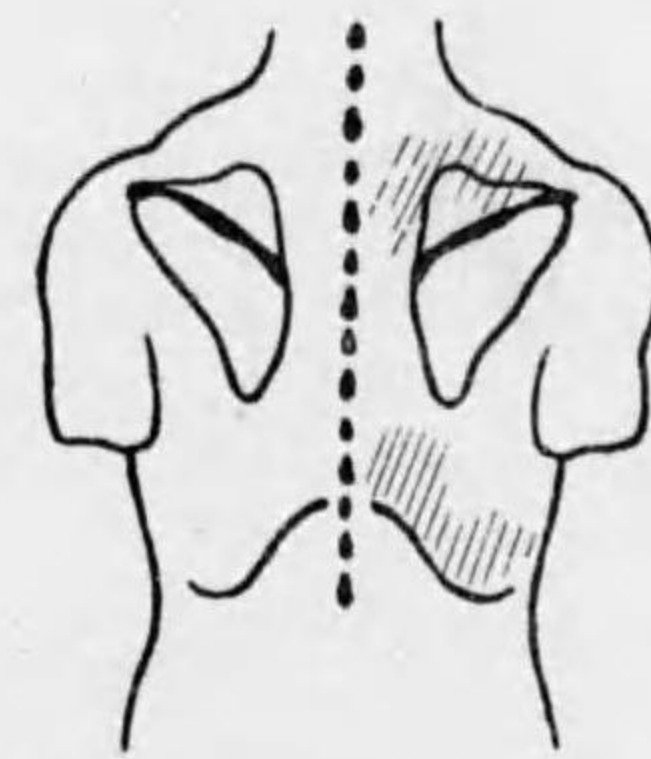
General expansion poor, right lower chest more prominent than the left side.  
Posterior signs less marked than before.



Dullness increased below 4th rib. B. S. dim.  
V. S. and V. F. dim.  
W. V. dim. and high pitched. Otherwise same as before.



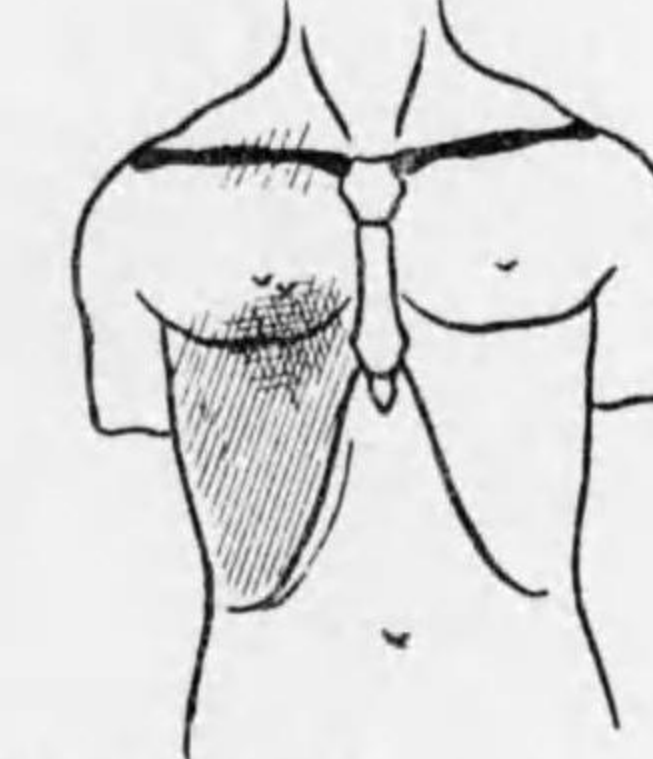
May 16th, 1923.



B. S. harsh, occasional crocotes. Posteriorly signs still less.



Similar signs below 4th rib.

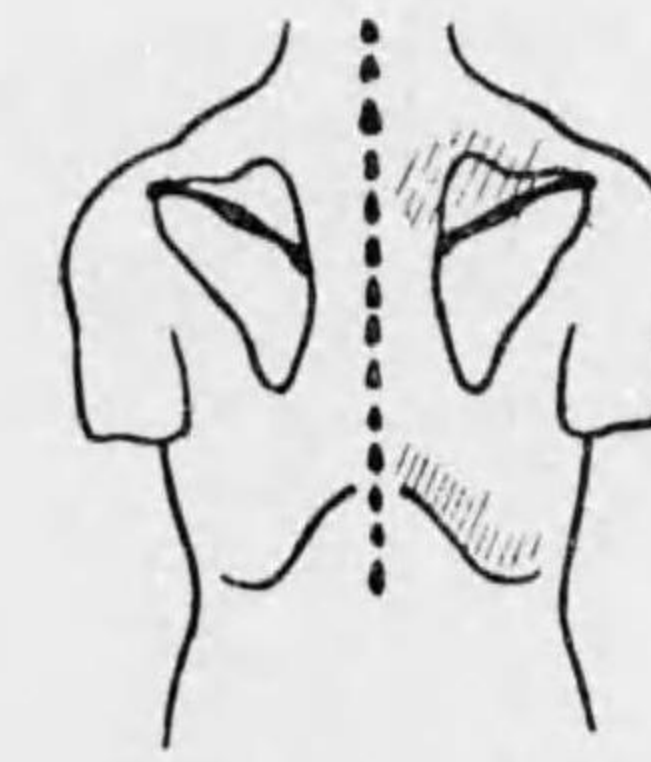


Hyper-resonant.

A few days later exploratory punc. at (x) obtained 1 cc. of creamy pus, whose culture resulted negative.

Similar signs and condition continued without change.

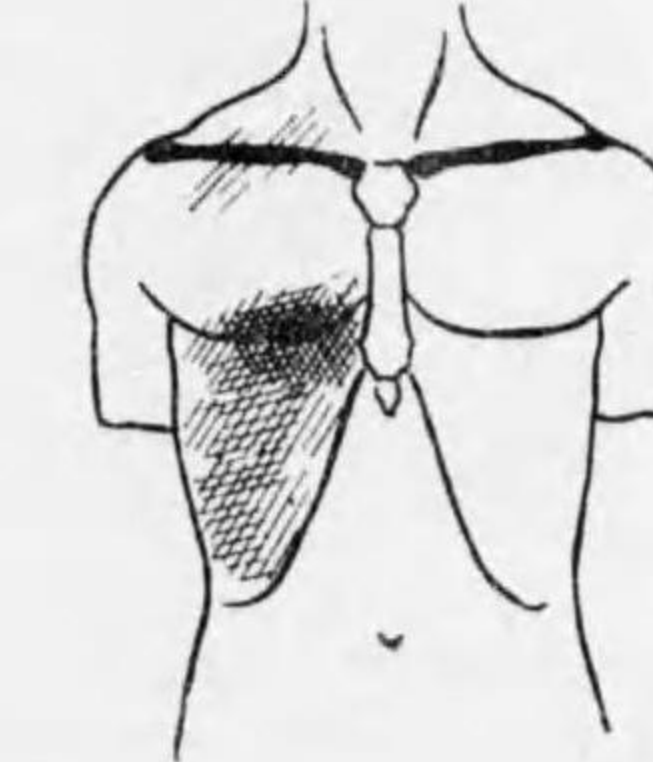
October 17th, 1923.



Rt. side generally, normal resonance, Br. S. dim. but vesicular. V. F. and V. S. normal.



Dullness. B. S. normal.



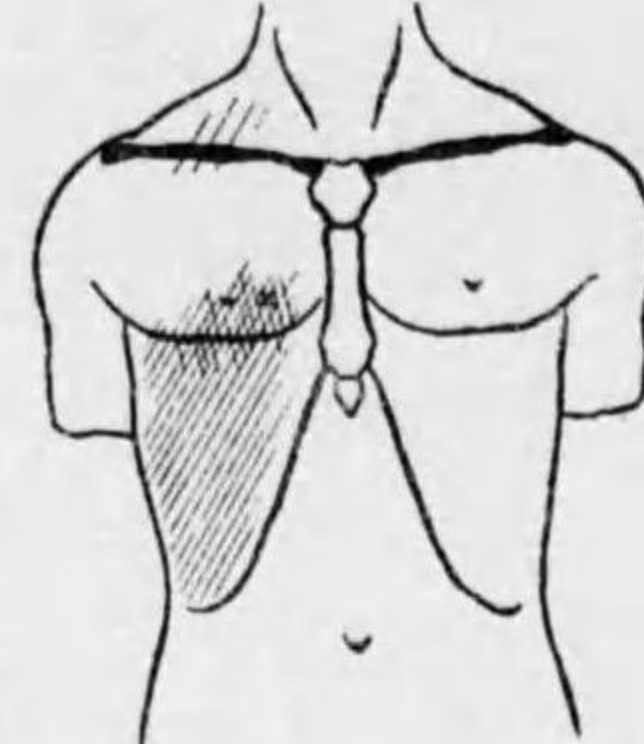
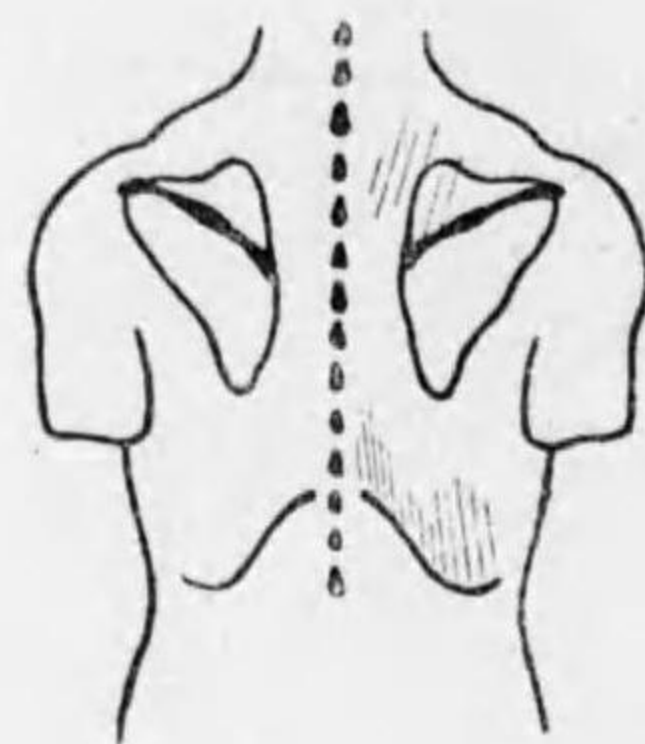
Flat and B. S. absent.

Notice gradual disappearance of the signs posteriorly and the concentration of the signs anteriorly.

Case XVI.

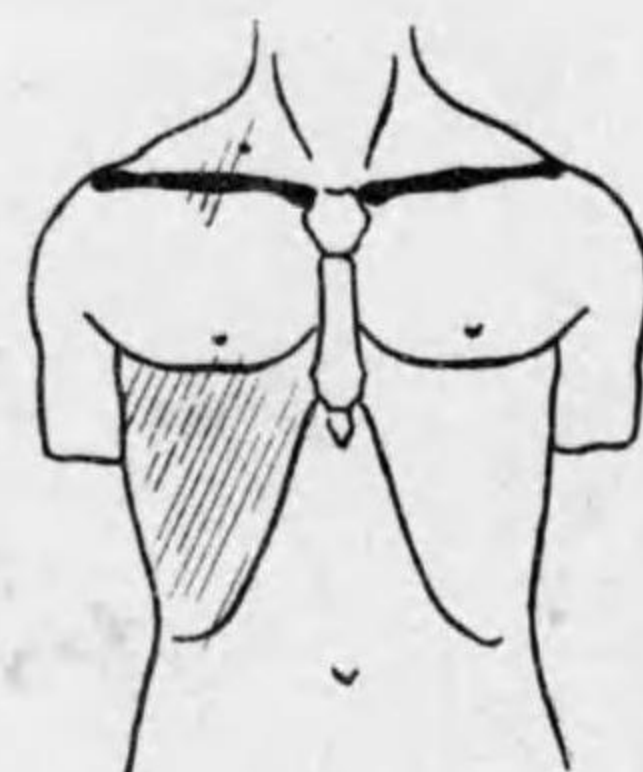
February 25th, 1924.

On Feb. 20th, given 150 cc. diagnostic air;  
On Feb. 22nd, given 250 cc. diagnostic air;  
On Feb. 27th, given 270 cc. diagnostic air;  
No effect produced.



Practically negative physical signs except anteriorly, which is less marked than before. Exploratory puncture at (x) met a definite resistance and nothing obtained.

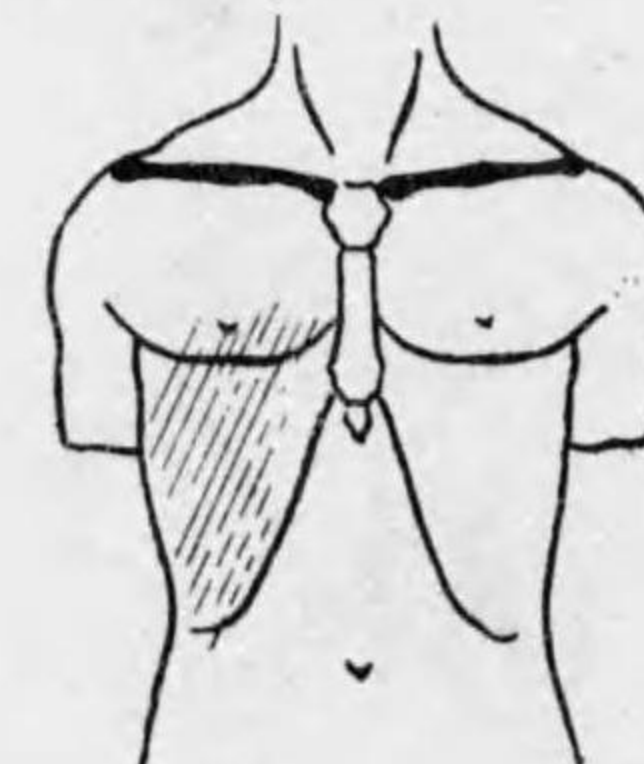
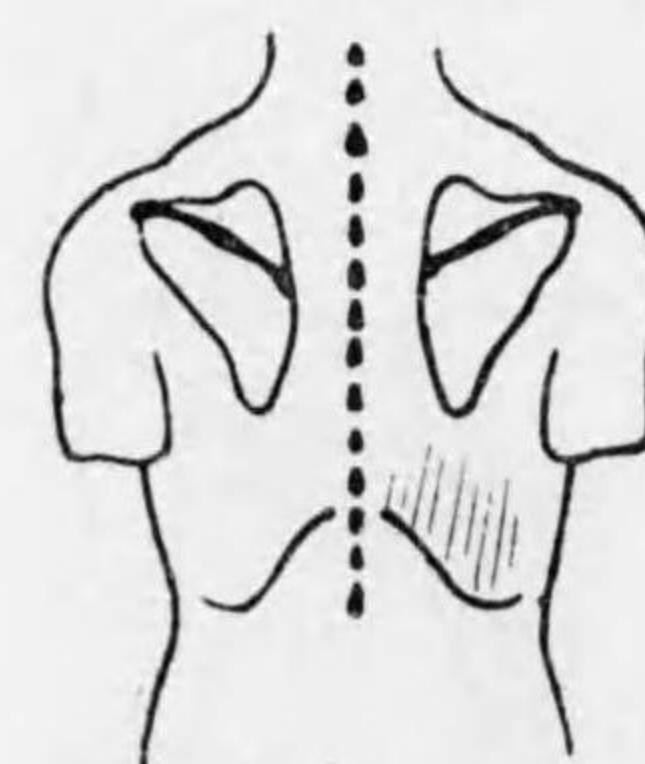
February 19th, 1924.



Negative. Br. S. slightly decreased. Only slight dullness. A few fine rales. Similar condition persisted without any change to the physical signs.

April 20th, 1924.

On April 19 bronchoscoped and as patient coughed, pus was seen to come out from bronchus of mid lobe (?). The following day pt. had fever and restlessness. Signs at base somewhat increased but not definite enough for pneumonia.



Dullness slightly increased.  
B. S. dim., broncho-vesicular.  
V. Res. slightly nasal.  
W. V. dim. but slightly high pitched.

Pt. quickly recovered from the temporary disturbance; exploratory thoracotomy performed on May 15th, but no pathology revealed.  
Patient died of streptococcus haemolyticus septicemia, May 23rd, 1924.

and no collapsing of lung obtained. April 19th bronchoscopy in examination showed: mucous membrane of trachea appeared normal, no pus in trachea on either side. After coughing, a small amount of pus could be seen coming from the right middle (?) lobe bronchus. Patient became acutely ill after bronchoscopy, but recovered after a week. May 15, exploratory thoracotomy was performed. The operative findings were: There were no adhesions in the anterior portion of the chest, and lung collapsed on opening the chest. The lung looked dark in color, but no signs of abscess could be found. The pleura was not thickened. Operative diagnosis (?).

Outcome—patient died of streptococcus haemolyticus septicemia following the operation, a very unfortunate occurrence.

X-ray Findings:

Fig. 111, May 11, 1923, antero-posterior view in erect position. There is a homogeneous hazy shadow at right lower lung, below the level of the 7th dorsal vertebra. The right diaphragm is highly situated, and its upper limit is seen with difficulty through the upper hazy shadow. The upper border of the shadow is sharply defined and dome shaped instead of being concave as usually seen in pleural effusions. Increased lung markings are seen through this shadow. The right diaphragm seems to be adherent at its inner 1/3. The shadow suggests a sacculated liquid at base of the lung, rather than consolidation of the lower lobe, at least the upper dome shaped clear outline and the physical signs do not confirm the latter diagnosis. The right root is thickened. The upper portion of the right upper lobe is clouded, which is not characteristic of tuberculosis but suggests more chronic engorgement. Heart seems to be slightly displaced to the left.

Fig. 112, the postero-anterior view in erect position, May 11, 1923. This presents practically the same picture as that of antero-posterior view, excepting a certain difference which has bearing of some importance. The heart is not so far to the left side, but its shadow is more condensed. The shadow at right base is more dense at its upper portion and assumes a triangular shape with the apex downward. This concentration of the shadow should be considered as due to the fact that the sacculated liquid is situated nearer to the anterior thoracic wall. Such picture is never presented by free fluid in the pleural cavity. Furthermore the triangular shadow appears mottled by presence of a few rarefied areas, and with its inner upper angle it appears as if it is connected with bronchus giving "hooked like" appearance. The "vacuolization" in the shadow may be caused by scattered aerated lung tissue or abscess. The Fluoroscopic examination in postero-anterior position showed that there was a shifting level of the fluid and it moved up and down with respiration. There are various possibilities in the nature of this shadow and many interpretations was made by different observers: (1) a sacculated fluid at base, (2) pneumonic consolidation of lower lobe (v.i. Wessler and Jaches, Clinical Roentgenology of Diseases of the Chest. Page 205), (3) a thickened pleura, (4) lung abscess, (5) pleural effusion. This is to be decided by later Roentgenological evidence.

Fig. 113-114. May 16, 1923, antero-posterior view. Presents the similar picture except that there is more density in its inner third at base, and not as homogeneous as the previous picture.

Fig. 115-116. June 12, 1923. The density is of hazy character, upper border being indistinct, and thickened bronchial walls are brought out.

Fig. 117-118. June 25, 1923. Some haziness at the right base, but here its upper

border is more indistinct. Right root is more thickened and appears fibrous; the right upper lobe is shown in "net work" like mottling suggestive of congestive nature rather than tuberculous.

Fig. 119-120. Oct. 17, 1923. Very similar to the one taken on June, 1923 (Fig. 115) however, there is a suggestion that the bronchus is pulled to the right and somewhat dilated. The upper level of the basal shadow is much lower now than the first picture and suggests more localized thickened pleura than abscess of fluid. Milder induration in the lung tissue cannot however, be eliminated.

Fig. 121-122. October 22, 1923. The level of right diaphragm is higher than previous; lower right bronchus quite thickened; there is a same haziness at base but no definite evidence of abscess, although there is a circular area in mid portion of the hazy area although without abscess wall.

Fig. 123-124. November 2, 1923. There is again increased density re-appearing at the base with clear cut upper border. This picture will clear up all mystery about the case. In the small print, Fig. 124, the character of the density is shown in detail. There is a group of small ring formation packed together giving honeycombed appearance. They are surrounded by indurated lower lobe which is shown by homogeneous character of density. Lower bronchi are shown much thickened and dilated.

From foregoing series of Roentgenograms, the probable pathology is made out as follows: There was at first induration of right lower lung with sacculated basal empyema, and later penetrating into the lung. This partially healed and bronchiectasis was the result, cough and expectoration continued; stagnation of infective product re-infected surrounding lung tissue and there was again localized pneumonia. This process will continue to be repeated in this case, which we will see in the later development.

Fig. 125-126-127. November 19, 1923. The shadow at the base has decreased in density but it is now more fibrous in appearance. A few calcified nodes near the root, upper lung field appears more mottling with fine "net-work" markings. The descending bronchus appears to form sacculated dilatation.

Film taken on December 8, 1923, presented similar picture; there is an impression of less density.

Fig. 128. January 22, 1924. This shows much diminished density at base with a few rarefied areas within, otherwise remains the same.

Fig. 129. Feb. 15, 1924. This film was taken at low focus so that the diaphragm is more highly situated in relation to the ribs. There is again increased shadow at the right base, appearing mottling or rather honey-combed. The right mediastinal border is widened probably due to traction on mediastinum. The upper field appears more granular or blotched.

Fig. 130-131. Feb. 25, 1924. There is again distinct increase in the density as observed in Fig. 125. The patient is repeating the same process of infiltration; otherwise the same. Exactly the same picture presented on March 24, 1924.

April 14, 1924, about the same. This time the induration persisted for a long time and within the shadow there are bronchiectatic cavities observed. In addition there is slight pneumo-thorax artificially produced with the evidence of adhesion. The heart and mediastinum are found in normal position.

Fig. 132. May 28, 1924. The last film which was taken of the patient shortly after thoracotomy was performed. There is partial pneumo-thorax present. The shadow

has diminished in density. There is thickened interlobar pleura and quite thickened bronchi.

Conclusion: To sum up the Roentgenological course, most of the films were variously interpreted, majority in favor of pleural thickening, and the least for lung abscess. If we look back on the whole, however, with all film in front of us, aided by the clinical course, it becomes evident that the first film indicated lung abscess, secondary to circulated fluid, with indurated lung tissue, which was entirely limited to the right lower lobe. There was rapid healing tendency and it became limited to bronchiectatic abscess, with less parenchymatous induration. The collection, however, again produced acute inflammation, casting a dense shadow similar as before. During a quiescent stage, there would have been little to be seen or felt from outside. If the nature was fully understood, there would have been better chance for the patient under management other than radical operation. Interpretation from a single film taken at one occasion would lead to pernicious misunderstanding.

Localized lesion in the lower lobe at the extreme end of the bronchus with mild symptom—these cases should get better result by bronchoscopical treatment.

The presence of mottling throughout the right lung, which was seen increased in later period, might have been considered as tuberculous; but uniform "net-work" like blotched appearance and the absence of other characteristic Roentgenographic findings, such as miliary calcification "tufted cirrus," "fibro cirrus" cloudiness, together with absence in the physical signs make one think more of other condition than tuberculosis. Scattered chronic broncho-pneumonia, or simply congestive changes in the lung tissue is a more reasonable inference from these films, especially in consideration of the presence of the such chronic disease as bronchiectatic lung abscess.

One interesting interpretation made on one occasion, on a film of the later period, by one of the well known Roentgenologists was "interstitial inflammation of the right lower lobe, with marked thickening of the pleura and fibrosis and shrinkage of the right lower lobe. Within this retracted lobe there are bronchiectatic cavities."

Unfortunately, however, the said shrinkage of the lobe and markedly thickened pleura were not observed at the time of operation. The failure to locate the lesion was due to the fact that it was situated deeply near the vertebra close behind the right border of the heart, in addition to the fact that the bronchiectatic cavities were imbedded in the lung tissue which was not greatly indurated. The sad outcome of the infection might have resulted from the spreading of streptococcus haemolyticus which was imbedded in the chronic foci as the result of manipulation—this type of micro-organism often remains latent in such a chronic focus and may produce sudden fulminating infection if it gets loose.

### Case XVII. J. P.

Boy of eight, U. S. white, family history as well as past history negative, except he had abscess of left femoral lymph node in Oct. 1923.

Present Illness: On September 4, 1924 was operated on hypertrophied tonsils and adenoid. He apparently got well after the operation, but a week after operation he was noticed to be inactive and feverish, and so he was brought to the hospital on September 13, 1924.

Physical Examinations: His development subnormal for his age, poorly nourished, frail looking boy, acutely ill lying on his right side persistently.

Laboratory Findings: Blood, red, 3,464,000 Hbg. 65, W. B. C. 15,000 poly. 90% Blood culture sterile. On admission Temp. 103, p. 120, Resp. 28. Lung signs as charted.

Course: Sept. 17, 1924 thoracentesis gave 7 cc. sero-sanguinous fluid. Has moderate cough, but no expectoration. On Sept. 29, numerous rales on the right back all disappeared and only an area of dullness, bronchial breathing, bronchophony persisted. About October 4, child was up and around, apparently feeling well, temperature flat. About Oct. 7 our little patient appeared more or less inactive, more pale and had evening rise of temperature. There was no cough or expectoration. Physically, the localized area of bronchophony became somewhat increased in size and in intensity. Then a few crackling rales appeared in lower level. On Oct. 14, a small needle was put in the 9th i.c.s. 6 cm. to right of spine, and about 10 cc. of thick green yellow pus obtained. Radiography on October 7 indicated presence of fluid. Operation Oct. 15, 1924. Short curved incision was made over 8th rib in mid scapular line on right. Rib exposed and resected for an area about one inch. Pleura, which was considerably thickened, was then opened and a large amount of thick greenish pus escaped. Cavity aspirated and a rubber tube drain inserted.

Post-operative course was uneventful, made slow but gradual improvement and patient was sent to the country about four weeks after the operation.

Fig. 133 taken in prone position on day of admission or Sept. 13, 1924. There is density in middle portion of right lung field, involving lower 2/3 of upper lobe. It is most dense and mottling at root, while periphery it becomes diffuse. Its upper margin is hazy and diffuses into normally radiant lung field. Its lower border is rather more dense and mottling while the outline is indefinite. This picture suggests acute destructive area near the root; a rarefied area at root at level of 5th and 6th dorsal vertebra does not indicate cavitation but it is suspicious; the outer diffuse area is due to reactive pneumonitis. The right diaphragm is placed high and the heart is somewhat pushed to the left. The physical signs are rather scant compared with the radiography. Costophrenic angles are clear, the right lower lobe is not involved.

Fig. 135-136 taken in erect position on September 18 or five days after the first film. The pneumonic shadow now spreading to lower half, and it is of diffuse hazy character suggesting thickened pleura. The mottling density at root is still present, although it is at slightly lower level than in previous picture which is probably due to erect position, and to low focus. The interlobar pleura is thickened, the heart is back to its normal position. The diaphragm is in usual low position; costophrenic angles seem to be clear. Along axillary border there is a faint streak or shadow suggesting fibrous pleurisy. This suggests now more pleuritic involvement with localized induration at the root. The physical signs in the upper region indicate some localized consolidation and bronchitis. The signs at base agree with thickened pleura.

Comment: Looking back on the history, physical signs, and the X-ray information and the finding of sacculated pus pocket in pleural cavity makes it possible to assume that a small abscess cavity at the root of middle lobe broke through and became sacculated between the lobes. First the patient appeared much improved with flat temperature, corresponding to the period of the rupture of the abscess into the pleural cavity. The second rise of the temperature and toxic symptoms were due to empyema.

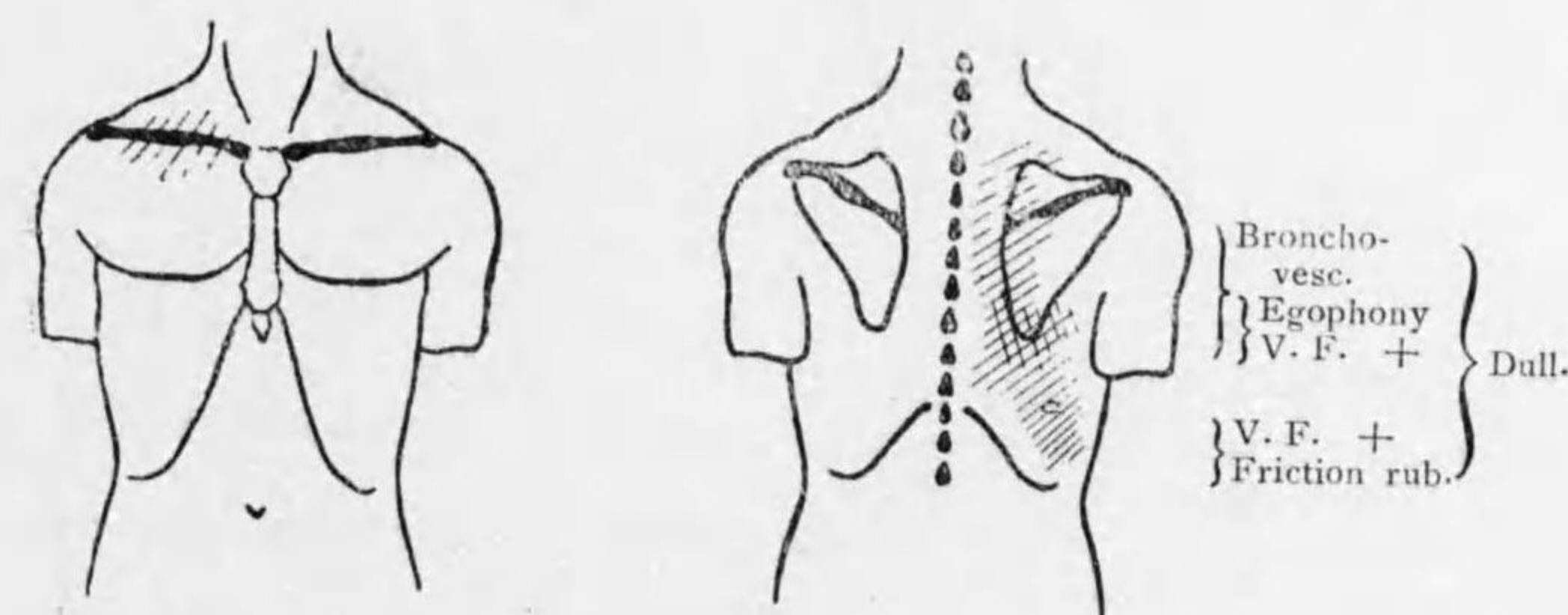
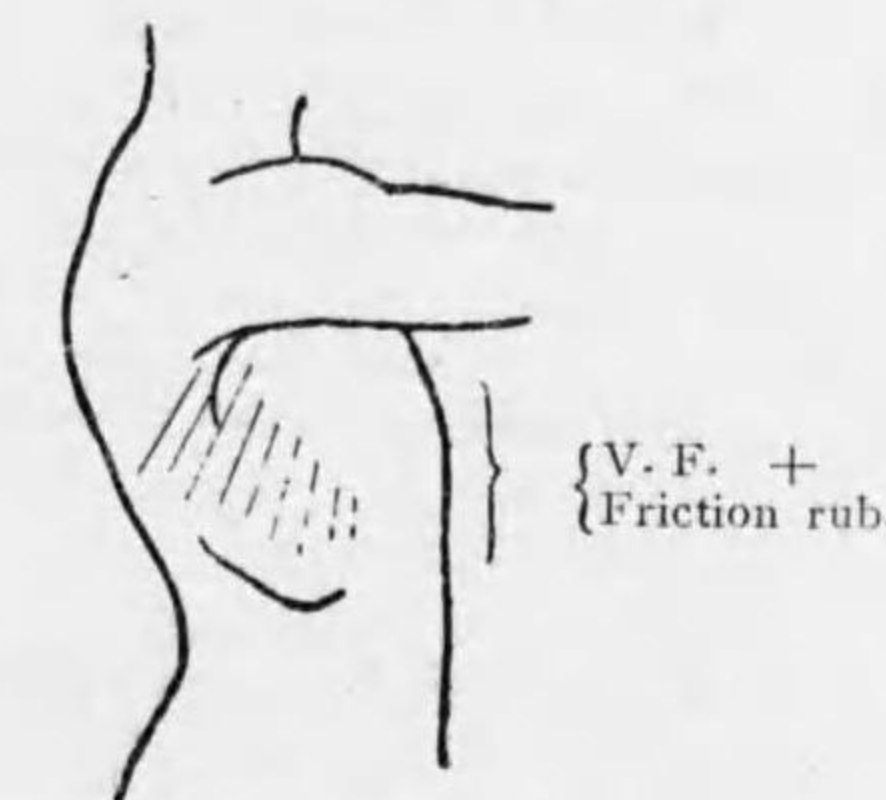
Fig. 137. September 26th, erect position presents practically similar picture: density at root is diminishing, but there is increased haziness. At lower axillary region shadow is becoming more dense. The right costophrenic angle is filled and suspicious of very small amount of fluid.

Fig. 138. October 7, 1924, erect. Haziness in lower half still increasing, diffuse homogeneous, lung markings are scarcely visible through the area, suggesting quite thickened pleura with fluid at base.

Fig. 139. October 23, erect. Right after thoracotomy and drain tube in position. There is intense mottling at root and increased linear markings on the root.

Joseph Phellan — I.

September 13th, 1924.

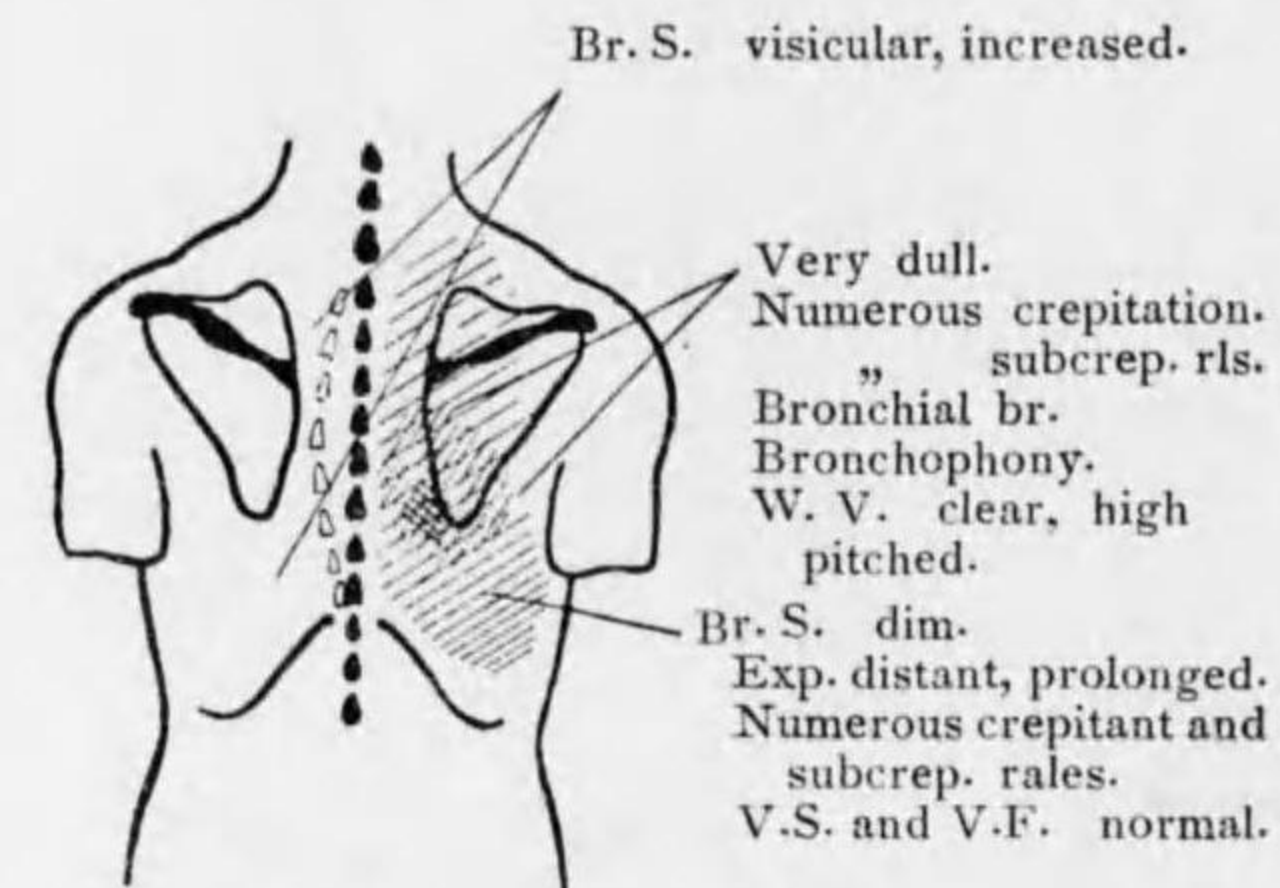
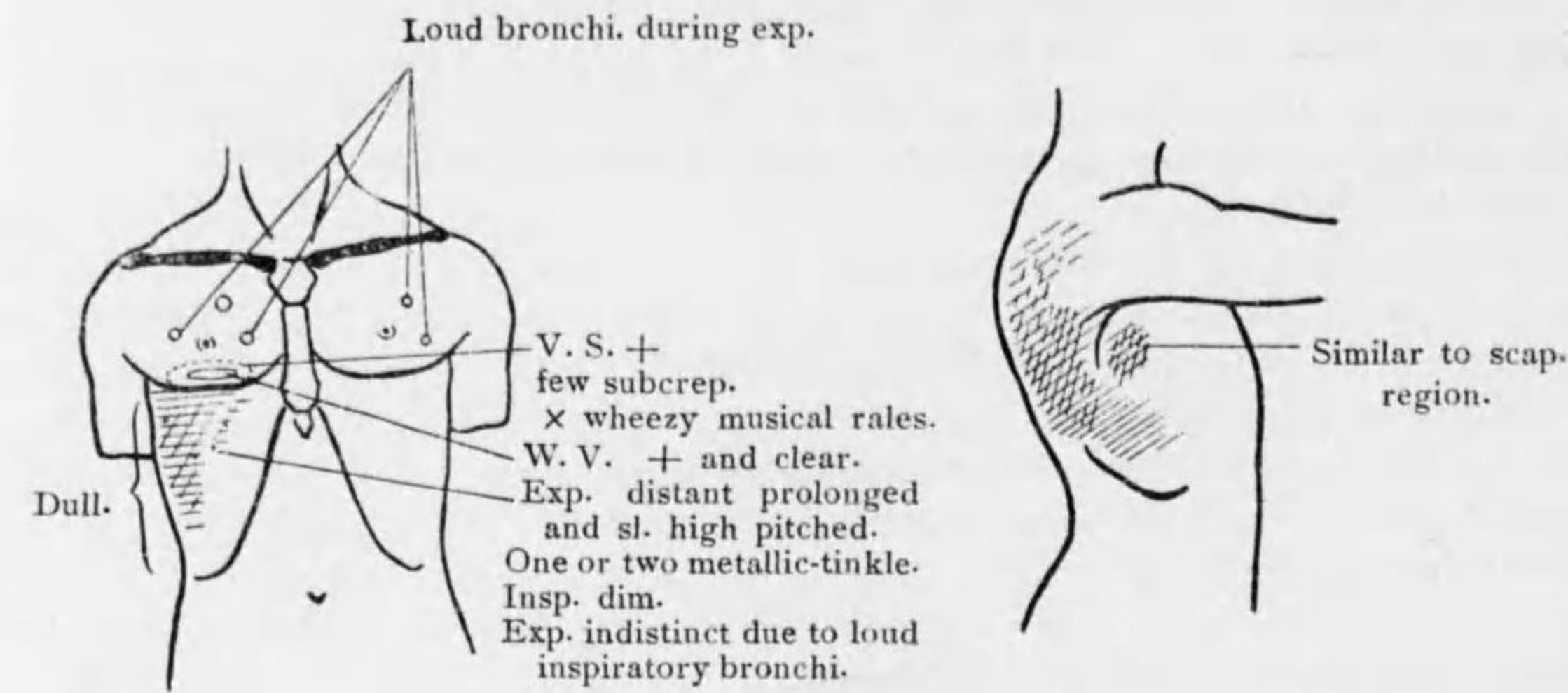


X. R.: Large area of increased density on Rt. lower. Diag. pneumonia or lung abscess. Sept. 13th, 1924.

Sept. 18th, shadow in Rt. chest more dense than previous occasion. Interlobar pleurisy in upper and mid lobes—suggests more pleurisy, nothing conclusive of lung abscess.

Joseph Phellan — II.

September 19th, 1924.



Heart: In 5th i.c.s., on nipple line.

Left lung: Normally resonant, breath sound generally increased, expiratory bronchi probably transmitted from right.

Rt. lung, upper anterior normal resonance; very loud expiratory bronchi. interferes detection of expiratory sound.

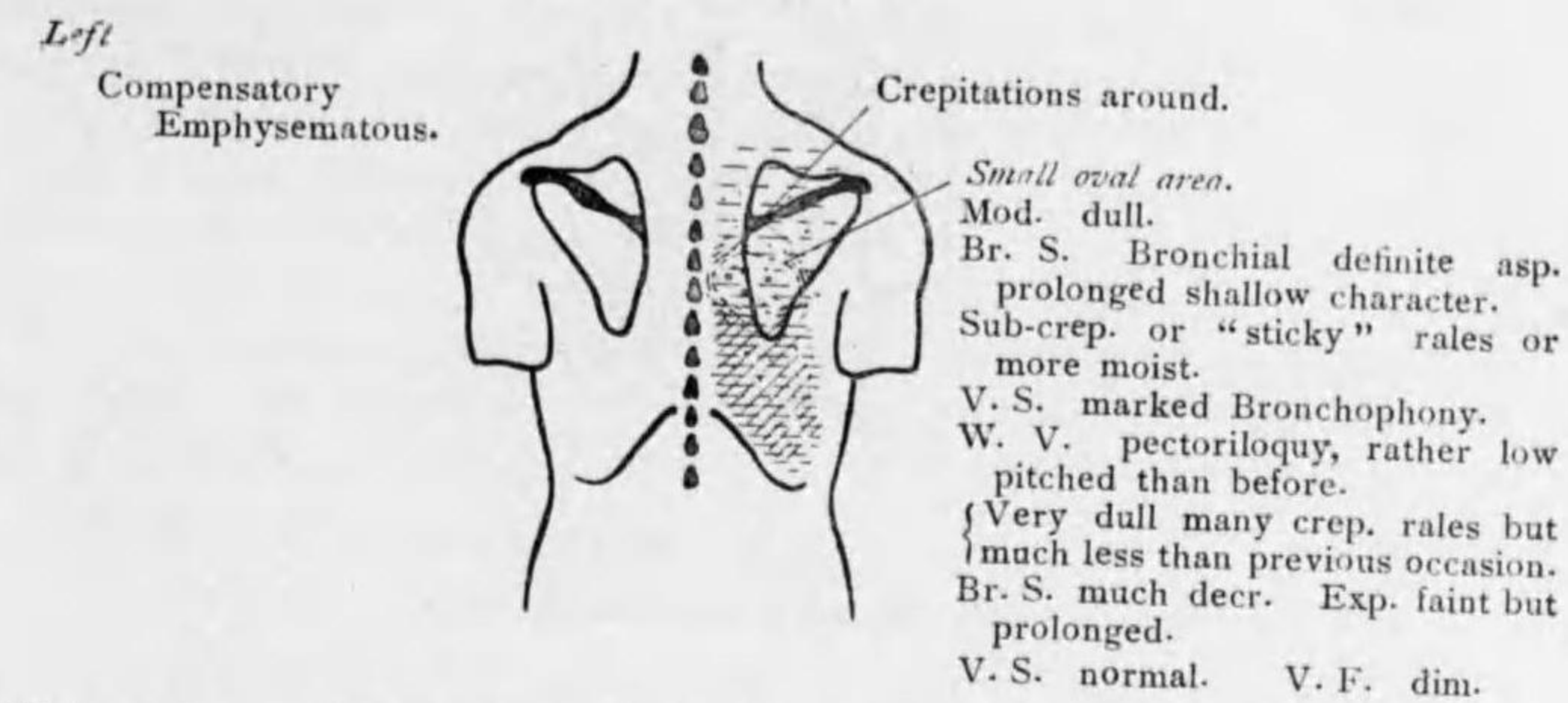
This bronchi and numerous rales probably mostly originate in bronchi and bronchioles; the child is weak and hardly coughs out the mucus.

There is no definite sign indicating the presence of cavity; but pneumonia seems to be the chief cause. Diag. Lobar pneumonia of lower lung, and broncho-pneumonia of upper.

Child is weak, no throughout examination of the base was made, but seems to be that there is no collection of fluid there.

Joseph Phellan. — III.

September 26th, 1924.



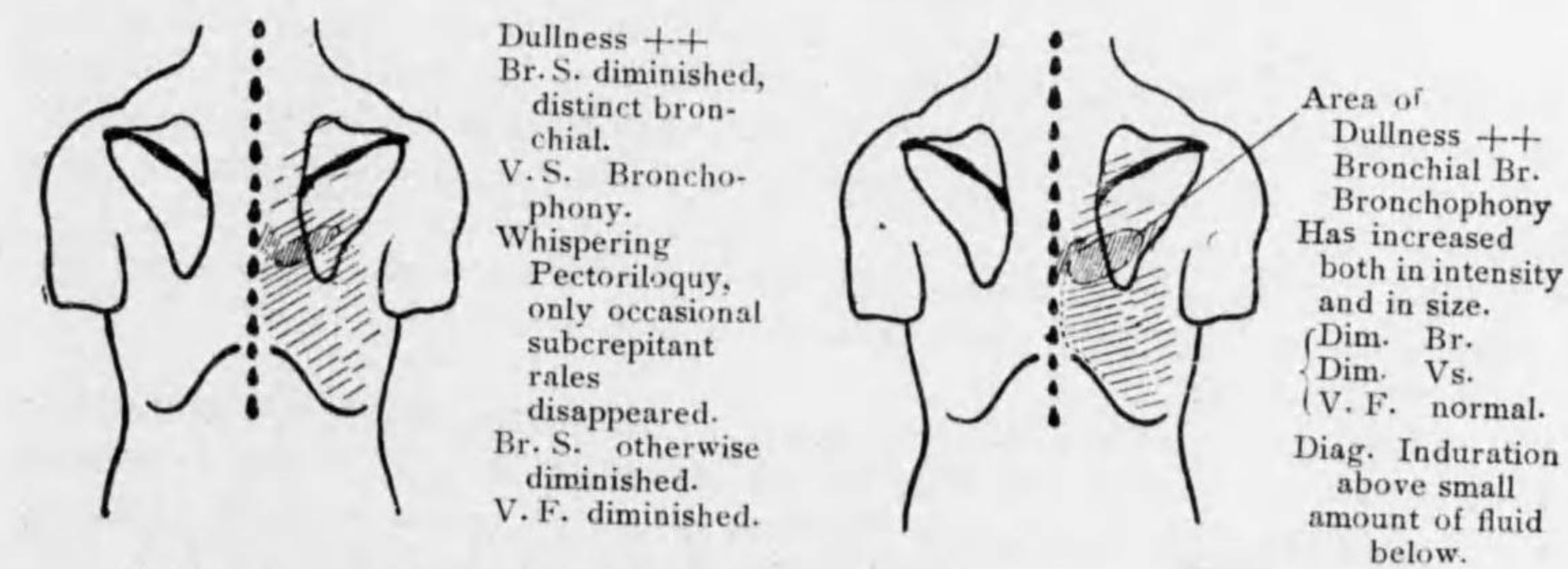
Child is sitting up in bed, apparently feeling much better; coughs occasionally, sounds more moist, does not bring up.

Lung signs posteriorly: The interscapular region which was most dull at an early period, is now much less so, while the portion below this is quite dull always through to the base. The small area with bronchial breathing, at level of 5-6th spine, reaching laterally to about midway of scapula, is ovoid in shape. The bronchial Br. is at times very clear when child coughs out, and at times it is very distant, possibly the mucus prevents passage of the air. Voice is bronchophony, and in central limited area has egophonic character. Whispered voice is clear to the ear, definite pectoriloquy, somewhat lower pitched than previous occasion.

Even without any expectoration, and no foul breath, there seems to be a small cavity present, near the root, in upper portion of lower lobe.

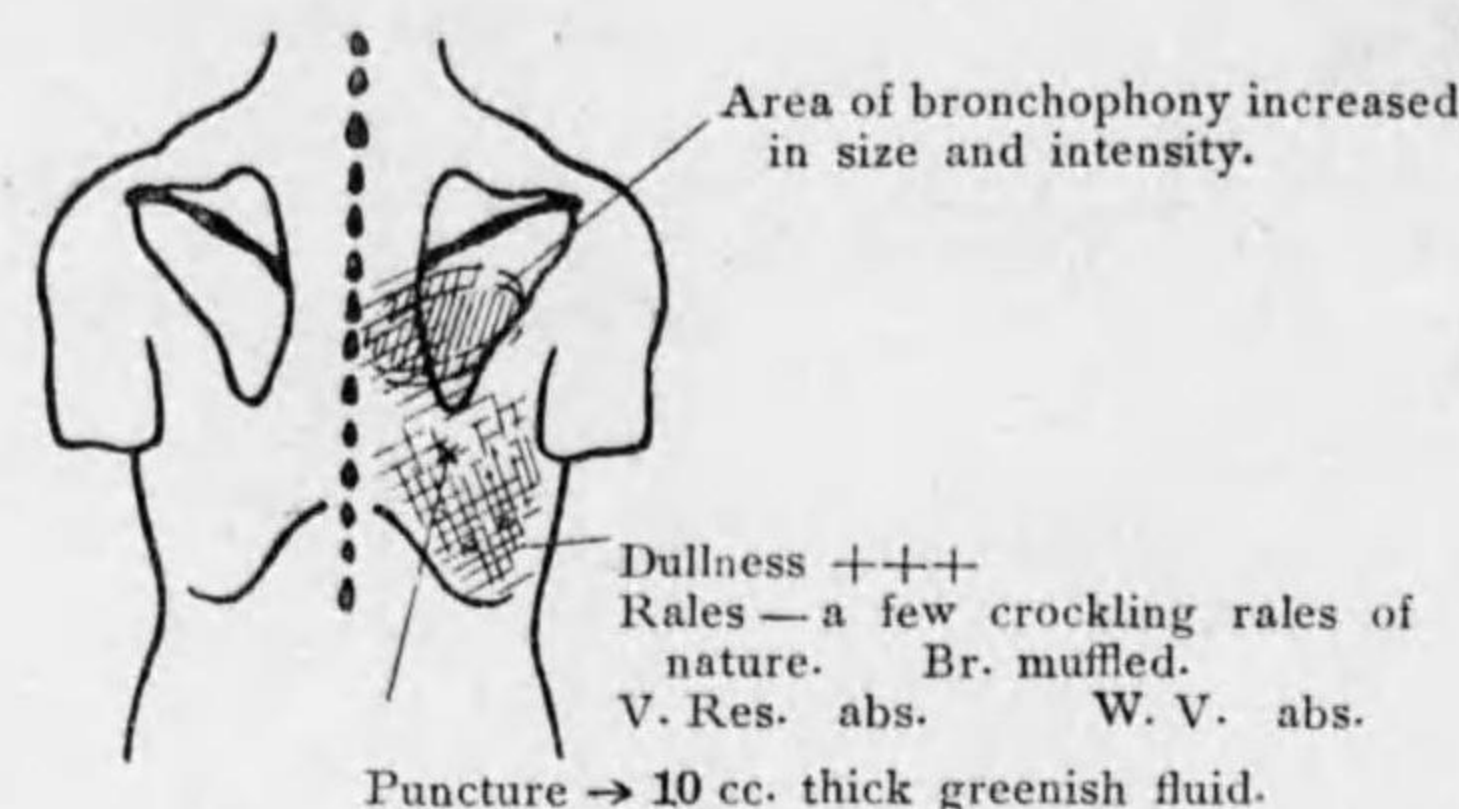
Joseph Phellan. — IV.

October 4th, 1924.



Child is up around, only a few coughs. An oval area of distinct bronchial breathing, and dullness. Bronchial quality of Br. S., bronchophony, high pitched sharp and distinct whispered voice can only be best heard by "direct" auscultation, while using stethoscope can easily miss them.

October, 4th.



Diag.—Induration at Root area of lung, Suppurative pleurisy.

Case XVIII. S. S.

Italian machinist, aged 39. Family history negative, in his past history he had malaria in 1902, appendix removed for chronic appendicitis in 1920, but without a cure for his pain in epigastrium. On July 1921 operated on for epigastric hernia.

Present Illness: October 25, 1921, admitted to the hospital for recurrent epigastric pain. Patient had marked pyorrhea and heavily coated tongue. Lung and heart were negative. X-ray confirmed presence of ulceration on lesser middle curvature with contraction of greater curvature slightly distal to ulcer site on lesser curvature. Fluoroscopy verified ulcer on lesser curvature in addition to prepyloric ulcer. Oct. 31, 1921 patient was operated on.

P. O. Course, there was rise of temperature between 100-105 F Pulse 104-148, Resp. 20-30, accompanied by annoying cough. The findings on the chest as shown in the chart indicated pneumonic invasion. Patient developed pain in right shoulder and coughed a great deal. On Nov. 21, he expectorated blood for the first time, and pain in the chest increased. On Nov. 30 he was treated by a.p.t. which made him very sick. On Dec. 3 coughed up about 4 oz. of blood. Repeated sputum examinations resulted negative for tbc. Attempt of a.p.t. on Dec. 5th, was followed extensive subcutaneous emphysema, involving face, chest, abdomen and thighs; then he rapidly coursed down the hill. He was given blood transfusion three times but he never pulled up again.

P.M. On December 31 showed as follows: part of mid and most of lower lobe gangrenous containing many small cavities filled with pus.

X-ray Findings:

140-141, prone position, November 3, 1921. Dense triangular shadow at the right base, mottled in character, both hilus shadow increased. Mediastinal shadow widened on the right side, lung markings are increased at both apices more on right, appearing "fibrous cirrus." Diagnosis, pneumonia right lower.

Fig. 142. November, 9, 1921. Prone. Shows similar picture except somewhat increased in density and generally more hazy. Apices clear.

Fig. 143-144, Prone, November 28, 1921. Right lower shadow appears much more

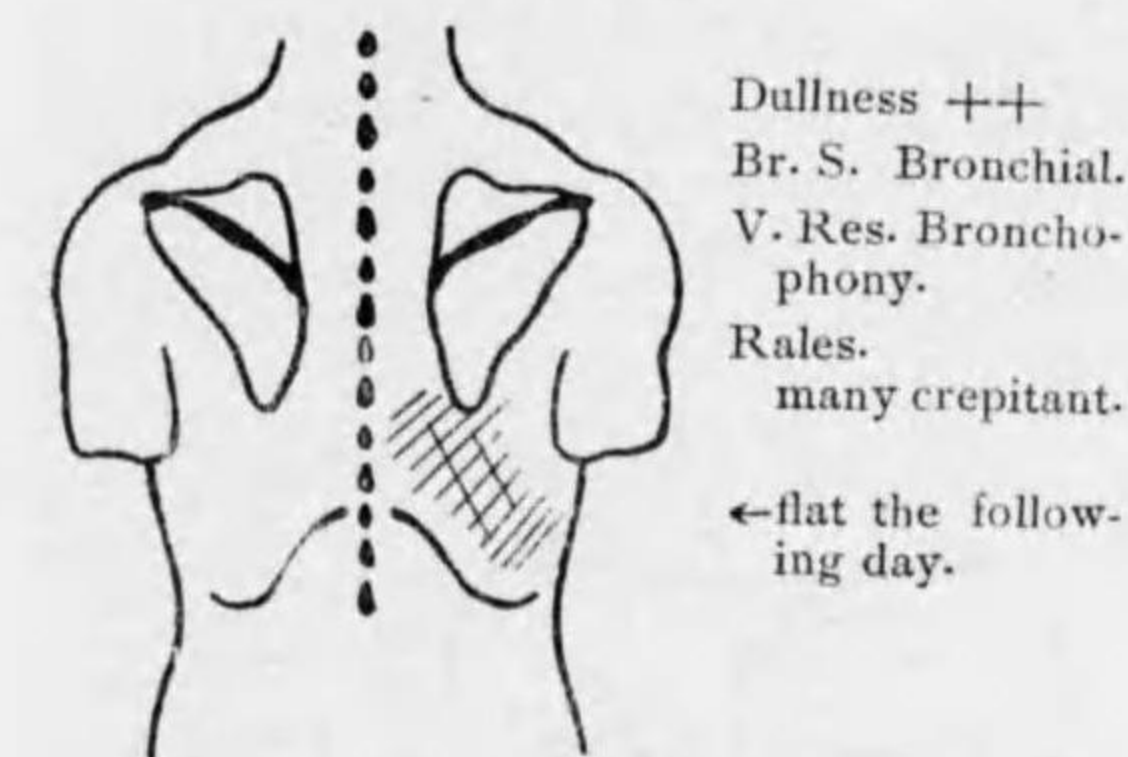
fibrous with mottle and honeycombed appearance indicating multiple destructive lung lesions. There is small amount of air, result of a.p.t. One irregular rarefied area, close to the heart, seems to be a faulty cavity, produced by hilar shadows. Owing to the weak condition of the patient, no film was taken in erect position.

Fig. 145-146. December 1, 1921 in erect position. Shadow in right lower much more increased, mottling and spreading upwards. No cavities can be made out, there is some air and a dense adhesion at base. Both hilar shadows seem to be projecting outward, indicating mediastinal emphysema.

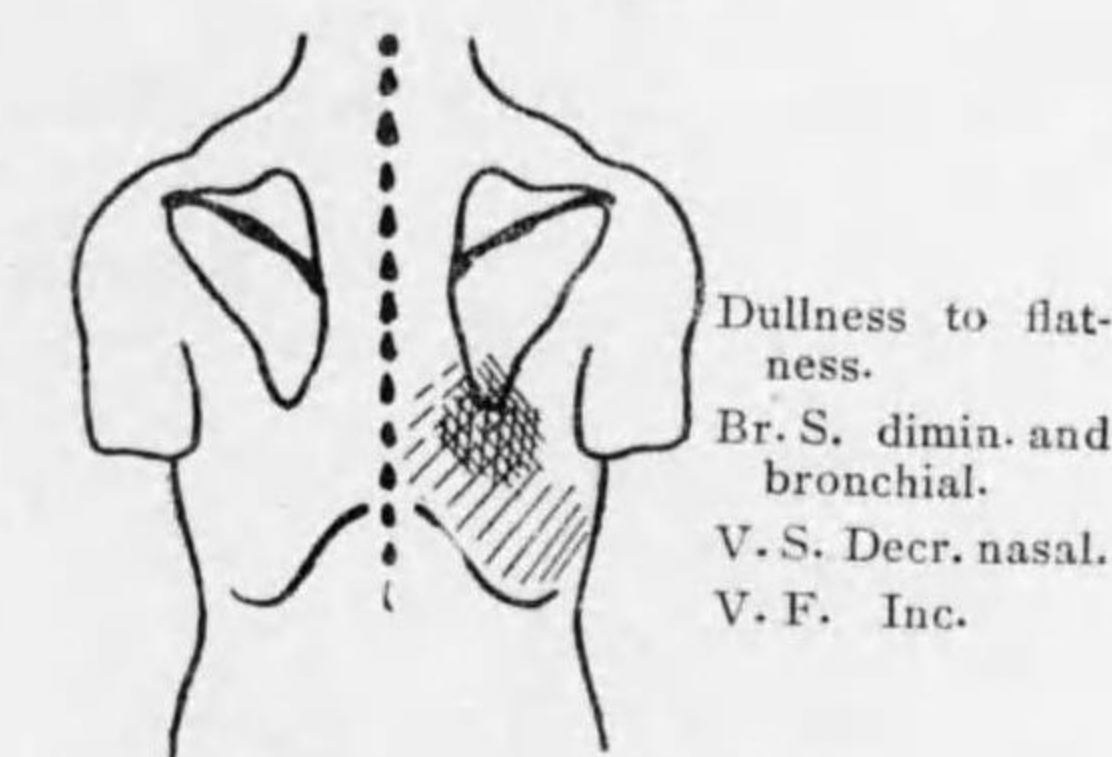
Summary: These films show a type of lung abscess, multiple without healing attempt. This case began as post-operative pneumonia terminating in acute gangrene of the lung. There is an impression that the advanced pyorrhea and the unsanitary oral condition had some important bearings on the severe lung involvement.

Stephen Salvino.

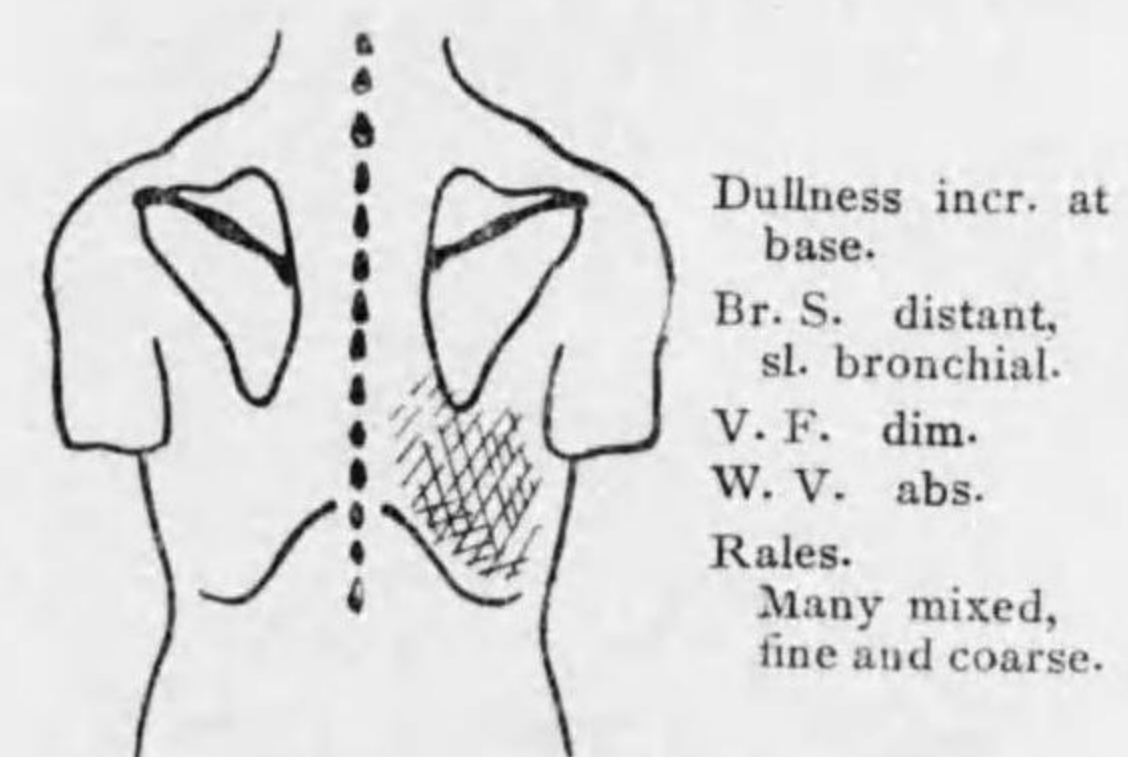
Nov. 3rd, 1921.



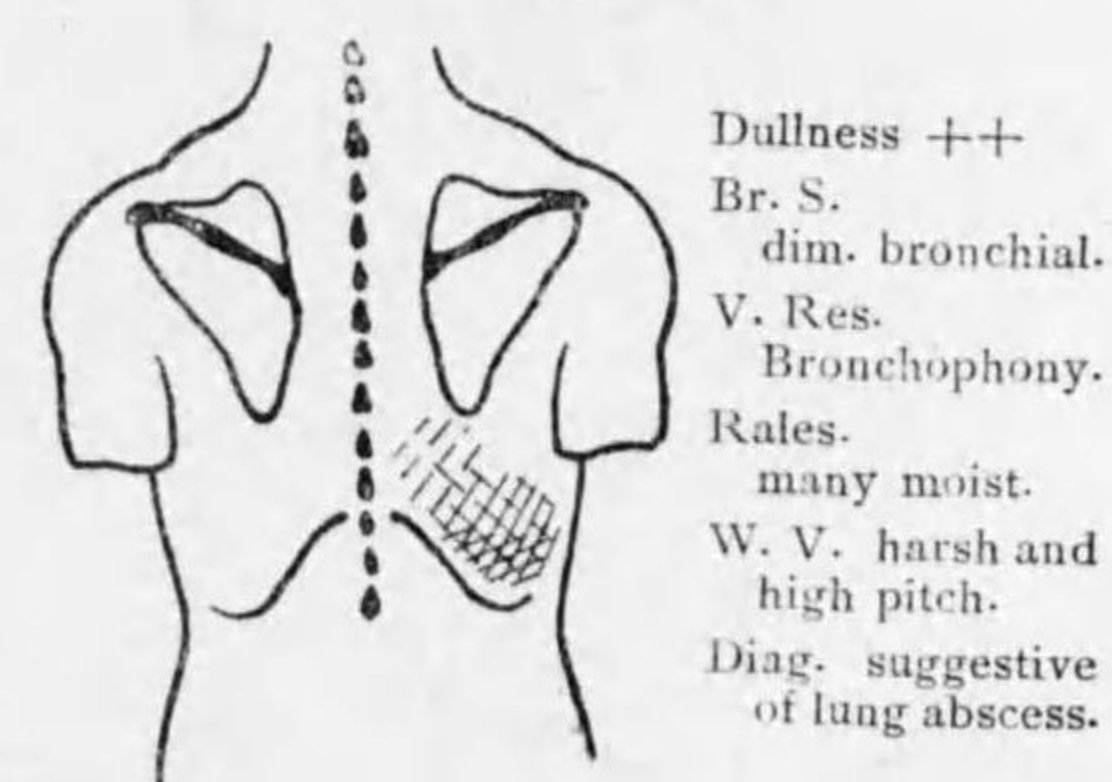
Nov. 9th, 1921.



Nov. 17th, 1921.



Nov. 29th, 1921.



Case XIX. H. D.

U. S. white Chauffeur, 38. His family history and his past history negative. Admitted on December 21, 1921 with a chief complaint of cough and expectoration.

Present Illness: Dated back for seven months when he had "pleurisy"; he was in bed for about four weeks, then he went to work but cough and expectoration persisted.



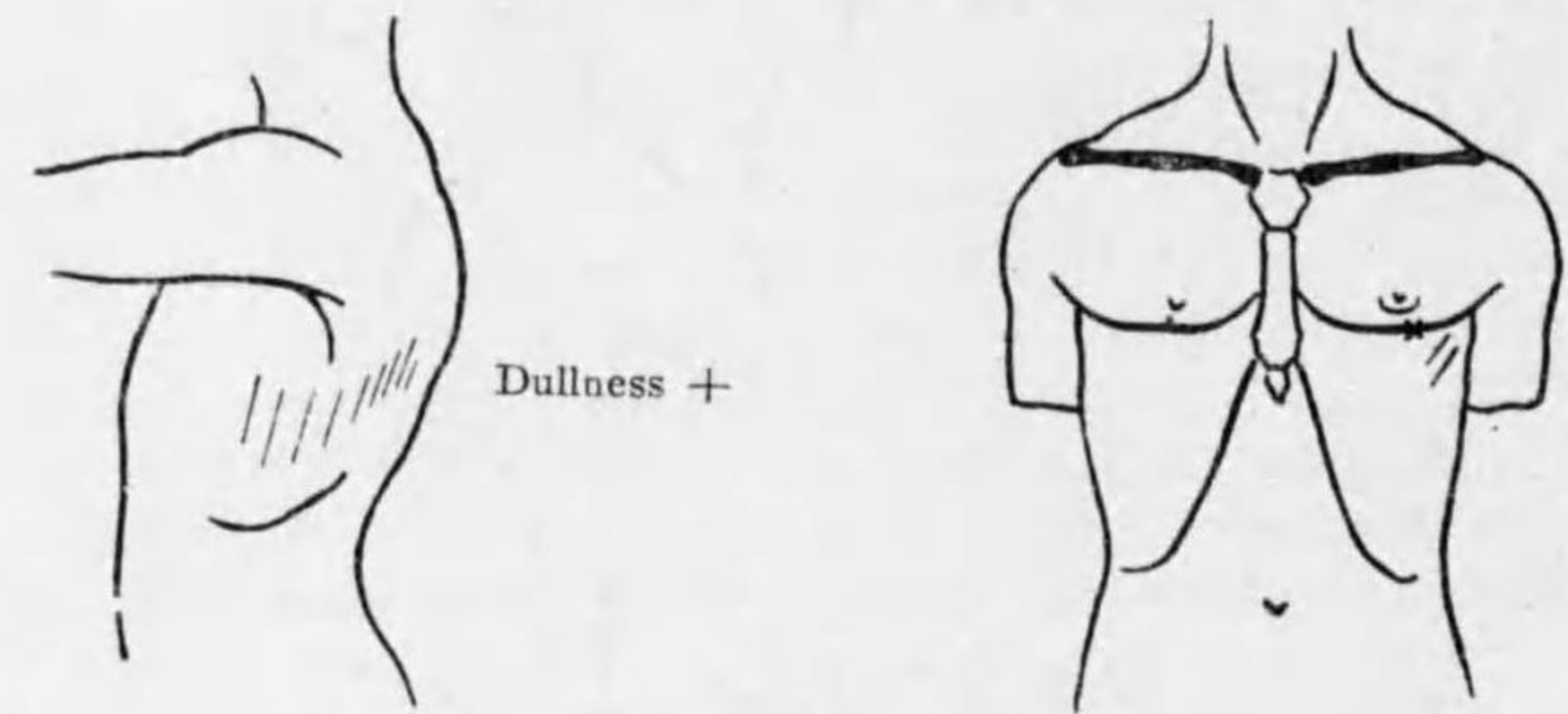
Ten days before admission he began to have pain on left chest, which was caused by deep breathing and coughing. Expecterated large quantities of foul smelling pussy sputum, repeated examination of which resulted negative for tbc., although elastic tissue was demonstrated occasionally. His lung signs were almost nil. W.B. C., 12,000, poly. 74% Wassermann negative. Fluoroscopy showed left diaphragm high and fixed to chest wall laterally; dense area in left lower lobe, continuous with exaggerated shadow at hilus.

Course: Patient received four series of a.p.t. followed by rather rapid improvement and was discharged on January 6, 1921. He returned a year later for examination when cough and expectoration became much less, was feeling better, gained in weight. Lung signs were negative except diminished breathing and dullness.

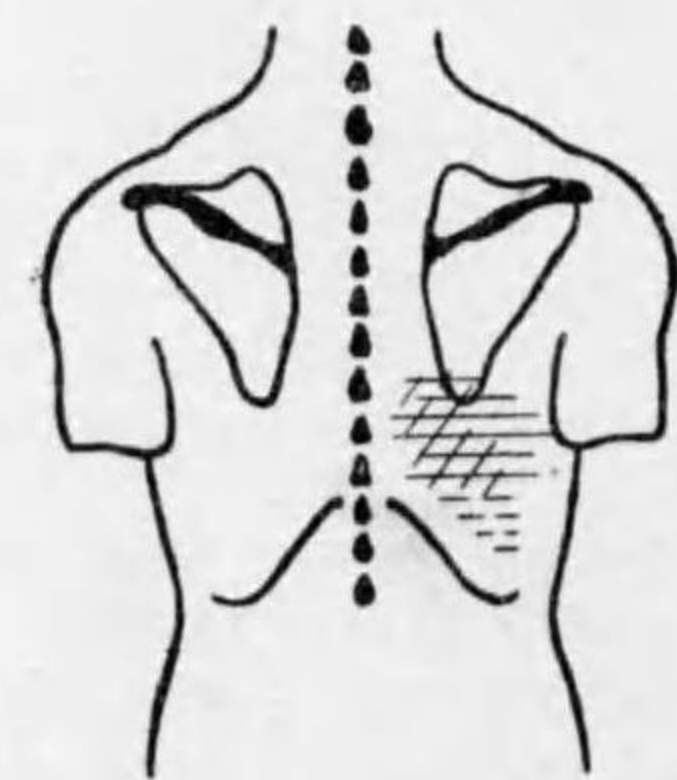
Summary: Apparently began as pleurisy, of left lower lobe; he ran a mild course, physical signs almost negative. X-ray showed a more fibrous appearance. This type of case would do worse if operated.

Henry Doell.

December 21st, 1921.

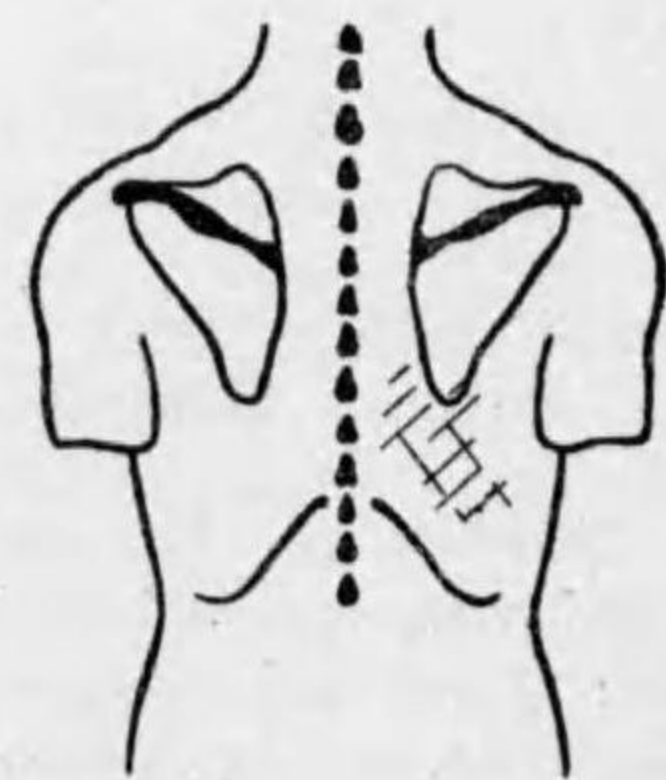


December 21st, 1921.



Dullness ++  
Br. S. dim.  
Rales. a few  
crashes.  
V. Res. sl. nasal.  
V. F. normal.  
W. V. Diminished  
but harsh and  
sl. high pitched.

January, 1923.



Dullness +  
Br. S. sl. dim.  
and coarse.  
Rales none.  
V. Res. } normal.  
V. F. }  
W. V. }harsh, sl.  
high pitched.

X-ray Findings.

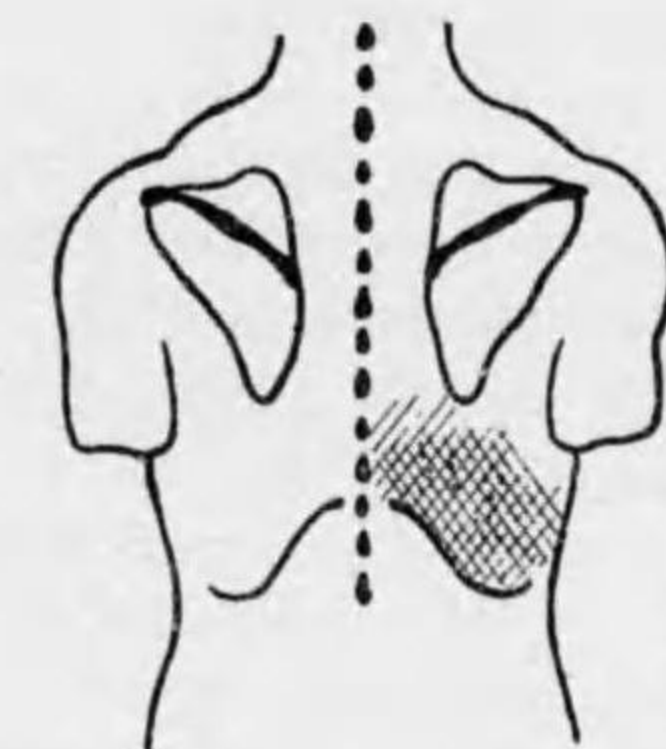
Fig. 147-148, taken in erect position December 22, 1921. Right hilum shadow somewhat increased with increased linear markings in the lower lung field. Left root quite thick and the shadow continues downward into density, nearly at the base. The latter density is mottling and fused out periphery into fibrous haziness. At its upper margin and where it meets with thickened downward extension of the root shadow it gives somewhat honey-combed appearance but evidence of cavitation is lacking. It presents chronic process, probably multiple small bronchiectatic cavities surrounded by pneumonic area.

Fig. 149-150. There is slight adhesion at the right base; left lower density has diminished in size and is occupied by fine fibrous area. At the extreme lower end of the thickened hilum there is an irregular rarefied area with increased density just below it, which suggests cavity and which is now made visible as the result of decreased pneumonic process and decreased exudate. The surrounding area appears not unlike that of dissolving pneumonia.

Summary: Etiology in this case is not clear. If patient had been examined in early period true nature of the condition would have been brought to light. Together, the history and these latter X-ray findings make us think of pleurisy accompanied by mild pneumonia as a preceding condition.

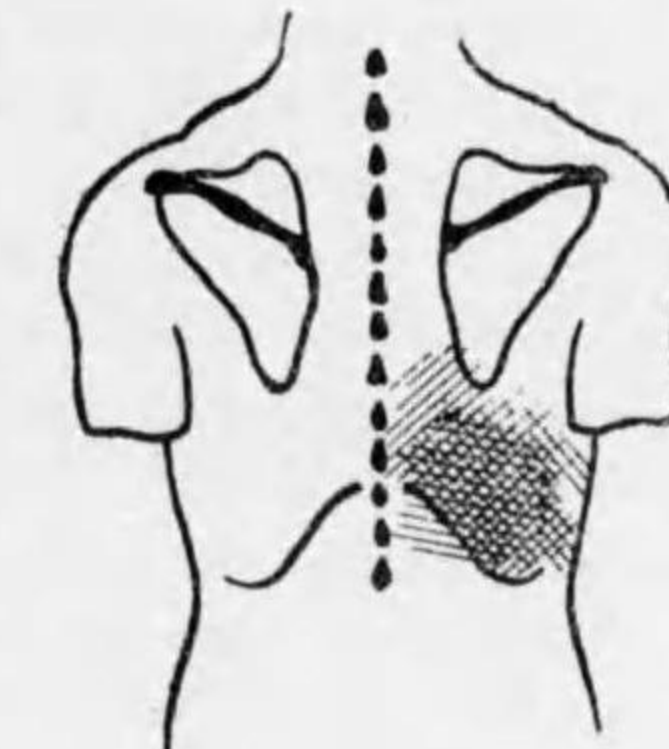
Case XVIII, operation on October 31st.

November 2nd, 1921.



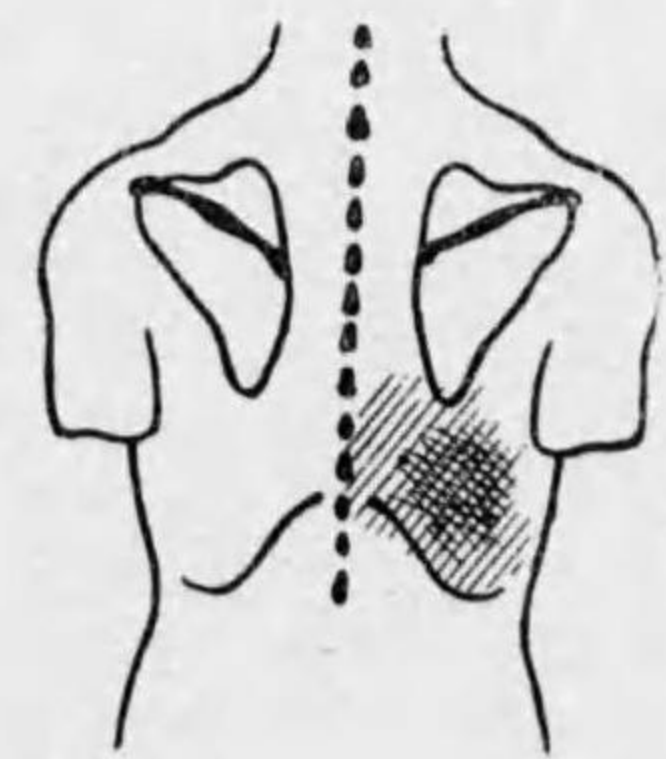
Pain on rt. lower posteriorly.  
  
Dullness ++  
Br. S. bronchial.  
V. S. bronchophony.  
W. V. increased, pitched high.  
Rales fine, crepitant.

November 3rd, 1921.



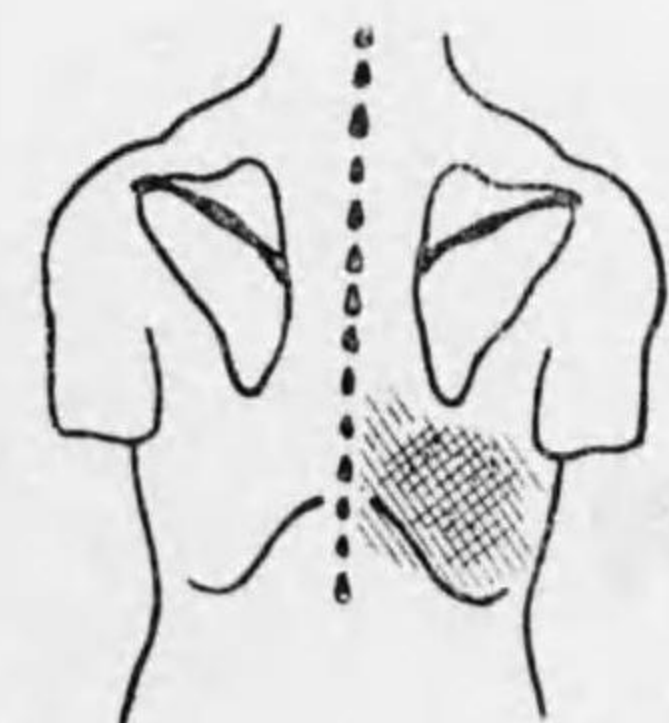
Sharp pain.  
  
Dullness ++ → to flatness.  
Br. S. bronchial.  
V. F. incr.  
V. S. bronchophony.  
W. V. inc. and harsh.  
Rales many fine.

November 9th, 1921.

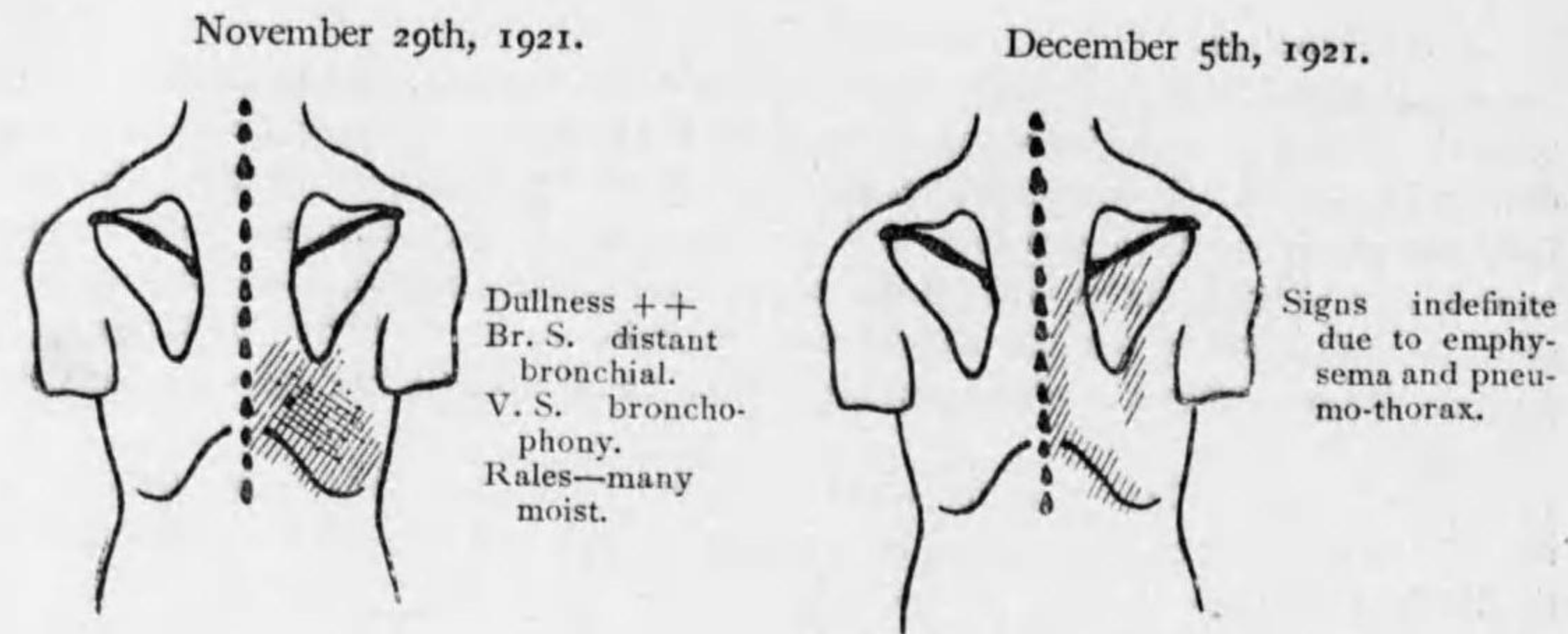


Dullness ++  
Br. S. incr.  
V. S. incr.  
V. F. incr.  
Rales—many moist plus friction rub.  
  
Central area of dullness, Br. S. dim. distant bronchial, V.S. dim.

November 17th, 1921.



Dullness ++ → at base +++  
Br. S. dim., distant bronchial.  
V. F. dim.  
V. S. dim.  
Rales—many mixed fine and coarse.



Case XX. M. T.

Woman aged 60. Family history and past history negative. Admitted to hospital on April 9th, 1923.

Present Illness: Six weeks previous to admission patient had pneumonia, followed by pleurisy, and empyema. She had considerable cough, pain in the chest and fever, lasting four weeks. On the day of admission she suddenly coughed out quantities of light brown material of foul odor.

Laboratory Findings: Repeated examinations of her sputum were negative for tbc., urinary sugar 2%, blood sugar, .34%.

Physical signs on her chest, as indicated in the chart, were not conclusive, but pointed out small amount of fluid at base, much thickened pleura in lower half of her left chest and some bronchitis. There were no definite signs indicating a cavity.

Course: Patient was treated by careful diet and insulin but she rapidly went down hill and died of terminal nephritis, and edema of lungs on April 15.

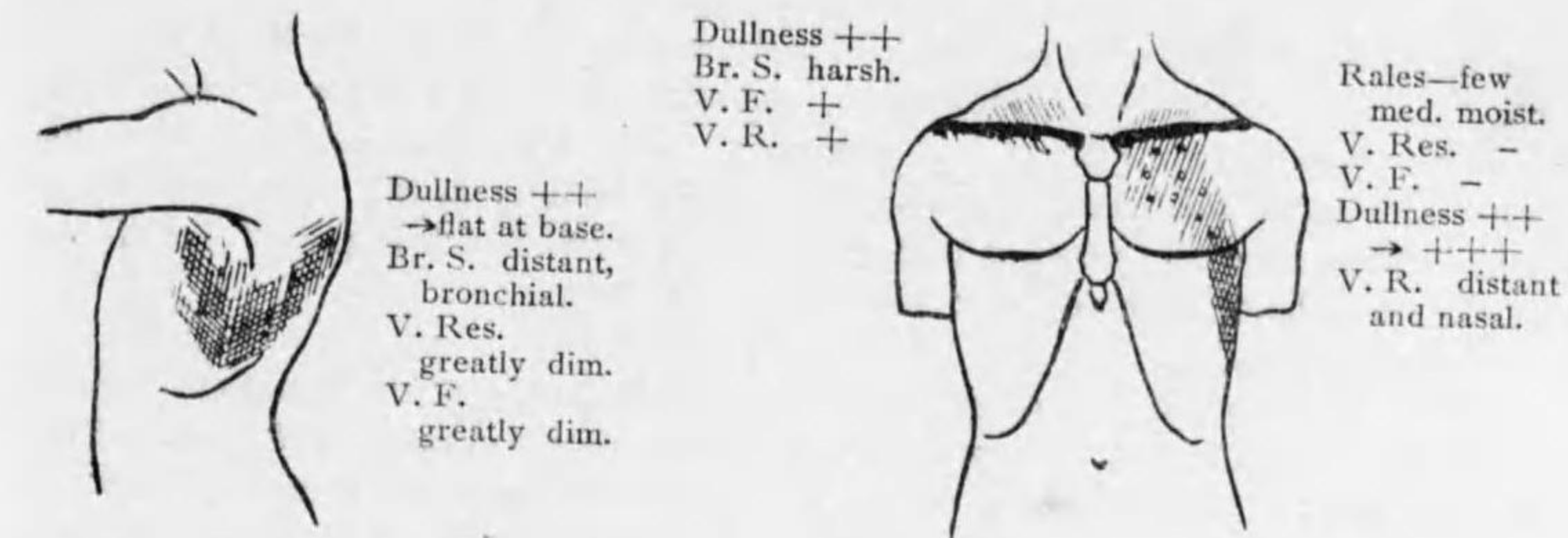
P.M. Summary—dilatation of heart, a large abscess cavity in upper portion of left lower lower lobe besides many small cavities in rest of the lobe, surrounded by highly indurated parenchyma. Also chronic obsolete tuberculosis in left upper and some scattered recent lesions on right. Adhesions and thickened pleura on left with thick bloody exudate. Kidney—acute parenchymatic nephritis.

Comment: The outlook of diabetic patients is very poor. The importance of proper management of such a patient is indicated by the excellent result obtained by Strouse (169) even in a difficult case. This is post-pneumonic abscess. The presence of old healed calcified tubercles on the left upper and few recent spots on the right make us think of the recurrence of tuberculosis after the acute pneumococcus infection.

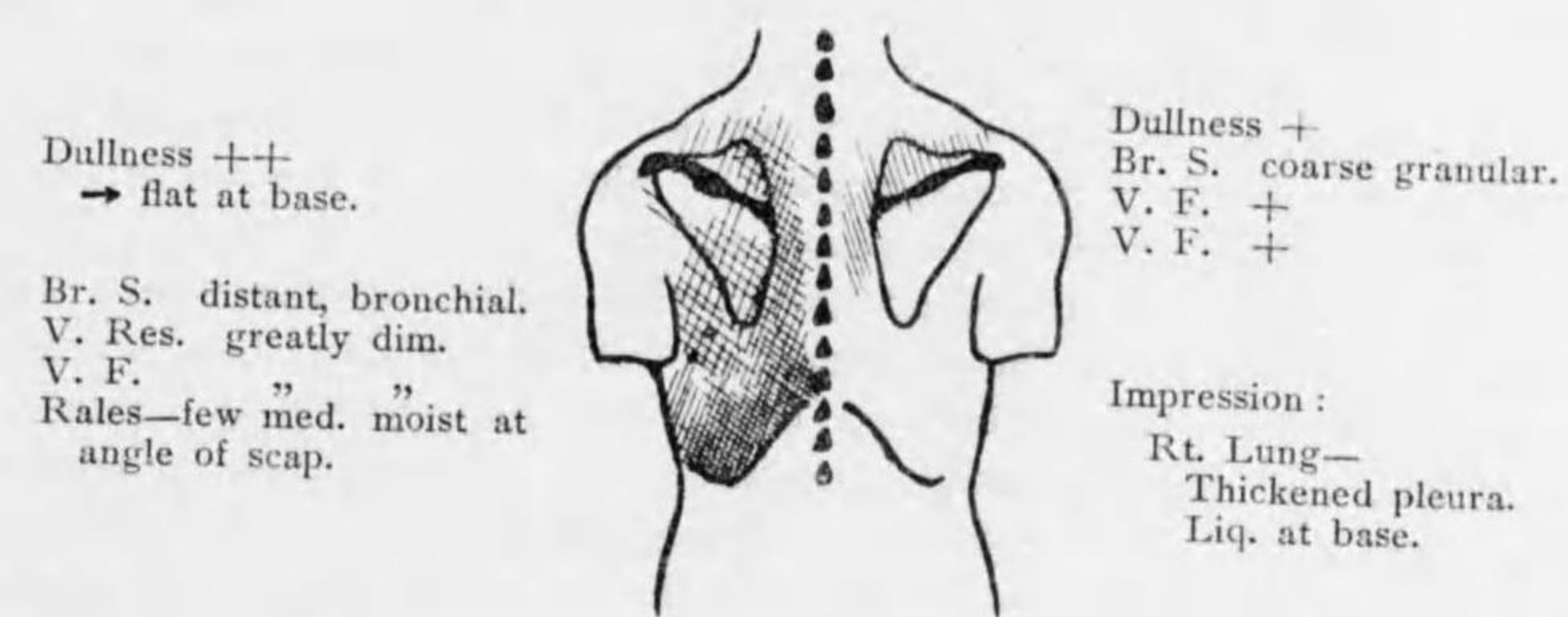
Fig. 151-152. Large dense triangular shadow in the left lower with base at mediastinum; ovoid shaped rarefied area to the periphery which was later proved to be a lung abscess cavity by autopsy. Here no cavity walls or fluid level were shown as it is overlaid by much indurated and broncho-pneumonic lung. Above this shadow numerous spots characteristic of tuberculous infiltration are seen, similar spots are observed, also scattered in right lung, but they are more hazy than those on the left side, and more confluent in the region of mid lobe, presenting "tufted cirrus" cloud.

Case XX. M. T.

April 9th, 1923.



April 9th, 1923.



Case XXI. W. B.

Merchant, Russian, age 56. Admitted to the hospital November 11, 1924. Complained of frequent attacks of coughing with pain in the chest. His family and past histories are essentially negative.

Present Illness dates back to the mid of last April, or seven months ago, when, while eating he had a sensation that his chest was filled with something and had difficulty in breathing. The next evening he began to cough and his appetite began to fail and his weakness increased. He then went to the Beth Israel Hospital in Newark and stayed there for ten weeks. During the first two weeks there, he raised up large quantities of foul smelling sputum. He then went to the mountains for ten weeks, where his coughing continued, on three occasions raising small amount of blood. Coughing has continued becoming worse just before admission. He lost about five pounds since April and has been free from fever for several weeks before admission. The course in the hospital has been as follows: Temperature at first in the region of 100 F. and has gradually stabilized between 98-90.

Sputum on admission was about 250 cc. in 24 hours, rather foul smelling, contained elastic fibres, and quite pussy. No tbc. and the culture showed micrococcus catarrhalis to be the predominant organisms. He had a mild secondary anaemia but no leucocytosis. Sputum gradually became less in volume, at present he raises about 100 cc. per day, which again later increased from 250-350 cc. On Nov. 19th a.p.t. was attempted, but because of adhesions no collapse was obtained. No definite abscess cavity has been found on repeated X-ray examinations, and a physical examination has at all times been negative for cavitation. The signs have consisted of a fine coarse rales and a small area of distant bronchial breathing in the right interscapular region. There have been no signs anteriorly. His general health improved and he was allowed to go home with advise to come back for observation.

X-ray Findings.

Fig. 153. November 22, 1924. Marked localized density at root with some haziness peripherally in middle third of right lung field. Otherwise the same as the following films.

Fig. 154-155. November 13, 1924. Taken in prone position stereoscopically. It presents no conclusive picture for diagnosis, but there is definite thickening at the right root area and a scattered haziness involving lower half of the upper lobe. The central portion of the area presents "geographical" mottling in mild degree, while the region just below this contains some increased linear markings which may be cast by engorged vessels. As for cavitations there are two somewhat suspicious areas at "A" and "B" for the proper interpretation of which we have to wait for the next development. The fluoroscopic view is not characteristic with only the presence of scattered haziness at sub-clavicular and infra-mammary region.

Fig. 156-157. November 23, 1924 taken in erect position about ten days after the one before. In addition to the more intensified scattered density there is a general haziness involving the whole right lung field which may be due to inflammatory pleural re-action, and increased scattered pneumonitis. No evidence of local fluid collection or cavitation. This probably, multiple small abscesses. Attempted a.p.t. is not shown in this film, and the failure probably due to various factors in this case, i.e. adhesions, engorged lung tissues, thickened pleura and emphysema.

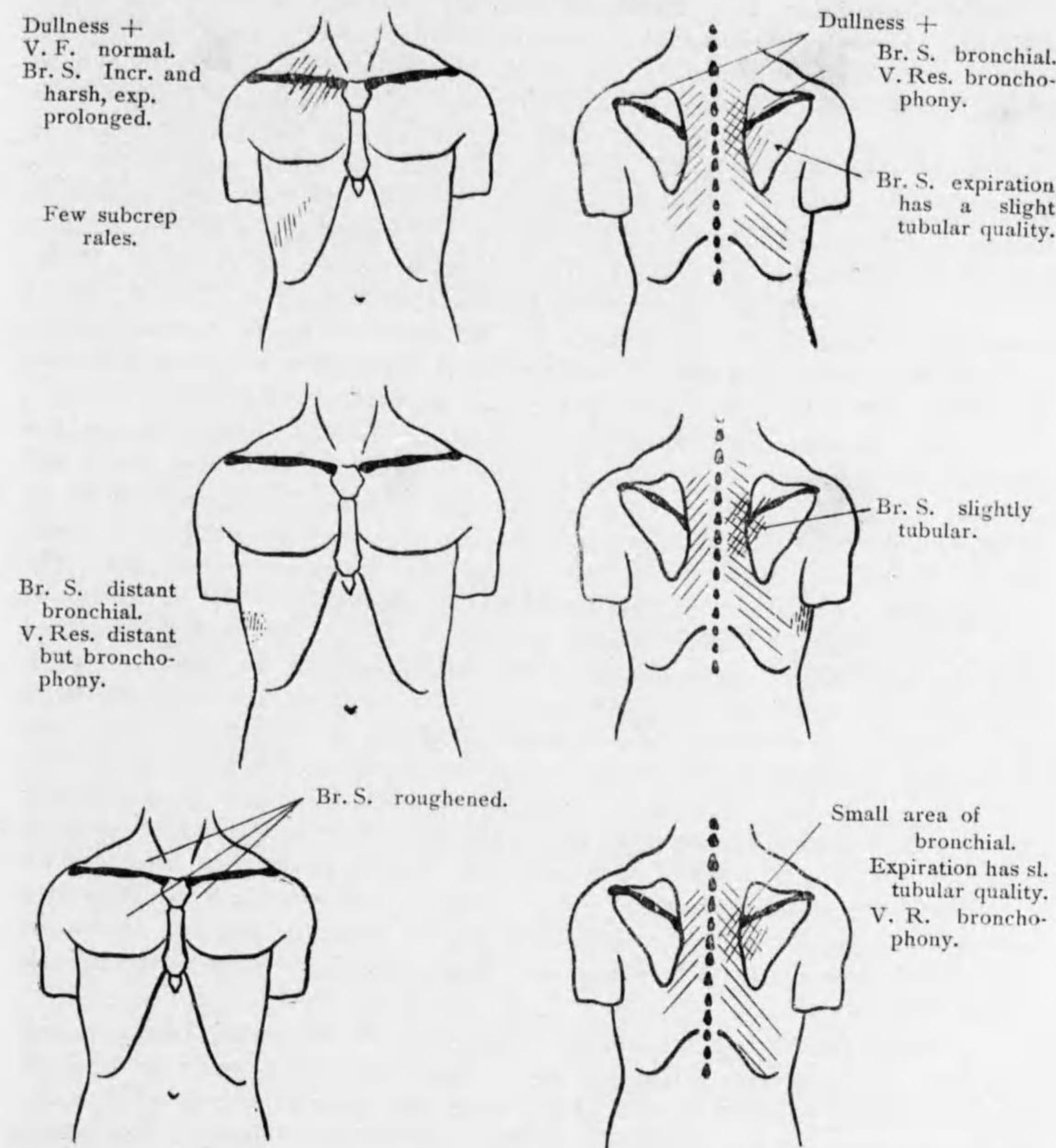
Fig. 158, a and b, 159. December 5, 1924. Stereoscopic view. The violent reaction with scattered pneumonitis has mostly subsided within the period of two weeks. Here we have a similar picture as presented in Fig. 154 with marked accentuation of bronchial markings and root shadow. In the present picture, however, the indefinite islands "a" and "b" have become confluent and present an irregular ovoid shape lying between the level of 6th and 8th dorsal vertebra. This shadow so faint as it is, is often interpreted as pleural adhesions, but in this case represents area of some defective parenchyma. In the case of pleural adhesion, the outline is more indistinct and it is not bounded by dense infiltrating area.

Fig. 160. Taken erect in lateral position. The interpretation of such lateral view is difficult, but at hilar region there is elongated triangular shadow which looks like foreign body, but not conclusively. Bronchoscopy is advisable.

Comment: There is very little on physical signs except suspicion at right inter-scapula region. The X-ray shadows were much more than what was shown by physical signs, although there were no definite signs of cavitation. Fig. 154, showed "geographic" mottling areas which would suggest cavitations with infiltrated area around especially in its dependent position. The whole picture suggests lung suppuration of foreign body origin.

Wm. Blaut.

November 13th, 1924.



Case XXII. M. W.

Woman 57, U. S. white, married. Admitted on July 10, 1923. Family history negative. In her past history she was found to be diabetic, ten months previous to admission losing 45 pounds during that period; otherwise negative.

Present Illness: About January 1923 or five months previous to admission, she caught a "severe cold" associated with pain on right chest and shoulder. A few days later suddenly she felt something break in her chest and she brought up very foul

smelling material, slightly bloody tinged. Ever since then she had been coughing and expectorating much. Her sputum had been examined several times but it was always negative for tbc.

Physical Findings: Well developed, somewhat undernourished, appearing chronically ill. Besides her carious teeth nothing abnormal was found about her neck and abdomen. Thorax as well formed, movement both sides equal. Lungs showed, as illustration, dullness, diminished breath sounds, coarse rales, and rhonchi in right axilla and just below the angle of scapula, giving an impression of partial consolidation in right lower lobe. Sputum about 100 cc. in 24 hours, repeatedly negative for tbc., yellowish, mucopurulent, occasionally tinged brownish. Sputum culture showed: streptococcus haemolyticus and salivarius, micrococcus tetragenus and catarrhalis. Her temperature on admission 100-101 F. pulse 70-100, resp. 20-22, B. P. 138/90. Blood, W. B. C. 10,000, poly. 84%, Wassermann negative. Urine, trace of albumine, but no sugar. Blood sugar .234%, urea N 10.12 mg. per 100 cc. of blood. Her Roentgenogram taken on July 11 showed localized density at right hilum and diffused haziness over entire right lower lobe. A new growth was suspected at right hilum.

Course: Because of the history of excreting sugar in her urine, although her urine on admission showed no sugar, she was given anti-diabetic diet which was gradually increased to C. 60, P. 65 and fat 100 gm. per day. During her residence in the hospital she never showed sugar under this diet, and there was no need of Iletin. She daily raised foul sputum and was running mild temperature every day. The diagnosis was at first uncertain, even Hodgkin's Disease was considered on account of the first X-ray report, but this was never proved. On July 18, her chest was explored by needle and obtained small amount of sero-sanguinous fluid, the culture of which was sterile. She was given a postural treatment, and by the end of July, the cough and amount of expectoration became much decreased, and her temperature came slowly down to normal during the 5th week of her residence. The physical signs also improved a great deal; dullness decreased, fewer rales could now be heard. Her general condition also became much better, although at times she had severe night sweat. So it was with later X-ray pictures; the shadow at the root became much smaller, and new growth now can be safely ruled out. Although her X-ray films were not conclusive, but her general symptoms and physical signs, together with her history, a lung abscess was more certain in her case. She was discharged with much improvement on August 13, 1923.

Outcome: On November 14, 1923, she reported that she gained twenty pounds in weight. There was no cough or expectoration; but not as strong as formerly. Her physical signs of chest were negative, urine was sugar free, and had no fever. On May 28, 1924, she was seen again, her lung condition had completely disappeared. At the end of the year she was again found free from all the symptoms.

X-ray Findings.

Fig. 161-162: taken in erect position on July 12, 1923. Showed irregular mottling density at the region of right hilum, and diffuse haziness in lower two thirds of the lung. Throughout the shadow the lung markings are seen through, which are increased, giving an impression of post-pneumonic condition. The right diaphragm is high, and the density at the root may show anything from new growth, enlarged lymph nodes or lung abscess. Proper diagnosis depends on later findings.

Fig. 163-164. Erect position, August 2, 1923 about three weeks after previous

picture. There is ill defined mottling density in the region of middle lobe of the right lung. The density is more circumscribed than in the previous picture and has extended to periphery. The surrounding pneumonic area has much decreased. It now suggests more abscess. The right diaphragm is still located high. (Compare with next case, Fig. 167-172).

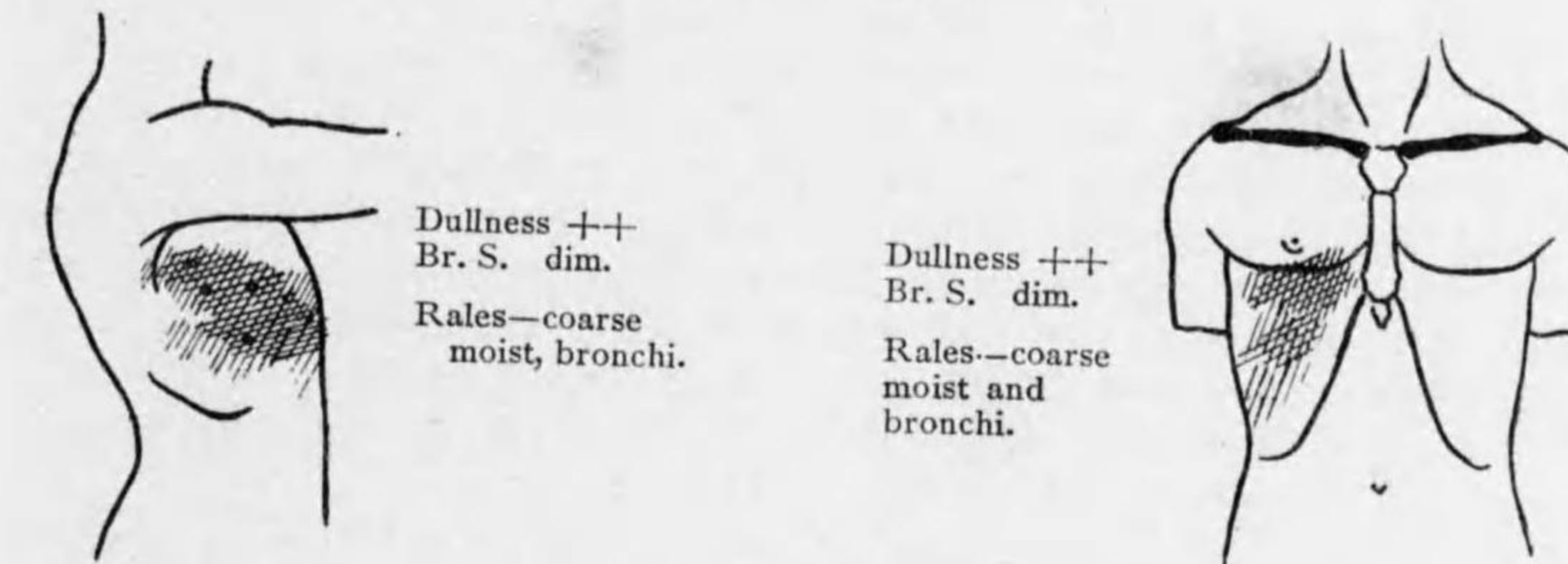
Fig. 165-166, erect, August 13, 1923, ten days later. There are two separate rounded empty cavities, surrounded by dense fibrous shadow. The pneumonic area has now gone. This will eliminate the question of new growth.

Comment: This case began with sensation that something had broken in her chest followed by sudden evacuation of pus; what she described as "severe cold" which lasted for only a few days, was evidently caused by abscess formation. This may be an idiopathic form, unless due to unknown foreign body introduction.

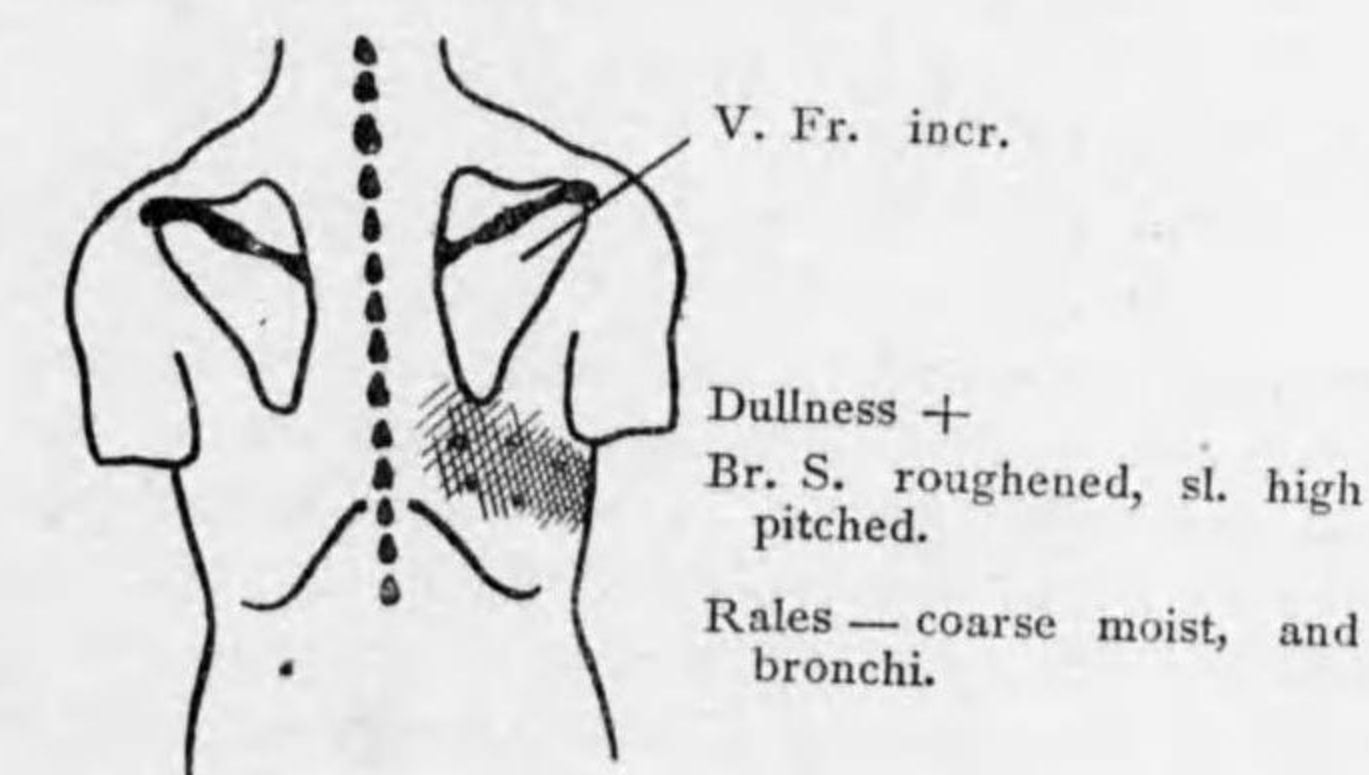
The nature of the X-ray suggests foreign body lung abscess.

M. Warner.

July 10th, 1933.



July 10th, 1923.



Case XXIII. F. S.

U. S. White aged 40. Her family history negative. In her past history, she had partial mastectomy for breast carcinoma seven years ago at Memorial Hospital, otherwise negative.

Present Illness: About January 15, 1925 she swallowed a piece of chocolate candy, this was followed by severe coughing spell, but all symptoms had disappeared. A week after this, she had pain in her right chest and started to cough and expectorate, associated with mild fever. The expectoration increased and became more pussy, and some times bloody stains. At Memorial Hospital this was at first thought to be metastatic recurrence of carcinoma of lung in view of her past history. The lymph nodes of axillary, super- or sub-clavicular regions were not, however, involved and the other breast was healthy; the X-ray examination was not quite conclusive. With these negative findings together with the definite etiology which was soon followed by definite clinical symptoms, this case was considered more in favor of foreign body lung abscess. She was admitted to this hospital on Feb. 9, 1925. She was given postural drain and was under observation aided by periodic X-ray examinations.

Outcome: Her lung shadow became gradually decreased and the lung signs as well as the symptoms became much better. By the end of July 1925, she was coughing only very little and now raising only a little sputum.

#### X-ray Findings:

Fig. 167. Feb. 2, 1925, stereoscopically in erect position. There is an elongated marked density resembling an onion root, extending downward along the right root area from the level of thoracic vertebra ending in bud like enlargement near the base of the lung. There is mottled hazy area reaching almost to axilla along the seventh rib forming fan shape, indicating inflammatory re-action of the lung tissue. The elongated dense area is limited by more or less straight and clear outline from the hazy triangular area. Such density can be produced by highly dilated bronchus with peri-bronchial infiltration. In the left lung field, there is accentuation of lung markings and hilar shadow which appears also displaced outward suggesting emphysema.

Fig. 168-169. Practically same as before, but outer pneumonic area has diminished and the "onion-root" density also somewhat small.

Fig. 170-171. The picture taken in right oblique position presents irregular polygonal dense shadow composed by lateral triangular and vertical elongated areas as seen in the previous film, indicating that the shadow of diseased area in anterior portion of the lung is now condensed on the dense root area. There is, however, no cavity or signs of fluid seen.

Fig. 172-173. The antero-posterior radiation with the patient on her left side does not show any direct evidence of cavity or fluid. The mottling dense shadow is triangular in shape with its base at the root of the lung. This difference in the shape from that of the erect position is perhaps due to the following few factors: (1) focused more from right side (2) mediastinum and heart somewhat displaced to left with patient on left sided position. (3) exudation in lung tissue and bronchi gravitated down to the left side. There is an irregular rarefied spot with hazy outline at the apex of this triangular area which may represent a defective parenchymal tissue. This lesion may perhaps involve the middle lobe. This is a difficult case for differentiating it Roentgenologically from new growth although throughout these films, no apparent metastasis in lymph nodes was observed.

Fig. 174-175. Taken on Feb. 26, 1925, or two weeks later than the previous occasion, in erect position.

It presents similar character as in Fig. 168 except the shadow is much smaller. In this type of case, the most important service of the Rentgenologists is called upon

in order to decide upon the proper management of the case. In the case of metastatic carcinoma, the outlook is grave and requires deep ray therapy, while in abscess case, active drainage is required, the outlook is much better.

Metastatic carcinoma is usually multiple with rare exceptions. The earliest metastasis appears as small, faint, circular shadows which are clearly outlined in the lung. They are first seen in the lower lobes where they are a.p.t. to attain their greatest size. As they increase in size they usually retain their circular shape, although occasionally, especially in the case of carcinoma and hyper-nephroma, they may become oval or irregular in outline. To this last statement, there are however exceptions, (refer to the author's paper on "Metastatic Testicular Carcinoma of the Lung").

Sarcoma, on the other hand, even when they occupy a whole lobe, usually remain smooth and circular. The dyspnea which is such an early and characteristic symptom of tumor of the mediastinum is apt to bring the patient quickly to his physician; on the other hand, the cough and expectoration which mark the onset of a tumor of the lungs are such common symptoms of less serious respiratory diseases, that the patient is prone to disregard them for a considerable time. The shadows cast by mediastinal tumors are homogeneous and dense. They stand out sharply against the surrounding lung tissue and only rarely show evidence of infiltration of the latter, although this is often seen at autopsy. They are nearly always bilateral, especially when they are well grown and this in most cases, will serve to distinguish them from primary tumors of the lung. The growth on the two sides is however unequal in extent. Fluoroscopic examination in the oblique position may be of a considerable help in determining whether the growth originates in the lung or in the mediastinum. There are varieties of variation in the new growth whether in lung or mediastinum and I may have occasion to discuss the subject fully. It must be, however, distinctly stated that various pictures are sometimes produced in the new growth as our present case. The definite diagnosis in this case was approached by the finding of definite history of foreign body introduction, by immediate clinical symptoms which followed, the difference in the size of the inflammatory condition and the later shrinkage of the shadows. (Fig. 167 and 175). Shadows in the lung abscess diminish in a briefer time, while in the case of carcinoma, it is usually in constant increase. Mottling character of lung abscess is also stated as characteristic by some authorities, but this is found only in later metastatical stage.

#### Case XXIV. E. R.

U. S. white woman aged 29, admitted to the hospital for cough and bloody sputum on Feb. 9, 1921. Family history negative, past history showed malaria at 13, appendectomy at 14. Had two pregnancies with high blood pressure and albuminuria at each. Otherwise always healthy.

Present Illness: Began with her last confinement on Jan. 9, 1921 or a month preceding her admission. A week after her confinement, spontaneously coughed up an oz. of bright blood, followed by sharp stick pain in her right chest which was made worse by taking in breath or coughing. Since then patient continued to cough up dark, brownish colored sputum. On the morning of the day before her admission,

when she turned over in her bed, she felt that something seemed to burst inside her although without pain and she coughed up a lot of foul smelling brownish material. She kept coughing considerable amount of similar material until admission. She had a fever of 102-104 during first five days. Physically, she appeared well nourished and well developed looking not very ill. Her chest was well developed, expansion was free and equal and no lagging.

Laboratory findings, Wassermann negative, culture of chest fluid showed bc. subtilis.

Course: During her hospital residence she coughed up large quantities of bloody mucopurulent sputum. Thoracentesis in 9th i.c.s. in right mid scapular line yielded 100 cc. pus, which showed bc. subtilis. Treatment consisted of many repeated doses of a.p.t. Under the treatment she made steady improvement and was discharged cured on April 14, 1921. She is not coughing or raising at present.

X-ray considerations:

Feb. 11, 1921. The X-ray showed density in the right lower region with pleural adhesions, more suggestive of involvement above the diaphragm, but sub-diaphragmatic trouble could not be ruled out.

Edna Reed.

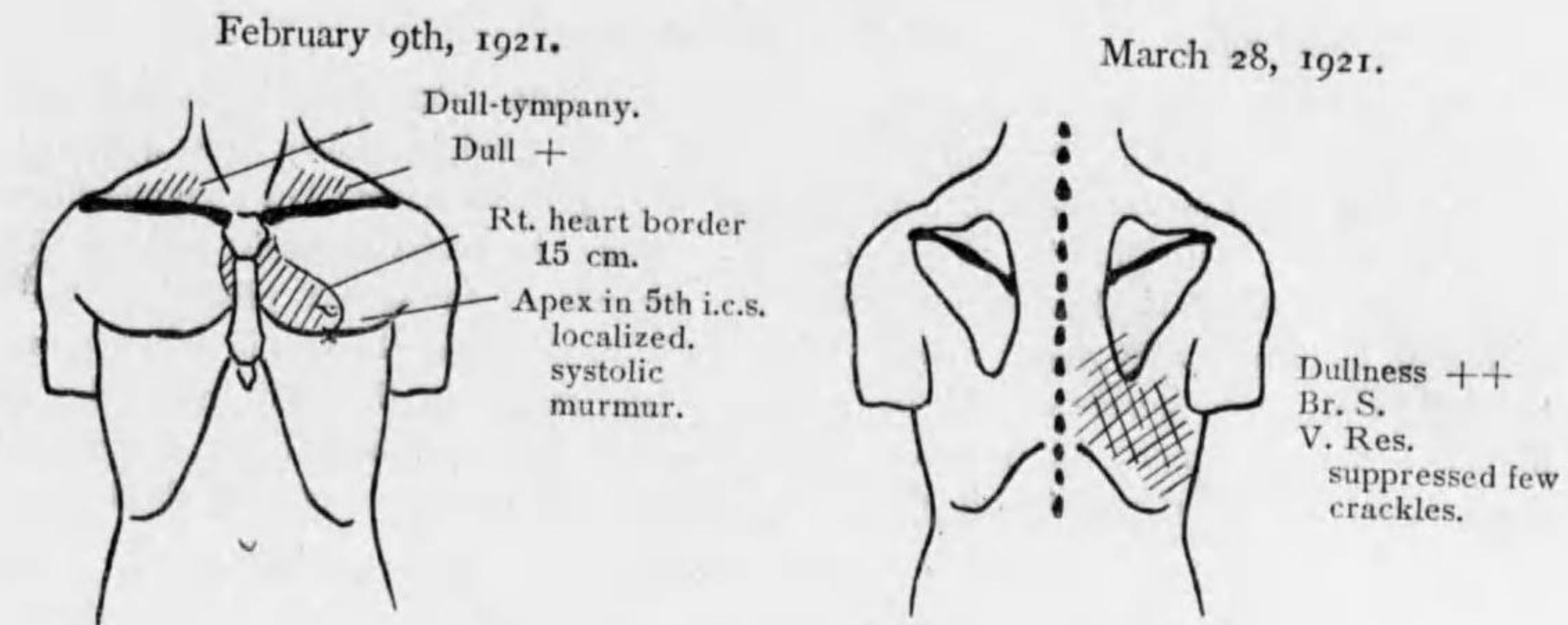
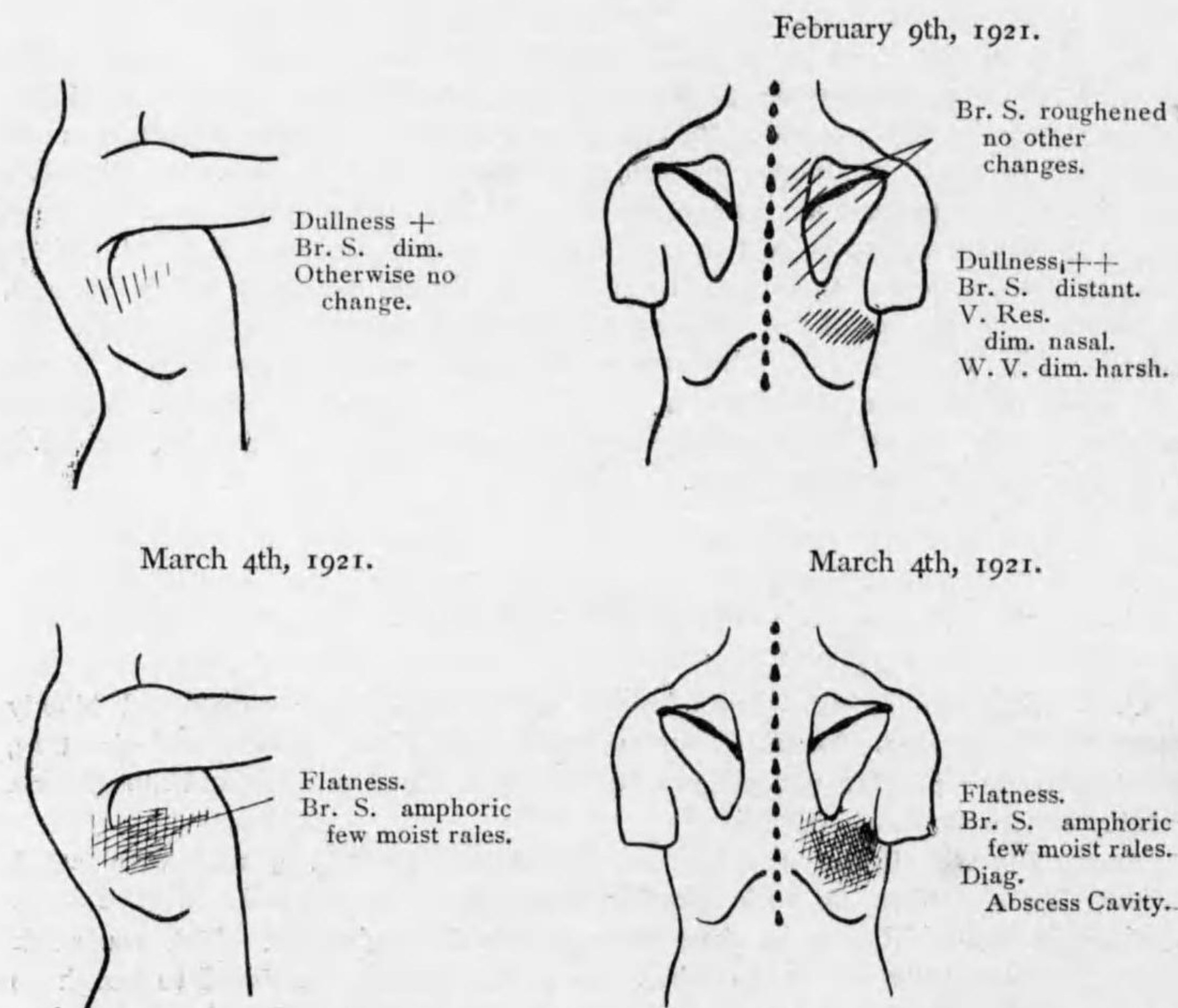


Fig. 176-177. Feb. 26, 1921. Taken erect, upper part of lung collapsed by pneumo-thorax. Density at base suggests thickened pleura and adhesion plus indurated lung. No cavity shadows. Other four films taken consecutively showed similar features but always not abscess cavity indicated.

March 29, 1921 showed expansion of the lung, quite thickened pleura in right lower.

Comment: The clinical course suggests lung infarct due to post partum, resulting in lung abscess. X-ray did not confirm the presence of cavity, probably located behind the diaphragm. The physical signs, however, in this case, were more definite. Compare this case with case XXV.

Case XXV. E. M.

Austrian widow, aged 47, admitted to hospital on December 16, 1920 with the chief complaint of cough and expectoration for six months. Family history negative, past history generally healthy; influenza in 1918, pneumonia in May 1920.

Present Illness: Since last attack of pneumonia several months ago she developed a persistent cough later bringing up quantities of foul smelling sputum which was sometimes streaked with blood. There was pain in her side which was made worse by deep breathing. More recently she developed shortness of breath and blood in her sputum increased. On admission she had a temperature of 103.5 F, Pulse 136, Resp. 36. She had many crowned teeth, some decayed and a great deal of pyorrhea. Her chest expanded equally on both sides but shallow. The signs as indicated in the chart, pointed out fluid or abscess of lung.

Laboratory Findings: Sputum 200 cc. per day, negative for tbc. Blood Wassermann, negative, W. B. C. 11,000, poly. 83%; Hgb. 75%; culture of chest fluid sterile.

Course: Tapped right chest and obtained about 150 cc. turbid reddish fluid. On December 17 gave a.p.t. four hundred cc., the following day, she had a severe cough and bloody sputum, and also slight hemoptysis. She became progressively weak, pulse 152, and finally died.

Post Mortem. Right lung showed a large cavity at the base close to posterior wall; fibro-purulent pleurisy on both sides with adhesions of thickened pleura.

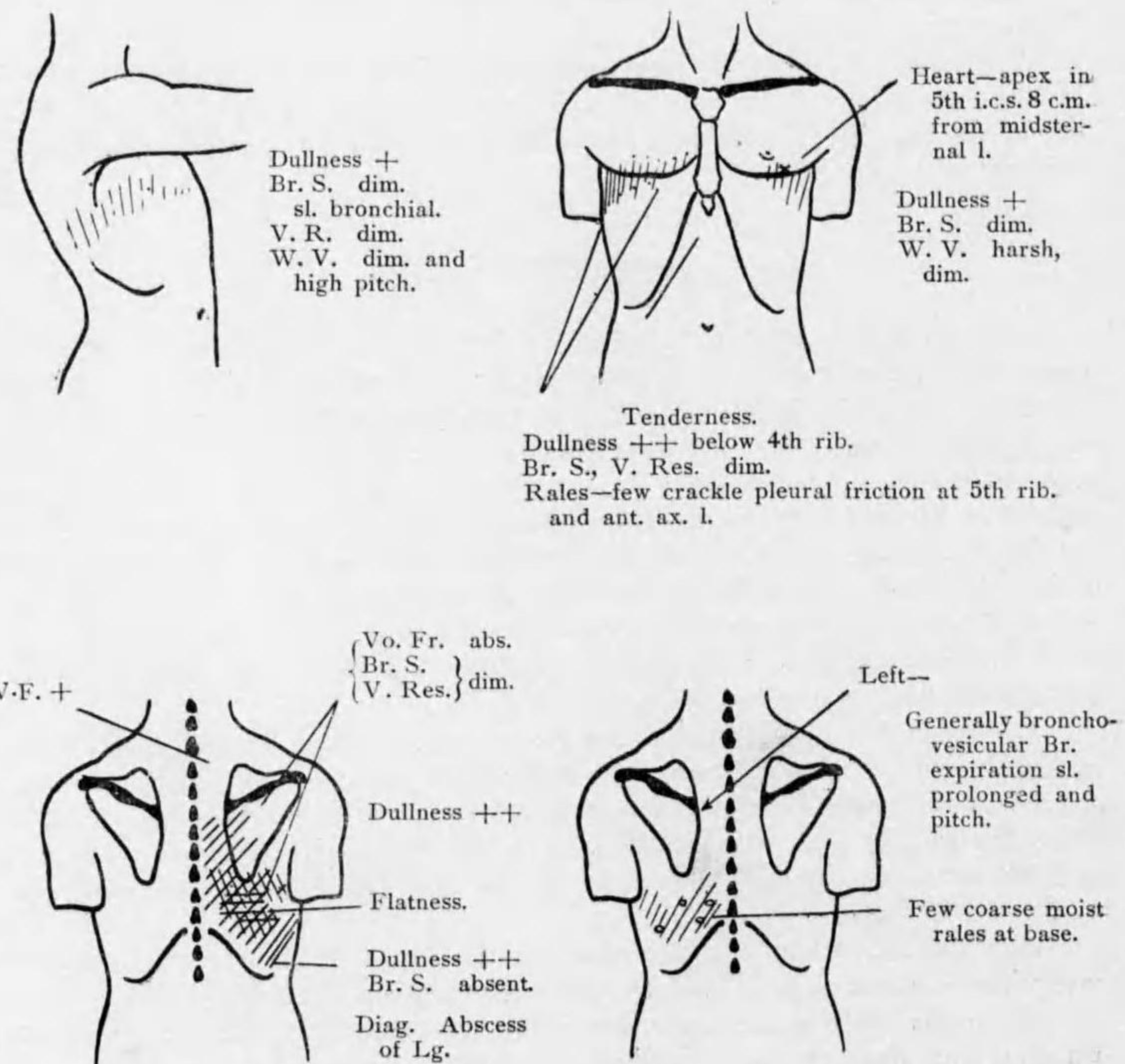
Comment: In this case a.p.t. seemed to have hastened death, whether an artery was punctured or emphysema interfered with cardiac function.

X-ray Findings:

Fig. 178-179. December 17, erect position. On both sides there is homogeneous ebonization at base. On the right side a faint fluid level is shown and a shadow along axilla which made indistinct on account of scapular shadow; but suggests fibropurulent pleurisy with pus in pleural cavities. There is probably fluid on left side also, a definite fluid shadow is not shown on account of thickened pleura which is indicated by diffuse hazy upper margin. The right mediastinal shadow is widened and the hilar shadow is increased. There is traction on trachea to the right side, due to fibrosis. Abscess cannot be demonstrated because of its position at base, behind the diaphragm. A lateral position in this case, would have shown cavity with fluid level.

Esther Mermelstein.

Dec. 16th, 1920.



Case XXVI. J. R.

U. S. white 36, clerk. Family history, mother died of carcinoma at age of 63, otherwise negative. Past history, usual childhood diseases, pneumonia at age of 23, appendectomy for acute appendicitis in November 1919 with p. o. complication of lobar pneumonia from which he made a complete recovery.

Present Illness: On June 15, 1920 he had a sudden chill and fever, but was not sick enough to remain in bed; got somewhat better and went to the country. On the day of admission, July 4, he again had chills. Physical examination showed that he was well developed, well nourished young man looking acutely ill. Chest expanded equally on both sides. Lungs, as illustrated, indicated consolidation of right upper lobe. Laboratory findings: blood culture, negative, Widal negative, Wassermann negative and sputum negative for tbc. Typhoid was considered.

Course: On July 13 exploratory thoracentesis was performed at 4th i.c.s. on mid clavicular line. Then the patient at once collapsed and expectorated blood. Patient was restrained, but later he was very restless and was sometimes delirious. The following day, patient moaned, was cyanotic, had tremor of whole body and had four convulsions. Lungs were filled with fine and coarse moist rales. He finally expired, probably from cerebral embolism.

P. M. Multiple abscesses of lung, involving chiefly right upper lobe. Pleuritic adhesions on both sides; acute septic splenitis, obsolete pulmonary tbc. The right pleural cavity is completely obliterated by adhesions, especially over upper lobe. The right lung is restricted and left lung is carried over to the right; the border lying under right costochondral junction. Both pleural cavities are dry.

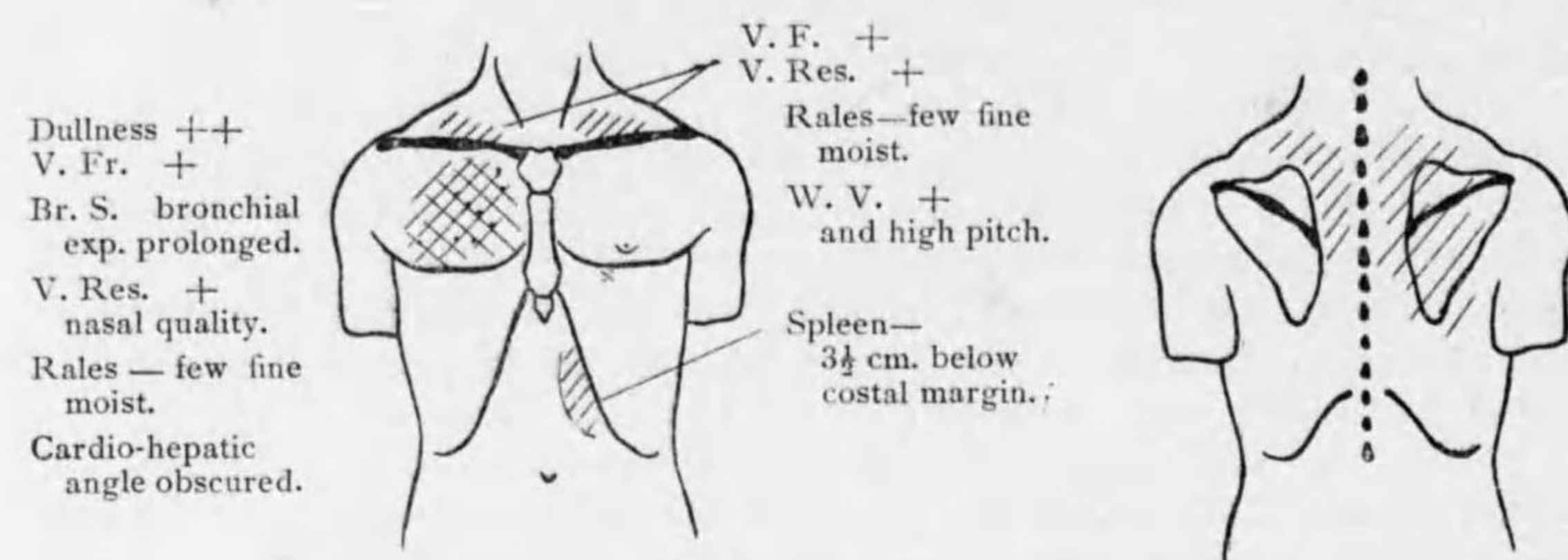
X-ray Findings:

Fig. 180-181, July 6, 1920, taken in prone position. Dense shadow occupying inner upper quadrant of right lung field, appearing thickened fibrosis. There is displacement of mediastinum and heart and root shadow is much accentuated. The outer portion of the shadow is hazy and along the axilla it is more dense and diffuse, indicating thickened pleura and perhaps some adhesions. The haziness at apex may be also due to thickened pleura. The interlobar pleura is quite thickened. The heart is displaced to the left, the right diaphragm is high and there are some adhesions. Both costphrenic angles clear showing there is no fluid.

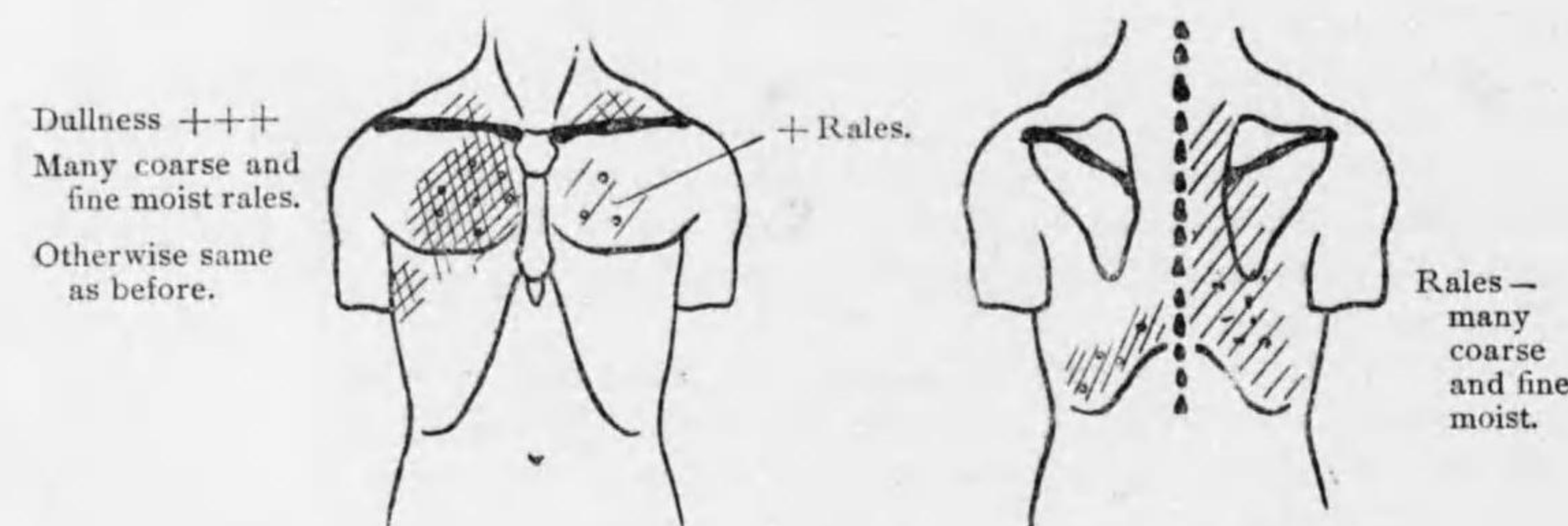
Comment: The clinical history, the X-ray findings and autopsy findings suggest an influenzal invasion. Such dense adhesions as shown in films and as found in the autopsy indicate the nature's remarkable attempt of resisting the infection. With right root shadow almost in mid clavicular line and the density caused chiefly by fibrosis, and possibly by engorged vessels, do not warrant thoracentesis in fourth i.c.s. in mid clavicular line. Such procedure is responsible for the patient's collapse and hemoptysis. Careful radiographical interpretation should have been used as a supreme guide. Unwarranted thoracentesis is frequently a source of danger. A large circular rarefied area on the right clavicle was mistaken by Roentgenologist for a "large empty abscess cavity." This is not a cavity, but it is formed by adherent pleura on the one side and thickened root on the other. Not only that its border is diffuse and hazy, but it lacks usual triangular shaped density in its dependent position. The lack of mottling appearance which is usual picture of multiple small cavities, in this film may be explained by the fact that this film was taken in early stage when the intergration of lung tissue was not pronounced. Otherwise this film agrees exactly with autopsy findings.

Joseph Ronald.

July 4th, 1920.



July 14th, 1920.



Case XXVII. E. M.

Russian housewife, aged 26; admitted to the hospital with the chief complaint of pain in the left chest for last six weeks. Her family history was negative. In her past history, she had measles and occasional sore throat during her childhood, and appendectomy 7 years ago and for acute appendicitis. Otherwise she had been generally in good health.

Present Illness: Six weeks before admission, patient swallowed chicken bone, and that night she thought that she had a "cold." The following day she developed pain in her left side and difficult breathing on account of the pain which was made worse by deeply breathing and by coughing. Sputum became more increased, and during a few days before admission sputum was bloody tinged. She had occasional night sweat, slept poorly and had poor appetite.

Physical Findings: The patient was well developed and fairly well nourished, appearing not acutely ill. Tonsils were enlarged, cystic, and moderately congested. Extremities were negative. The lung signs suggested partial consolidation in the left upper lung field, as illustrated in the following diagrams.

Course: On Nov. 20th the developed acute tonsillitis. On Dec. 2nd she had chill lasting for 25 minutes; complained of pain in the left inguinal region, which was later proved to be a phlebitis. The patient was coughing severely and the sputum was bloody tinged, which was repeatedly negative for acid fast bacteria. The signs in her chest showed incomplete consolidation in right and left upper lung fields with bronchitis. Total white blood cells 16,000, poly. 89%; the throat cultures were negative for diphtheria; blood culture sterile. On Dec. 3rd, again had severe chill. On Dec. 11th the bronchoscopic examination revealed no foreign body, but there was dilatation of bronchi of the left lower lobe from which direction pus was coming out. The signs in the chest, X-ray findings and the course so far are too indefinite to establish the diagnosis.

If foreign body or abscess present at extreme end of left bronchus, it is overshadowed by the heart. Bronchoscopic treatment is most beneficial in this case.

ROENTGENOLOGIC FINDINGS.

Fig. 182-183, Nov. 12, 1923. The upper dorsal spinal column curved to the right. There is uniform density of the left mediastinum from 7th dorsal vertebra up to the apical region where the density is the widest, occupying nearly whole apical field, the outer margin is hazy; the rib shadows are seen through the cloudy area; the lung markings are obliterated excepting at the extreme edge of the shadow. The right lung field is clear, but there is definite widening of the mediastinal shadow. The latter shadow is either due to the enlargement of the mediastinal lymph nodes or due to the pressure from the opposite side. The shadow in the left may be due to similar enlargement of the mediastinal lymph nodes or enlarged thymus, although it has no definite outlines for the latter cause. The shadow gradually diffuses into normal lung shadow at the apex, suggesting a pneumonia rather than tumors. A mediastinal pleurisy should also be considered in this case. The right hilar shadow bulges out and is accentuated.

Fig. 184, taken on Nov. 19th, 1923, or a week later than the previous one. This is focused for the spine. There is similar shadow on the left upper mediastinum although it is broader because the lesion is out-focused. Outer border of the 4th to 9th bodies show some irregularity which is unusual in appearance, and this may be caused by some circulatory disturbance or pressure.

Fig. 185-186, Nov. 26, 1923, taken another week later in erect posture. The shadow here, is not as dense as the previous film, but shows similar condition. At the apical region there is somewhat distinct outer wall, and the lung field just outside to this is mottling in appearance. This is more suggestive of enlarged mediastinal lymphatics secondary to infective process around the root area. There is no evidence of lung abscess.

Fig. 187-188, Dec. 3, 1923. Taken four weeks after the first picture. The mediastinal shadow is quite wide and has uniform density. The outer margins are hazy. The pulmonary vessels are engorged. Diagnosis, enlarged mediastinal lymph nodes. Consolidation not possible.

Comment. This may be caused by foreign body, although bronchoscopy was negative, we may consider that the sojourn of foreign body may take place and it

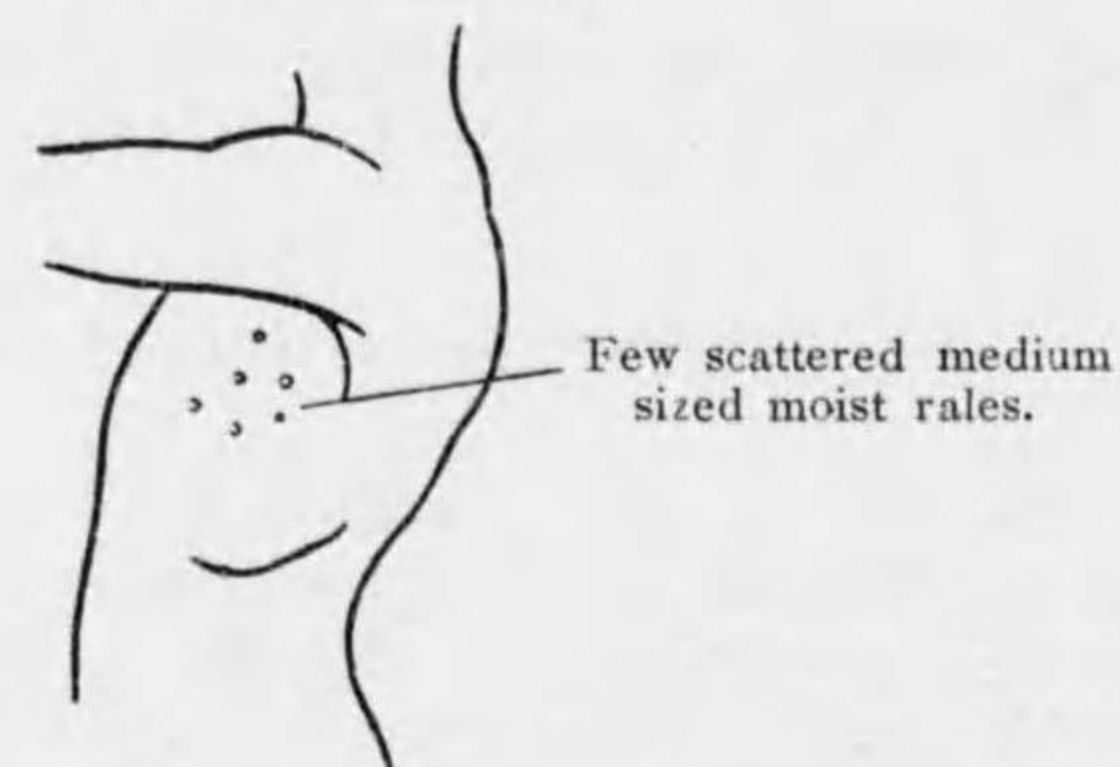


might be, as this case, lodged deep to upper lobe. Even solid body causes abscess in upper, not necessarily in right lower.

As far as the X-ray pictures are concerned in this case, there are many possibilities of interpretations, such as simply indurated mediastinal lymph nodes, lymphoma, other new growth or mediastinal pleurisy. These possibilities must be eliminated by the history, from the course and by careful periodic observations under Roentgenoscopy.

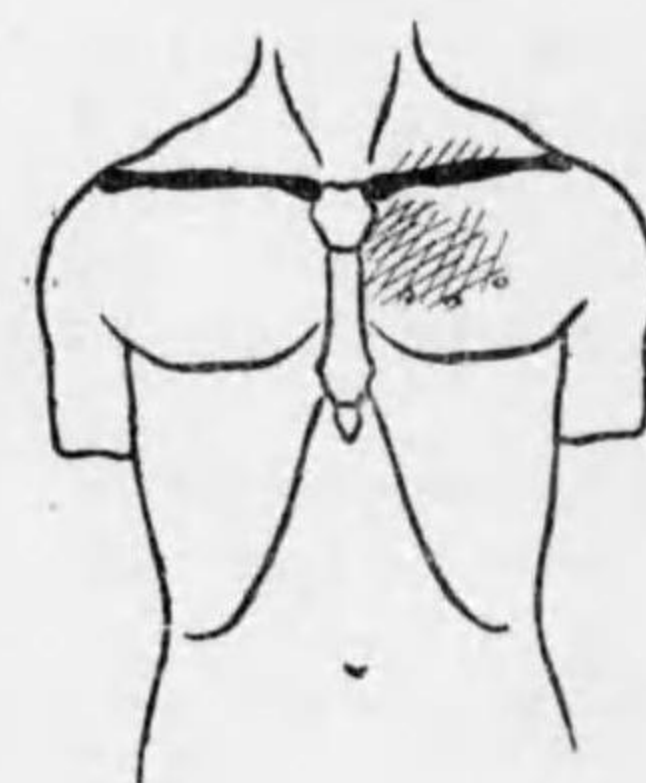
Ethel Massman.

November 11th, 1923.

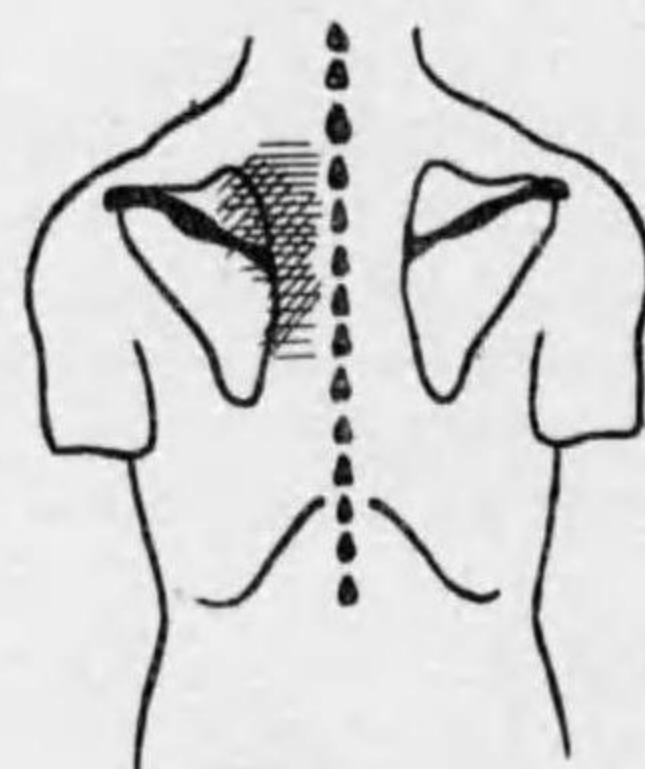


Few scattered medium sized moist rales.

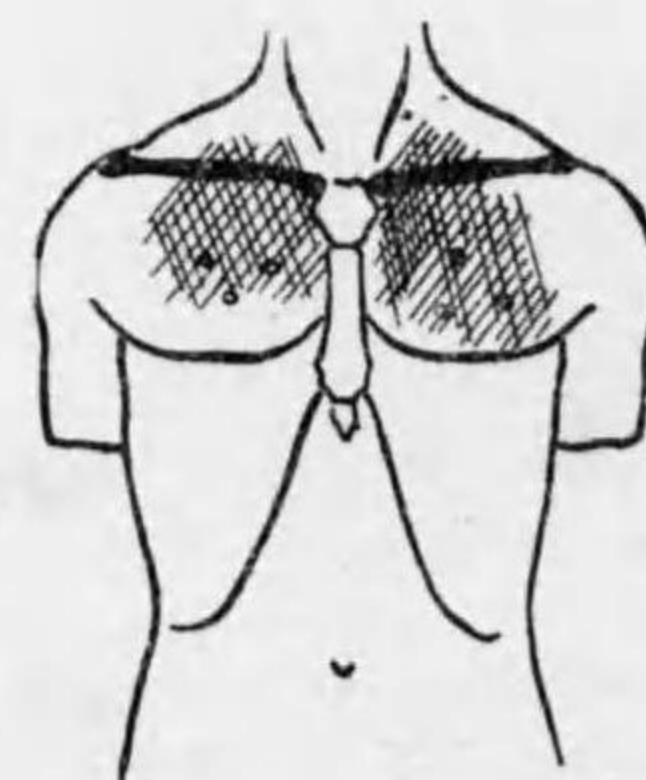
November 11th, 1923.



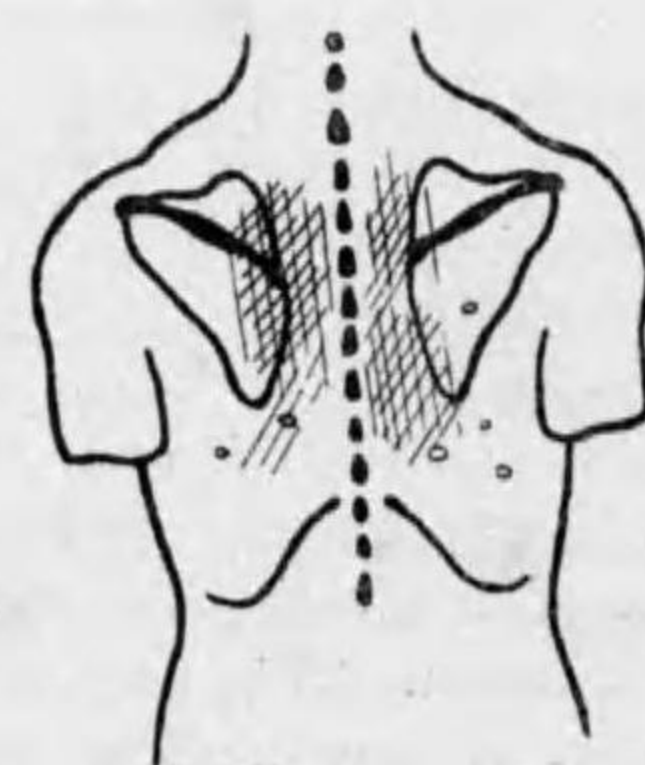
Dullness ++  
Br. S. bronchial.  
V. Res. +  
V. F. +  
Rales oc. moist.



December 2nd, 1923.



Dullness +  
V. F. +  
Br. S.  
distant and tubular.  
Rales many coarse and fine moist.



Case XXVIII. C. E.

Painter aged 69, admitted to the hospital on May 14, 1923 with the chief complaint of cough and expectoration of foul smelling sputum. His family history was negative. In his past history, he had rheumatic arthritis of knee joint at age of 24, typhoid at 37, muscular rheumatism at 38.

Present Illness: Dated back to the years of 1891 or, about 32 years ago, when he started "chronic bronchitis" which would bother him every winter but would leave him by the spring. His cough was not accompanied by expectoration except that during past two years when he raised a good deal of foul smelling matter. The recent attack started about Dec. 19, 1923, or five months ago, with cough and expectoration of foul smelling sputum. This time cough and expectoration became increasingly worse, until the time of admission, and he lost about 16 lbs. of weight during three months. Physically well developed man, but emaciated and looking acutely ill. His lung signs are as illustrated, those of consolidation in left lung; with the difference in the breath sounds which would be plain bronchial in ordinary case of lobar pneumonia.

Laboratory findings: Urine negative, blood, W. B. C. 7,000, poly. 55% which later increased to 17,000 with 88% poly., Wassermann was negative. Repeated sputum examination was negative for tbc.

X-ray findings on May 14 was large irregular opacity in middle third of left lung which was interpreted as possible abscess formation, but it was not definite.

Course: Patient gradually became worse, his temperature went higher and finally died on June 11, 1923.

Post-mortem diagnosis: Abscess of left lung; chronic suppurating bronchitis, pleuritic adhesion; chronic interstitial nephritis. In the right lung at apex and also at the upper margin of the lower lobe laterally, there were small puckered fibrous nodules representing obsolete tuberculous lesions in addition to the chronic purulent bronchitis. Left lung was occupied by a large number of irregular cavities varying in diameter from 2-5 cm. lined with necrotic and granulation tissue and filled with greyish red foul smelling pus, associated with general purulent bronchitis. No active tuberculous lesion however. There was no bronchiectasis throughout both lungs.

Comment: Clinical symptoms suggest Bronchiectasis, but P. M. revealed no such lesions. This was a case of long standing bronchitis, which terminated in multiple lung abscesses. The case will illustrate another etiology in causing lung abscess. Multiple abscesses are only shown as localized mottling area in the X-ray film. The physical signs are very indefinite. Such a case would do badly any way if surgical interference was done.

X-ray Findings:

189-190 June 6, 1923. Left lung field, excepting the central small area is occupied by dense shadows. In the upper lobe, above the 5th dorsal vertebra, there is haziness roughly triangular in shape and somewhat mottling in character. The ribs and certain lung markings are visible through this area. The film is underdeveloped and this must be taken in account. The lower shadow is very dense, both the ribs and heart shadows being obscured. The shadow is irregular in shape. There is some aerated triangular area at costo-phrenic region, while the irregular hazy upper margin of the

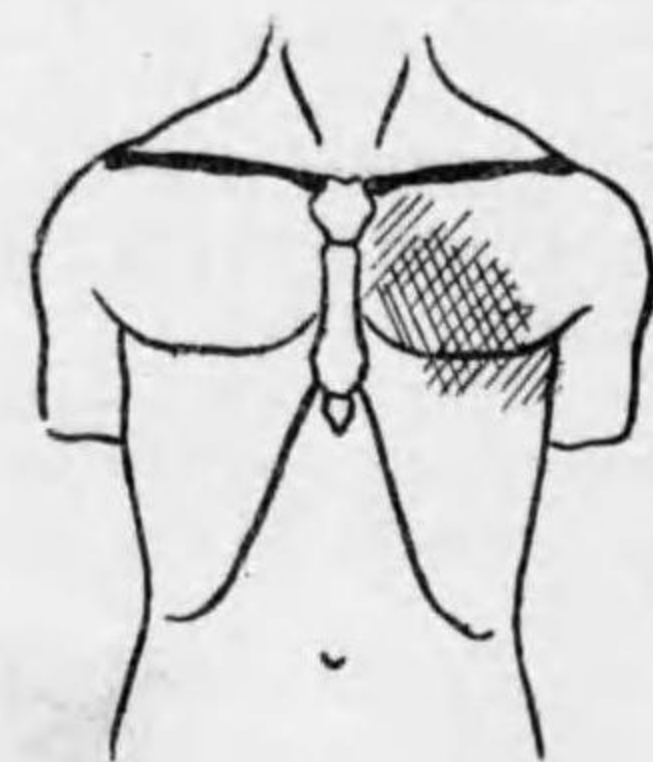
density gradually mingles into the normally aerated lung tissue above. There are a few calcified nodes along the upper margin. There is no cavity observable. Heart is somewhat displaced toward the affected side; there may be an atelectasis. The right lung field is hyperaerated and the intercostal spaces are widened probably due to compensatory emphysema. The apex is well lighted up, while the lower portion shows increased lineal markings. This lineal marking reveals cloudy appearance instead of fibrous in character. This is very suggestive of congestive pulmonary vessels. The lower dense shadows can be a lung abscess with marked reactive induration in the surrounding lung tissue. No pleural fluid or pus in pleura. Diagnosis: infiltration of left apex and lung abscess of left lower. Few calcified nodes above the shadow and one near right root region associated by fibrous cloudiness, constituting "fibrous cirrus cloud" a suggestion of tuberculous lesion.

Chas. Edwards.

May 14th, 1923.

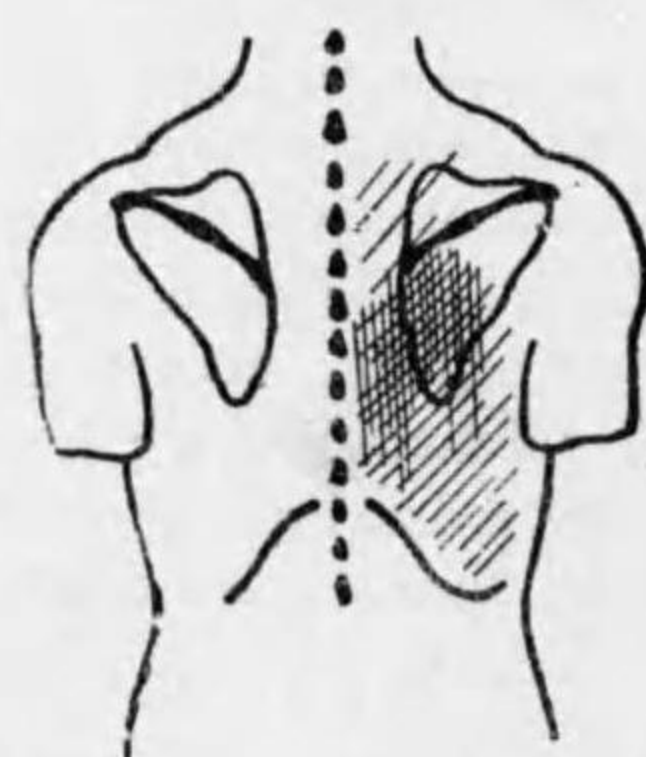


Dullness +  
Br. S. harsh.  
W. V. harsh and  
high pitched.  
Oc. crackling rales.  
Otherwise negative.



Dullness ++  
in 2nd, 3rd i.c.s.  
Br. S. diminished,  
distant bronchial.  
U. S. dim. and nasal  
quality.  
W. V. harsh and  
high pitched.  
P. 2nd accentuated.

May 14th, 1923.



Dullness +++  
Br. S. bronchial.  
V. Res. bronchophony.  
W. V. harsh.  
Rales—many medim. in-  
constant.

**Case XXIX. H. K.**

Russian tailor, aged 28. Admitted to hospital on December 10, 1922 with pain in the right side and back of ten days duration. His family history negative; during childhood he had typhoid; recently had occasional headaches and epistaxis; otherwise his past history was negative.

Present Illness: Ten days previous to admission he had acute pain on his back and right side, severe tearing in character and made worse by taking in deep breath. He was tapped at that time and obtained 30 cc. thin blood tinged fluid. He had had moderate fever, but did not have any chills or cough. Sputum showed staphylococcus aureus, repeated examination resulted in negative finding of tbc. He had large cryptic and congested tonsils and pyorrhea of moderate degree. On admission his temperature was 102-103, pulse 100-112, resp. 20-24 W. B. C. 15,000, poly. 88%, later they increased to 28,000 with poly. 75%. His lung signs are found in the accompanying charts. On January 14th the tap, showed thick greenish yellow pus, culture of which was sterile, including Guinea pig inoculation. On Jan. 17, 1923, rib resection for empyema of his right chest was performed. This revealed a large abscess cavity, about 5 inches in diameter, lying between the diaphragm and the lung, penetrating an inch of the lung tissue at its base. On January 25 he was given transfusion of 500 cc. of blood from universal donor, with 100 cc. of saline. After this he made an improvement but commenced to expectorate profuse foul sputum and profuse purulent discharge from the wound. On January 12, he showed signs on his left chest, which was needled in 10th i.c.s. posteriorly which gave negative result. The wound became sufficiently healed and he was discharged unimproved so far as his cough and expectoration were concerned, on Feb. 15, 1923, or a month after operation.

Fig. 191-192. Dec. 18, 1922. Diffuse cloudiness at lower to thirds of the right lung field; the apex is uninvolved. Below the level of 8th dorsal vertebra, the density is still greater and the shadow of the diaphragm is obscured. This latter dense area has a convex dome shaped upper margin which is barely visible. Above this level the lung markings are accentuated. The right root is markedly thickened appearing quite mottled. Along the 7th dorsal rib there is an almost horizontal line indicating thickened interlobar pleura and the same shadow persists in all the films taken subsequently. The density at the base with dome shaped upper margin was thought to be a sacculated liquid; but highly relaxed diaphragm complicated by thickened pleura with pussy exudate can not be ruled out.

Fig. 193-194. Jan. 10, 1923. Taken a little over three weeks later. The haziness in upper lung field is less than before, and the linear markings are more fibrous in appearance. The density at the root and the base still great, although in a slightly less degree than before. The interlobar pleura is thickened. The dome shaped shadow previously observed is not visible here, and the upper limit of the basal density is diffuse. Within the basal density there is a rarefied area with irregular outline, situating at the lower extremity of the thickened root, indicating probable cavity formation. The whole picture suggests a combination of thickened pleura, suppurative exudate, indurating lung and perhaps lung abscess.

Fig. 195. Jan. 29, 1923. In prone position, ten days after thoracotomy performed. Increased haziness in lower two thirds of right lung field with central density just below the thickened interlobar pleura, suggesting pneumonic area and thickened pleura. General lung markings are increased; diaphragmatic shadow hazy due to much thickened pleura. If there is any fluid in the pleural cavity it is scant. Both apices are clear.

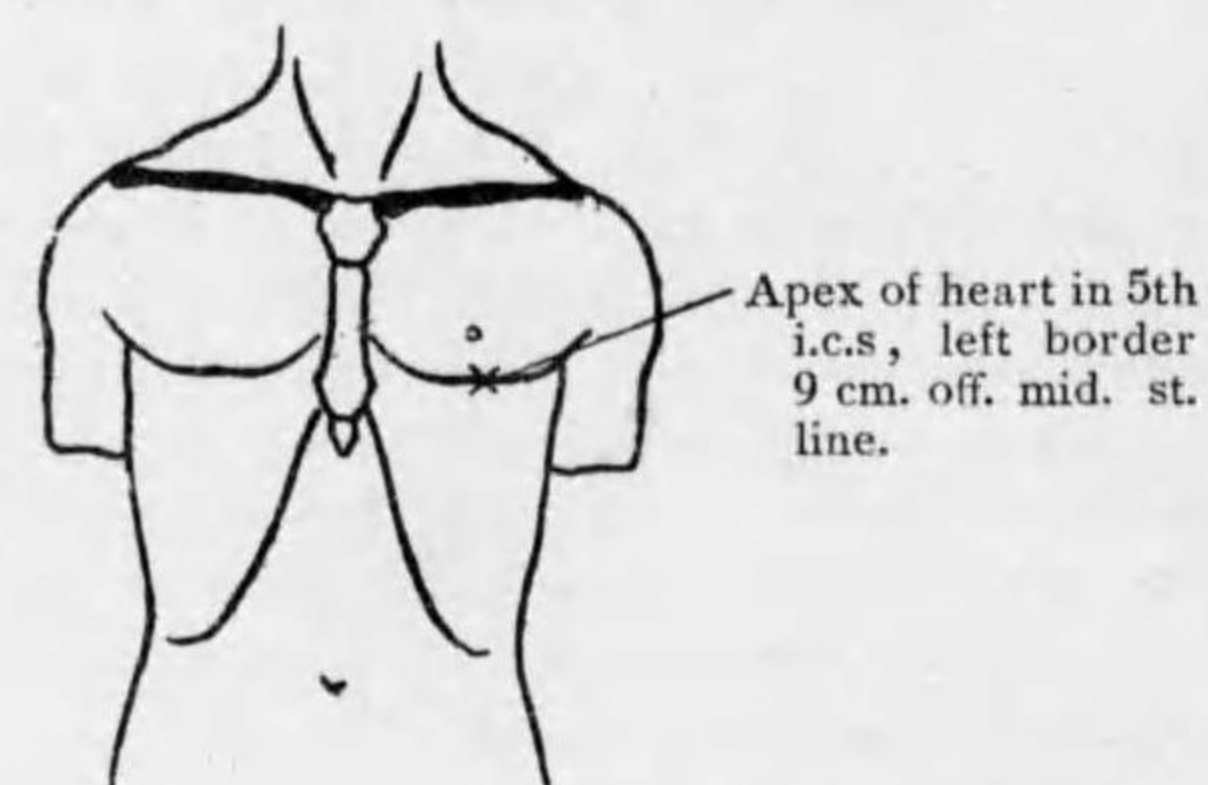
Fig. 196-197. Feb. 6, 1923. One week after the last picture or fifty days since the first picture. We now see a decided change. The density at the base has almost completely cleared up and here is remaining hazy central area, a thickened root, thickened pleura and increased lung markings. The central haziness has rather clear

rounded lower margin separated from the diaphragmatic shadow by a clear zone; its upper boundaries are diffuse. There is still thickened interlobar pleura. The costo-phrenic angle is obliterated indicating the presence of small amount of fluid or pus, with slight adhesions. Within thickened right root there is irregular ovoid hazy outline at level of 6th and 7th dorsal rib, indicating pleural adhesions. Central pneumonic area is still present. There is slight amount of fluid at costo-phrenic angle. Heart slightly displaced to right with adhesions.

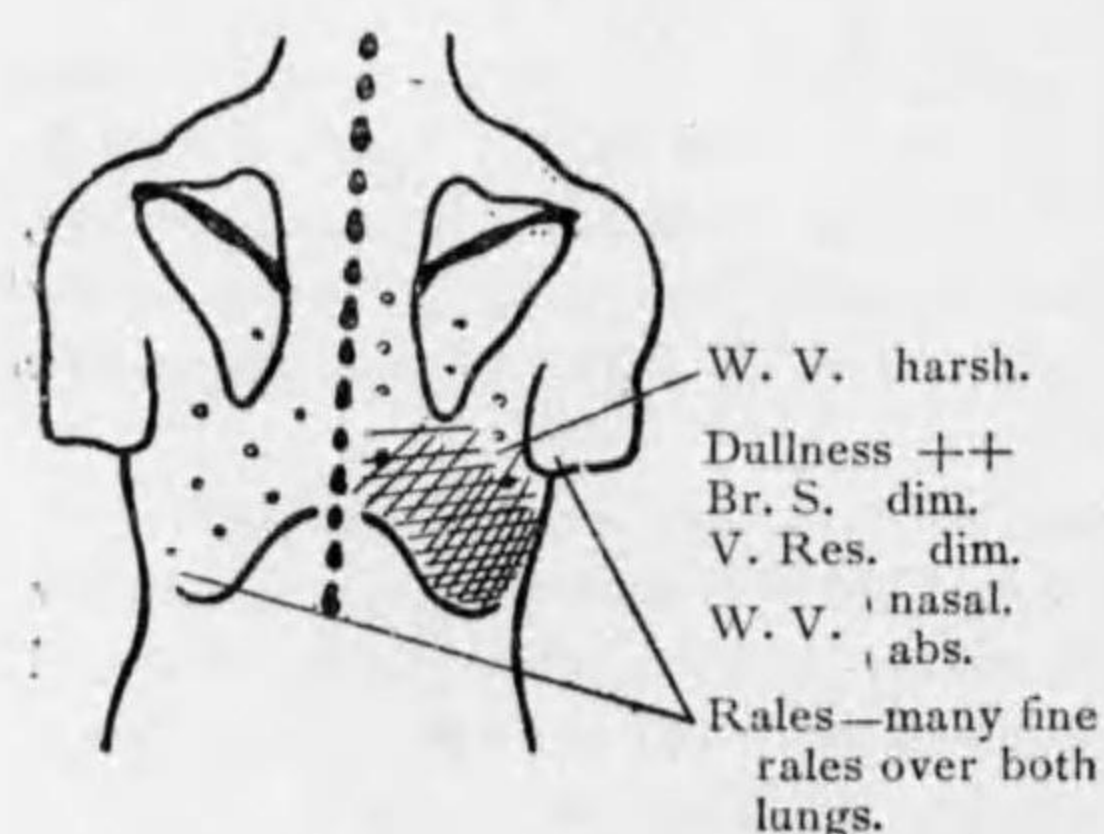
Comment: This case apparently started with pleurisy. The thoracentesis of pleural cavity in the early period might have injured the lung resulting in abscess at the base. The characteristic appearance of cough and expectoration was rather late indicating its intrinsic cause. Cavity shadow although so large as found at operation could not be demonstrated in X-ray on account of the position and complicating empyema. Tuberculosis can be fairly well ruled out in this case. Regarding the treatment, combined thoracis and drain such as described by Willy Meyer and Bronchoscopic drain ought to be carried out.

Hyman Kellan.

December 10th, 1922.

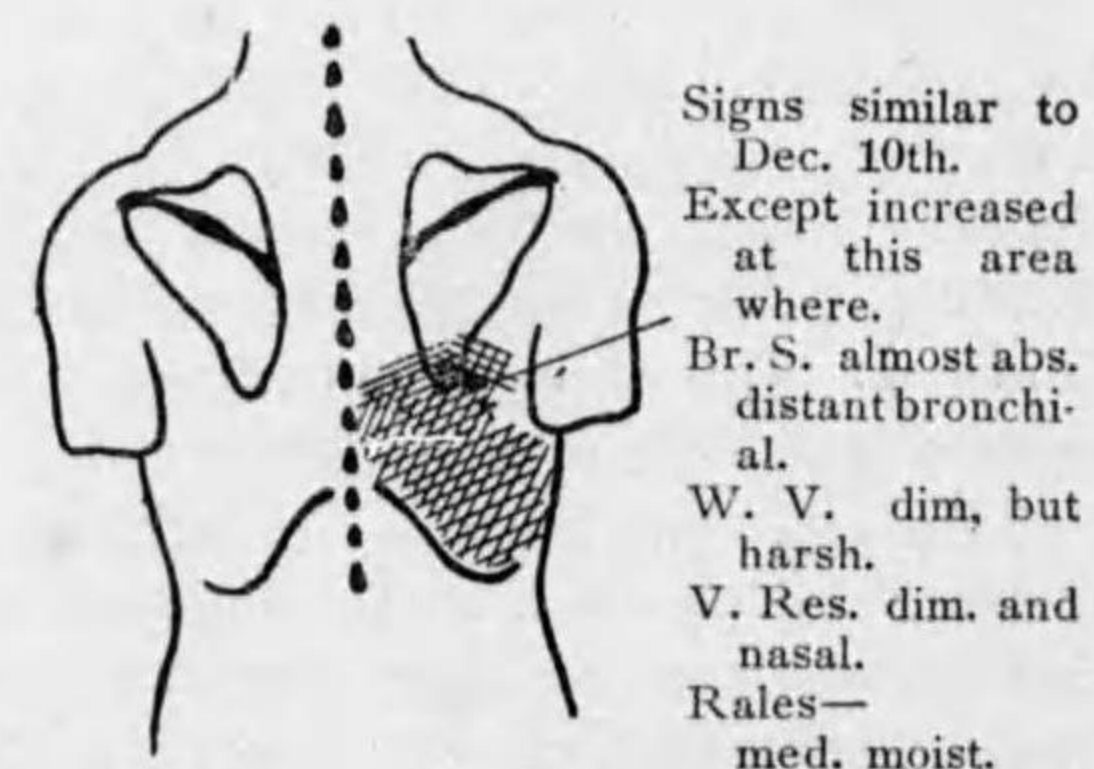


December 10th, 1922.



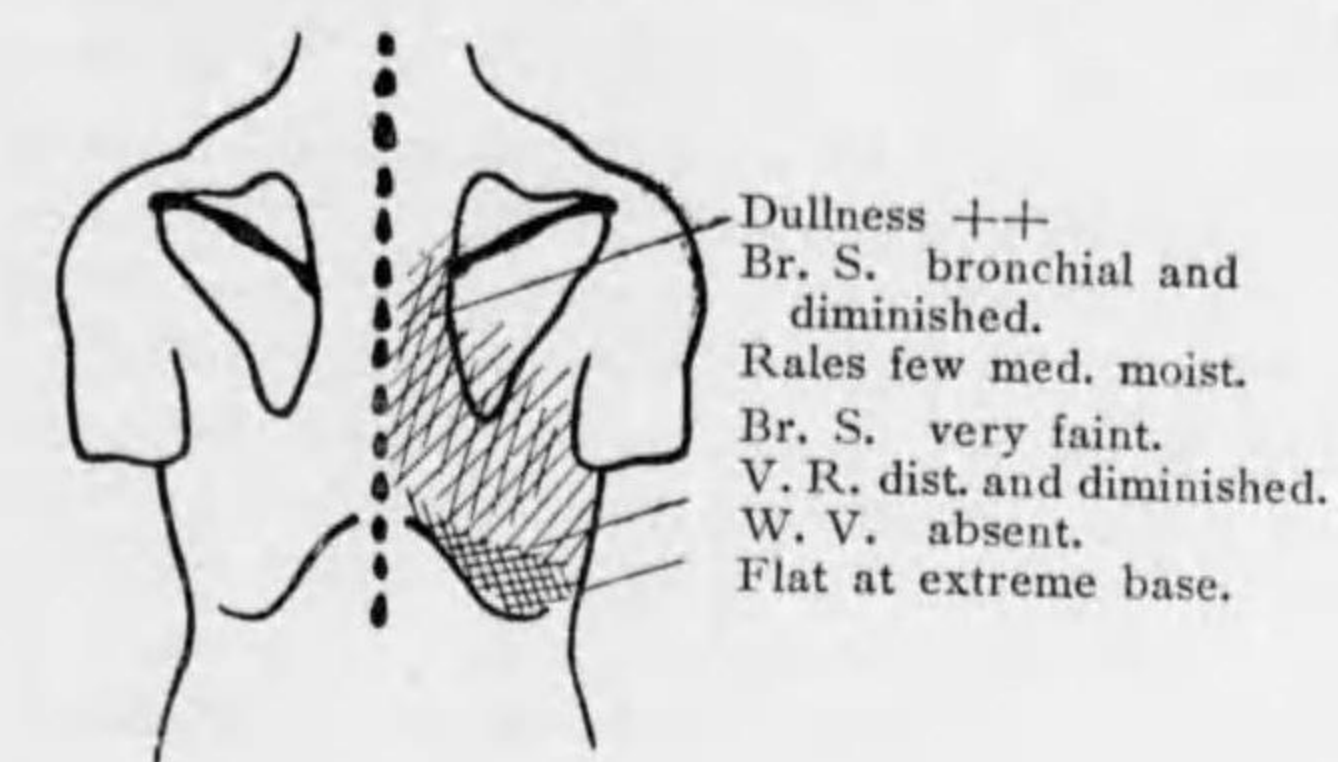
Impression — Liquid in Rt. pl. cavity, general bronchitis.

January 9th, 1922.



Impression — Puzzling, between, pleu. effusion, empyema or Lg. abs. (Pt. has no expectoration enough). Jan. 14th puncture here yielded 10 cc. of thick greenish pus.

February 5th, 1923.



Case XXX. E. S.

German painter aged 67, admitted to the hospital on March 29th, 1924 with the chief complaint of foul expectoration, cough and progressive weakness. His family history and past history were not important.

Present Illness: Dated back about three months, began with an insidious onset of weakness and shortness of breath. For last one month this condition became progressively worse, being troubled a great deal with productive cough. He had foul smelling sputum in large quantities. For about a week before entrance to the hospital he had edema of legs. Physically his development and nutrition was poor and he looked acutely ill. The thorax, the movement was limited on both sides. The lung signs are shown in the illustration. On admission, Temperature 99-102, Pulse 100-124, Resp. 20-24. W. B. C. 20,000, poly. 78%, urea N, 17.94 mg. per 100 cc. of blood, urine normal. Sputum large quantity, muco-purulent settled three layers when it stood, acid fast bc. repeatedly negative.

Course: Thoracentesis resulted negative. Patient seemed to have improved for a few days, but he had sudden severe precordial pain, short breath and rapid pulse and died in a few hours.

Post Mortem: Empyema, right lower half, multiple abscess of right mid lobe, filled with pus. Slight hydrothorax on left chest and peritoneal cavity. Heart showed coronary block of emboli.

Comment: Cause of the lung condition of this case is unknown, but evidently he had insidious onset probably bronchiectatic in origin. The immediate death cause was coronary embolic obstruction. The X-ray on this patient was very unsatisfactory as a matter of fact, multiple abscess, is characterized by such obscure picture.

X-ray Findings:

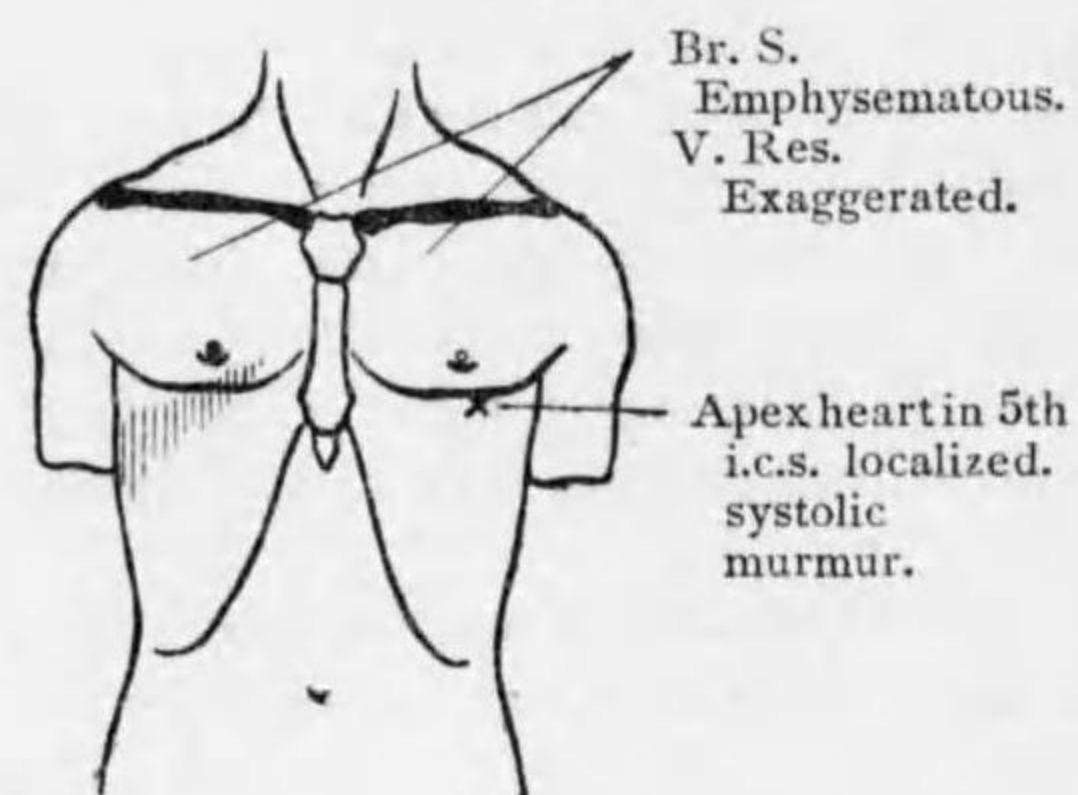
198-199. March 31, 1924 taken in erect position. The right chest considerably narrowed, the intercostal spaces narrowed. There is considerable homogeneous density occupying lower half of the right lung field, its upper margin gradually mingles with upper normal or somewhat accentuated lung marking. The axillar region up to the clavicle there is narrow strand of shadow of uniform density with border well defined from the lung field; nothing but fibro-purulent pleurisy produces this picture. The homogeneous density at base can be produced by indurated lung and thickened pleura.

probably with fluid. The fluid seems to be purulent in nature because of the diffuse upper margin and the presence of fibrino-purulent pleural exudate with retraction of lung from the chest walls. No pathology on left except increased linear markings.

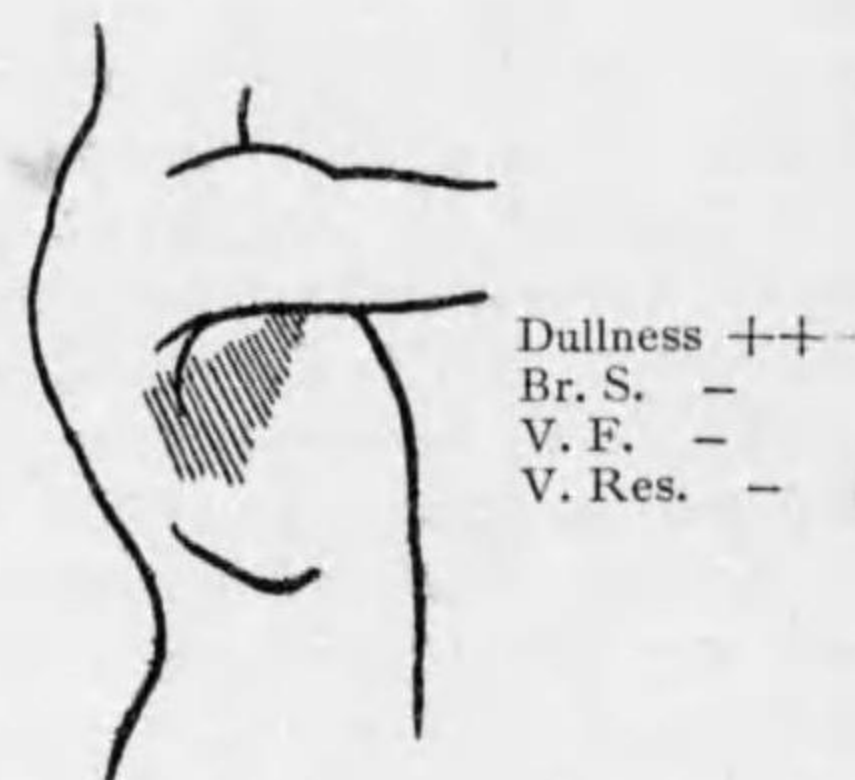
Summary: In such an acute process with thick pleural exudate no cavity can be demonstrated in the film, especially when it is multiple small cavities unless this becomes confluent and forms a larger cavity. However, the patient did not live long enough. This picture coincides with the usual etiology and pathology. This is the non-aspiratory type of lung abscess, the course of the disease is reqlently more chronic from its inception. Primarily the process is not suppurative or gangrenous, but an insidious development of a sub-acute or chronic pneumonitis with fibrosis, which as in the other forms of the disease, is responsible for multiple bronchial dilatations. The disease may be arrested at this stage for a variable period of time, for months or years during which evidence of suppuration or gangrene of the lung may be absent, or mild infection is continuous. It is only with the advent of putrefactive bacteria that a really suppurative and destructive lung area is produced.

Emil Scheffold.

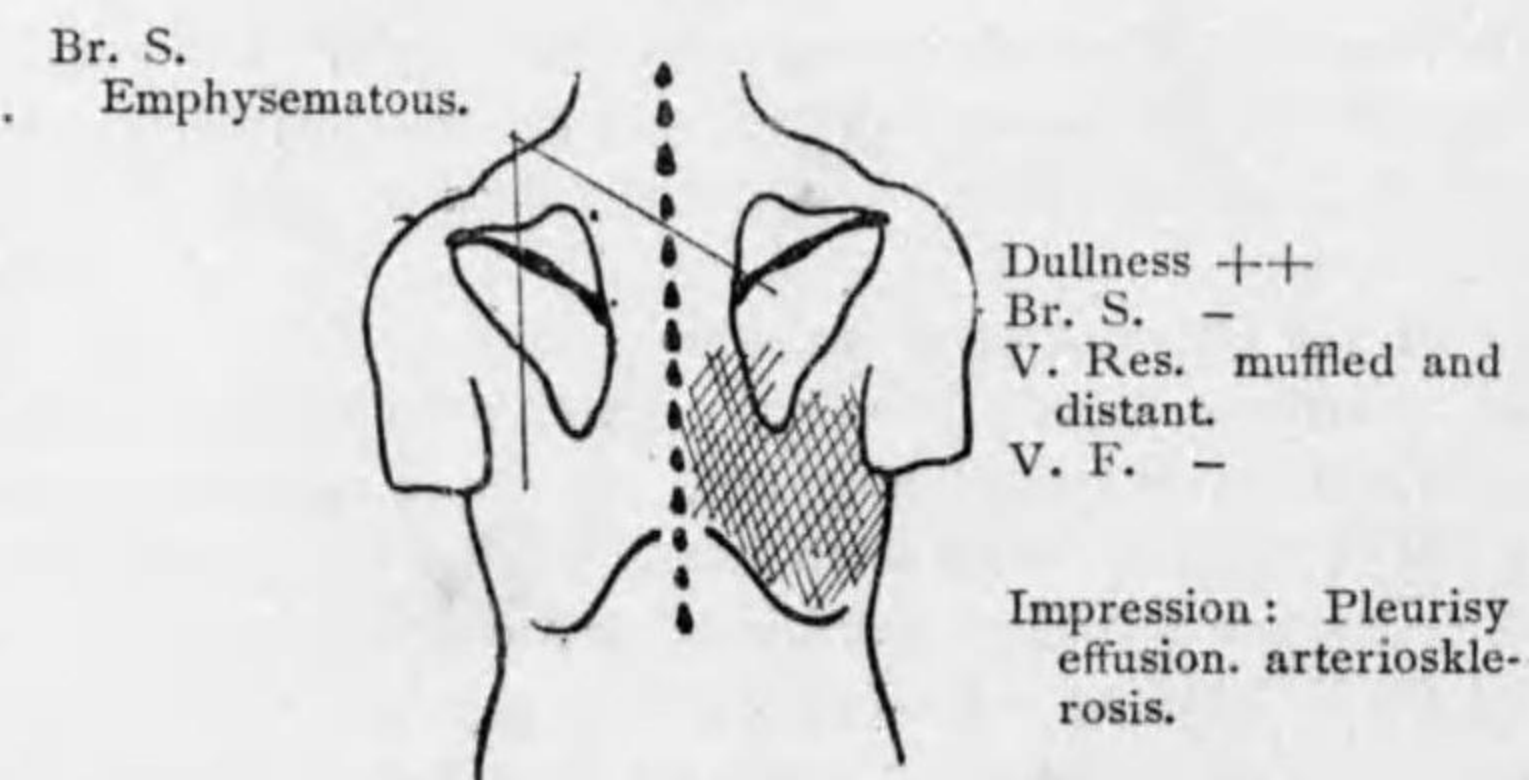
March 29th, 1924.



March 29th, 1924.



March 29th, 1924.



Case XXXI. B. K.

Girl of 15, admitted to hospital on November 11, 1920 for the removal of hypertrophied and infected tonsils. During operation about 8 cc. of thick greenish pus appeared. On Nov. 15 or three days after operation patient had temperature of 102, Resp. 28 and she coughed a great deal. Physical findings of chest, indicated lobar pneumonia in right lower lung, which sign became more increased in next few days. Nov. 22, signs on right side suggested unresolved pneumonia or a presence of necrotic area.

Patient had abundant cough and expectoration which was not offensive. Casual X-ray report given as "fluid" in chest, but with the retraction of heart and vessels plus the physical signs will be more toward acute inflammatory condition of the lung with atelectasis. Under the impression of lung abscess we did artificial pneumothorax introducing 400 cc. of air. The result was remarkable as shown in the films, patient discharged much improved on Dec. 6, 1920 and sent to the country, she was expectorating about 100 cc. q.d. December 27, 1920, more air was given to chest. During the interval patient had still had morning cough with thick greenish foul expectoration two to three ounces every day, at times with bloody tinge. Frequent examinations for tbc. were negative; had lost weight about five pounds during past six months. X-ray on May 5, 1922 showed slight area of scattered and mottled opacity in the right lower lobe, which was thought possible site of foreign body infection. Patient was readmitted to the hospital on May 15, 1922 for observation. The physical signs on that day were slight, consisting of unimpaired resonance, slight roughened breath sounds and occasional rales after cough over right posteriorly, below the angle of scapula. See accompanying X-rays and physical chartes. Patient was sent to the country again on May 23, 1922.

Follow Up: On Oct. 20, patient reported that she had gained 9 pounds since, was feeling well, raises very little sputum, physical condition practically normal. On June 13, 1924, reported that she had no cough, but would occasionally raise a greenish thick sputum about 4 cc. every four hours, but still gaining in weight. On April 13, 1925, patient reported again that she had been all well excepting occasional mild cold, some productive cough 3 or 4 times a day spitting thick greenish matter without any odor. Had lost 10 pounds since last report. Physically: very faulty posture, round shouldered, scoliosis, uses right chest less than left, few rales on right base.

X-ray Findings:

Fig. 200-201. November 20, 1920, in erect position. Lower 2/3 of the right lung field below the 6th dorsal vertebra is occupied by great density. Its upper border appears quite mottling and ill defined. Shortly below this there are a few spots which are surrounded by denser areas. It is impossible to state whether these are cavities, but suspicious. The widening right border of the mediastinum is homogeneous density, and this is either indurative, peribronchial lymph nodes, or retraction of mediastinum. The heart also appears to be retracted to the right. Most of the lower density is caused by thickened pleura and indurated lung. It is, however not possible to rule out fluid. Especially when upper margin of such marked density is irregular and fuses with upper normally aerated lung, there is a suggesting of purulent pleurisy. Casual interpretation of the shadow may be fluid in chest; but retraction of mediastinum

and heart to the affected side and physical signs, indicate inflammation and atelectasis of the lung.

Fig. 202-203. November 27, 1920, erect position. Taken right after a.p.t. The lung is greatly compressed especially the upper lobe. Costo-diaphragmatic angle clear and fluid is now ruled out. No demonstrated cavitation except some honey-combed appearance near the root in the lower lobe. The diaphragm is somewhat adherent in its medial aspect.

Fig. 204-205. December 28, 1920. In erect position, just after another a.p.t. There is rounded shadow with definite lateral border appearing like heart shadow. On close examination, however, the right heart border is made out within this shadow. This shadow appears mottling, containing "net-works" which is probably caused by combination of congestive vessels, thickened bronchi, indurated and fibrosed lower lobe. At its base, there is a hazy "islands" which is probably cavitation. There is some air and some fluid at base.

Fig. 206-207. Taken one year and one half after previous film in erect position, May 2, 1922. Right upper lung field clear, well expanded, at base below 9th dorsal rib, there is mottling and fibrous fields. Heart is displaced to the right. The left hilum is moderately thickened.

Etiology, the course and previous X-ray findings, together, strongly suggest that the patient had aspiratory lung abscess in the right lower lobe. The immediate procedure with a.p.t. was successful.

Fig. 208-209. May 20, 1922. Taken for stereoscopic study. Similar appearance as previous, except that the shadow has diminished both in size and in intensity, indicating absorption of fibrous tissue. No evidence of foreign body or presence of cavity.

Fig. 210-211. October 20, 1922. Very similar to our last film. The heart slightly more pulled toward right and there are numerous fibrous strands at the base, so much as that this picture was interpreted as fibromata.

Summary: This is aspirated lung abscess following tonsillectomy probably multiple in the right lower lobe. The association of severe pneumonitis was misleading at first. Our treatment of successful a.p.t. because of absence of adhesions in the early period. The patient was seen last in April 1925, when she has apparently—doing well, excepting chronic bronchitis and faulty posture due to fibrous contraction.

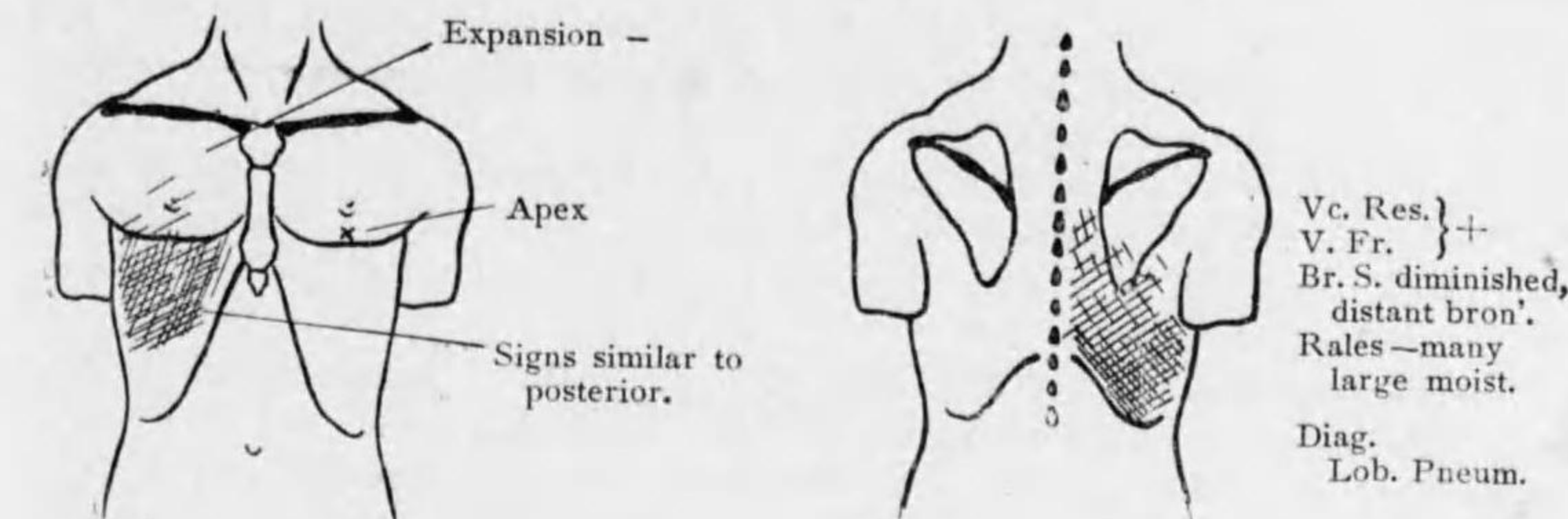
The Roentgenogram represented in Fig. 200 and 201 is of interest from the diagnostic point. This film was first interpreted as "Fluid in the right chest with retraction of heart and vessels." But careful analysis of the picture will show following points:

1. Diffuse haziness whose upper margin diffuses out.
2. Costo-phrenic region appears much less dense than would be caused by fluid.
3. No fluid line is shown.
4. Mid portion is most dense, while periphery is much less.
5. Heart and vessels are retracted to the affected side.

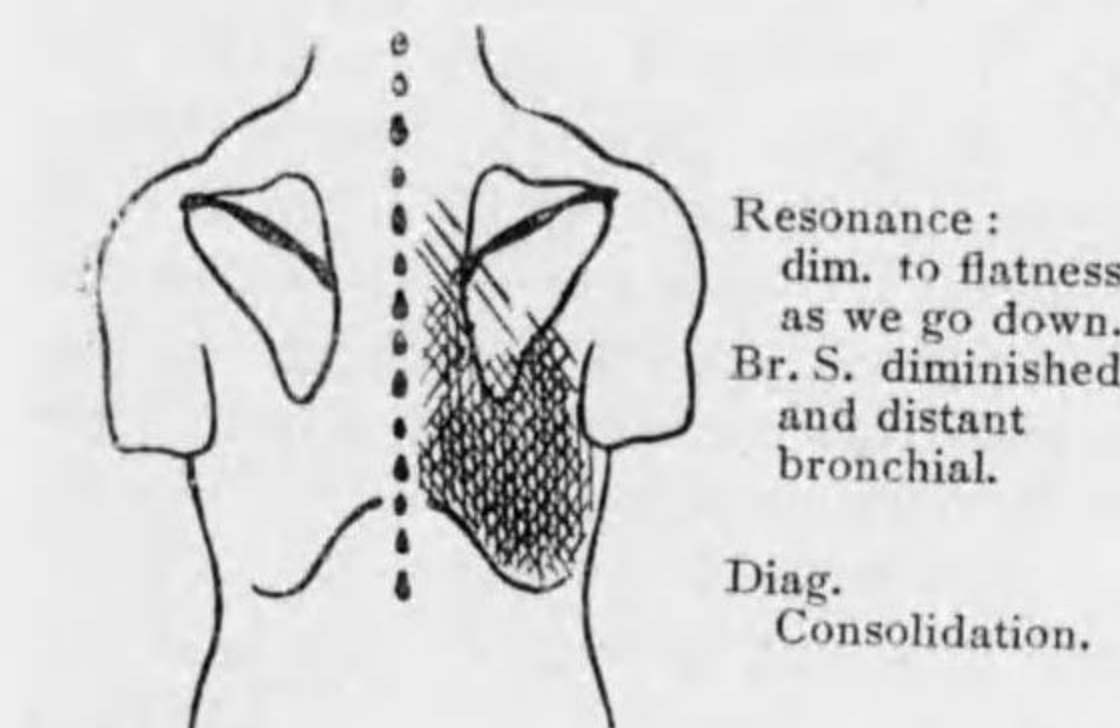
The above findings together the physical signs should make one think of pneumonitis instead of fluid in the chest.

Bertha Kotcher.

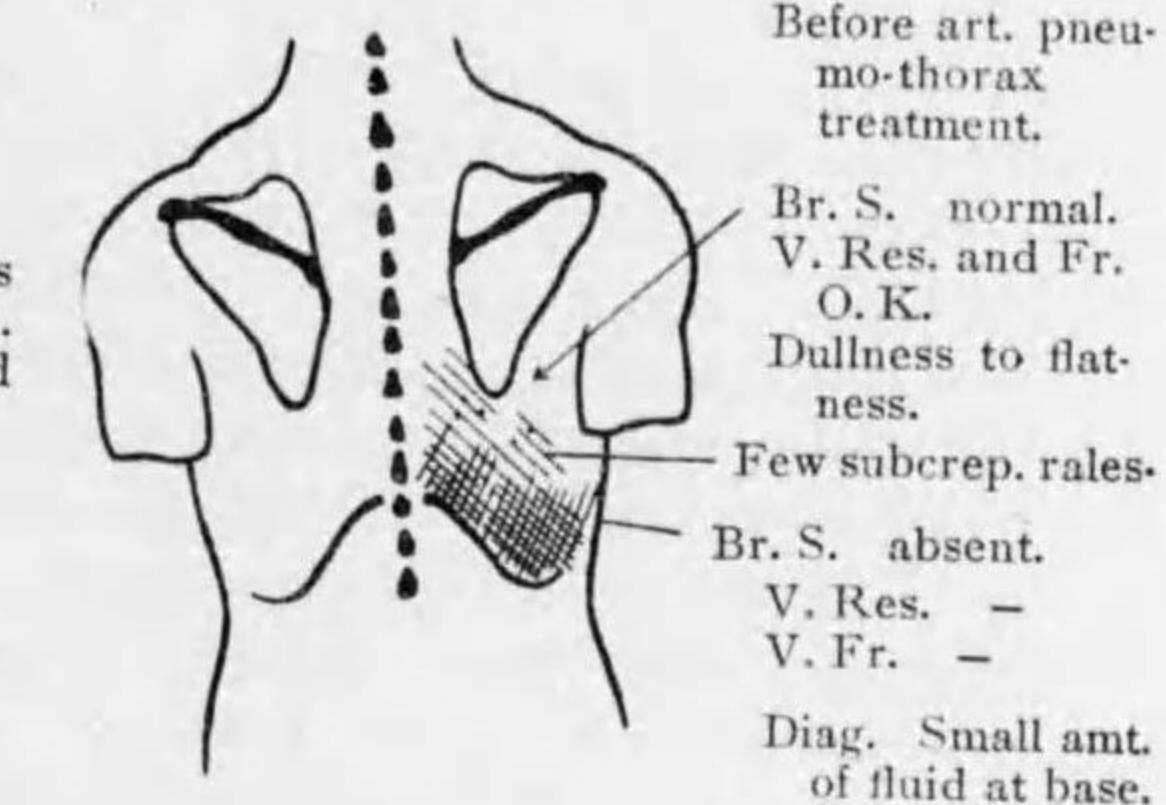
November 15th, 1920.



November 19th, 1920.



December 27, 1920.



### Case XXXII. M. S.

Polish laborer aged 38, admitted to the hospital on December 29, 1920 with lobar pneumonia. Family history negative, no tuberculosis in the family. Past history generally enjoyed good health, had mastoid operation seven years ago, had never been sick otherwise for any length of time, except during past one year or so, he had not been as strong as before.

Present Illness: Was of sudden onset. Five days ago before admission, patient had chill and fever, pain on right side, and cough. On the day of admission he first noticed rusty sputum. He was well developed and well nourished man but somewhat cynosed and appeared acutely ill. Super-clavicular fossae slightly retracted; respiration 22, temp. 103 F pulse 104. Lung signs as indicated in the diagrams, suggested consolidation in his right upper lobe.

Laboratory Findings: Blood, Wassermann negative, blood culture sterile, sputum showed pneumococcus, type III.

Course: His lung signs not cleared up but became more complicated. On January 9th, there was suggestive X-ray of lung abscess, and suspicious tubercular foci.

Patient expectorated about 200 cc. of foul sputum every day. Regular daily sputum examinations including guinea pig inoculation were, however, negative. W. B. C. 10,000, poly. 87%, blood culture negative. On January 12, he was given first a.p.t. thereafter repeating every third day. On January 27 developed extensive sub-cutaneous emphysema over his right back. On Feb. 19, chest was punctured and pus was obtained, whose bacteriological test showed *Bc. proteus*, which gave negative Guinea pig inoculation for tbc. About Feb. 23, general condition began to improve and he was discharged much improved on April 11, 1921. On July 6, 1921, patient returned to the hospital with the statement that after spending two months in the country, he attempted to work but found himself unequal to the task. He still had quantities of foul sputum each morning.

Physical Findings: Chest showed restricted expansion on right, retraction at right apex. Percussion note much impaired throughout front, right upper down to 3rd i.c.s. tubular breathing throughout this area. Posteriorly, impaired percussion note down to scapula and inter-scapula on the right. Breath sounds are distant and tubular in quality. Base and extending into axillary in front has impaired note, breath sounds are distant and have prolonged expansion. Perhaps a thickened pleura and considerable fibrosis with adhesive pleurisy. Left lung is all right. Patient removed to the country. While patient was in the country for two months, he gained in weight, had less amount of sputum which he expectorated always in the morning. Had occasional stick pain in both sides of his chest. He was re-admitted on December 5, 1921. Physical signs: Heart, apex at 5th i.c.s. on nipple line or 9 cm. left of mid sternal line, indicating no displacement; finger showed marked clubbing and marked curving of finger nails. X-ray on December 3, 1921 showed tbc. consolidation right upper, with infiltration throughout both lungs, more on right. Sputum became positive for the first time. Patient sent to the country.

Comment: This patient started with lobar pneumonia of type III and went into formation of disseminating lung abscess of mixed infection. He must have had quiescent tbc. previous to pneumonia, but his sputum, Guinea pig inoculation, and blood culture always resulted negative until very late in the stage. His early clinical symptoms and signs were quite complicated so that tuberculosis or lung abscess could not be differentiated. The X-ray tracings, however, always presented very suggestive features of tuberculous nature of the lesion, unlike ordinary lung abscess cases. The decision on the case has great importance for the management. A.p.t. is indicated but surgical interference will inevitably be a failure; bronchoscopic treatment will be again of no avail.

#### X-ray Findings:

Fig. 212-213. Taken prone, December 31, 1920. Large area of density occupying more than upper half of right lung. Its upper and lower margins indefinite, it is homogeneous at axilla, but becoming more mottling toward the root, this suggests probably lobar pneumonia. Above the clavicle, there is homogeneous haziness suggesting thickened pleura, the diaphragmatic shadow is indistinct, however, its upper border is very hazy in its outer half and is irregularly fibrous at its inner half, suggesting thickened pleura and adhesions. This film is blurred, so that more particulars can not be interpreted.

Fig. 214. Erect position, January 10, 1921. The pneumonic shadow is more clearly defined, its inner half is definitely mottling, there is a suspicious cavity shadow just below the clavicle near spine and possibly another one just below it. Scattered

over whole lower lobe there are spotty shadows, or "tufted cirrus" cloudiness. If they are not submiliary tubercular infiltration, it is something like influenzal bronchopneumonia, the former is more probable. The diaphragmatic shadow is no clear, there is no fluid. The haziness in preceding film at base, which was first thought as thickened pleura now needs correction. It was due to poor film and, to some extent, to congestion.

Fig. 215. Erect, January 13, 1921. Similar to previous picture, except number of infiltrated spots are seen in supra-clavicular region.

Fig. 216-217. January 17th, 1921. Erect. Similar pneumonic shadow, shadow appears coarsely granular and few irregular cavitations are seen, evidently tuberculous in nature. Pneumo-thorax with adhesion.

Fig. 218. January 25, 1921. Erect. Similar pneumonic shadow and increased pneumo-thorax. The physical signs—flatness obtained on percussion, is located slightly lower than X-ray indicated, and in less extent in its upper limit; this may be due to muscles and bony structure. The amphoric breath sounds obtained at axilla at this period may be due to pneumo-thorax, the tension upon the compressed lung caused better transmission of the breath sound. See section on Physical signs.

Fig. 219. Prone, Feb. 24, 1921. Similar pneumonic shadow with several rarefied areas with ragged border. Increased pneumo-thorax adhesions.

Fig. 220. Erect. March 7, 1921. Similar pneumonic shadow with large area of pneumo-thorax. At right costophrenic angle a suspicious shadow indicating adhesion or small amount of fluid. Left lung shadows somewhat increased root shadow.

Fig. 221. Erect. March 10, 1921. Similar picture. A large empty cavity is now seen below the clavicle. Shadow at costophrenic angle now indicates adhesion. Physical signs at this period indicate definite amphoric breath sound obtained at axilla, this is due to compressed indurated lung, and better transmission of cavity sounds. The positive coin test is also due to similar cause. There is no fluid.

Fig. 223. Erect position. April 6, 1921. Similar pneumonic shadow, definite lobulated cavity at arrow and fluid level at base. The physical signs obtained on March 28 at lower axilla and toward front was due to the pleural effusion.

Fig. 224. Erect. July 7, 1921. This presents a very interesting picture. The pneumonic area still presents, but appears quite fibrous, except at periphery where it is uniformly dense, there are many cavitations. The lower lung has re-expanded. Heart and aorta are pulled to the right. There is a large egg shaped sacculated fluid at base against the costal wall. It has "curved" fluid level, above which there is some air. The wall of the "egg" is quite thick. This condition is known as "swallow's nest hydro-pneumo-thorax" of which Borgherini-Sarabellin (154) speaks as frequently an inflammatory process of the pleura develops in the course of a pneumo-thorax. If thoracentesis is performed for the purpose of emptying the fluid, it is sometimes found that adhesions have formed between the parietal and visceral pleura which may divide the pleural cavity into several chambers so that it is necessary to puncture at several different levels to remove all the fluid. This form of affection has been named swallow's nest hydro-pneumo-thorax. Roentgenoscopic examination shows these accumulations of fluid at different levels; generally the amount in each cavity is small but it may be as much as a liter or more. The treatment is to break up the adhesions. In some cases, as for example in one described, they may be ruptured by applying a pneumo-thorax under very high pressure but in other cases they have to be

resected by operation or with the galvanic cautery if the type of adhesion is suitable. Compare the physical signs at this stage.

Fig. 226. Erect. December 6, 1921. Again diffuse haziness in right upper and "fibrous cirrus" cloudiness in lower lung with a few calcified nodes. There is still some sacculated fluid at costophrenic angle. The lung markings on left are quite increased.

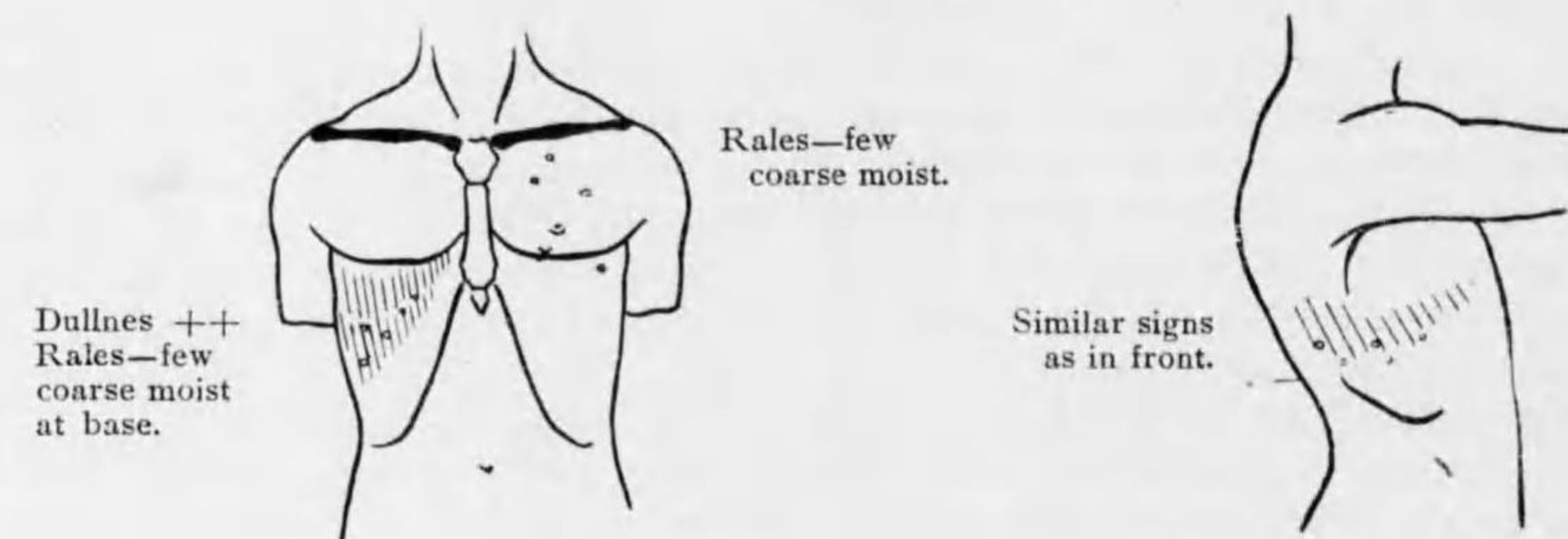
Fig. 227. Erect position. December 13, 1921. Similar as before. The upper lung field appears more fibrous and pleura thickened.

Comment: The foregoing X-ray illustrations involve following points which deserve attention:

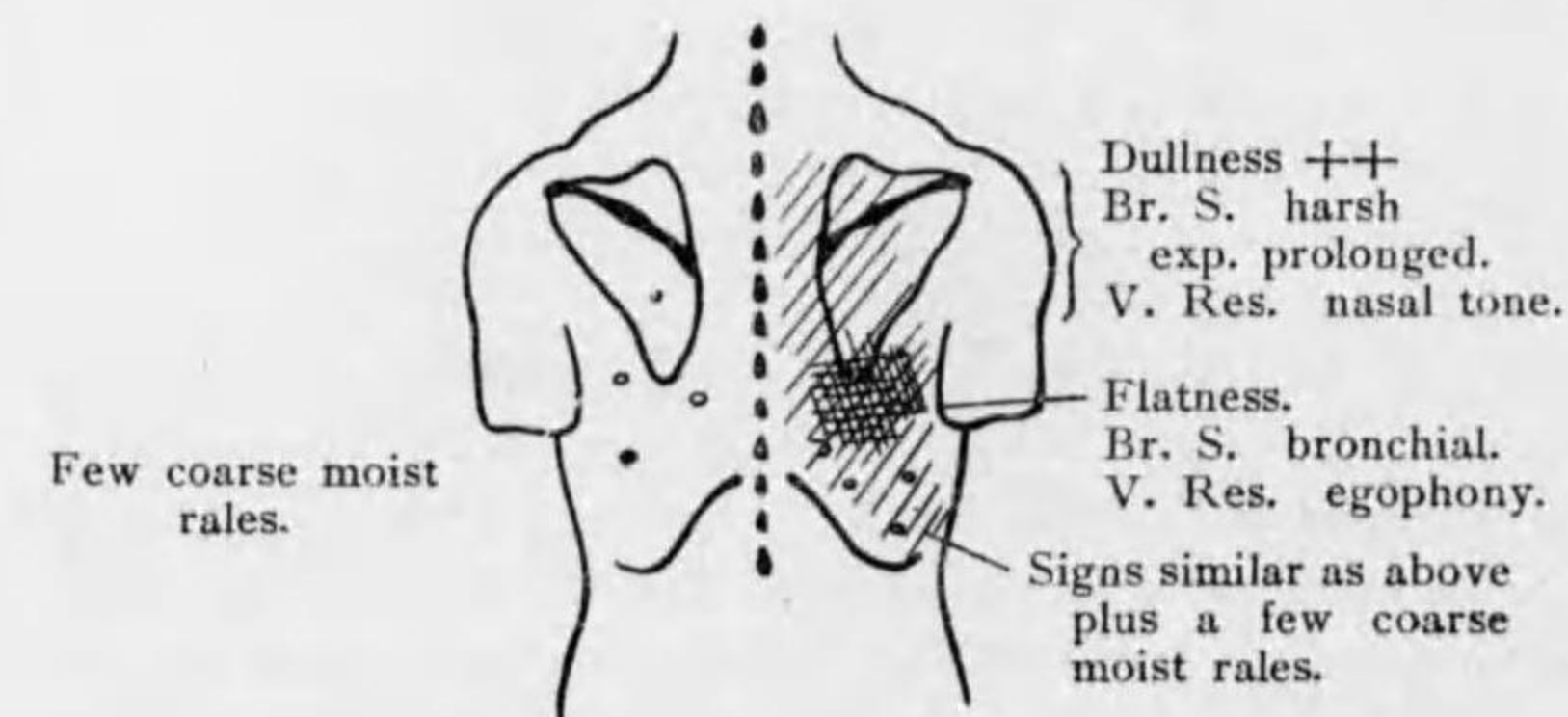
1. Revealed infection complex throughout the course betraying the clinical picture in which the laboratory examinations failed in the beginning.
2. Tendency of fibrosis which is accentuated in tuberculous individual
3. Interesting picture of encysted hydro-pneumo-thorax.

Mike Sabozyryn—I.

December 30th, 1920.

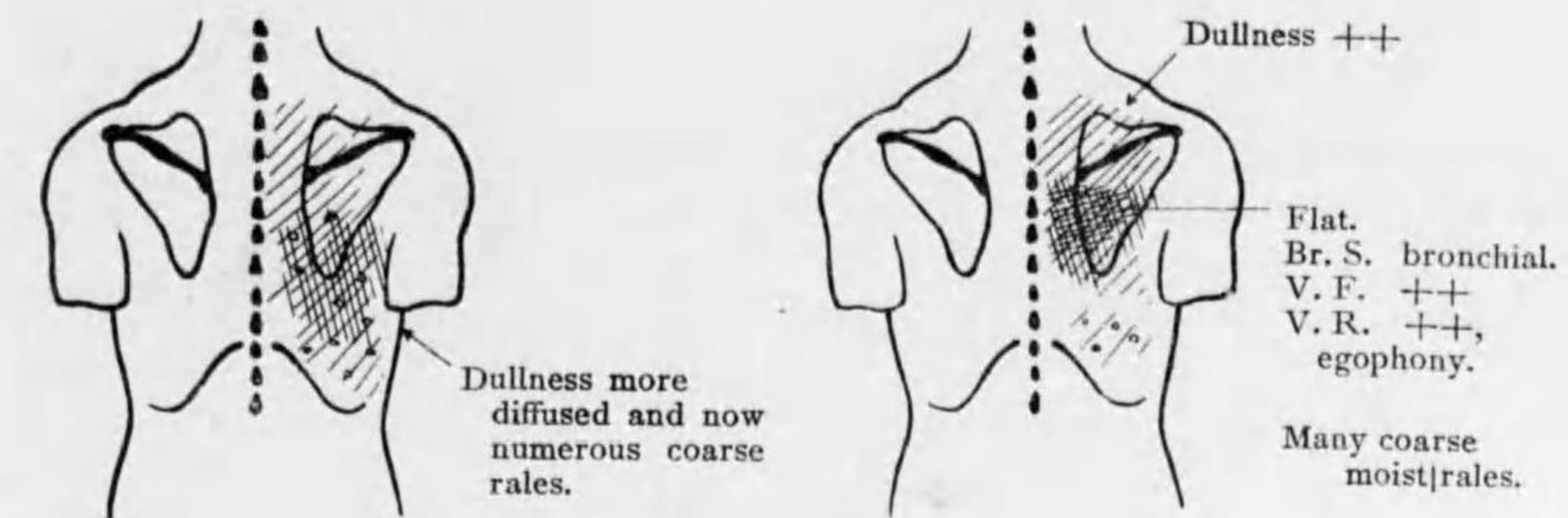


December 30th, 1920.



January 2nd, 1921.

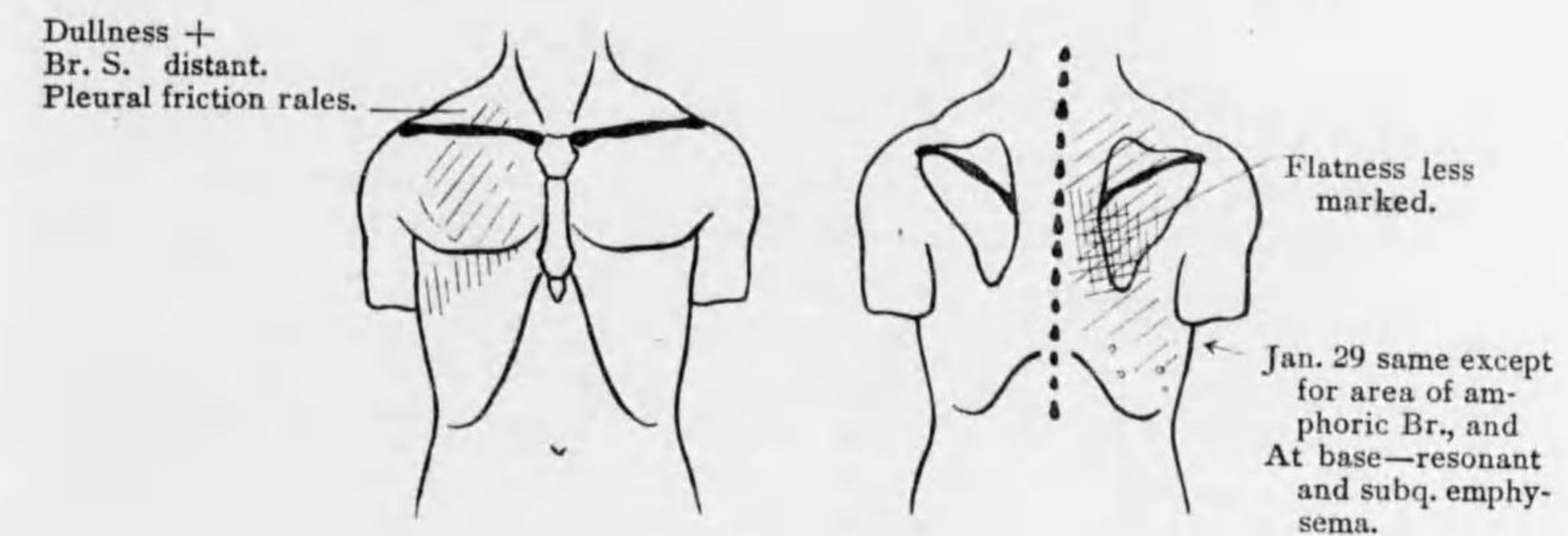
January 18, 1921.



Mike Sabozyryn—II.

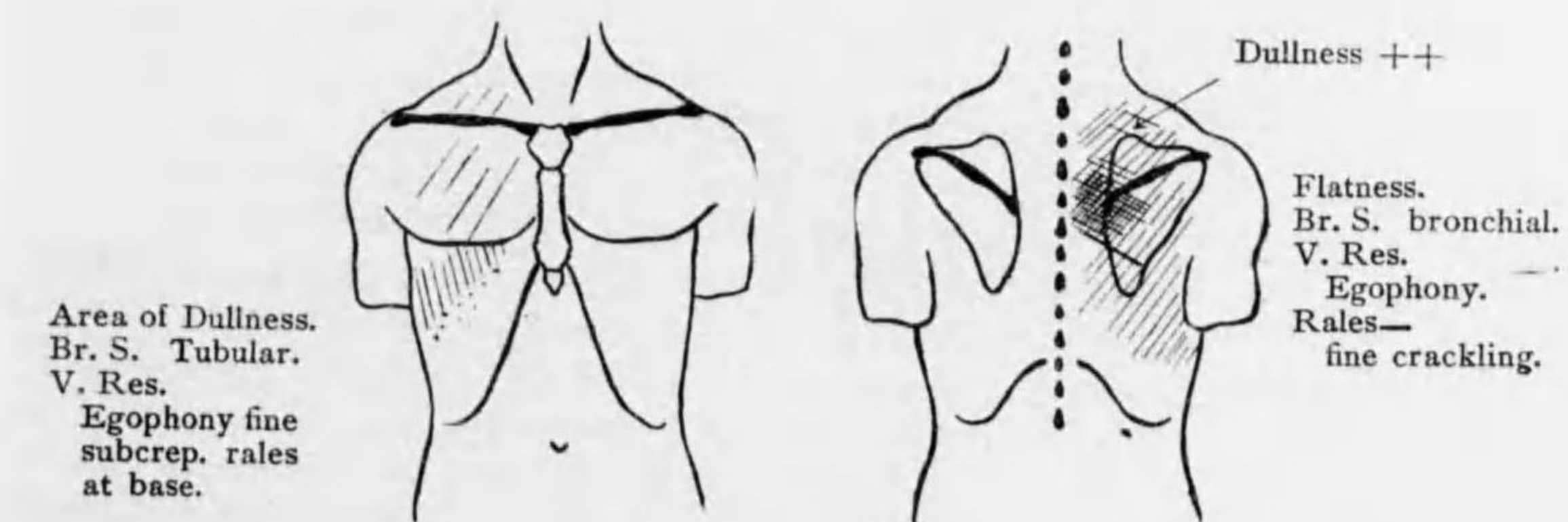
January 18th, 1921.

January 26th, 1921.

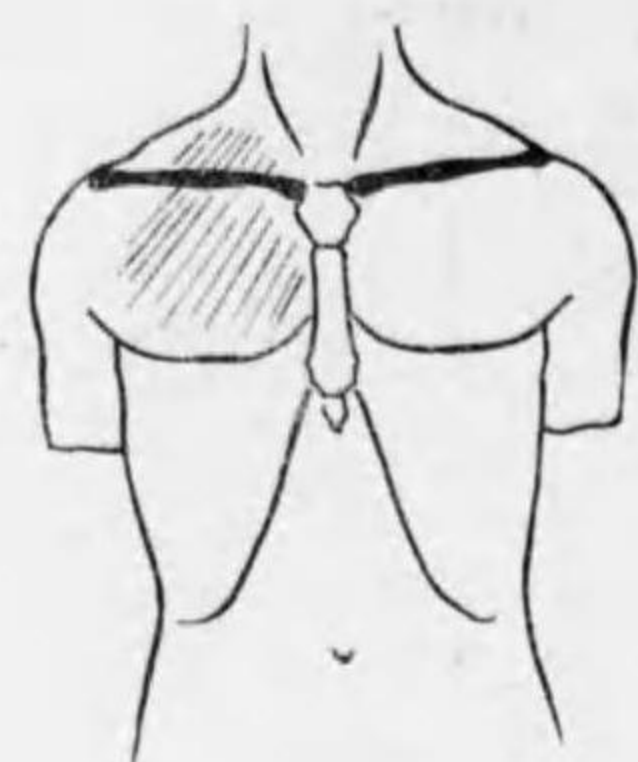


February 17th, 1921.

February 17th, 1921.

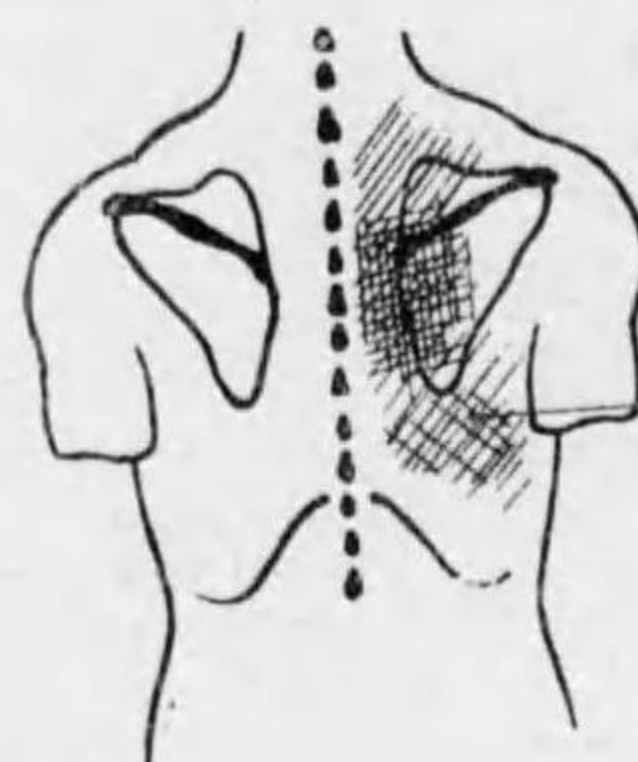


March 12th, 1921.



Dullness increased.

March 12th, 1921.



Dullness +++  
Br. S. bronchial.  
Flat area increased.  
Br. S. bronchial.  
Br. S. amphoric.  
Positive coin test.

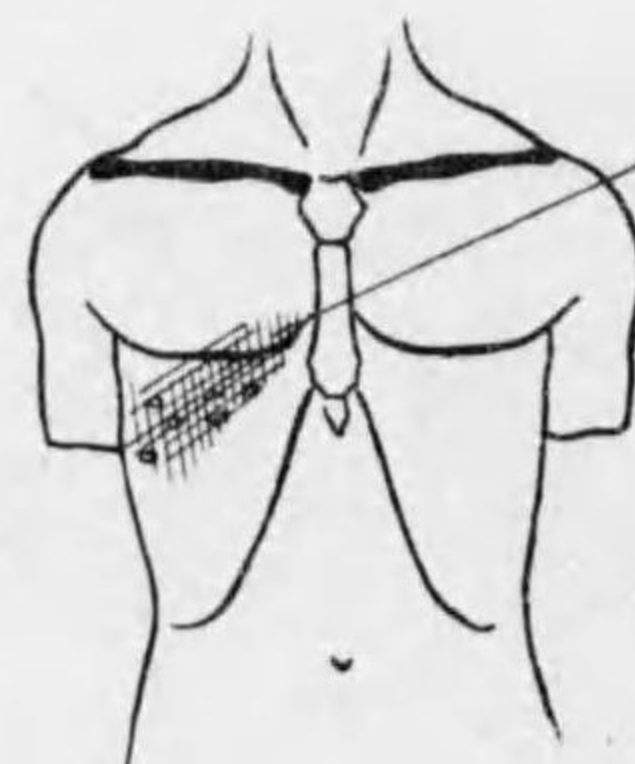
Mike Sabozyryn—III.

March 12th, 1921.



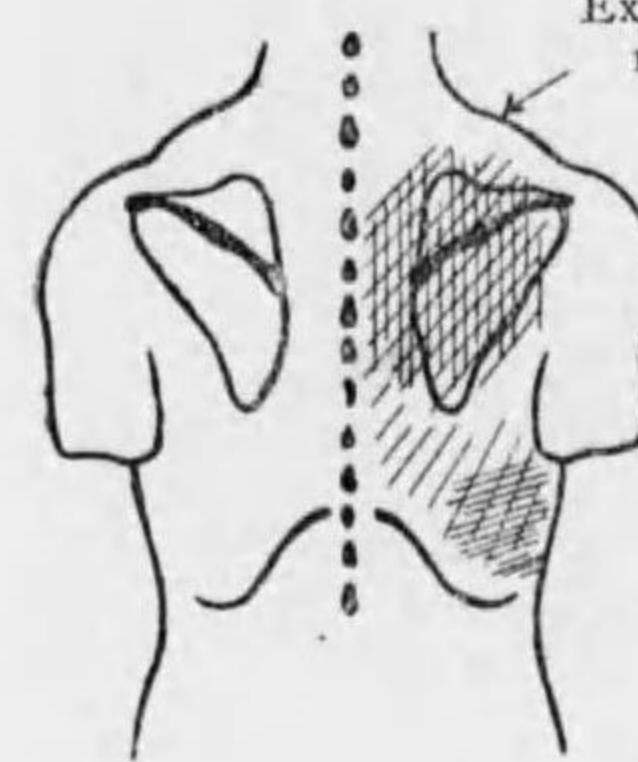
Br. S. amphoric.  
Coin test +

March 28th, 1921.



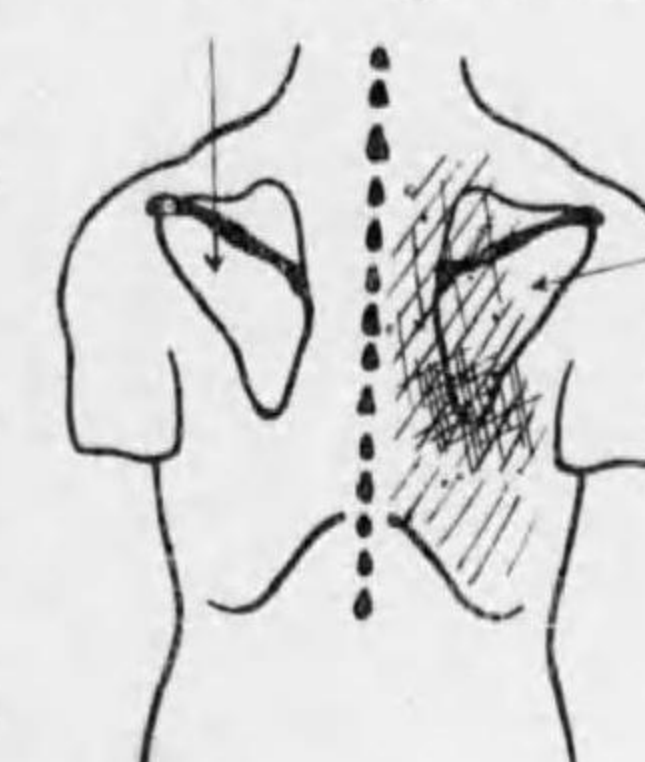
Dullness  
Br. S. bronchial.  
Vo. Res. bronchial.  
Rales—many coarse moist.  
Patient has much pain here.

July 6th, 1921.



Expansion restricted, retraction at apex.  
Dullness +++  
Br. S. bronchial distant.  
Dullness +++  
Br. S. distant, broncho-vesicular prolonged expiration.  
Diag. The consolidation at upper.  
Thickened pleura with adhesions at base.

December 5th, 1921.



Br. S. hyperresonant.

Dullness ++ to flatness.  
Br. S. tubular.  
Many crepitant and subcrepitant rales during both exp. and inspiration.  
Similar findings in front above 3rd rib.

Case XXXIII. H. W.

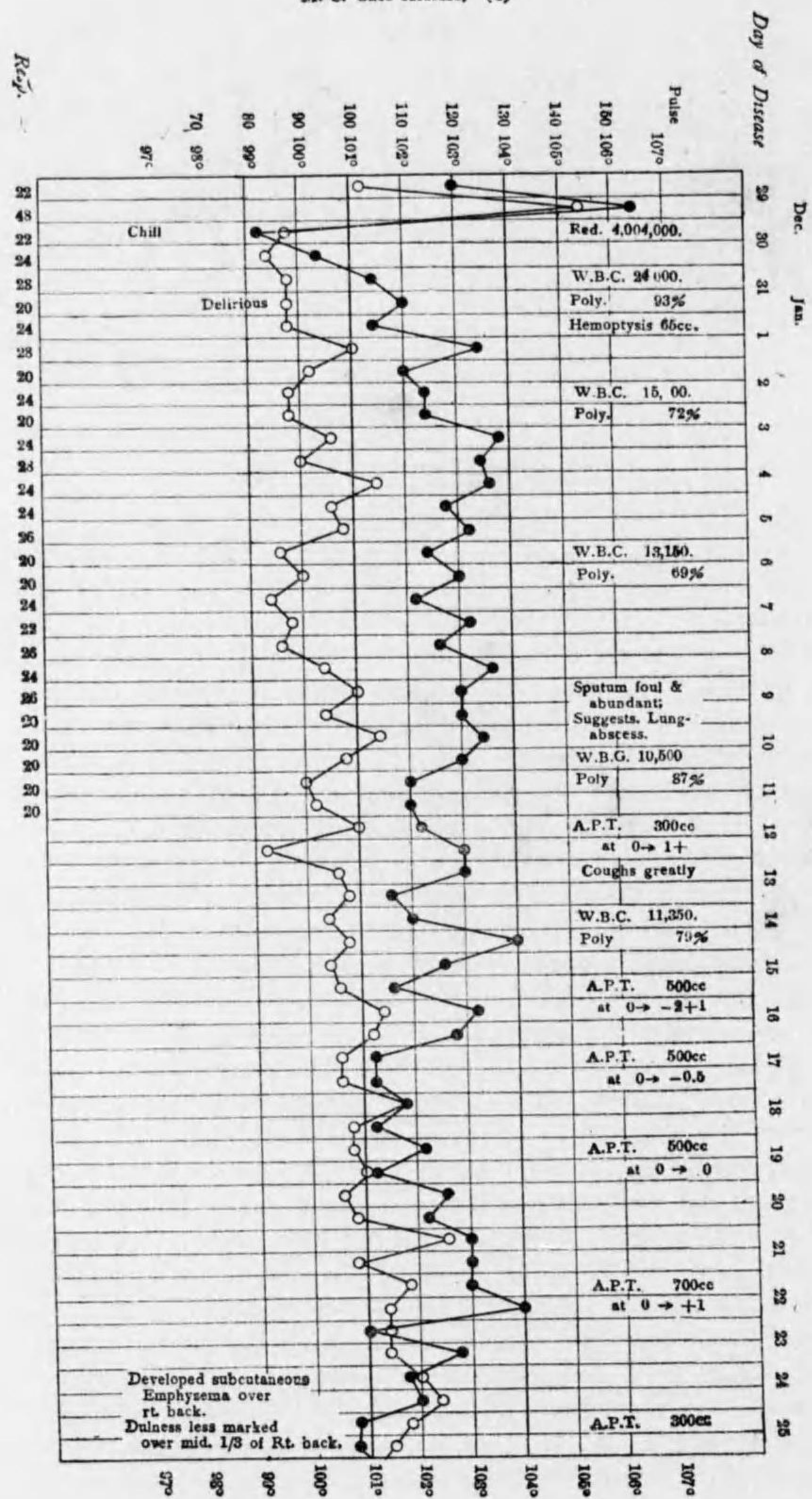
American white laborer, aged 28. Family history negative. His past history: bronchitis ever since at the age of five, scarlet fever at 14, measles at 15, always subject to tonsillitis.

Present Illness: Patient was first seen in Feb. 1908, and was treated for cough and mouth bleeding. At that time he had markedly hypertrophied tonsils and pharyngeal adenoids for which the operation was not advised because of a tumor in mediastinum which was accidentally detected by X-ray and embarrassed breathing. Cough continued and X-ray showed increased size of the tumor mass in the left pleural cavity. Did not have any fever or night sweat. Examination on July 1908 showed that tonsils were still enlarged and few adenoids. Lung showed slight hyperresonance, breath sounds were exaggerated with occasional sonorous rales on the side. On the left side, below the angle of scapula and extending into axilla there was relative dullness, diminished breath sounds, and a few rales between this level. Under the impression of bronchiectasis, thoracotomy was done with resection of ribs, but there was no pus found. After the operation, however, tapping resulted in finding about two ounces of pus. This must have come from somewhere hidden, unable to detect during thoracotomy. Patient made a good improvement from the operation. Had tonsillectomy in 1912 followed by empyema in the same year. Ever since the attack of empyema, patient had had foul smelling breath and expectorated quantities of thick offensive greenish pussy sputum lasting for three years. Without, however, interfering much with his general health. He did not have dyspnea or haemoptysis. The patient reentered in August 1915. At this time his physical was as follows: Sternum deviated to left, left side of the chest more prominent than the right. Lung: right anterior, broncho-vesicular, few crackling rales. Right posterior, dullness, decreased vocal fremitus. Right apex, broncho-vesicular breathing and practically no change. Left base: breath sounds were very distant and there was moderate dullness.

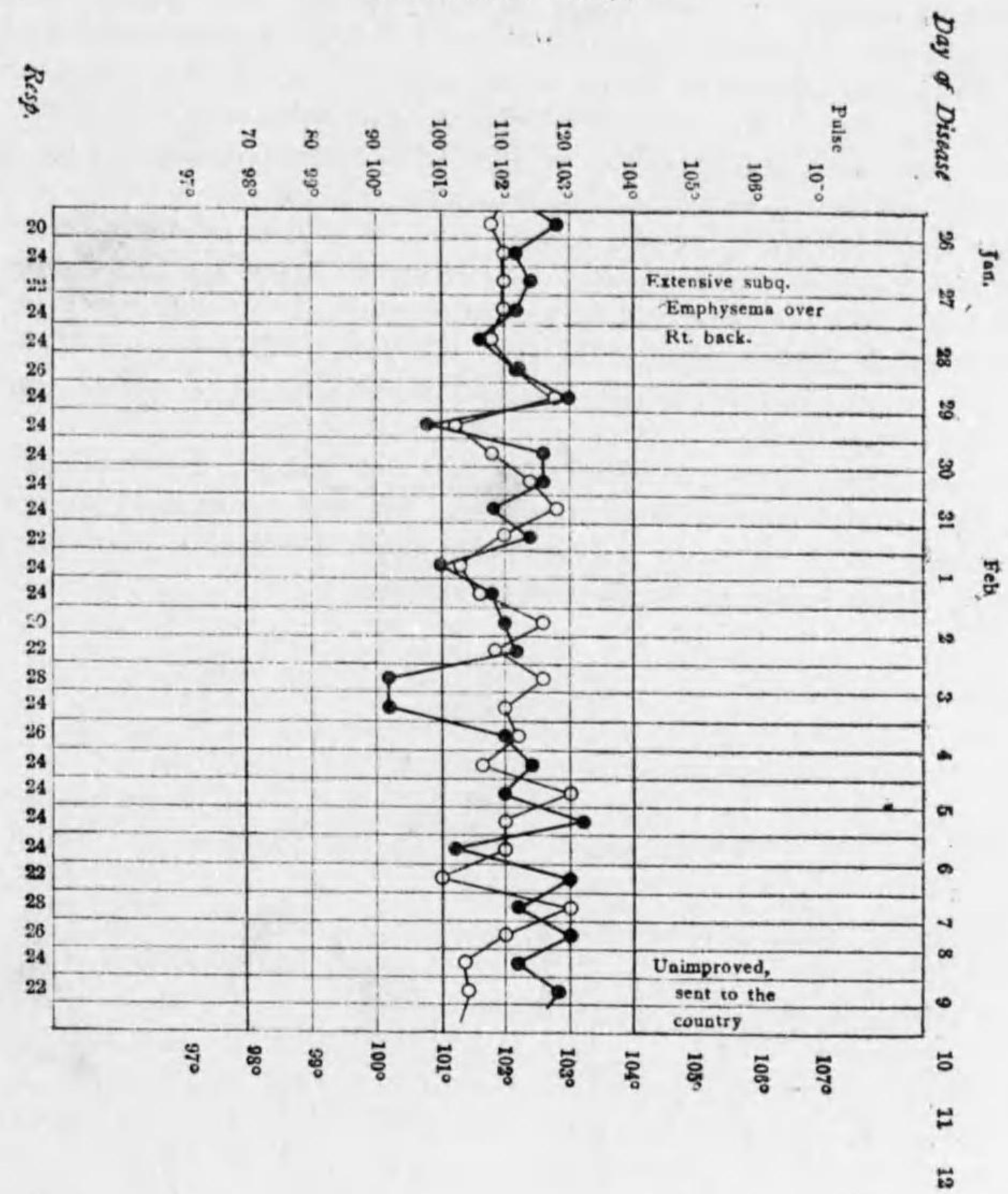
Laboratory Findings: W. B. C. 10,600, poly. 60%, X-ray suspicious pulmonary tbc. and abscess on left lower lobe, but repeated sputum examination resulted negative. He was operated on for lung abscess by collapsing the lung by thoracotomy from which operation he made rapid improvement and was discharged from the hospital at



M. S. Case XXXII, (1)



M. S. Case XXXII, (2)



the end of October 1915. Since discharge patient was under observation from time to time. He continued to cough and brought up quantities of thick green pus every day but never had haemoptysis. On June 9th, 1921, the findings were as follows: Chest, lagging on both sides. On left chest over precordial area there was slight prominence, left lower posterior region showed healed scar or old thoracotomy and no sinus. Lung signs are as indicated in the chart. Sputum, 200 cc. per day, forming in three layers, negative tbc., negative elastic tissue. Attempt to give a.p.t. treatment failed on account of dense adhesion to the chest wall.

Sept. 1921 patient in the country, gained some weight, improved much, had cough and expectoration, although diminished in amount. About June 1922, he slowly improved in health and is now at work.

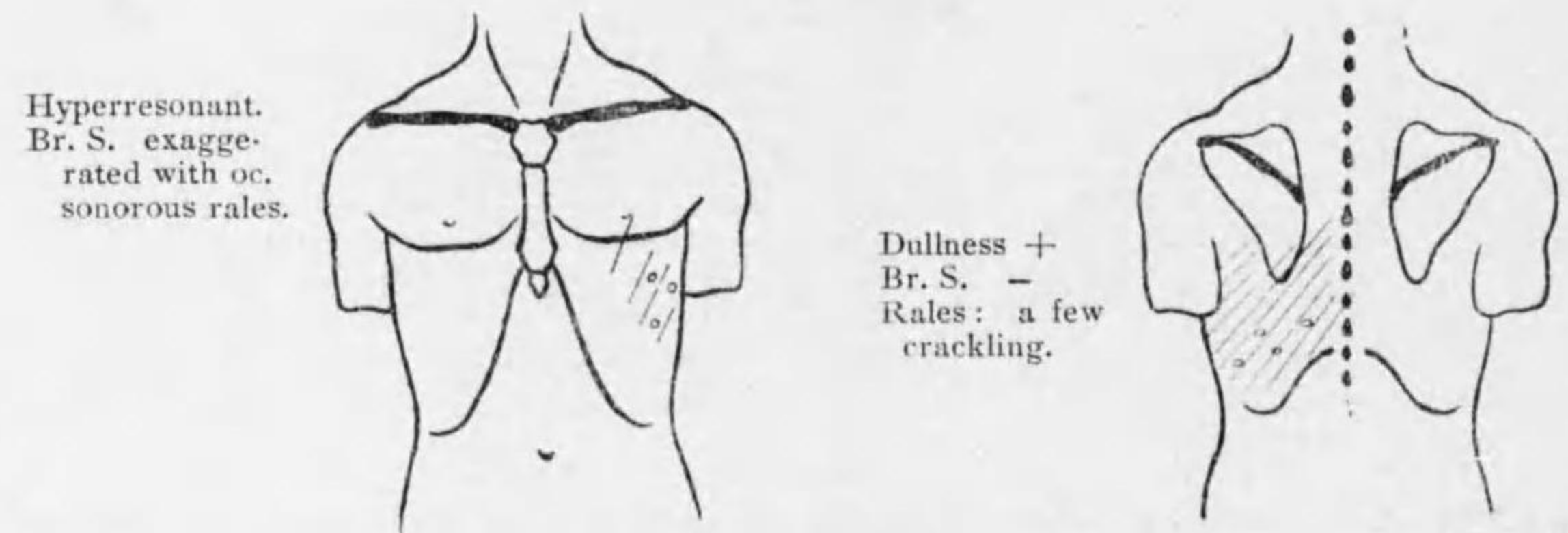
Summary of the history: His pulmonary condition began since his childhood resulting in bronchiectasis. The early Roentgenologic diagnosis of mediastinal tumor which was not seen in recent film must have been an inflammatory mediastinal lymphoid tissue with exaggerated hilum shadow.

Fig. 228-229. Erect. July 9, 1921. Both hilum shadows are increased, the lung markings also increased on both sides, especially in the lower parts. Right apex light up normally, the trachea and great vessel and heart somewhat displaced to the right. The right diaphragm is uneven on its medial aspect due to adhesions, and at the base a few calcified nodes are seen indicating old inflammatory processes. There is dense homogeneous density below the level of 8th dorsal vertebra on the left. Its upper border appears more fibrous and honeycombed; near the root dilated bronchi with quite thickened walls are occasionally seen. The area of density is separated from the chest wall by a faint "space" thus giving an impression that the dense area is pulled away from the chest wall by fibrous contraction. At left apex there is haziness indicating thickened pleura with some adhesions, caused by old thoracotomy. There is a faint visibility of left cardiac border but diaphragmatic shadow is obliterated.

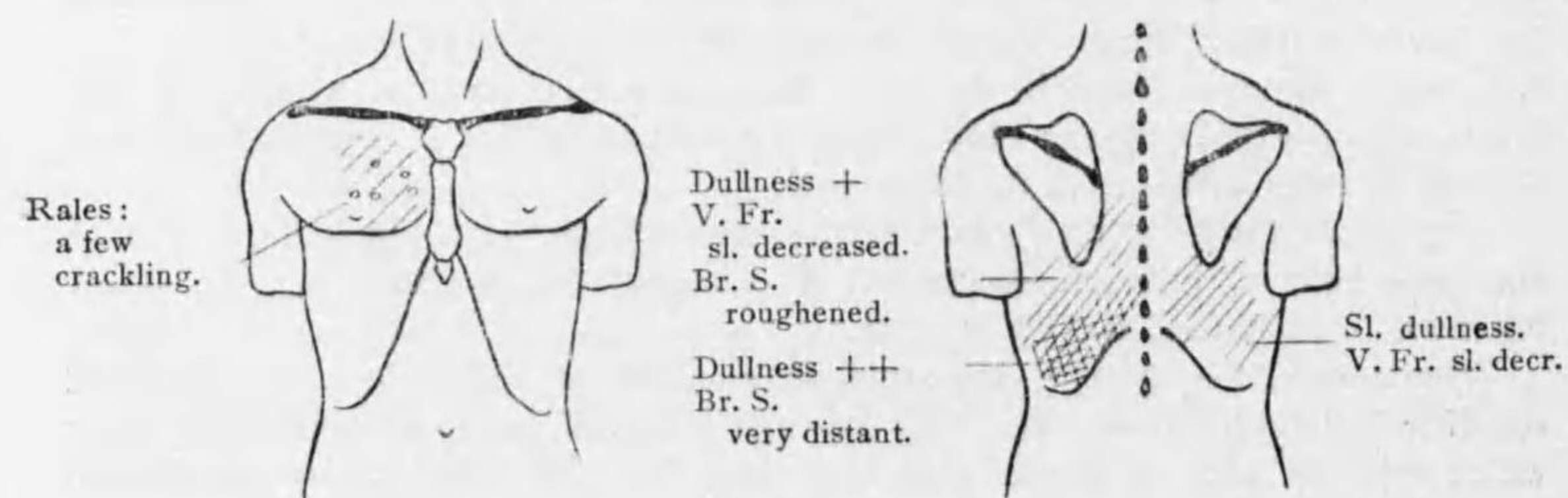
Fig. 230. Erect. June 10, 1921, is just the same picture. Effect of a.p.t. is not shown. Left basal shadow is denser than before, which is due to daily change in fluid content. After patient is made to expectorate much, the shadow may appear more clearly and even a hollow cavity may be brought up.

H. Williams.

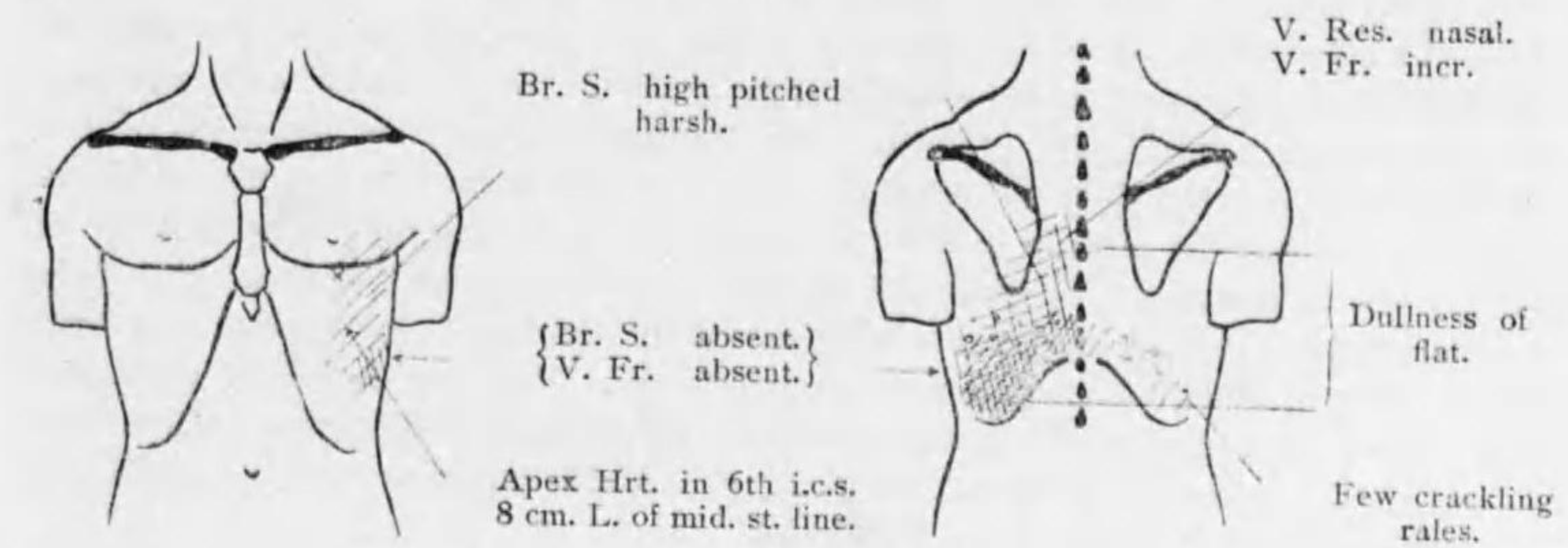
June, 1908.



August 16th, 1919.



June 9th, 1921.



Case XXXIV. E. L.

U. S. white, hotel clerk, aged 58. Admitted to the hospital with the chief complaint of pain in "stomach." His family history negative as well as his past history.

Present Illness: Patient had been drinking whole lot and had had pain in stomach for indefinite duration. Recently he began to cough and expectorated some. No blood, however, was noticed in the sputum. Patient became very dyspneic, he was brought to the hospital.

Physical findings: The patient was apparently an alcoholic, his pupils were contracted and irregular, K. J. was absent. His teeth were all missing and tongue was heavily coated. The lung signs are those of thickened pleura or incomplete consolidation.

Laboratory findings: W. B. C., 9,700 poly. 87%, Hgb. 57%. Sputum Culture: Streptococcus, Bc. Coli. Com., Staph. Albus, Bc. subtilis, Strept. cc. haem., Micrcc. tetragenus, Strept. cc. non haemo., Mic. cat., Pneumococcus (with type mark as obtained no growth.)

Course: July 8, tapping in the region of left lower angle of scapula gave 350 cc. of foul swelling green fluid. Question whether this pocketing is in the pleural cavity or from a ruptured lung abscess. Presence of large amount of pus and absence of productive cough seems in favor of empyema. General condition of the patient was very poor. July 11th, intercostal thoracotomy was done in 8th i.c.s. in post axillary line, which revealed a large amount of foul smelling thick pus. Patient gradually became worse and died on July 17th or on the 4th day after the simple operation.

P. M. Report: Diagnosis, Pneumonia Lobaris Chronica. Abscess of left lower lobe. Empyema pleurae sinistra. Lungs: Left lung weighs 525 grams. Is of grey color in the upper, of grey red color in the lower part. The lower lobe is firm in consistence, its surface is covered by thick whitish yellow masses. On cut surface the lower lobe is completely consolidated, of greyish red color. The pleura visceralis is yellowish white, 1-2 mm. thick. The lower lobe contains a cavity of irregular shape, about 6 cm. in diameter filled with thick purulent masses, at one place the cavity reaches the pleura visceralis. The upper lobe shows no gross lesions.

Microscopic examination. Lower lobe of left lung: shows extreme increase of

the interstitial connective tissue. This interstitial tissue contains very many spindle and round cells. In large areas nothing of the alveolar structure can be recognized. At some other places where the normal structure can be recognized, we see within the lumina accumulations of cells. Most of them are large pale roundish cells showing a fine granulation probably fat granular cells. At several places we see cords of connective tissue growing into the lumen. There are only a few leukocytes within the alveoli. The bronchi contain exudate with polynuclear leukocytes. The wall of the abscess cavity is formed by granulation tissue with extra- and intravascular blood accumulations. The pleura visceralis is extremely thickened by fibrous connective tissue with accumulation of mononuclear round cells. Near the surface is a considerable hyperaemia and some infiltration with polynuclear leukocytes. Microscopic diagnosis: Pneumonia chronica fibrosa. Pneumonia chronica abscedens. Pleuritis fibrinosa purulenta. Spleen, acute splenitis.

Comment: The etiology of the lung abscess in this case is apparently alcoholism. In patient's alcoholic narcosis infective material is introduced into the lungs without causing much reflex irritation. The culture of the sputum is interesting in that there were varieties of infective organisms. The form must be acute dissecting one, such a large cavity was immune to physical signs and even X-ray was not so characteristic. Empyema was evidently secondary to the rupture of the abscess.

Figure 231-232, taken on July 3rd, 1924, in erect position. The right lung field: the root shadow is accentuated with suggestion of peribronchial infiltration and slight adhesion at base. The apex is lighted up normally; the costophrenic angle is clear.

The left lung field: General haziness in lower half, and it is most marked at base. The diaphragmatic shadow is indistinct, but seems to be depressed. There is pericardio-phrenic adhesion; the costophrenic angle is clouded, but this does not suggest any collection of fluid. The conus is prominent. There is much mottling appearance extending outward and downward from the root region suggesting broncho-pneumonia.

Situating to the left of the heart shadow and extending to the periphery, there is an ovoid, homogeneous density suggesting pus cavity. Its outer margin fuses out into hazy pleural shadow; the shadow seems to be not communicated with the root shadow (or bronchus).

Diagnosis—Chronic bronchitis on the right; diffuse broncho-pneumonia including an abscess cavity in the left lower lobe; and thickened pleura.

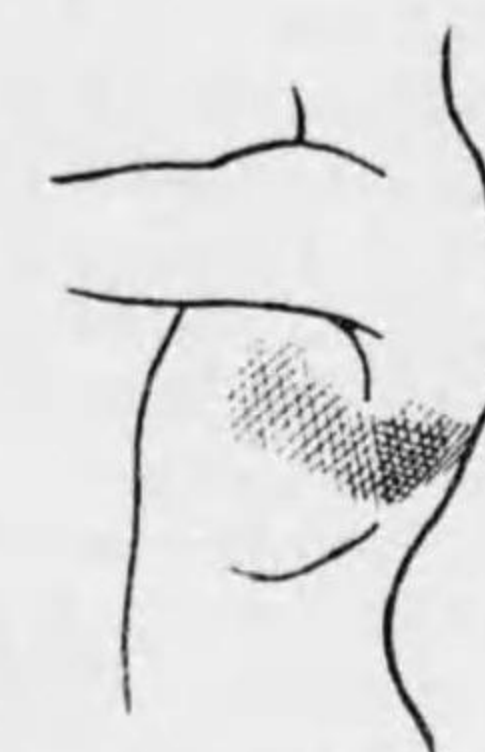
Figure 233-234: Taken on July 10th, 1924, in prone position by portable machine. The film is of poor quality.

The right lung: Shows moderately accentuated root shadow, high diaphragm (partly due to low focus), suggests patient in motion.

The left lung field: There is homogeneous haziness in the lower half, suggesting combination of indurated lung and thickened pleura, rather than collection of fluid, because of (1) less dense than that of fluid shadow, (2) periphery it is more light, (3) no fluid level seen, (4) its upper limit is quite diffuse.

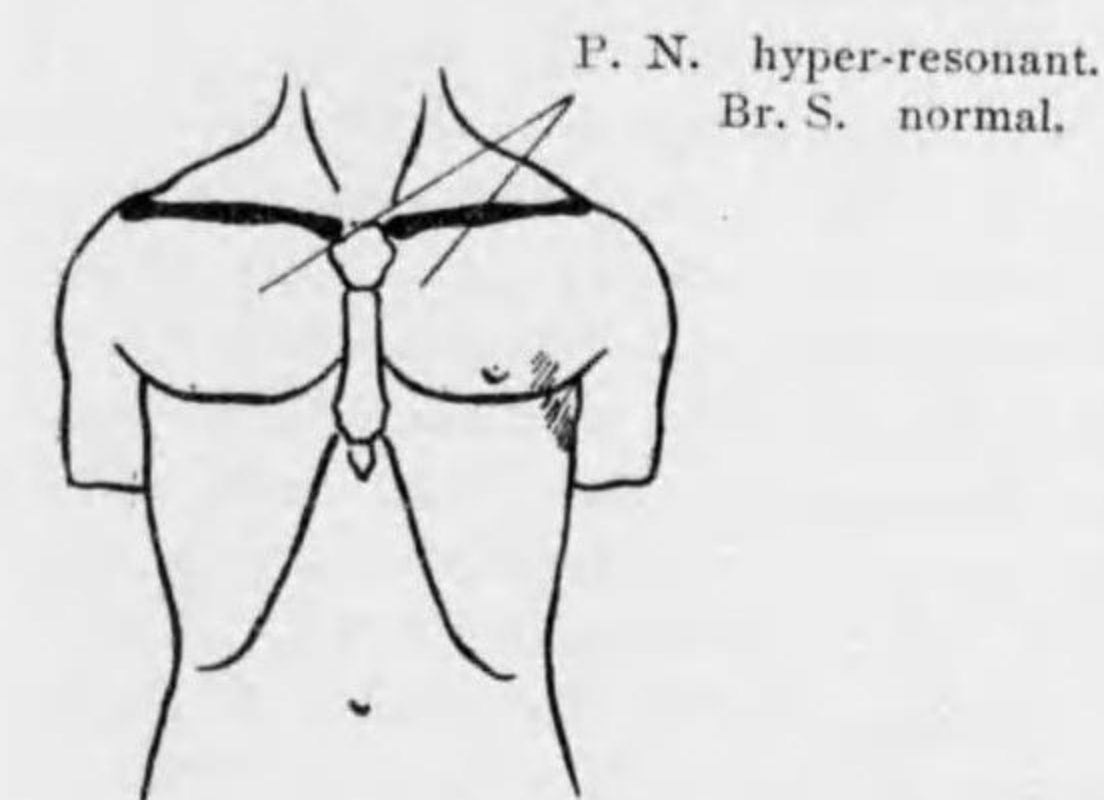
In view of the acute clinical course and the findings in the previous film, this shadow may be caused by chiefly fibro-purulent exudate. Advanced broncho-pneumonia is also suggested by the same reasons, and dense mottling character of the shadow around the hilar area. In this picture no cavity is made out. Compare this with autopsy finding—the cavity wall consisted of soft granulating substance which speaks for not casting definite cavity outline.

E. L.



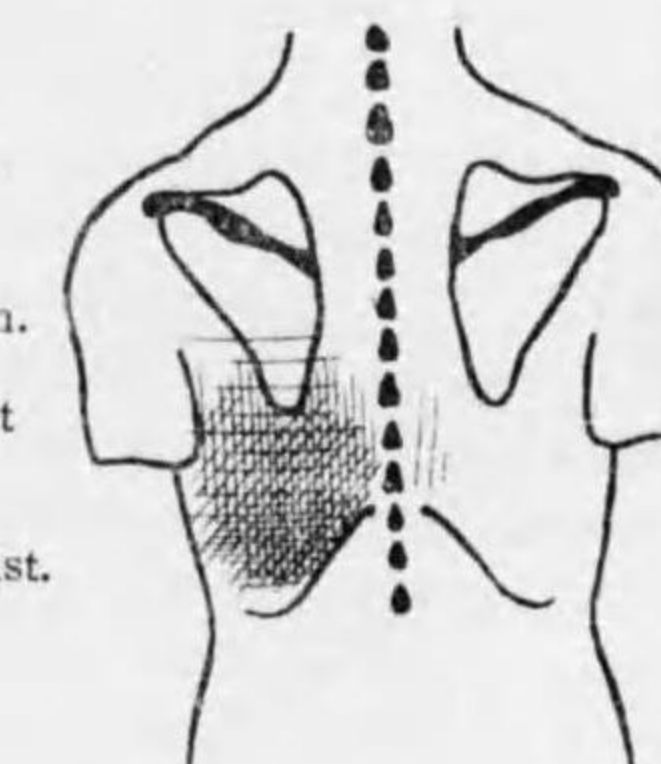
Dullness ++  
Br. S. much dim.  
V. Res. " "  
V. Fr. " "  
Rales few subcrepitant.

July 2nd, 1924.



P. N. hyper-resonant.  
Br. S. normal.

Dullness ++  
→ +++  
Br. S. dim.  
distant bron.  
V. F. dim.  
V. R. distant  
and poor.  
Rales—few  
medim, moist.



## Case XXXV. E. S.

First admission. Admitted March 5, 1922, discharged cured on April 2, 1912. Aged 9.

Present Illness. Three days before admission the child was sick with fever and cough. The cough which had been present for a week, then began to get worse, prostrated. Temp. 108.8 F. W. B. C. 10,500, poly. 68%, Hgb. 80%, lung per illustration. X-ray of March 13, 1922, considerable area of consolidation in central portion of right lung with slight thickened interlobar pleura. No evidence of liquid.

Course: Temperature fell by lysis; convalescence slow, but complete; cure after 28 days, sent to the country. Signs were localized, but subjective symptoms would indicate broncho-pneumonia.

Second admission. During the interval patient fully recovered usual health.

Present Illness: 7 days before admission patient was suddenly seized with a high fever and began to cough. For the first 4 days the fever stayed at 103-104 F, then began to run up and down between 99-103 F. Her chest was aspirated by her doctor on left posterior region but no fluid was then obtained. Patient admitted to hospital on June 12, 1922.

Physical Findings: Rapid respiration, quite marked restriction of respiratory movements on the left side, apparently some collapse of this side of the chest. Lungs, as illustrated.

June 22 thoracentesis between 7th and 8th rib in interscapular line yielded small amount of thick pus from which non-haemolytic streptococcus was obtained on culture. June 24, exploratory puncture for left empyema under ether anaesthesia, duration ten minutes. Chest was aspirated in several places without result and it was not deemed wise to proceed further. July 3, operation for suppurative pleurisy performed. In incision between 7th and 8th ribs in posterior scapular line evacuating small amount of thick pus. Tube drain placed, patient still running temperature and there was no improvement. July 8, sputum rusty colored, about 10 cc., elastic tissue not found; Guinea pig inoculation was negative, von Pirquet, negative. Patient has much cough, but unable to spit out, complained of sore throat and pain in chest. July 18, exploration for lung abscess, previous incision enlarged with fingers and instrument into the lung abscess, tube drain, duration ten minutes. July 22, thoracotomy for empyema under local anaesthesia with ethylchloride, duration ten minutes. Needle inserted in mid axillary line evacuating a small amount of thick pus. Knife inserted along the needle in pleural cavity, 1 inch incision, tube drain. No further pus was evacuated. Temperature was always septic running between 99 to 104, but after the last operation it remained at between 99-101.5 F. Patient gradually improved and sent to the country on Aug. 27, 1922. During the interval patient was coughing much and still had been running temperature and admitted to the hospital again on Oct. 3, 1922 and discharged improved on Oct. 27. No operation was done, the thoracic sinus continued to discharge. Patient returned to hospital for the 4th time on November 9, 1922. Lobectomy was done for bronchiectasis with complicating bronchial fistula. From the operation the patient made gradual improvement, the discharge also diminished. Gained 9 pounds of weight, became apparently perfectly well, only small amount of discharge, left hospital as cured on Feb. 9, 1923.

Fifth Admission: Patient again became feverish, discharge from sinus increased, had several haemoptysis and headache. Guinea pig inoculation of discharge and spinal fluid negative. On the 6th day of the present admission, patient developed severe headache, temperature of 102, rigid neck, positive Kernig and became drowsy. Spinal fluid, 7,490 cells, 76 poly., no organism, sterile on culture, patient had convulsion and died on May 16, 1923.

Cause of death. Meningitis secondary to haematogenous infection from lung.

#### X-ray Consideration.

Fig. 235-236. June 13, 1922. Prone. Heart and trachea markedly displaced to the right giving impression as if dextro-cardia. There is a large shadow occupying upper half of the left lung field. It is most dense medially and becomes gradually diffuse periphery. On close inspection with the shadow there is wedge shaped increased density at about the region corresponding to normal hilum shadow, with apex downward. Just above the base there is an irregular indistinct rarefied area which may indicate cavity. Right lung field: lung markings accentuated and there are numerous small faint spotty cloudiness suggestive of scattered broncho-pneumonia. Both costo-phrenic angles are clear. The displacement of heart and mediastinal structures may be due to emphysema which is also suggested by hyperaerated left lower lung field. If the displacement is due to adhesions caused by previous pneumonia, it will be

permanent, and if otherwise re-shifting of these structures, will be noticed in later films.

Fig. 237-338. June 21, 22. Erect. The shadow in left lung field is much greater but is of same nature. The irregular, suspicious cavity has much increased in size. Homogeneous haziness in lower left suggests thickened pleura. The diaphragmatic shadow is obscured. No evidence of fluid, large amount of gas in stomach. Heart and mediastinum displaced in much less degree. Lung markings on the right have decreased. Outline of left diaphragm is not visible, due to diffuse haziness suggesting thickened pleura.

Fig. 239-240. June 26, 1922. Erect. About the same. The suspicious cavity shadow is more visible and more irregular. Lung markings on the right is accentuated; the thickened root shadow is somewhat displaced outward.

Fig. 240-241. July 7, 1922. In prone position. Similar shadow as previous film on the left, although there is an impression that the upper part has somewhat cleared up. Notice rarefied area around, a tube drain at "a"; another irregular rarefied area just above it more toward mediastinum with thickened wall indicating possible degenerated spots; the surrounding area appears more granular indicating diminished induration and fibrino-production.

Fig. 243-244. August 7, 1922. Erect. Marked change is noticed. Mediastinum and heart are being pulled to the left. In upper left, instead of induration, we notice honeycombed appearance suggesting fibrosis. Oval ring formation at "b" with hazy border, indicates pleural adhesion. Also some honeycombed shadow at lower left corner at "a" suggests defects. Costophrenic angle is clear. The spine is curved to the left; rib spaces are narrowed. The whole picture suggests intrathoracic fibrous contraction.

Fig. 245-246, A. and B., August 23, 1922. Erect. The lesion is becoming more fibrous in appearance with numerous annular shadows at "b" and "c" suggesting pleural adhesions, small numerous honeycombed spots may indicate bronchiectasis. At "a" there are hazy spotty shadows suggesting broncho-pneumonic area still present with surrounding induration. The contracted trachea to the left is visible at "d". The right lung markings are accentuated.

Fig. 247-248, A and B. November 5, 1923. Erect. Taken more than a year since the previous showing a decided change. Heart and mediastinum displaced to the left, there is localized honeycombed density at root suggesting bronchiectatic cavities; the surrounding induration and pleural shadows have all disappeared. The costo-phrenic angle is clear. The displaced bronchus can be traced as far down as to the honeycombed density. The upper hyper-aerated area corresponds to area of lobectomy.

Comment: Shortly before the onset of lung abscess this patient had a broncho-pneumonia of right lower lobe from which the patient apparently fully recovered. Within a few months patient had acute suppuration of left lung beginning at left root area and upper left lobe, which must be a type of so-called "idiopathic lung abscess" and whose etiological organism may be the same as what produced the previous broncho-pneumonia on the right side. The case terminated in bronchiectasis without showing evidence of empyema at any stage. The patient survived wonderfully, such severe operation as lobectomy in which the whole upper left lobe was removed for bronchiectasis. At no time did the cultures from blood, pus and spinal fluid reveal causative organisms. In other words without apparent systemic infection the patient developed metastatic intra-cranial involvement from bronchiectasis.

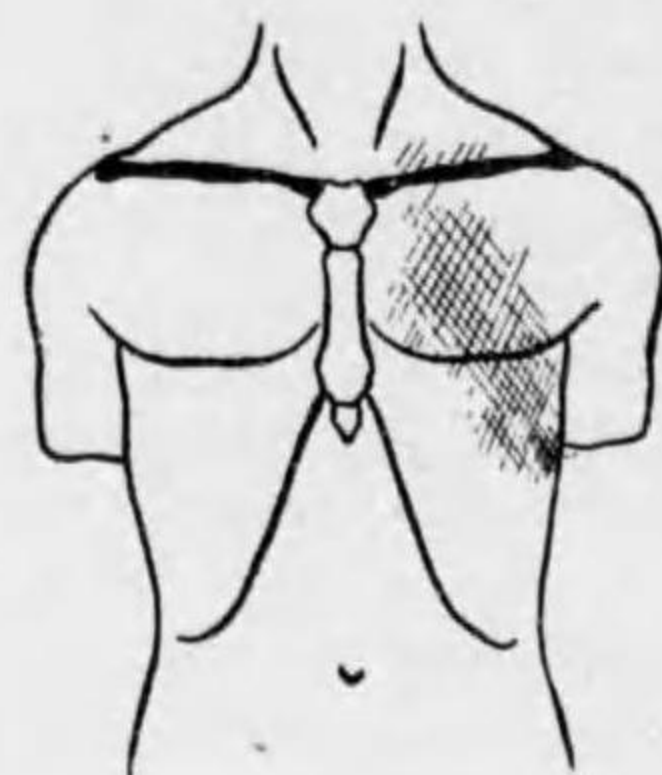
E. S.

June 12th, 1922.



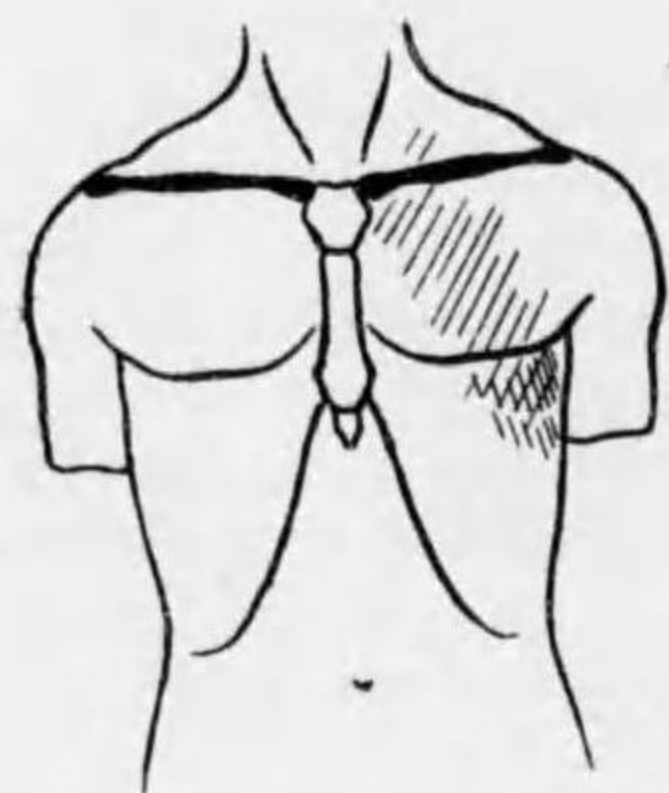
Dullness 2+  
→ 1+  
B. S. much dim.  
distant.  
V. S. dim.  
W. V. " harsh.  
Rales—medium,  
moist.

June 12th, 1922.



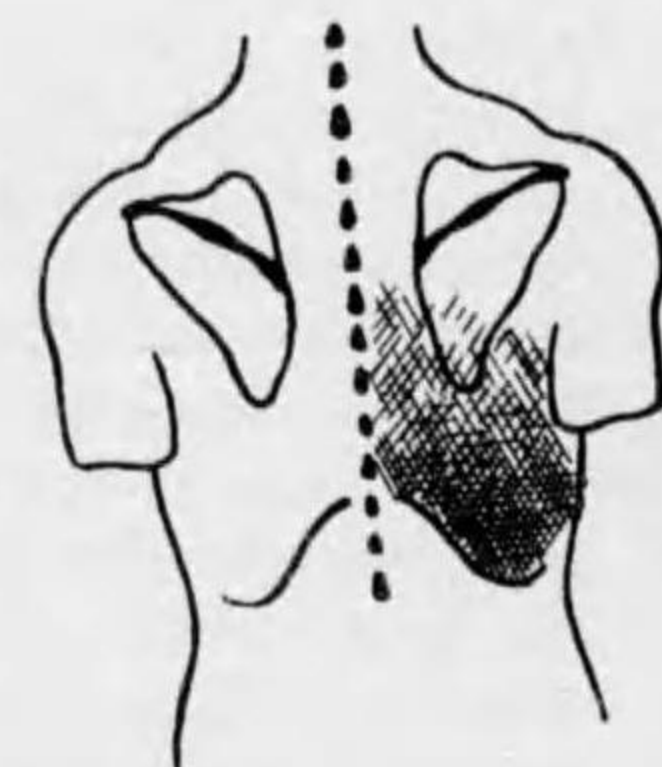
Dullness 2+  
Br. S. +  
V. S. +  
W. V. + harsh.  
Rales—few med.  
moist.  
Oc. sibilant, and  
sonorous.

October 4th, 1922.



Dullness +  
B. S. -  
V. S. +  
W. V. harsh.  
Rales—few med.  
moist.  
Dullness ++

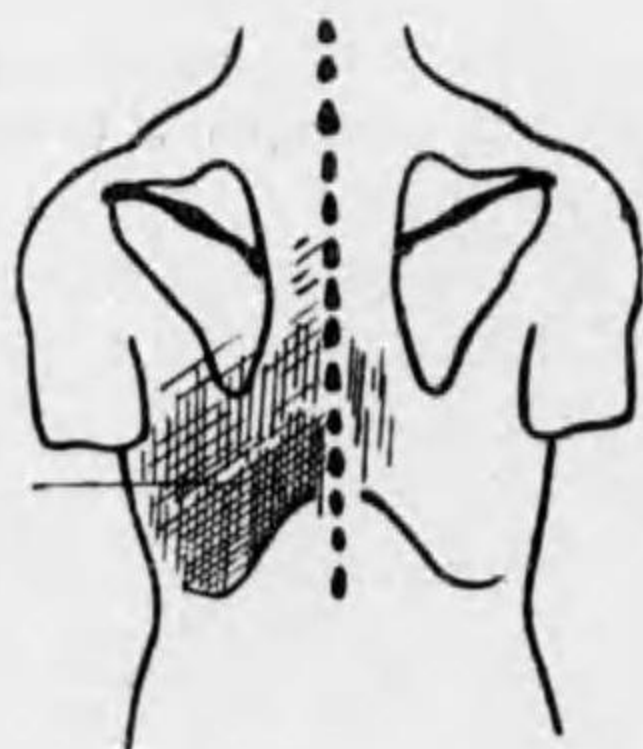
March 5th, 1922.



Dullness  
2+ → 3+  
Br. S. dim.  
W. V. +  
V. S. +  
Rales few  
crackles.  
Diag.—  
Lob. Pneum.

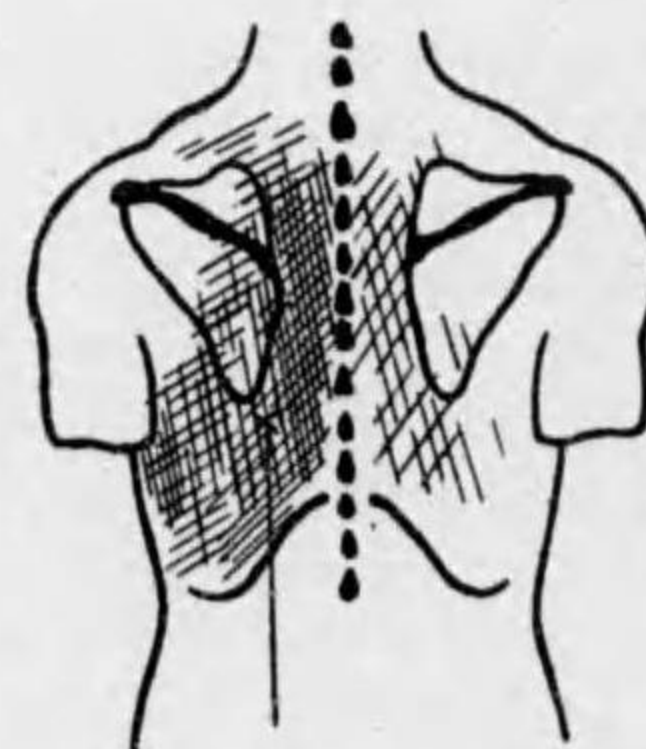
November 2nd, 1922.

Hyper-resonant  
Both ant. and  
post.  
Br. S. coarse and  
prol.



Dullness +++  
Br. S. absent.

June 12th, 1922.

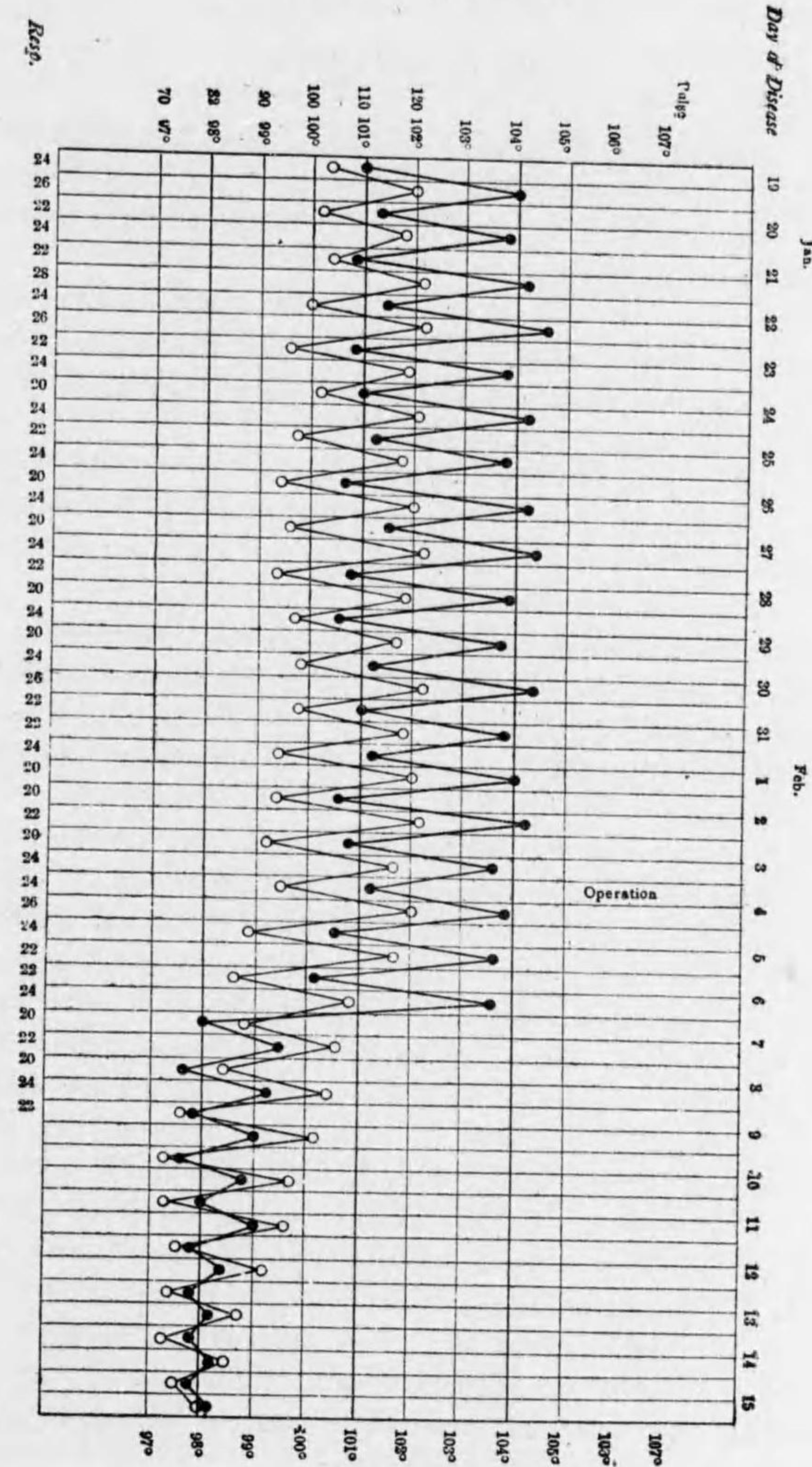


Dullness 3+  
→ 2+  
Br. S. absent,  
much dim. or  
dim. at lower  
level.  
V. S. +, nasal.  
W. V. +, harsh.  
Rales—few moist,  
fine.

6 / 22 / 22.

Needle—small amount of pus  
obtained.

SUPPLEMENTARY CASE P. S.



## CHAPTER V. — DIAGNOSIS.

## SECTION I.—SYMPTOMS.

The case illustrations in the foregoing chapter may make it clear that the clinical symptoms usually draw first attention to the existence of pulmonary abscesses in the majority of cases, and when the patients present themselves for examination, the disease is usually well advanced.

Sudden evacuation of a large amount of foul smelling pus, or prolonged expectoration of quantities of such material associated with obstinate cough are pathognomonic, especially when there is a history of aspirating foreign body or previous operations in the upper respiratory tract.

When we come to the final diagnosis, however, especially when the case runs less difficult course or when we fail in finding etiological factors, we hesitate in making any definite statement regarding the pathology, and then the Roentgenological findings become the greatest aid to the clinician.

Exploratory thoracentesis or even exploratory thoracotomy may result in negative findings, even if the disease may begin with clear history and presents all the pathognomonic symptoms in the face of other negative findings, one is made to be more uncertain in the diagnosis, because there are other conditions which may produce the same symptoms.

Chalver (123) speaks of that lung abscess is a fairly rare condition. Nevertheless, it is essential that a correct diagnosis is made, in order that the case may be correctly treated when it does occur. Abscess should always be suspected in the case of pneumonia, which, after a suitable period of time apparently does not resolve. Occasionally the diagnosis is established by a sudden attack in which the patient vomits pus and afterwards coughs and brings up a foul expectoration. It is very difficult to differentiate abscess from localized empyema. The physical signs may be identical. As a rule, in lung abscess, the constitutional symptoms are much more severe, such as rapid loss of weight and strength. Of course, when pus is expectorated, the diagnosis is no longer in question. Occasionally lung abscess has been mistaken for tuberculosis. The X-ray is the most reliable aid to diagnosis in most cases, and, guided by it, an aspiration of cavity with the needle is conclusive.

Lemon (122) reported a case of lung abscess which followed pneumonia, illustrating difficulties of diagnosis, with general discussion on diagnosis.

Langenskiold (124) admits the difficulties in diagnosis in many of his cases in which several exploratory punctures were negative.

Fetteroef (125) cited a case in a man of 33 who had chronic congested tonsils,

operated on by ether anaesthesia. He had severe post-operative haemorrhage 2-3 pints in all. Vigorous cough on the eighth day with spitting of blood and some foul smelling material, septical fever, localized pulmonary focus, but never definite evidence of abscess, except septic pneumonitis involving large area of left lower lobe. Aspirated twice which resulted negative. Death occurred on the 42nd day. Post Mortem, irregularly shaped cavity filled with pus, strong pleural adhesion corresponding to the point of exploring needle which had been introduced at a point corresponding to the left scapular line. If the needle had been pushed onward in this region 1 inch further it would have entered this abscess cavity.

Heuer and MacGreay (49) reported in 1923, 62 cases of lung abscess from Johns Hopkins hospital, in 13 of which (or 22.5%) the conditions was recognized only at autopsy, summarizing clinical history.

Abscesses of various sizes are frequently discovered at autopsy suggesting that they are often recovered from or escape clinical detection. (Oxford Loose Leaf Medical Vol. II, Page 102).

Occurrences of erroneous diagnosis have been quoted by many other writers, namely Jackson (47) Morgan (48) and others.

## SECTION II.—SUMMARY OF SYMPTOMS:

Symptoms and the clinical course of lung abscess vary somewhat according to the cause. They are more distinctive and more characteristic in a case due to aspiration than in other forms.

In the case which follows tonsillectomy, or operations under general anaesthesia, after a day or so, the patient develops fever and cough. The temperature persists, the cough becomes more severe, and varying amount of mucopurulent sputum are raised. The leukocytes are moderately increased (14,000 to 22,000) the polymorphonuclears predominating (80 to 90%). At this stage physical signs may reveal no pulmonary abnormality or there may be evidence of local infiltration and consolidation. The diagnosis of "consolidation" or broncho-pneumonia is usually made. At the end of a week the temperature becomes irregular, the cough is more severe and larger amounts of mucopurulent sputum are expectorated. In about a week or fourteen days sputum usually acquired characteristic, fetid odor, and the diagnosis of abscess can then readily be made. During the third or fourth week the symptoms as a rule begin to change somewhat. The temperature becomes frankly septic in type and displays variations in proportion to other symptoms. Cough may become less annoying and large amounts of sputum may be brought up at one time. At times the sputum has a disagreeable odor, at other times, none.

Often the symptoms go along in a recurring sequence. The patient will expectorate

a large amount of fetid sputum, the temperature will drop, cough will be diminished and the patient will experience sensations of relief and relative well-being. The temperature may remain at nearly a normal level for a day or two and give rise to the hope that recovery is on the way. Then gradually the temperature mounts again, the symptoms of intoxication return, cough becomes harassing, but only a little mucopurulent sputum comes up, until after a number of days, suddenly a large amount of fetid sputum is expectorated and temporary improvement again begins.

During this period the sputum is often bloody and occasionally frank haemoptysis occurs, although large hemorrhages are nearly always restricted to later stages of the disease.

During the second month many symptoms of abscesses gradually heal.\*<sup>1</sup> The symptoms slowly recede and finally temperature remains normal, cough and sputum disappear and the general health is rapidly restored. Sometimes an abscess will heal when drainage of the pleural cavity is established.\*<sup>2</sup>

Sometimes an abscess produces widespread pulmonary suppuration and gangrene and may be rapidly fatal. Abscesses that do not heal within two or three months enter a chronic stage and hope of spontaneous cure must then be abandoned. When pulmonary induration has reached an advanced stage complete obliteration of the abscess cavity is not likely to occur. The patients from then on have symptoms like those with bronchiectatic dilatation. They have cough with profuse expectoration, which is sometimes restricted to certain times of the day. For instance, they may empty the cavity or cavities two or three times a day and be free from cough during the intervals, such as illustrated in Case VII, in which evacuation took place at greater intervals.

Unfortunately even such a relatively satisfactory state of affairs seldom exists. The sputum is often transiently or permanently so foul that the patients are social outcasts; they have recurring attacks of fever that undermine the general health; hemorrhages are frequent; and they are constantly in danger of the more serious symptoms of rapidly spreading pulmonary infection or other metastatic infections in other parts of the body.

#### SECTION III.—

The Symptoms of Abscess following Lobar Pneumonia are not nearly so clear. At the termination of the acute symptoms of the disease, fever persists and the consolidation fails to resolve. Empyema, induration, abscess, and tuberculosis are

\*1. Excepting perhaps those cases in which the foreign bodies have not been removed or discharged out.

\*2. Or after a lapse of time of an apparent cure, a sudden spread of infection and septic manifestation, or infective embolism may take place in other part of the body.

suspected. The fever is usually irregular, there is increasing cough and mucopurulent sputum and the leukocyte count remains elevated. The diagnosis is definitely made when the sputum acquires the characteristic odor or when large amounts of purulent sputum are expectorated at one time. The evacuation of the abscess may be followed by recovery or the abscess may go on to the chronic stage as already described.

As it has been pointed out, localized gangrene nearly always goes hand in hand with abscess formation. It gives the characteristic odor to the sputum.

When gangrene oversteps these local bounds and becomes widespread, more serious symptoms supervene. The temperature is higher and the evidence of more severe intoxication is apparent, the patients lose flesh and strength more rapidly and the disease is more often quickly fatal. The sputum is usually more fluid than in abscess, of a greenish, darkly brown or prune juice color. The fetid odor is intense and may penetrate a whole house.

In a number of cases in the present series, the symptoms began insidiously with cough and mucopurulent expectoration frequently streaked with blood, accompanied by occasional night sweats, rise in temperature and pain in the chest for a more or less long period. In those cases the etiological factors were not quite clear, but in their early history, non-epidemic influenza, bronchitis, or pleurisy were suspected. Those patients terminate in one of three ways: (1) under proper management, cough, expectoration and other symptoms gradually diminish and marked improvement takes place, or (2) they may enter in more chronic stage as described before, or (3) the lesion rapidly spreads without warning and the patient dies of severe toxemia and broncho-pneumonia.

#### SECTION IV.—SYMPTOMS FOLLOWING FOREIGN BODY INHALATION.

The diagnosis of foreign body origin is quite important as these are the cases which are best benefited by bronchoscopic treatment, cure being effected in 90-100 per cent (according to Jackson), and so long as they are not removed there is no cure.

Introduction of solid foreign body into the bronchus is usually given in the history, and it is immediately followed by distinct symptoms leading to the confirmation of the etiology. Immediately following the entrance of the foreign body, into the larynx, the patient is seized with a paroxysm of coughing, becomes dyspneic, and cyanosed. In most instances, the patient experiences the sensation of suffocation. Instance, Case XXIII, in which patient swallowed chicken bone, this was followed by pain on left side of the chest, dyspnea, and later expectorated blood; bronchoscopy negative, still later showed dilatation of the bronchus; chill and fever came on as long as six months later. In another case, XXI it began with only choking sensation followed by "cold" and insidious illness, X-ray showed characteristic root shadow.

After the acute symptoms are over, there may be a sense of soreness beneath the sternum and very often the tenderness is referred to the right of the sternum. There develops moderate cough, expectoration, if present, is scanty at first and may be bloody tinged.

To enumerate the immediate effect produced by the introduced foreign body: choking spells, coughing, dyspnea, cyanosis, spasmodic cough, bloody expectoration, inspiratory crowing and aphonia.

These initial symptoms may be so mild and of brief duration that patient may forget all about it. Jackson (47). Again foreign body may lodge in the bronchi without causing symptoms, even cough, for an interval of a number of weeks between the initial coughing and the vague onset of bronchial and later general symptoms. In our cases the following varieties of symptoms were described by the patients: that severe coughing spell soon followed, a week later, pain, cough, expectoration and fever (Case XXIII); that while eating he had sensation that his chest was filled with something accompanied by difficult breathing (Case XXI); that swallowed a chicken bone without ill effect but followed by "cold," and that in one case, it was followed by dyspnea, severe cough, followed by mild chronic cough, and three months later blood in sputum, chills and fever appeared.

The secondary manifestations develop insidiously, the cough gradually becomes worse and is attended with considerable mucopurulent expectoration. In some cases, indeed, tuberculosis is suspected because of the hectic type of fever, sweating and loss of weight. In some there is gradually symptoms of bronchiectasis,—a paroxysm of cough, large quantities of purulent sputum, fever and clubbing of fingers. Thus many cases of solid foreign body origin run chronic course, and in others they take sudden turn of acute course as described elsewhere.

#### SECTION V.—

In a case following infarct of the lung there is sudden severe thoracic pain, rise of temperature and haemoptysis and then there follows the same course as those following pneumonia or that of gangrene. Those occurrences as complication of general sepsis run a short course generally marked with severe toxemia.\*

\* Refer to the case No. VI, Fig. 44-45.

Infarcts of the lung cast recognizable shadows on the X-ray plate only when they are large. It is a common experience to find at autopsy numerous small infarcts of which the Roentgen examination gave us no evidence during life. In their typical forms, they appear as large triangular shadows, with their bases toward the axilla, which may occupy a large part of a lobe. On the other hand, the lung about them may be in such a state of inflammatory reaction that the resulting shadow may be indistinguishable from that of a pneumonic process.

#### SECTION VI.—

Finally in a so called "idiopathic" form the initial symptoms resemble that of pneumonia, but are soon followed by characteristic symptoms of lung abscess, although expectoration is not marked or may even be absent in small children,—our case XXXV was a true idiopathic case.

### CHAPTER VI.—CARDINAL INDICATION OF LUNG ABSCESS.

Lord (70) speaks of five cardinal indications of pulmonary abscess, (1) foul sputum and foul breath, (2) cough and explosive expectoration, (3) elastic tissue with alveolar arrangement in the sputum, (4) dullness on percussion over a circumscribed area (5) the demonstration by X-ray examination of a cavity with fluid level.

These cardinal points are not always fulfilled and there are sometimes concomitant points which will aid in the diagnosis, they are pain, constitutional symptoms, clubbing of fingers, thoracentesis and bronchoscopy. These important symptoms and signs are enumerated as follows: and discussion will be made in detail on each of these points.\*

- (1) Foul sputum and foul breath.
- (2) Cough and explosive expectoration.
- (3) Elastic tissue with alveolar arrangement.
- (4) haemoptysis.
- (5) Pain.
- (6) Clubbing of fingers.
- (7) Physical signs.
- (8) Exploratory thoracentesis.
- (9) Differential diagnosis.

#### SECTION I.—FOUL SPUTUM AND FOUL BREATH.

They are very usual accompanying symptoms with a lung abscess case. In the present series they were noticed in 75% of the cases. Sometimes it is so evident

\* An abscess is to be suspected if the patient develops respiratory symptoms herein enumerated, in addition to one of the known etiological factors, especially history of introduction of foreign bodies, operation in the upper air tract, administration of general anaesthesia, undissolved broncho- or lobar-pneumonia, or signs and symptoms referable to pulmonary infarct.



that the whole ward in which a patient of lung abscess case is taken care of, smells so characteristic that one will notice it immediately. In some instances the odor is not so bad, and it is only noticeable when one comes in contact with the patient or his sputum cover is removed, at an attempt of its examination. In very rare instances the sputum and the breath are not malodorous, and the absence of bad odor is, therefore, not an assurance against such abscess. In some of the present series, in which frank abscesses were demonstrable, either in X-rays or at post mortem examinations, during some period of their courses, especially in the early stage, there was no bad odor noticeable. In some patients, they described their breath and sputum odor "cheezy" smelling, as for instance in case XVI.

Certain medications, such as hexamethylenetetramine or turpentine when used internally sometimes entirely remove or disguise the bad odor of the breath as well as of the sputum. The presence of odor or the difference in the odor present must depend on the causative organisms found. In many of the series, green producing streptococcus was found; in the case which followed drowning in the sea in the vicinity of New York City, predominating colon bacilli or colon group were discovered from the sputum in which cases there was characteristic odor noticeable. Pilot (116) stated that many pulmonary abscess cases, especially with foul expectoration, are associated with fuso-spirilen infection. In Greenberg's (224) case, there was no bad odor to the sputum, tapped pus contained influenza bacilli, sometimes micrococcus catarrhalis.

#### SECTION II.—COUGH AND EXPLOSIVE EXPECTORATION.

Initial explosive expectoration is, when it occurs in a frank manner, quite diagnostic in itself. It occurred in 11% in the series of Lord, and in the writer's series, in 8%. Some patients described this condition as vomiting pus, and in some patients it occurred periodically. Case VII had several of these periodic explosive evacuations of his lung cavity at one or two months intervals, usually preceded by a short period of ill feeling, followed by disappearance of such symptoms after each evacuation. Complete freedom from cough in the intervals may occur and cough may be entirely absent in some cases.\* In Lord's series, he found four such cases. In small children this is not a prominent symptom, in our case XVII the absence of cough and expectoration was perhaps due to the early evacuation of the abscess into the pleural cavity. In this case although his chest was full of mucous rales, the child could not expectorate. In case XXII it began with sudden expectoration without any previous history.

\* Cough or expectoration may take place only in certain position assumed by the patient. The gangrene may lead to no expectoration, particularly in children.

Mild or severe septic manifestations may follow incomplete evacuation. In a majority of cases, there was daily a large amount of expectoration, varying from 50-500 cc., and when kept in sputum cup, it formed in three layers.

#### SECTION III.—ELASTIC TISSUE IN SPUTUM.

This is a very important sign which often is overlooked. In many hospitals when look in at the laboratory records of lung abscess cases, the usual finding is "elastic fibre found" or "elastic tissue absent," furthermore in many of the reported cases, this important point was usually not emphasized. For the diagnosis or detection of this tissue, a careful search and method should be followed. Such methods and characteristic form of the tissue in alveolar arrangement are fully described in France, Differential diagnosis, page 642. In our present series elastic tissue was found in about 25%. No doubt that this would have been found in greater number and in more characteristic way if more carefully sought. The mere finding of elastic tissue is not pathognomonic. Elastic tissue without an alveolar arrangement may come from the pleura or the bronchi as well as the lung—Lord (126).

The exclusion of pulmonary tuberculosis is of paramount importance in selection of cases for proper management of them. In as much as tuberculous lesions which have progressed to the stage of the expectoration of sputum containing elastic tissue are likely also to show tubercular bacilli, the demonstration of elastic tissue and the failure to find tubercular bacilli in repeated examinations, are strong assurance against tubercular nature of the disturbance.

In some patients, plugs are noticed in their sputum. They are known as Dittrich's plugs, which are soft putty like masses made up of bacteria, fatty acids, free fat and debris of a most disagreeable odor.—(Oxford Loose Leaf Medicine, Vol. II, Page 105). Such plugs were noticed in our case No. XVI. The one which was found in another case No. XIII, was somewhat different microscopically from what is described in Oxford. The specimen consisted of an irregular firm piece of tissue about 3 cm. in diameter. Microscopically, consisted of connective tissue with foci of polynuclear cells and plasma cells.

#### SECTION IV.—HAEMOPTYSIS.

Thirty cases of the present series had blood in sputum varying in amount from a mere streak to actual haemoptysis. Eight cases had active haemoptysis, sometimes as much as 300 cc. at a time in one case. Some started haemoptysis after a.p.t. was instituted. Some cases had haemoptysis as the initial symptom, like haemoptysis in a pulmonary tuberculosis. A number of patients who had expectoration and sputum were not alarmed until they observed blood in their sputum when they consulted their physician for the first time. In Greenberg's case (224) the initial haemorrhage was as much as 3 pints.

## SECTION V.—PAIN.

40% of the cases in this series had pain in the thorax, usually on the affected side. Many had pain as the initial symptom. Some started with sudden pain, the majority had more or less pain in the beginning but it was less marked in the later period. In the chronic stage, the pain was produced usually by deep inspiration or certain position of the body, and was usually of dull aching character. Refer to case II. As a rule such a pain is roughly referred to the affected area.

## SECTION VI.—CLUBBING OF FINGERS.

This is not really a physical sign of lung abscess, but it is a frequent complication. As it is a peculiar characteristic accompanying phenomenon, a few words of comment on this condition is not amiss. This was noticed in 10% of the series in marked degree. Lemon (122) says that interesting accompaniment of suppurative disease of lung is a peculiar deformity of the extremities. He observed all degrees from simple clubbing, or hippocratic deformity, to true pulmonary osteoarthropathy, with characteristic burring of the terminal phalanges and periosteal overgrowth extending far up the long bones of the upper and lower extremities. Funk (127) describes various types of these changes from simple clubbing to so called "hypertrophic pulmonary osteoarthropathy of Marie." He refers to West's patient with empyema in whom the clubbing became well marked in a fortnight and disappeared entirely after incision and drainage, before the end of three months.

Clubbing of fingers, the process is not necessarily, as sometimes intimated, the result of a congenital heart lesion or pulmonary abscess occurring only in infancy or early childhood, it can come on at any time in life.

Mix (128) represents excellent photographic illustrations of this condition, and says that he noticed the process occurred in brief time in a patient suffering from pulmonary abscess.

## SECTION VII.—PHYSICAL SIGNS.

The statements regarding the physical signs in the lung abscess are various, and on most occasions they are described as "slight" and there is tendency among a majority of the investigators to disregard this most important subject. Buxton (69) puts them as "very slight, and usually valueless," while Schwerdtfeger (129) describes them as "very indefinite." Greenberg's (224) case showed only localized dullness while the lesion was quite extensive.\*

\* In case I, despite a large area involved there were only dullness and a few rales with normal breath sounds; more signs were obtained in other places than X-ray film indicated.—Case I, Fig. 1-8.

As it is obvious in these cases presented here, the physical signs are quite indefinite and disheartening if one is expecting to find all the characteristic physical signs as one sees in text book descriptions; but throughout all the cases one thing is always constant, the findings of the percussion—a localized dullness.

Lord (126) places dullness in "the first of the trias of signs" viz, (1) dullness, (2) circumscribed X-ray shadow, (3) destructive sign of pulmonary tissue—finding of elastic tissue in alveolar arrangement in the expectoration.

In a small proportion of cases with small or deep seated processes, there are no physical signs of abscess which is first disclosed by X-ray examination or autopsy. Dullness on percussion is common to all cases with positive physical findings, and is the most important SINGLE SIGN. Signs other than dullness are variable, but in general conform to those which may be expected in the presence of encapsulated fluid within the chest, i.e., diminished voice whisper, and tactofremitus. Rales usually accompany the more recent and active destructive lesions due to pneumonia about the abscess. In certain abscesses, however, there is very little reactive neighborhood inflammation, and in such cases no rales may be heard.

Refer to case II, and XVI, Figs. 21-24, 111-132.

On the other hand in the latter case, if the abscess cavity is communicated with the bronchus with partial presence of fluid, we may get some rales. Over the area where dullness is obtained the voice sound is altered. It may be increased or diminished but has nasal quality and close to the ear. The whispered voice, as said above, is usually diminished, but whenever it is present it is heard always accentuated in its pitch, which is best obtained when one listens carefully with direct auscultation, and through stethoscope. This is another point next to the dullness.\*

The breath is usually bronchial and of diminished intensity, which character is represented in the text as "a distant bronchial." Here again direct method of auscultation is emphasized, because, stethoscope often misses it. A marked increase in voice, whisper, and tactile fremitus may be present over large superficial abscess communicating freely with the bronchi.

The "Text Book signs" of cavity are infrequent, and they were noticed in 12 per cent of the present series, while Lord (70) noticed in eighteen of his 100 cases. There were four cases in this series in which definite physical signs were obtained but Roentgenograph did not demonstrate the cavitations. Refer to case XXVI.

\* VOCAL FREMITUS -- whether this is increased or decreased depends on local condition just as other signs stated in page 142. It may be increased when there is much consolidation around the cavity which is communicated with bronchi. It is, however, theoretically and pathologically diminished due to the following common condition—Landis and Norris, Diseases of Chest, page 51: (1) obstructed bronchus, (2) cavity not surrounded by marked consolidation, (3) due to increased reflection or diffusion of the sound (pleural thickening, effusion, or pneumo-thorax).

In some definite amphoric breathing was obtained after patient coughed out quantities of pus. case VII. When present, it is the most common single sign, although this sign, in the presence of pneumo-thorax, is quite deceptive as explained in page 144.

Tympany on percussion, cracked-pot resonance, and metallic resonance and metallic rales are occasionally noted. Succussion splash was not found in any case of uncomplicated abscess in this series.

Metallic tinkles were obtained in some cases which were complicated with suppurative pleurisy, especially in the early stage. These rales seemed to be due to the presence of small communication between pleural cavity and bronchi, as Norris and Landis state—*Diseases of the Chest and Principles of Physical Diagnosis*, page 129.

Illustration: Case XVIII, Fig. 133-136.

According to Norris and Landis, this is a clear, vibrating musical sound which may be heard in many cases of hydropneumo-thorax. It has been likened to the distant, clear high-pitched silver bell.

The genesis of metallic tinkle may be illustrated by the following experiment: If we attach a stethoscopic tubing to the mouth piece of a wash bottle and listen while air is being forced through the other glass tube into the liquid, the phenomenon of metallic tinkle can be accurately reproduced. It will further be noted that the sound occurs at the moment the bubble is given off and not at the time at which it reaches the surface. If, on the other hand, we listen while water is allowed to fall from a pipette upon the surface of the water, only a dull, indifferent sound will be heard. (Barach: *Arch. Diag.* Jan., 1910).

It is evident both from this and for anatomic reasons, that metallic tinkle is due to air bubbles ascending through an effusion (1) from a fistulous tract in the lung below the level of the liquid, and not, as was formerly taught, to liquid dropping from a moist pleura upon the effusion beneath.

Metallic tinkle may also be produced (2) by the bursting of bubbles in a bronchial tube which communicates with a pneumo-thorax or (3) by a bubble in the surface of a moist perforated lung above the level of the fluid if the bubble is expelled with sufficient force. In either case, the musical quality is due to the rhythmic vibration of the air and the reverberation is due to the large air filled, stiff-walled resonator—the pleural cavity.

According to Norris and Landis, the only distinctive features are the signs indicative of a cavity, i.e. tympany on percussion, whispering pectoriloquy, amphoric or cavernous breathing and consonating rales. These are rarely present at one time. Whether these signs can be elicited or not, will depend on whether the abscess has emptied itself and formed a cavity and also on the location of the excavation.

These signs may be obtained, if the cavity is sufficiently large, superficially placed and empty, communicating with bronchus.

They are not obtained, if cavity is deeply placed in the centre of the lower lobe, if cavity is filled with pus, not communicated with bronchus, irregular cavity with necrotic walls surrounded by dense induration, or complicated by pleural diseases. As a majority of single abscess are so situated it is not surprising that signs of excavation are so frequently absent.

The physical findings are even more uncertain in multiple abscesses than in the case of the single isolated lesion. Similar signs obtained in variety of pulmonary conditions. Scattered rales, scattered rales with friction rub, scattered rales and areas of dullness, dullness at one base alone, or signs of cavity. They are suggestive of abscess formation only when there is a known focus of suppuration; when there are symptoms indicative of general septic infection, and when in addition, the sputum is purulent or bloody in character and occurs in fairly large amounts.

Pathological tympany was not obtained in any cavity cases which were not complicated.

Cavernous or amphoric breath sounds were more often obtained in cases complicated by pneumo-thorax. Illustration: Case X, Fig. 76-77, Case XXXII, Fig. 221-222. The production of the sounds can be explained as follows: The sound produced in the trachea or larger bronchi are the determining factor in the quality of the breast sounds; the compressed and indurated lung acts as a better transmitter of the bronchial sound; the air content in the pleural cavity under certain tension acts as an excellent resonator. According to Norris and Landis new sound production due to the air entering or leaving an excavation is generally, if not always, a negligible factor—*Diseases of the Chest*—page 61.\* *Notes on cavernous and amphoric B. S.*, page 256.

Moreover such amphoric breath sounds may be best obtained at the location marked "B" in Fig. 1, of the following page, by the fact that the transmitted sound is better resonated and modified by the sympathetic vibration of the air content under tension in its neighborhood, while at "A" the sound tends to be bronchial or broncho-vesicular, according to the degree of the air containing alveolar tissue. At "C" the breath sounds may be either absent or distant bronchial.

On the other hand, if the cavity, which is surrounded by indurated tissue, is interposed by a variable amount of normal air containing alveolar tissue between the outer thoracic wall and the lesion, the breath sounds are that of distant bronchial or even broncho-vesicular, Fig. 2 "A." Even when the abscess cavity is situated close to the costal wall, if it is not directly communicated with the large bronchi, and especi-

\* It is infrequent to meet a hollow cavity of any dimension that may act as a resonator giving exaggerated tympanic or cavernous breath sounds. According to Flint—Landis and Norris, *Diseases of Chest*, page 118—cavernous breath sounds are apt to be confused with normal vesicular breathing than with the bronchial type, and is to be differentiated from the former "only by the absence of the vesicular quality in the inspiratory sounds."

ally if there is any amount of air containing alveolar tissue interposed between "B" in Fig. 3, there may be hardly any noticeable change in the breath sounds at "A" obtainable except much diminished breath sounds which may be of distant bronchial quality. In such a case whispered sounds are more dependable, by the fact that such sounds "broad cast" at (c) will travel along the alveolar tissue and "picked up" by consolidated mass. The difference between normal and pathological whispered sounds is distinctly noticeable, although other respiratory sound may be negligible, because such small sounds are not affected by secondary vibratory sounds. Case II, Fig. 15 and 16.

Norris and Landis obtained cavity signs in 8 of their 30 cases; and state that the area about the angle of scapula is the most frequent site of the cavity signs. Their above statement can be explained by the following facts: (1) nearness of the cavity to the costal wall, (2) less amounts of air containing tissue interposed, (3) nearness to large bronchi and mediastinal tissue assisting transmission of the sounds, (4) thinness of the costal wall. Besides the regional frequency of occurrence of abscess and less complicated by pleural involvement in this locality may also count.

Norris and Landis (Diseases of the Chest, page 575) quoted Stanton and Cruice, who found that in cases of pneumo-thorax, hyperresonant or tympanitic percussion

Fig. 1. Showing deceptive Breath Sounds. At "A" distant bronchial; at "B" amphoric or cavernous, which may be taken for cavity sign; at "C" no B.S. or faint broncho-vesicular.

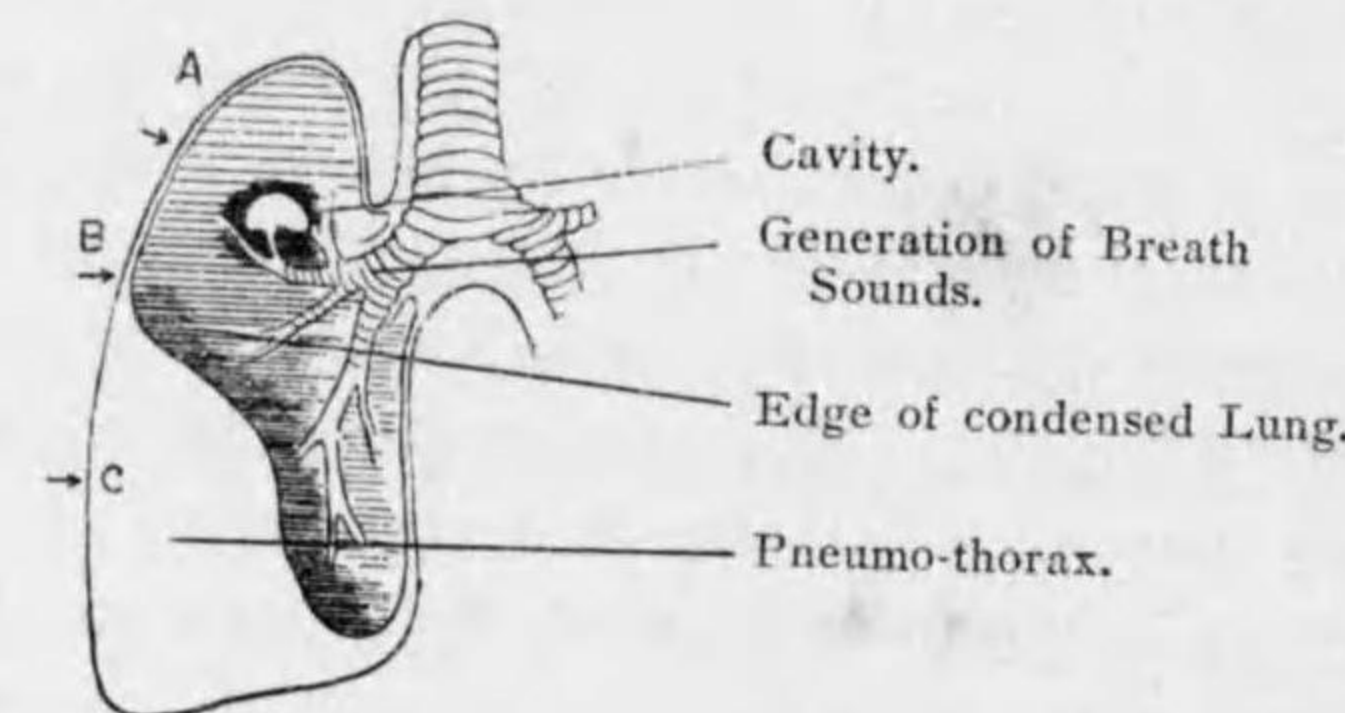


Fig. 2. At "A" practically no change, may be faint broncho-vesicular.

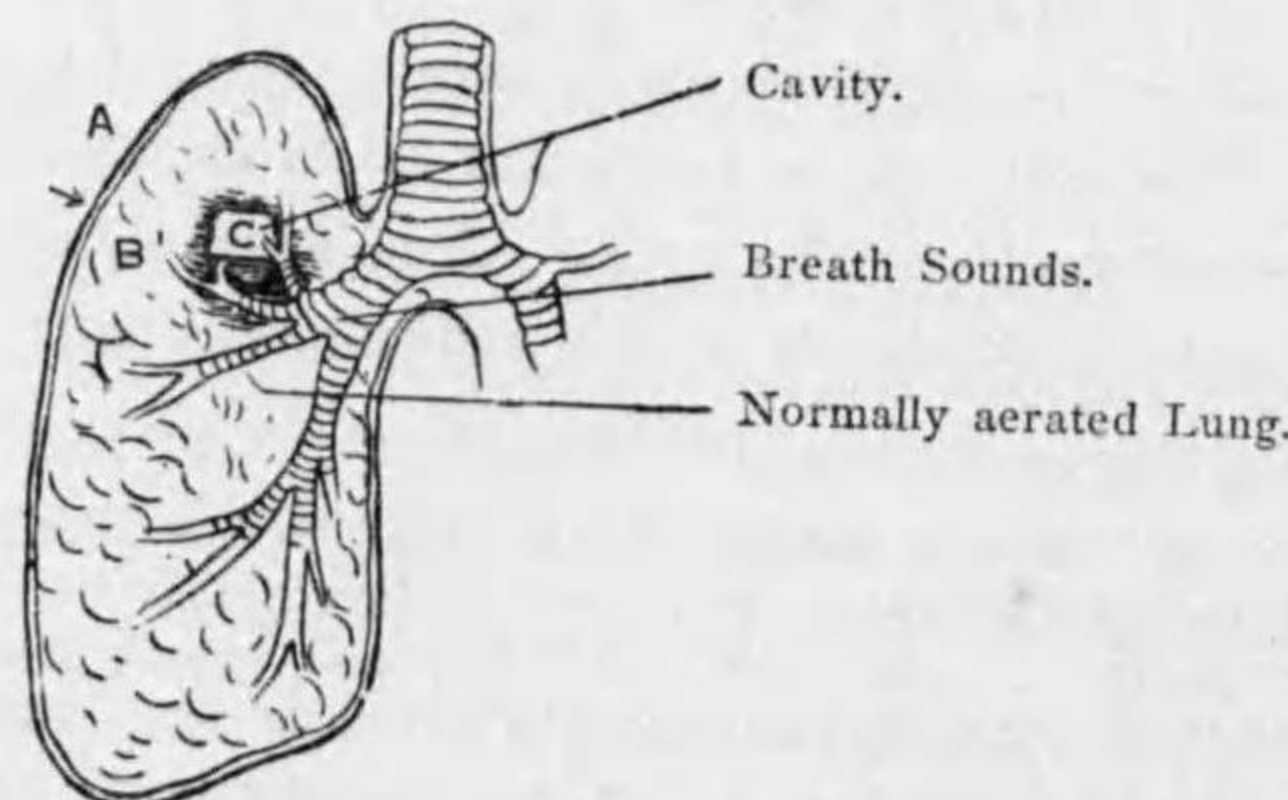
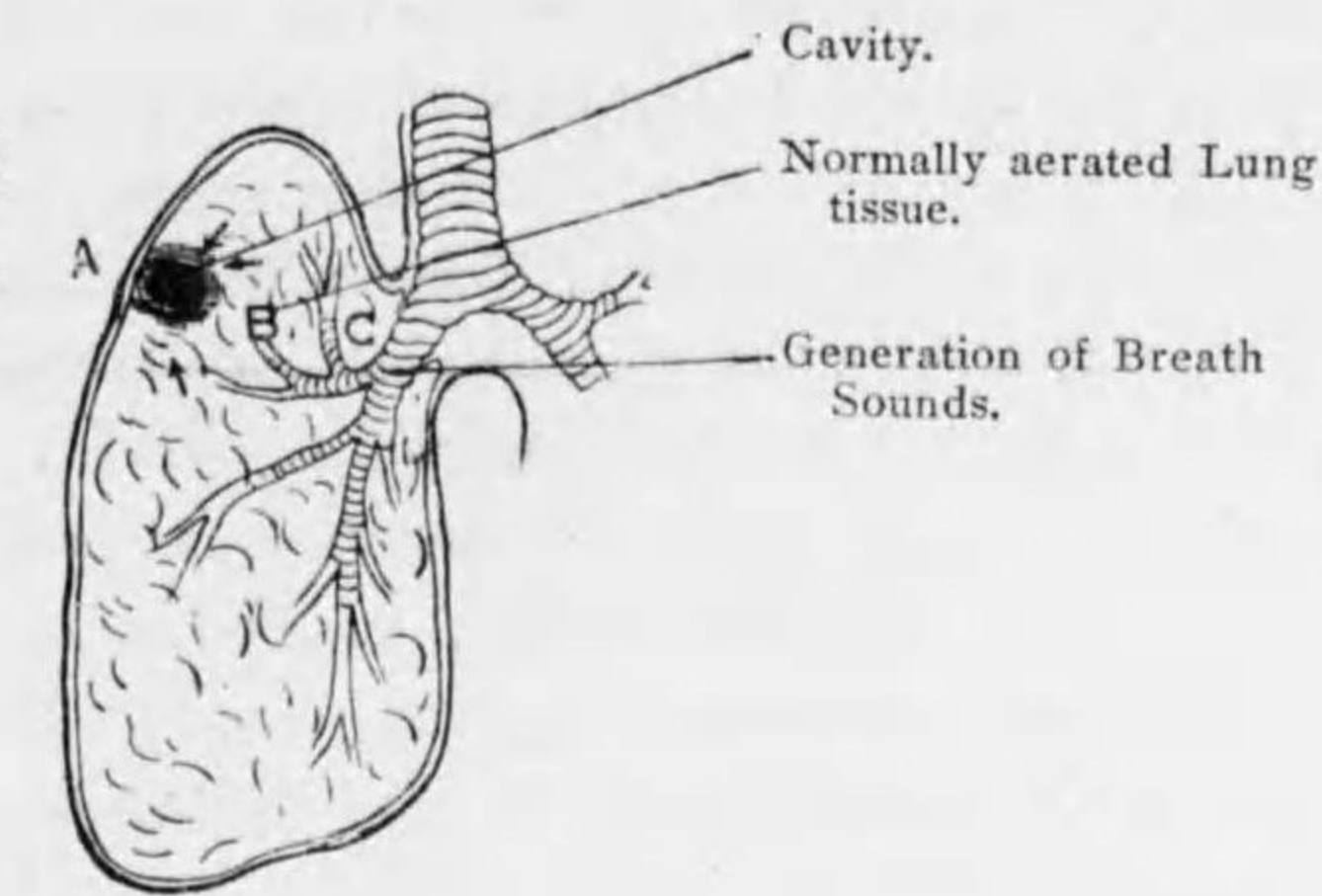


Fig. 3. No change except slight dullness, slightly diminished B.S., moderate changes in spoken and whispered voices.



were present in 82.02%, amphoric breath sounds in 15.78%, cavernous breath sounds in 7.58%, and metallic tinkle in 38.88%, and who stated that metallic tinkle is a sign of great value when present. It is a curious musical echo which accompanied the breath sounds or spoken voice or may be produced by coughing. While not always the case, it usually occurs in association with amphoric breathing and amphoric voice sounds.

Lord (70) emphasizes that in all cases presenting symptoms referable to pulmonary destructive lesion, the possibility of tuberculosis should be constantly in mind. Percussion should be rapidly done so that slight differences are more readily appreciated by an immediate contrast of abnormal with normal resonance. The mere finding of a dull area is not enough. Its limits and character of the dullness throughout all parts of the region should then be determined. An error commonly made in the percussion of dull area at the lower limits of the lung, is to fail to note the degree of dullness at the extreme base. In the period during which we have controlled our chest findings with the X-ray there have been a number of cases in which the X-ray has shown an uninvolved portion of the lung between the upper limits of the diaphragm and dull area on percussion and reinvestigation has shown that greater care in the determination of the limits of the area by percussion would have disclosed this.

The correlation of physical signs with pathologic lung conditions shows that there are two well defined groups of signs corresponding to two groups of lesions. (1) dullness bronchial breathing, increase of voice, whisper, and tactile fremitus are found when there is increased density of the pulmonary tissue and patent bronchi within the consolidated region as in ordinary lobar pneumonia, broncho-pneumonia, pulmonary infarction or retraction, and compression of the lung. (2) dullness, diminished or absent breathing, voice, whisper, and tactile fremitus are common to all lesions where there is increased density and lack of communication of the involved region with the

bronchi as with an accumulation of fluid or a tumor in the lung or pleura, cysts, atelectatic areas from bronchostenosis, and massive pneumonia.

In a given case with a combination of signs, such as, dullness, diminished tactile fremitus, bronchial breathing, increased voice and whisper, it does not fall into either group and suggests a combination of a member of one with one of the other group. The dullness, bronchial breathing, increased voice and whisper suggest a consolidation of the lung with patent bronchi due to pneumonic infiltration or infarction, and the diminished tactile fremitus, in addition, suggests fluid or solid lung or pleura without free communication with the bronchi. The absence of rales suggests that pneumonic infiltration if present is relatively inactive and probably of the indurative variety. From the signs alone no further conclusion as to the nature of the process seems justifiable. Such evidence against cavity as absence of cracked pot sound, amphoric breathing, tympany on percussion are of no value in excluding it. A cavity or small multiple cavities, if present, would not be likely to show any of these signs. Much depends on the position of the cavity, whether deep or superficial, and the freedom of the communication with the bronchi.

The smallest cavity detected in Lord's series measured at autopsy, 3 by 2 cm., and was just under the pleura in the posterior aspect of the left lower lobe.

In case II, there was a large ovoid cavity demonstrated by X-ray, situated in the upper posterior region of the right lung close to the pleura. Patient had spontaneous pain in this region. No one who examined his chest at that time, could find any notable signs except a localized dullness, and slight change in spoken and whispered voice. The negative signs in this case were due to the fact that the lesion was filled with pus, no communication with the bronchi, some aerated lung tissue between bronchi and the lesion, and a thick structure overlying the lesion.

#### SECTION VIII.—EXPLORATORY THORACENTESIS.

In doubtful cases positive result obtained by tapping the suspected cavity will decide on the diagnosis, although one should be better off if this procedure is not carried out as a routine for the diagnosis. There are many possible dangers which accompany this practice, and even in the presence of all other positive signs the thoracentesis may be negative, or one time may be positive while at different occasions it may be negative.

Again, it may so happen that the pus may have been obtained from the pleural cavity or encysted pleural pus pocket, instead of the pulmonary cavity.

Lay (111) met many cases in which the exploratory thoracentesis was often unsuccessful; Stewart (80) says that it is dangerous and unnecessary; Lord (70, 126) advises that it is better not to be done; Lockwood (2) emphasizes that needling is

condemned; and Gaarde (198) states that exploratory puncture for pus is warranted only after the careful exclusion of other lesions, especially Aneurysma.

In case XV the tap was negative but found a large abscess at the operation; in case XXX the tap was again unsuccessful, but at Post Mortem multiple abscesses were found; in case XXVI tapping was followed by immediate collapse of the patient, haemoptysis, repeated convulsions and death shortly after. In the latter case, the X-ray shadows represented by displaced hilum at adherent pleura were misinterpreted for a "large empty cavity," and this faulty cavity was punctured.

Tapping the infected pleural cavity may be another danger, thus carrying such infection deeper into the pulmonary tissue; such an impression may be derived in case XXIX.

### CHAPTER VII.—DIFFERENTIAL DIAGNOSIS.

The clinical differentiation of Lung Abscess from other intrathoracic diseases is often met with difficulties, especially in its early stage, and it requires careful, systematic analysis in each case.

In the process of Differentiation, all factors must be considered together, especially the etiology and the Roentgenologic findings; clinical study alone, without well founded Roentgenologic informations is not complete, and the X-ray films without being accompanied by thorough clinical analysis of the given case may possess no value, or may be even misleading.

Among many intrathoracic involvements which are to be differentiated from Lung Abscess, Bronchiectasis and Tuberculosis should perhaps draw our first attention, and brief references on these conditions are made in the following, the details regarding them and other diseases being left to be considered more properly later in the Chapter of Roentgenology.

#### BRONCHIECTASIS.

In Bronchiectasis the development of the disease is gradual and not sudden as in Abscess. In Abscess of the Lung, the characteristic feature is the sudden expectoration of a large quantity of mucopurulent material, often of sweetish odor. In the majority of cases of abscess the patient is acutely ill or has recently recovered from an acute illness.

In the case of a small chronic abscess the distinction is difficult. An X-ray examination may be of service. In case of doubt an exploratory operation may be advised, as an abscess, if present, should receive more beneficial result if proper drainage is secured.

## PULMONARY TUBERCULOSIS.

Pulmonary Tuberculosis is one of the most important conditions which have to be eliminated in the consideration of lung abscess. In this respect, the former offers most interesting aspects for the clinical consideration, and the writer believes that Pottenger presented the subject in most concise and comprehensive manner in his "Points of Differential Diagnosis value in Pulmonary abscess, Bronchiectasis and Pulmonary Tuberculosis," (206) which is quoted in the following pages.

CLINICAL DIFFERENTIATION BETWEEN PULMONARY ABSCESS,  
BRONCHIECTASIS AND PULMONARY TUBERCULOSIS.

The differential diagnosis of lung abscess, bronchiectasis and pulmonary tuberculosis is hard, needs a good deal of experience; often misdiagnosed, clinically usually depended on cough and expectoration. Even absence of tubercular bacilli is not proof. Clinical onset is important. Tuberculosis with cavity and tubercular bacilli in sputum heals up thick walled cavity left, and its secretion is expectorated in which tubercular bacilli seldom are seen.

Abscess usually follows acute disease or operation in the upper respiratory tract. After recent influenza epidemic, Pottenger saw many abscess cases; but prior to this most cases were from operation in upper respiratory tract, and fewer from acute respiratory disease. Clubbing of fingers, come on soon.

Bronchiectasis usually follows a pneumonia in childhood, much less in adolescence and early adult life. It may sometimes follow bronchitis. If it occurs in adult life, it may be of tuberculous nature. Has occasional exacerbation, with "cold." Cough is loose, sometimes bloody sputum, clubbing but less frequent, slow onset and less marked.

Pulmonary tuberculosis with cavity—has definite clinical entity before cavitation; cavity formation in tuberculosis is more liable to be preceded by repeated attacks of toxemia, sometimes months apart, while pulmonary abscess comes on promptly following an acute infection in a patient who has previously been in good health. Sometimes acute onset is seen in tuberculosis, in which they present more nervous symptoms and greater degree of nutritional disturbance. Cavity in pulmonary tuberculosis is usually located in the upper lobe.

Pulmonary tuberculosis, being a chronic infection resulting from micro-organisms which are not commonly found in the air passages of those who are not suffering from tuberculosis, and which require time for multiplication, is not disease which results immediately on the bacteria's gaining access to the air passages. If the patient has not been previously infected, the bacilli, after entering the tissues pass readily to and settle in the lymphatic glands and are later carried through the blood or lymph

stream to be disposed in the capillaries or lymph spaces of the pulmonary tissue. This is the manner in which lung infection most probably takes place. While implantation of the micro-organisms which produce the acute infections is favored by the relatively greater motion and greater force of the air currents in the lower lobes of the lung which force the bacteria deeper into the tissues, the relatively lessened motion of the apex favors implantation of the slowly developing blood and lymph born tubercular bacilli; consequently, active tuberculosis with cavity formation is usually first found near the apices while pulmonary abscess is usually found in the lower lobes, and bronchiectasis may be found in any portion, but often affecting the large bronchi near the hilum.

## INSPECTION.

On careful inspection a diminution of motion will nearly always be noted on the side of the involvement in all of these affections, because all reduce the elasticity of the lung tissue, cause a loss of tissue and produce a reflex diminution of motion through the diaphragm and other muscles of respiration. In pulmonary tuberculosis, this may be difficult to ascertain in those instances in which there is a lesion in both lungs. In bronchiectasis the lung involved is practically always contracted and the mediastinum shifted towards that side. In pulmonary abscess contraction with shifting of the mediastinum may or may not take place, although it usually does if the process is a chronic one. The same is true of tuberculosis. Case XXXI, Fig. 200-201; XXXV, Fig. 247.

Reflex changes in muscles and other soft tissues determined by inspection and palpation. The reflex spasm in the muscles and degeneration of the softer tissues, skin, sub-cutaneous tissue and muscles is, as a rule, not as marked in pulmonary abscess and bronchiectasis as it is in pulmonary tuberculosis. The extent of the degeneration, when the process has become chronic, depends upon the extent and character of the previous inflammatory process. Pulmonary abscess is a focal infection in the lung. It may be single or multiple, but, as a rule, it appears as an acute disease in tissue which has not been, as is the case with tuberculosis, for a long time previously the seat of widespread foci of infection. Those abscesses which have followed our recent epidemics of acute respiratory infections, however, often occur near the base in the midst of areas of wide spread fibrosis of pulmonary and pleural tissue. Bronchiectasis is, as a rule, limited in the amount of tissue involved. Like pulmonary abscess, and unlike pulmonary tuberculosis, it is rarely found in the midst of numerous active foci of infection. Pulmonary tuberculosis, on the other hand, when it becomes an active clinical process with cough, expectoration and cavity formation, is nearly always a chronic disease and the cavity is formed in tissue which, as a rule,

is and usually has been, for a long time the seat of many foci of infection, which have been undergoing all degrees of active inflammation. The result is that pulmonary tuberculosis offers the greatest opportunity for reflexes. The muscles of the shoulder girdle and diaphragm are more tense (increased tension in the latter is inferred from the limited motion) during the activity of the tuberculous process than is found in the other diseases. When the disease becomes chronic, these muscles and the softer structures (skin and subcutaneous tissue) in the neck and down to the second rib anteriorly and the spine of the scapula posteriorly show far more reflex trophic changes in tuberculosis than in the other two diseases. In fact, chronic tuberculosis of the lung may be suspected whenever the neck muscles with the subcutaneous tissue and skin of the neck and chest above the second rib anteriorly and the spine of the scapula posteriorly are markedly degenerated. Pulmonary abscess and bronchiectasis also cause degeneration in these same tissues, but as a rule, it is not so extensive and he has seen instances of these affections which caused practically no reflex trophic change.

Palpation and Percussion. Percussion may give a little or much information in abscess and bronchiectasis, but is of far more importance in pulmonary tuberculosis. Palpation has been of more aid to him than percussion.

#### AUSCULTATION.

On auscultation the signs elicited in pulmonary tuberculosis with expectoration are usually more or less definite. If a cavity is present in active tuberculosis, it is found in the midst of actively diseased tissue, which usually gives rise to characteristic respiratory sounds and many rales; if chronic, the tuberculous process outside the cavity may be partly or wholly healed, under which circumstances the signs elicited on auscultation may be similar to those of pulmonary abscess. The signs of pulmonary abscess and bronchiectasis, as determined on auscultation, are usually few and often very indefinite. In fact the nature of the process may be suspected from this fact: a definite history of cough and expectoration, usually a fairly large quantity, sometimes even several ounces a day, and comparatively few signs of moisture on auscultation.

#### EXPLANATION OF DIFFERENT AUSCULTATORY FINDINGS.

If the examiner only can form true conception of why there are marked changes on auscultation in pulmonary tuberculosis and why even with larger quantities of sputum, as is often the case, there is such an absence of changes on auscultation, in pulmonary abscess and bronchiectasis, then the differentiation of these affections will be easier. This point is shown graphically by the accompanying illustrations. The

explanation of this fact is based upon the difference in pathology as mentioned above when considering the reflex which arises from these processes.

Mucous rales or crepitations may or may not be elicited over cavities, depending upon whether or not the mucous which they contain is distributed by the ingress or egress of air. Rhonchi are sometimes heard over them. Conditions which favor the production of the most constant and greatest quantity of pulmonary rales are not found in the cavity itself but in the surrounding tissue as noted in pulmonary tuberculosis. The relative prominence of rales in these three affections may be illustrated by the accompanying figures:

Fig. 1. Illustrates the conditions present in pulmonary tuberculosis. A large cavity (A) has formed near the apex. It will be noticed that this has taken place in an area which is the seat of a widespread tuberculous involvement, as illustrated by the dotted area (B). Throughout which there are numerous small cavities (C). Here we have the ideal conditions for the production of crepitations and mucous rales; inflammation with foci of necrosis involving wall of air cells and bronchi accompanied by an increased production of mucus which must find its way toward the trachea through bronchi of all sizes. The cavity itself is at times the seat of coarse rales, at other times, no rales are elicited over it. Not infrequently, sudden disappearance of the rales takes place over an area of tuberculous infiltrations as a result of cavity formation.

Fig. 2. Illustrates the condition present in pulmonary abscesses. An abscess (A) has formed as the result of acute bacterial infection. As coming on within a few days after the implantation of the bacteria has occurred. The surrounding tissues may not be at all infected. This is particularly characteristic of these abscesses which follow an operative procedure upon the upper respiratory tract. The abscess often forms in a single focus the same as a boil forms on the surface of the body. When the pressure in the abscess becomes sufficiently great, rupture occurs at a point of least resistance, which is usually into a bronchus. A pus forming focus remains which discharges through the bronchus. The conditions in the surrounding tissues which favors the production of crepitations and rales as shown in pulmonary tuberculosis in figure 1, are absent and the chief source of whatever rales may be present is the abscess cavity itself and the bronchus or bronchi which drain it. The result is that crepitations and mucous rales are few in abscess produced by acute infections as compared with the abscess cavities which accompany pulmonary tuberculosis, unless the latter have existed for a long time and tuberculous involvement of the surrounding tissue is healed.

When multiple abscesses form in non-tuberculous lesions, as they sometimes do, particularly in those cases which become chronic, each one repeats the same cycle of events as noted in the acute single abscesses. Varying amount of scar tissue result,

but still the wide spread inflammation and the destructive processes which characterize tuberculosis and which favor so greatly the production of crepitations or mucous rales is absent. If the infectious process in either pulmonary tuberculosis or pulmonary abscess involves pleura, then crepitations may be present which may be differentiated from pulmonary rales only with greatest difficulties and sometimes not at all. Much the same condition is found in bronchiectasis as far as production of rales is concerned, as has just been described in pulmonary abscess.

Bronchi are dilated and their walls thickened, as shown at (A) in figure 3, in such a manner that dilatations have much the same physical appearance as abscess cavities. The surrounding tissue is thickened fibrous in nature and offers little opportunity for the production of crepitations and mucous rales. At times there is a constriction of the bronchi proximal to the dilatation which may favor accumulation of secretion and cause sounds on auscultation; but there are rarely heard on auscultation, either in abscess or in bronchiectasis, sounds which will afford any idea at all of the extent or the seriousness of the pathological process present.

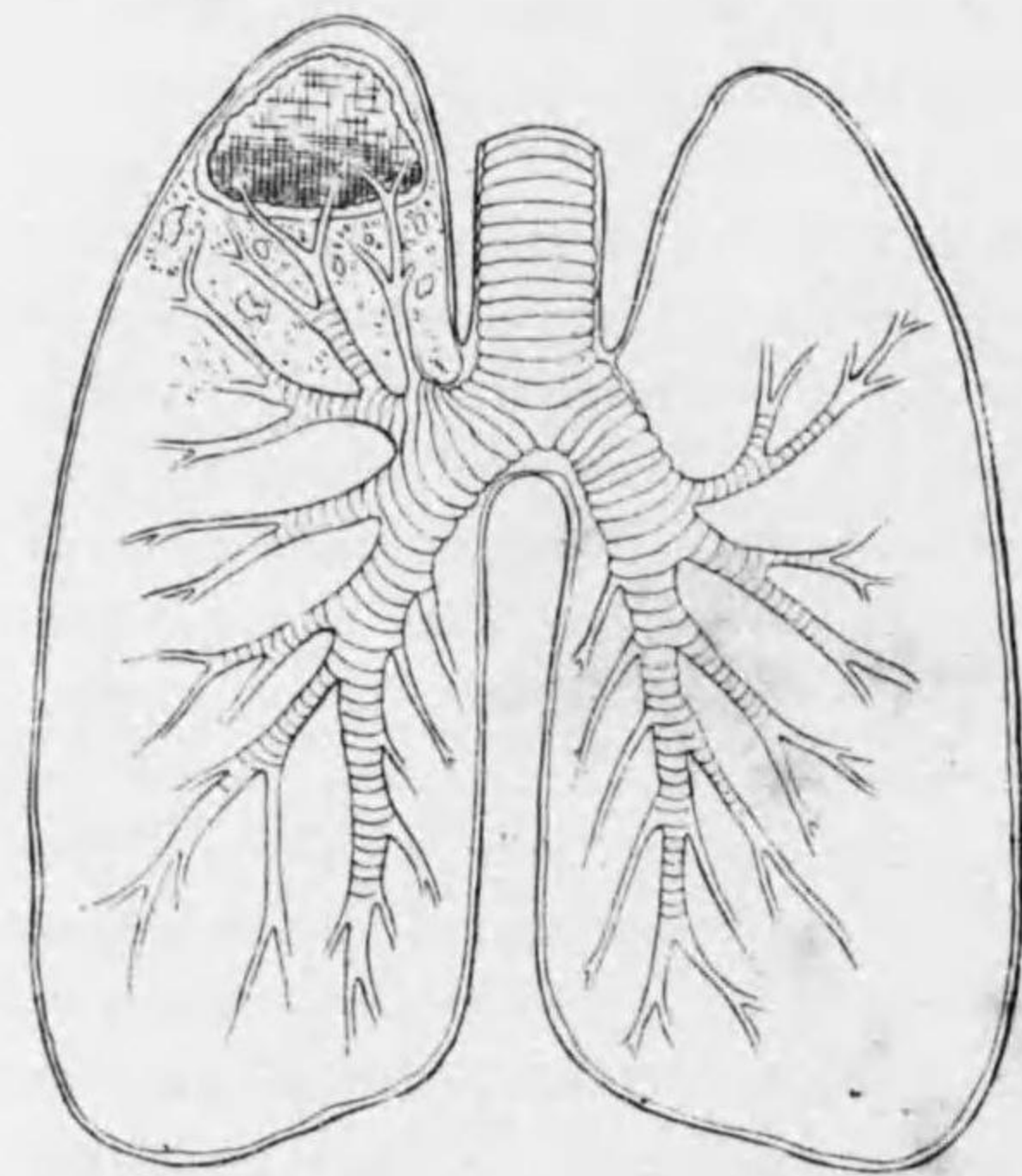


Fig. 1. Diagrammatic illustration of cavity due to pulmonary tuberculosis. The cavity "A" is surrounded by tissue which is surrounded by tissue which is the seat of tuberculous infiltration, "B," and which contains many small cavities, "C." These are ideal conditions for the production of rales.

(From Pottenger, modified by the writer).

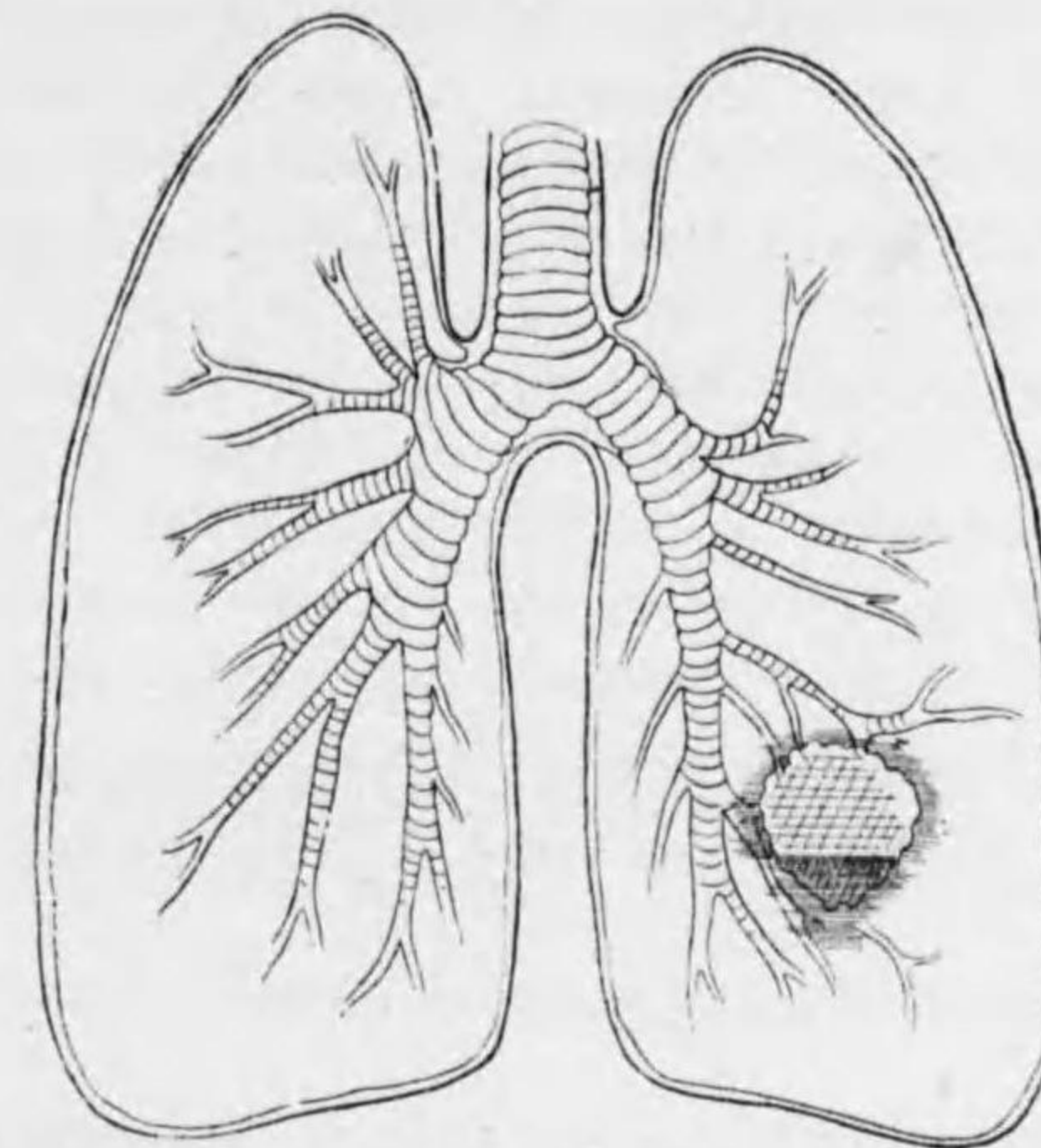


Fig. 2. Diagrammatic illustration of acute pulmonary abscess. The abscess "A," is situated in the midst of and surrounded by healthy pulmonary tissue. The source of rales is the cavity itself and the bronchi leading from it. This condition is not favorable to the production of many rales.

(From Pottenger, modified by the writer)

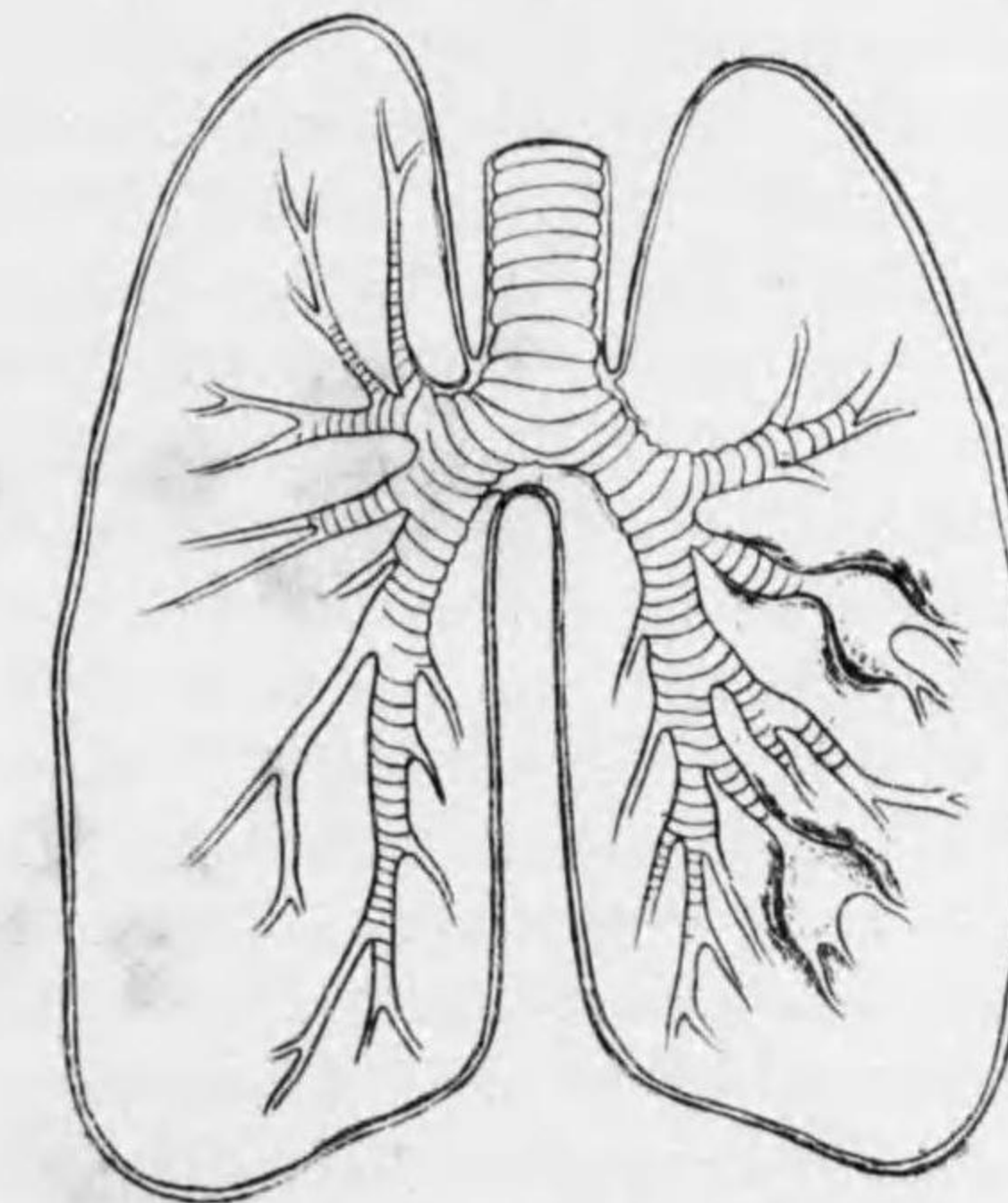


Fig. 3. Diagrammatic illustration of bronchiectasis. The bronchiectatic dilatation "A" are surrounded by pulmonary tissue which is not the seat of infection, consequently the main source of rales is the mucus which forms in the dilated bronchi. This condition is not favorable to the production of many rales.

(From Pottenger, modified by the writer)



A history of persistent expectorations of moderate or large quantities of sputum, with the diminished respiratory excursion on one side of the chest and an abscess of paucity of crepitations of mucous rales on auscultation over the side affected, should make one think of pulmonary abscess or bronchiectasis. Rhonchi are often present but they too may be absent.

For further consideration of the subject refer the Chapter on Roentgenologic Differential Diagnosis.

## CHAPTER VIII.—CLINICAL ROENTGENOLOGY OF SUPPURATIVE DISEASE OF LUNG.

### SECTION I.—GENERAL CONSIDERATION.

Value of the Roentgen-ray far surpasses that of any other laboratory examination; it is a method of inestimable value in the diagnosis of intra-thoracic diseases; in many instances it is the only method which calls forth any hope of reaching a correct diagnosis.

As expressed by Lord (70) it is an important educational measure for the physician, realized to its full extent only when physical examinations are first recorded for later comparison with X-ray findings. X-ray may then confirm the physical findings or disclose deep processes otherwise difficult or impossible of demonstration.

On the other hand, however, in the study of pulmonary conditions, it has suffered and may continue to suffer in reputation because, on the one hand, many who are unfamiliar with the type of evidence furnished by this method had expected too much of it, and on the other hand, many specializing in its use have exaggerated its importance and have made claims which are unwarranted by the results obtained, based on a frail foundation, lacking in clinical as well as pathological knowledge. Moreover, because of the supposed infallibility of this method, it seems that the burden of diagnosis of pulmonary disease has in some medical circles actually been transferred from the shoulders of the clinician to those of the Roentgenologist and the X-ray has been used virtually to the exclusion of the older method of examination.

In order to avoid the dangers which may result from this unwholesome tendency of the present day era of so-called "Specialist" 's notriety, and in order to contribute to the healthy growth of the Clinical Medicine as well as that of Clinical Roentgenology, it is highly desirable to encourage the combined study of both branches of Medicine under more intimate circumstance; the Roentgenologist must have more intimate concern with the Clinical medicine, and the Clinician as well ought to master

ordinal technic of the regional Roentgenology and to gain sufficient knowledge to be able to correctly interpret films.

Roentgenological study of the lung abscess has been given much attention by many investigators such as, Bowen (130), Ziegler (131), Pilot (116), Raynolds (132), Fossati (133), Gravier (134), Crayot (135), Aschner (136) and others.

Especially through the recent works of Lynoh (137), Stewart (138), Sante (64) and others, not only the diagnosis of the mere presence of the intra-thoracic diseases, but studies in various pathological processes or even pathogenic factors have been made possible in the living individual. The utility of Roentgenography and its value in relation to the other branches of medical science has thus become enhanced.

Before going into details of Roentgenographic description in lung abscess, a reference to the normal lung appearance on the Roentgenogram is desirable.

### SECTION II.—NORMAL LUNG MARKINGS.

The minute description regarding normal lung shadow as it appears on the Roentgenogram has been written by various authorities such as, Marquis (140), Overend (232), Fraenkel and Lorey (233), and Garcin (234).

The lung field is traversed by a net work of shadows which are produced by the bronchi, blood vessels, and lymphatics and by the small amount of connective tissue about them. They are capable of casting recognizable shadows by virtue of the air containing lungs in which they lie, which offer them the necessary contrast. It follows, therefore, that the more air there contained the more distinctly these networks are brought out, and the more blood content in the blood vessels, or the more fibrous tissue present in the structures the shadows become more intensified. The character of the Roentgen plate is notably influenced by the technique employed in its production. When the distance of the tube from the patient is short, the pulmonary shadows are exaggerated in size and acquire a haziness which interferes with their interpretation. For careful work it is also necessary to make the examination in the upright position. Only then it is possible to avoid engorgement of the pulmonary vessels and a corresponding blurring of the shadow, which vitiates the Roentgen examination when the patient is in the horizontal position. If any conclusions of value are to be derived from a Roentgen examination of the lungs, it is absolutely necessary that such extrinsic sources of error be avoided. For this reason, the examination should whenever possible, be made with the patient in the upright position and at as great a distance from the tube as is consistent with a thorough exposure. The Roentgenograms here represented were taken at six feet distance on most of the occasions.

The anatomical basis of the lung markings has long been a cause of dispute.

They have variously been ascribed to the bronchi, to the blood vessels, and to both of them together. At the present time, opinion, based on experimental and clinical ground inclines to the belief that the lung markings owe their origin in varying degrees to the blood vessels and the bronchi, more to the former and less to the latter. At the root the trachea and large bronchi contribute to a considerable degree to the production of the shadows, although even here the blood vessels play the greater role. As one approaches the periphery, the blood filled vessels have a greater and greater share in the production of the shadows until at the surface of the lung the fine mottling is probably become progressively smaller as they approach the periphery so that the lung acquires a mottled or marbled appearance and in the average individual they are no longer visible in the apices and the axillary region of the chest. In these locations the lungs have a homogeneous grey or black appearance depending upon the intensity of the exposure. Normal lymphoid tissue of the root of the lung has little influence, while small collection of mucus in bronchi will have varying effect on the root shadows.\*

Regarding the question which factor, blood vessels or bronchial tree, has more significance to the normal lung shadow, Assmann (139) made a classical experiment on dogs. He asserts that the normal lung picture is produced by summatory action, the blood-filled vessels contributing the most important factor, showing on the plate as solid shadow cords and spots, the lumina of the main bronchi as clear spaces, the ortho-roentgenograde bronchi as ring shadows, the walls of the greater bronchial branches having a slightly strengthening influence on other shadows, and that the influence of the lymphatics on the Roentgenogram is not usually of much significance except in pathologic conditions.

In order to determine how much effect the bronchial system has, Marquis of the Mayo Foundation (140) made experiments on dogs. Such experiments, to see which wall, blood vessel or bronchi, is more responsible for the linear markings of the lung, require the placing of both systems on exactly similar conditions. Marquis proceeded in the following manner:

(1) Blood vessels were washed out with physiological saline solution and then injected with air. The Roentgenogram showed only fine delicate linear shadows, which usually appear to be in duplicate. In this preparation there was no way to identify which structures were casting shadows.

(2) Then injected blood vessels again with citrated blood and found that there was marked absorption of the Roentgen rays by the blood.

\* Part of the artificially compressed lung is shown as a mildly homogeneous haziness. Such character of the shadow is due to less content of blood, and condensation of the lung tissue. If all lung markings are due to bronchial structure it would have been much more dense due to such concentration. Figure 56.

(3) All blood washed out with saline solution and injected with air; by inserting fine pieces of wire into the bronchi for land markings, and stereoscopic Roentgenograms were made. Then the wires were found parallel with the linear markings for only a brief distance from the hilus. The terminal parts of the wires appeared to be in parenchyma of the lung instead of within the linear shadows. The wires could also be seen apparently passing across the more prominent linear shadows in a slightly different plane; then the direction of the bronchi with the wire in situ proved that the wire was exactly retained within the boundary of the bronchial wall.

(4) Barium sulphate brown into the bronchi with the wires in position and X-rayed. The shadows of the wires were found within the shadow produced by the barium sulphate, and other fine linear markings (wall of blood vessels) were found to be in slightly different plane.

Based on the above experiments Marquis concludes:

(1) In the lungs of normal dogs the walls of the main bronchi at the hilus only may cast a shadow in a Roentgenogram.

(2) The bronchial walls in the outer portions of the pulmonary fields do not cause a shadow.

(3) In Roentgenograms of the lungs of normal dogs the broad solid ramifying shadows seen radiating out from the hilus are caused in the main by the walls of the vessels and the blood they contain.

### SECTION III.—METHOD OF PROCEDURE.

In the Roentgenographic investigation of lung abscess, a frequent mistake is to neglect the importance of such examination with the patient in various positions. Upright position in antero-posterior radiation is especially important. Cavities which have attained a moderate size practically always communicated with a bronchus; the free access of air causes their fluid contents to assume a horizontal level which is surrounded by a hemi-spherical air space. Such fluid collection, can be caused to shift its level by change of position. In the upright position, a free fluid if present in a cavity is easily brought up by such horizontal line, which is the best evidence of cavitation. If there is any doubt in the film taken in upright position, radiation in prone position if compared with one taken in upright position, will bring out a difference in the shape and density of the shadow thus enabling the observer to distinguish between fluid and solid mass.

Oblique position, when the cavity is present close to the spine or behind the heart and if unsatisfactory in the other two positions, this will be of great service.

Lateral position: the interpretation of the film taken in this position is difficult but it is sometimes necessary in the differential diagnosis or in localizing the lesions, when the other positions are not satisfactory. (Fig. 21, 160).

Lewald (141) emphasized the value of lateral projection, with special reference to the surgical treatment of lung abscess and in its significance to localization.

Lateral recumbent position again often serves to bring out pathological process better, especially if such lesion is situated behind the heart, on the left side.

In one of Wessler and Jaches' cases, the presence of a cavity in the left lower lobe was demonstrated, only by the lateral prone position. (Fig. 253-254).

When the abscess is complicated which is often the case, with the pleural effusion either serous or purulent, removal of the fluid previously to illumination is also helpful. (Fig. 251-252).

In another instance, take film both before and after, letting patient cough and expectorate out, and then by comparing these two films, one may be able to arrive at better interpretation of the shadow. Small annular shadows due to bronchial dilatation can be differentiated by such means, with patient in varied positions.

#### SECTION IV.—THE X-RAY CHARACTERISTICS OF LUNG ABSCESS.

(1) Single large abscess. The description of a single large abscess is somewhat different according to different writers. Paisean (142) says that the most important appearance of cavitation is an oval shadow of considerable vertical diameter and clear cut outline. It is lucky if one is able to get such a frank cavity shadow in a single observation.

According to Stewart (143) the early process of lung abscess is shown in the X-ray examination as a localized pneumonitis of varying degrees, usually oval or circular in shape; as soon as the abscess cavity begins to form, a lighter area appears as a clear space within a densely infiltrated area; if partially filled, a fluid level can be seen, with a clear area above; if entirely filled, it may be difficult to distinguish from the surrounding infiltration. The lesion most commonly mistaken Roentgenographically for lung abscess is a small sacculated empyema.

According to Lord (70) the most distinctive appearance is that of a dense area of increased density of variable but usually considerable width, inclosing a rarefied area about and a dense area below, with constant fluid level. Refer to Cases I-V. Figs. 1-6, 19, 20, 27-28, 37-40.

Such an appearance is distinctive of a cavity partially filled with fluid. Such cavities were demonstrated in 12% of Lord's one hundred cases, while in the writers series, they were observed in 20 out of the hundred cases. Doubtless a larger number would have been found if plates with patient in upright position had been taken in all cases, at more frequent intervals, because one occasion may show characteristic picture, while in most of other examinations, it may not be so characteristic.

The abscess itself usually appears as an irregularly rounded area of even density, its margins sharply defined or fading gradually into the lung markings. More definite findings are exceptional, but there are several groups of cases with somewhat different appearances. At times a rarefied central area or areas may be seen in the midst of a dense region, and such an appearance is not conclusive evidence of cavity, as it may represent a less dense infiltration or partial resolution within a pneumonic area. Valuable additional evidence regarding the cause of such an appearance on the film may be afforded by X-ray examination before and after efforts at evacuation are made by coughing. If a central area is repeatedly absent before and present after evacuation of a considerable amount of pus, a more certain conclusion may be drawn.

If such rarefied area is observed just above a triangular area of increased density with apex downward, especially when this triangular area of density changes in position with the changed position of the patient when radiography is made, or in other words, if the shadow is observed in the dependent position with the rarefied area above, it is quite certain that such rarefied area indicates a cavity.

Lord noticed that in rare instances, the limiting wall of an abscess presents a dense, thin, sharply defined circle of density with little or no diminished radiance in the surrounding tissue, and in such case it may be impossible to feel the limiting wall of the abscess cavity at operation as there is no indurating tissue around the cavity.

In one of Lord's cases, exploratory operation did not reveal any cavity and the patient died. After autopsy was found a thin walled abscess containing 8 ounces of pus in the left upper lobe. The absence of induration about the abscess, was ascribed as the failure to find it by palpation and was partly responsible for the operative failure. In three of his other cases, abscess was not found at operation, although they escaped grave consequences. In three of the writer's series, abscesses were not found at operations. In Case XVI, rather prolonged manipulation of the intrathoracic organ resulted in negative finding of the lesion; in Case XXXIII, an exploratory thorotomy failed to find the abscess although the needle obtained pus and in the second operation the cavity was located; in another case, although there was no cavity found, some amount of pus came out somewhere and this patient got well as a result of the operation. Accidental evacuation. On one occasion, the failure of the surgeon could be ascribed to the lesion being situated deeply between anterior thoracic wall and the diaphragm close to the heart surrounded by normally appearing lung tissue.

According to Hess (144) the characteristic appearance of lung abscess on the X-ray plate is that of a more or less spherical density occurring within one of the pulmonary lobes and surrounded by a halo due to the shadow infiltrated tissue. If free air exists in the cavity itself, its demonstration is unmistakable from the horizontal fluid level, and this is in itself definite proof of an abscess cavity.

When there is no free air in the cavity which is filled with pus, it is shown as

a dense spherical or elliptical shadow sharply limited with smooth boundary; and in absence of marked infiltration around, such shadow may be interpreted as a new growth. In most cases, however, abscess cavity is surrounded by dense induration and infiltrated area extending downward in its most dependent position. **ABSCCESS DUE TO ASPIRATION** of infective material is often shown in its early stage of evolution as a triangular dense shadow projecting outward from the mediastinal shadow with its apex pointing downward. At a later stage this shadow spreads and becomes more irregular, due to spreading infiltration and increasing induration of the surrounding tissue. Hence a characteristic cavitation may only be seen on a film taken at a certain period of the evolution of the lung abscess. The surrounding dense infiltrating area may also contain one or more cavities, which are not visualized due to the exudate within the cavity and dense pneumonic area around. Such possibilities are well illustrated by one of the cases of Wessel and Jaches (Clinical Roentgenology of Diseases of the Chest, page 246). In this case the first film taken on admission showed triangular shadow projecting from the mediastinal shadow, but no cavitation. The second examination, a few weeks later, a larger cavity was noticed on the plate above the base of the triangular shadow. The patient was then operated on and a considerable portion of the diseased upper lobe was resected. The Roentgenogram taken just after the operation showed several cavities of different sizes which had been entirely obscured by the overlying lung. Finally when at autopsy it was possible to examine the lung in detail, it was found to be full of innumerable small and large necrotic abscess cavities.

Cavitations are not always elliptical, or spherical, but more often they are shown as irregular rarefied areas imbedded in dense shadow, appearing as if "worm eaten" or sponge like appearance, in describing such shadow the writer used the term "geographical mottling." Most of the density surrounding such rarefied area or areas, however, represent indurative area as demonstrated by Lynah (137) by intrabronchial bismuth injection.

W. H. Stewart in 1915 purely accidentally found tracheo-esophageal fistula and bronchial tree by injecting bismuth paste, observing under fluoroscope and Roentgenogram with no ill effect. Jackson in 1918 described a case in which the main bronchi on the right side were outlined Roentgenographically after insufflating dry bismuth through the bronchoscope. J. C. Bullowa and C. Gottlieb of New York, in 1919 brought out of details of bronchial tree in living animals Roentgenographically with bismuth and barium mixtures. They were able to demonstrate a "wave like" peristaltic action in the bronchi and trachea. In 1920 the first successful efforts were made by Lynah to outline Roentgenographically lung cavities after the injection of opaque substances through the bronchoscope. X-ray plate was indefinite, but by injecting bismuth paste could bring out definite abscess shadow. This also brought

beneficial effect upon the patient, as expectoration became much less fetid, no foul odor to the breath, injected bismuth began to come out in short time. The bismuth may remain in the cavity from two weeks to two months.

Lynah and Stewart conclude from their experience with the bismuth injection into the cavities that (1) bismuth mixture thus injected does no harm, (2) greatest aid to thoracic surgeon by mapping out abscess cavity in the respective lobe of the lung. (3) A definite lung abscess cavity is seldom seen bronchoscopically. Pus is usually seen coming from a branch bronchus, although the abscess may be well around the corner, and not in that portion of the lung from which the pus is oozing. An injection of bismuth or some other opaque mixture will clear up this error. (4) Bismuth, when it enters the abscess cavity, is recognized by its metallic lustre, whereas when it is in the lobular lung structure, it is discerned as a dull opaque area. Pus diffuses and soaks the lobular structure in a manner similar to bismuth; this makes the involved area appear many times larger than it really is.

In cases in which there is mottled increase of density alone, abscesses if present, are likely to be small and multiple. Some of those cases with mottling appearance within which could be noted some rarefied area or areas representing so called "geographical mottling" turn out to be true abscess during subsequent Roentgenographical examinations.

Illustration: Case II, Fig. 9-20, Case IX, Fig. 70-75.

X-ray examination may be negative in the presence of abscess below the level of the dome of the diaphragm or behind the shadow of the heart. Lateral views are difficult of interpretation, but may be of great help in such cases.\*

Even if the cavity is situated in a favorable location, it may not be satisfactorily brought out at a single exposure. One of Lilienthal's (145) cases was such. Roentgenogram showed only diffuse opacity of left chest, and at operation found a large abscess cavity bound in thick cavity wall in left upper lobe.

Again Wessler and Jaches illustrate a case in which the Roentgenogram showed persistent pneumonia of eight months duration without visible cavitations on the plate, but in which the profuse purulent and fetid expectoration left no doubt of their presence and this was confirmed by the necropsy findings. (Roentgenology in Diseases of Chest P. 232).

Shadows of indurating lung which is usual accompanying picture of the lung

\* Case XXV, Figures 178-179, Case XXIV, Figures 176-177. In case XIII the X-ray showed only haziness at base (Fig. 92-93), but at operation a large cavity was found at the site. Similar incidence in case XXIX. Case XXIV showed indefinite X-ray shadow, but tap revealed large amount of pus; in case XXV, there was negative X-ray, but a large cavity was found at base at Post Mortem, Figures 178-179. In Case XXXIV there was chronic large abscess at the left base which was not shown in the X-ray.

abscess may also be entirely absent in the first Roentgenogram, as illustrated by case XIII, Figure 92-93.

The serial X-ray investigation will definitely prove the real value of the Roentgenography in the disease of the lung, this is illustrated in case I, Figures 1-8. In case XXVIII, fairly large sized cavities were shown only as mottled area—Figures 189-190. In case XXIV, a large abscess at base was not detected in the film—Figures 191-194.

ROENTGENOLOGIC CLASSIFICATION OF LUNG ABSCESS.

The Roentgenologic descriptions of lung abscesses by various authors are not uniform. This discrepancies may be partly due to multitudinous shadows cast by these lesions.

The hope of making more systematic study of the Roentgenologic complex of these lesions and to simplify their descriptions, the writer has attempted to classify these shadows in the following manner, based of the Roentgenologic analysis of one hundred cases of the lung abscess and referring to descriptions made by various investigators.

They are roughly divided into four classes:

Class I. Localized density including a cavity or cavities with definite fluid level or levels. The depending portion, of the cavity is usually much dense and of triangular shape with apex downward. This type of shadow was observed in 20% of all cases, and this is most authentic form of cavity shadow. This is illustrated by the accompanying diagram (1) on page 163. Figures 1-43, in Vol. II and III.

Class II. Localized density including a rarefied area or areas but in which definite fluid level could not be demonstrated. These rarefied areas may be ovoid or circular, and of homogeneous density, represented by the diagram (2) (-a); such an elliptical shadow of even density may not be surrounded by marked mottling density, represented by the diagram (2) (b). They constituted 15% of all the cases, Figures 44-83, in Vol. II and III. Case VI-XI. Class I and Class II represent. 100% positive cavity shadows.

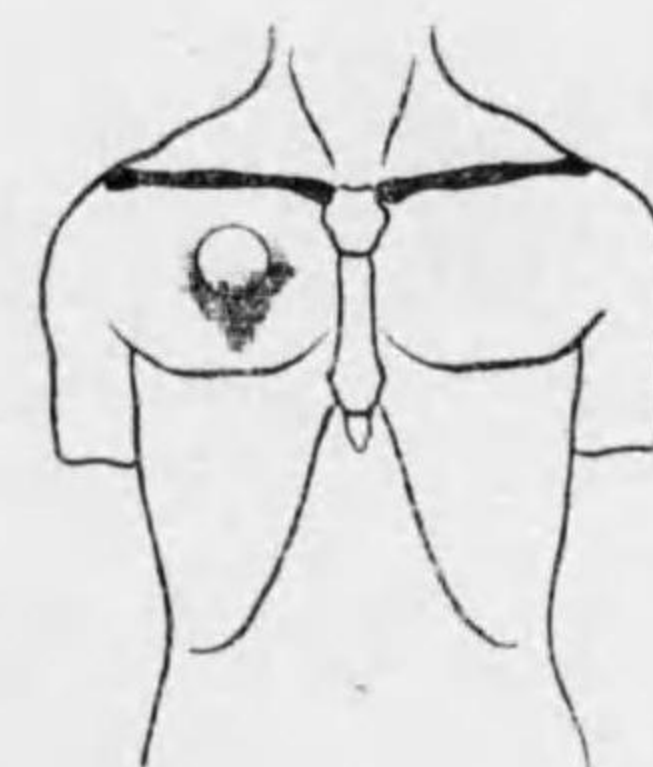
Class III. Represents those cases having either one or more of following characteristics: (a) localized mottling area with central rarefied field representing so termed "geographic mottling," reproduced in diagram (3), (b) localized density with bronchiectatic lesions as illustrated by diagram (4). Case XVI and XXXV, Figures 121-127, 245-248, in Vol. II and III. (c) Sharply localized density with more or less definite outline, which often forms a triangular shape with apex pointing downward. This is the characteristic shadow obtained in the early stage of aspiratory type of lung abscess. Diagram (5). This type of shadows often presents

difficulties in the diagnosis, as they are frequently confused with shadows due to new growth, encysted empyema and other localized lesions. 28% of the cases were of this type. Case XII-XXIII, Figures 84-175.

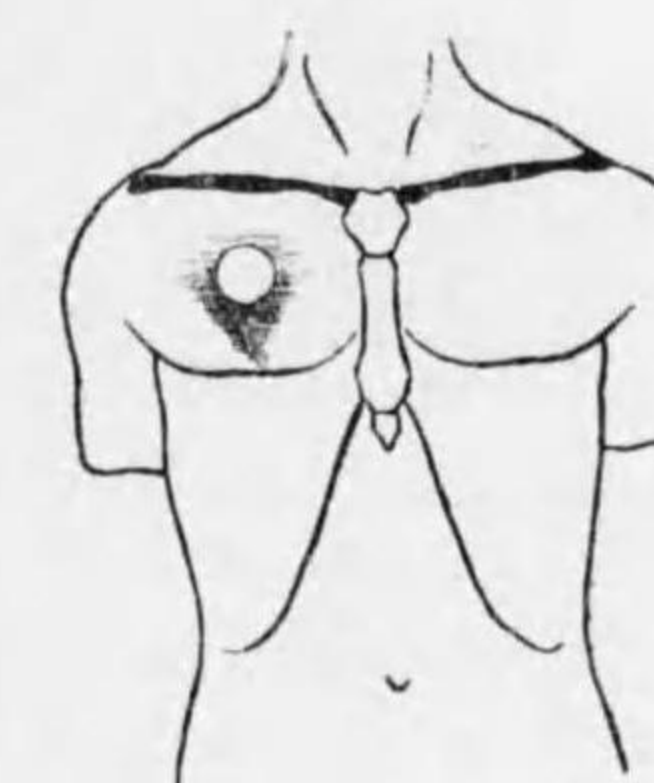
Class IV. Irregular density occupying large pulmonary field, often involving the lower half of either side of the chest, or most of the one lung field or even both lung fields. There may be "geographic mottling" within this area or areas, but no definite cavitations can be seen. Sometimes above the density it may be possible to observe semi-circular indefinite shadow indicating the cavity. Diagram (6).

In this group the cavities are often multiple, and usually complicated by suppurative pleurisy, with pus or serous fluid in the pleural cavity.

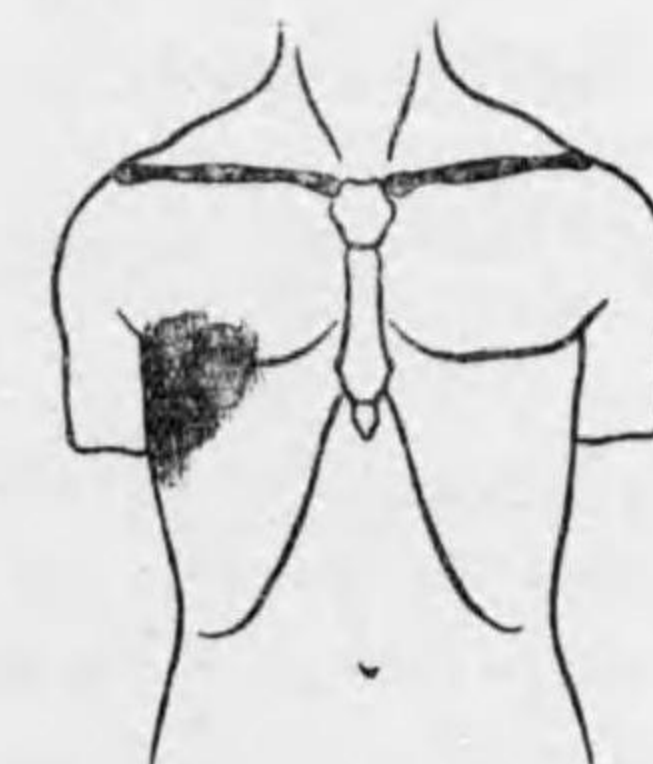
In this group the cavity shadows might have been those of class I or II, but owing to the presence of pleural complications they have been over-shadowed by the latter condition, or due to their position, over-ridden by cardiac or diaphragmatic shadows. Case XXIV-XXXV, Figures 176-248.



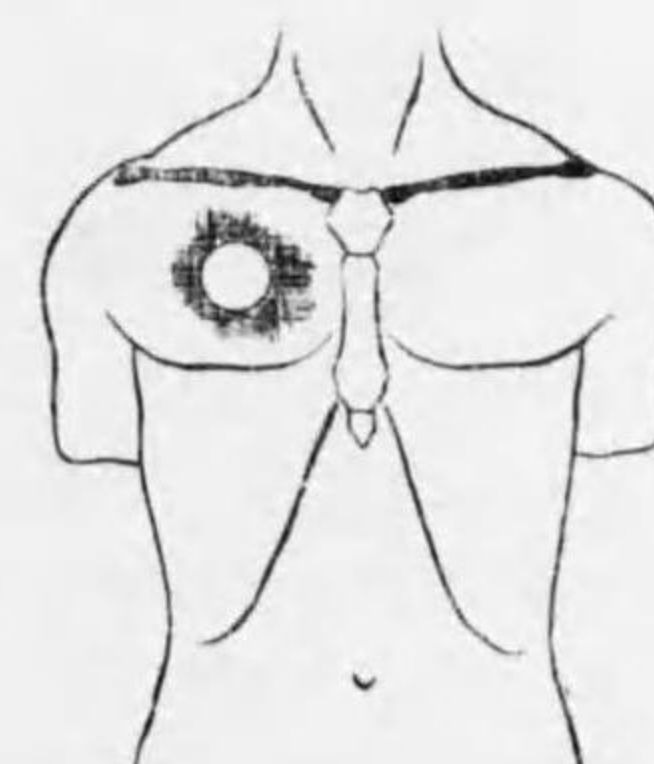
(1) A circular cavity with fluid level; dense triangular shadow below.



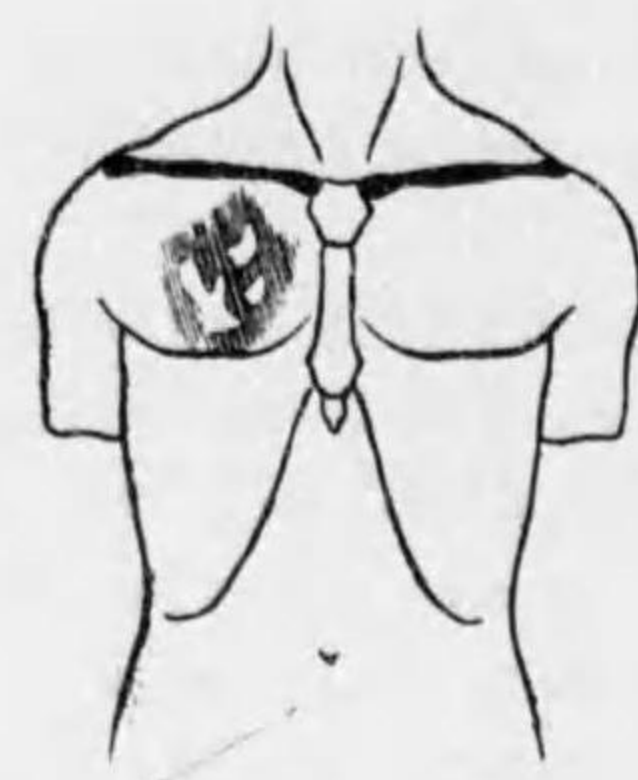
(2 -a) A circular cavity without fluid level; dense triangular shadow below.



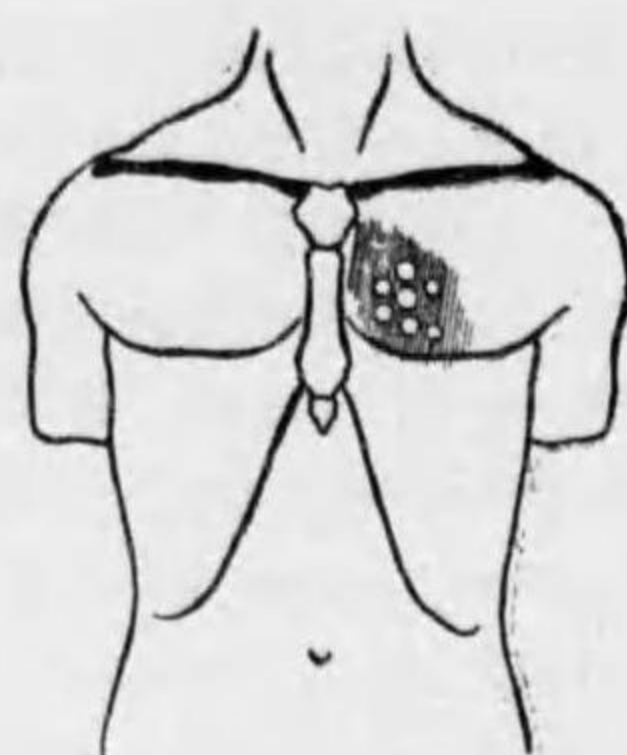
(2 -b) An elliptical or ovoid shadow of even density, not surrounded by marked density.



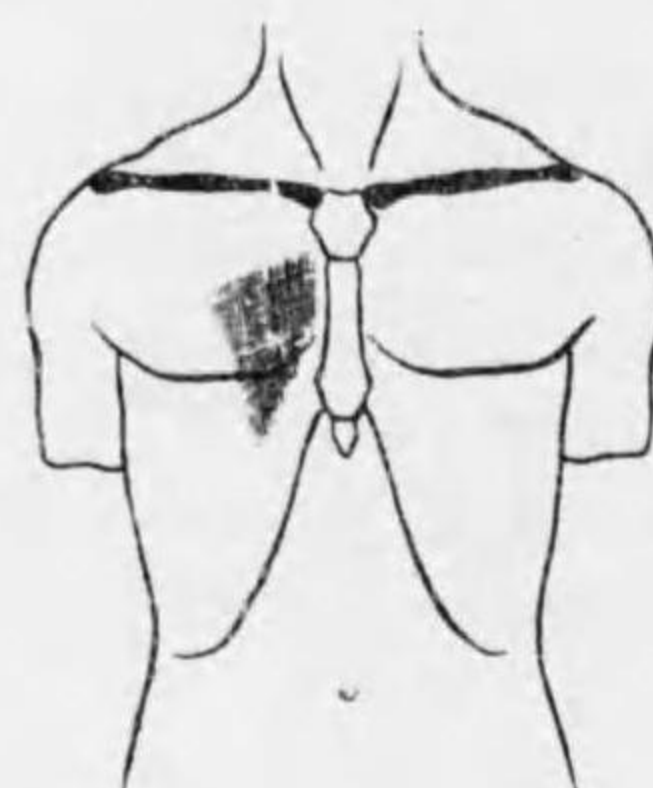
(2 -c) A rounded rarefied area imbedded in irregular mottling density.



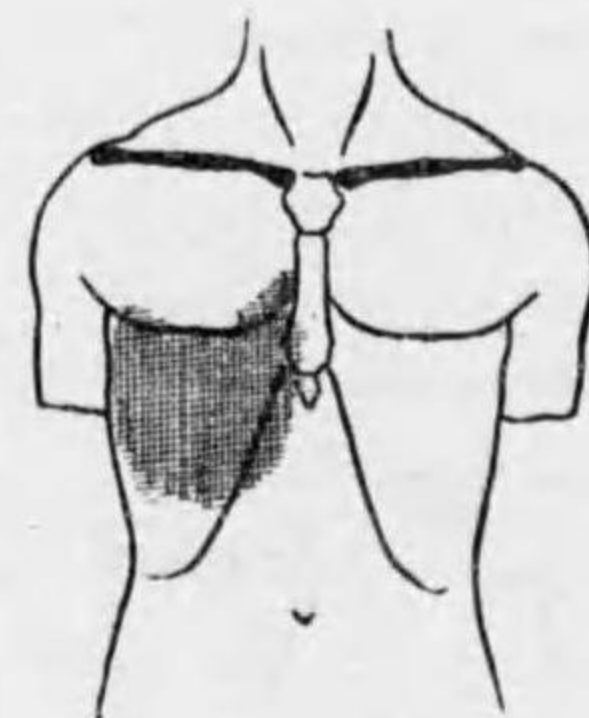
(3) Mottling density of irregular shape in which vague, irregular rarefied areas — "geographic mottling."



(4) Localized mottling with honey-comb appearance, indicating bronchiectatic cavities.



(5) Triangular density projecting from hilar region, usually of mottling character.



(6) A large homogeneous density with upper mottling or hazy margin. Sometimes a part of cavitation may be seen along its upper level.

### CHAPTER IX.—LOCATION OF LUNG ABSCESS.

#### SECTION I.—REVIEW OF LITERATURE AND CASE ANALYSIS.

As it has been discussed at length in the chapters of Etiology and Pathology and in the case illustrations, there is a pathological and clinical difference in the manifestation of the disease according to the etiology which may be roughly classified into aspiratory and endogeneous origins.

Then, in the Roentgenographic representations of the various phases of the pathological features of the lung abscess, we also expect to find a certain differences

according to the varied etiological factors. In the Clinical Roentgenology of Diseases of Chest (page 249), Wessler and Jaches state that if we analyse a sufficiently large number of cases in respect to the localization of the disease, a distinct difference will be found to exist between the acute aspiration or post-operative abscess and the chronic pneumonic type. In the former, there is a predilection for the upper lobes, which are involved twice as frequently as are the lower lobes.

Homans (146) published in 1923 the result of his study of 23 cases of lung abscesses which occurred at Peter Bent Brigham Hospital. Ten of these cases followed operation on mouth and throat. His record suggests the inhalation of septic material under general anaesthesia as a source of these abscesses. If such is the case, we should be able to demonstrate that the distribution of such abscesses is such as would be more consistent with aspiration of septic material than with any other factor, that the so-called aspiration abscess is more likely to be found in the upper lobes of the lungs than the post-pneumonic form has been repeatedly observed; only four of the ten cases were in the lower lobes, of Homan's series. That lung abscess due to all causes has a strong right sided and lower lobe preponderance, is attested by all available statistics. 61% of Homan's series were right sided; 55% were lower lobe abscesses. It may be inferred from such anatomical and clinical observation that abscess of the lung has a distribution in the right lower pulmonary area such as might be expected from any infection (tuberculosis excepted) whatever, and however carried to the lungs, with the exception of those resulting from surgical operations which have a tendency to appear in the upper lobes in undue proportion. Most observers believe that the actual development of abscesses is preceded by a pneumonic consolidation even in the post-operative form of the disease.

Not to discuss here regarding the cause of post-operative pneumonia,\* Elwyn's (102) record of post operative pneumonia showed the following distribution:

Right upper lobe	... ..	1
" lower "	... ..	41
Left upper lobe	... ..	21
" lower "	... ..	24
Right upper and right lower	... ..	1
Right both lobes	... ..	1
Total	... ..	89

If all abscesses develop on previous pneumonic area, then we ought to have great preponderance of number in lower lobes.

\* A consideration to the relationship between post-operative pneumonia and occurrence of lung abscess is given in the following.

Assuming that Whipple's (147) so called "post-operative pneumonitis" develops as a result of collapsing or non-re-expansion of the lung as Briscoe (148) maintains, and abscess is to start on such pneumonia area, then the statement frequently made that lung abscesses are more often found in peripheral region than central (Buxton 69) or more in lower lobes should be indorsed by incidents. Majority of post-operative lung abscesses, however, have been found near the root and in upper lung fields, thus emphasizing the aspiratory hypothesis more than metastatic.

Moore (96) in 1922 made a report based on 202 collected cases on the literature, and in these, 60% of the lesion situated in the lower lobes,—right lower, 41%; left lower, 19%. According to Stewart (80) right lower most common.

The decision on the accurate location of the abscess is difficult, and errors are inevitable.

In recording the situation of the abscess in the present series of 100 cases, the radiographic examinations were depended on in the majority of cases, while in number of other cases, they were recorded after being confirmed by either exploratory thoracotomy or at autopsy. None of the cases, however were recorded by physical signs only, which are doomed inaccurate in the localization of such lesions.

Among the cases demonstrated, number of the patients came under observation pretty late in the course, so that the disease had been well advanced; many of them, especially those presented type IV, Roentgenogram, were complicated either by pleural effusion, suppurative pleurisy, pleural adhesions, much thickened pleura, encysted fluid, multiplicity of the lesions or combinations of more than one of these conditions. Sometimes the lesions gave misleading physical signs; pneumo-thorax yielded signs of cavitations.

In recording the distributions of the abscesses, therefore, those points must be included in the consideration. Mere presence of density in the lower portion of the lung field does not indicate the true position of the cavity; if it is admitted that some of the reported cases, as far as the distribution of the lesion is concerned, were recorded from actual observations of the Roentgenograms and not checked up by exploratory thoracotomy or autopsy, the ration of lower lobe involvement and that of upper lobe would be much smaller.

The localization of the lesion in the middle lobe is difficult on the X-ray film alone, as there is overlapping of the lobes in this situation, although the occurrence of lesion in the middle lobe is rare. Therefore all shadows in this locality on the film, the location was described as "middle third" of the lung field, which included lesion at the hilar regions, lower portion of upper lobe, middle lobe and upper portion of lower lobe. In a total of one hundred cases, right upper regions were involved in 24 instances; right lower, in 28; right mid, in 13; left upper in 11; and left mid in 3; and left lower region in 16, as indicated in the table.

As it is made clear in the accompanying diagram, as given on page 168-169, lower lobes were more often involved in both lungs than the upper lobes, and the lesions occurred more often in the right lung than the left; these agree with findings of most of the investigators. Lung abscess which followed influenza were located in the upper lung field in 90% (epidemic type).

For the convenience of the present consideration, all the causative factors of lung abscess of this series, are divided into two groups, the pneumonic and the aspiratory. **THE PNEUMONIC GROUP** includes: lobar pneumonia, broncho-pneumonia, epidemic and non-epidemic influenza, pleurisy, empyema, bronchitis, "cold" bronchiectasis, embolic and infarct. **THE ASPIRATORY GROUP** includes: Sinusitis, operation on the eye (general anaesthesia) "choking," aspiration of foreign body, tonsillectomy, abdominal operation, state of coma, injuries in upper thoracic and respiratory tract.

Cases of undetermined and unknown causes are omitted from the present consideration. In these two groups the frequency in the occurrence of the lesions in the various regions of the lung field, is quite reversed: i.e., in the first group the lower lung field was much more frequently involved, while in the second group, the upper and mid regions of the lung field were more frequently involved, as is made clear on the diagram; page 167. This difference would have been more clearly brought out if the lesions were investigated Roentgenologically in their early stages in all cases, or confirmed by explorations.

It is certain that the majority of the lesions due to aspiratory cause start in the hilar region. These lesions spread rapidly toward periphery and downwards assisted by gravity and by consecutive spread along blood vessels and lymphatics. Even if the parenchymal lesions are situated above the basal region, complicating pleuric or intra-pleural lesions make them appear on the Roentgenograms as if occupying the lower lung field. In computing the results, 5 cases were omitted; one case with both upper involvement (Tbc.?) three cases, both bases, one case, whole right lung.

The first pneumonic group consisted of 54 cases, and the second group (aspiratory) consisted of 35 cases. It is obvious that if the second group contained equal or greater number of cases, the contrast between upper and lower field involvements in these two groups would become more distinctive.

The foregoing findings agree with those of Conner (149) who states that in considering the various series of cases, it is found that in general, abscesses of the lower lobe are twice as common as that of the upper, except those following operation under general anaesthesia, when the reverse is true.

Wessler and Jaches (46) also found that acute aspiratory or post-operative abscess has preponderance for the upper lobes.

Tewksbury's (150) result was remarkable in that twenty of his series of 25 cases

From the etiological analysis of 100 cases, following cases are selected for comparison for localization frequency according to the causes between the two groups:

I. PNEUMONIC GROUP INCLUDING 54 CASES:

Causes	Type of X-ray shadow.		Total No.
	Gp. I-III.	Gp. IV.	
Lobar Pneumonia ... ..	12	6	18
Broncho-pneumonia, influenza, epidemic and non-epidemic ... ..	8	5	13
Embolic ... ..	3	5	8
Pleurisy ... ..	6	1	7
Suppurative pleurisy... ..	—	1	1
Bronchitis ... ..	4	2	6
"Severe cold" ... ..	1	—	1
			54

II. ASPIRATORY GROUP INCLUDING 35 CASES

Sinusitis ... ..	1	—	1
Operation on the eye (general anaesthesia) ...	1	—	1
History of choking ... ..	1	—	1
Foreign body ... ..	3	1	4
Tonsillectomy ... ..	6	3	9
Operations under general anaesthesia ... ..	8	5	13
State of coma ... ..	2	2	4
Mastoiditis with cellulitis... ..	1	—	1
Fracture of jaw ... ..	1	—	1
			35

Cases omitted: 1 tuberculosis, 1 perforating gastric ulcer, and the rest of the cases which had bilateral or one whole lung field involved.

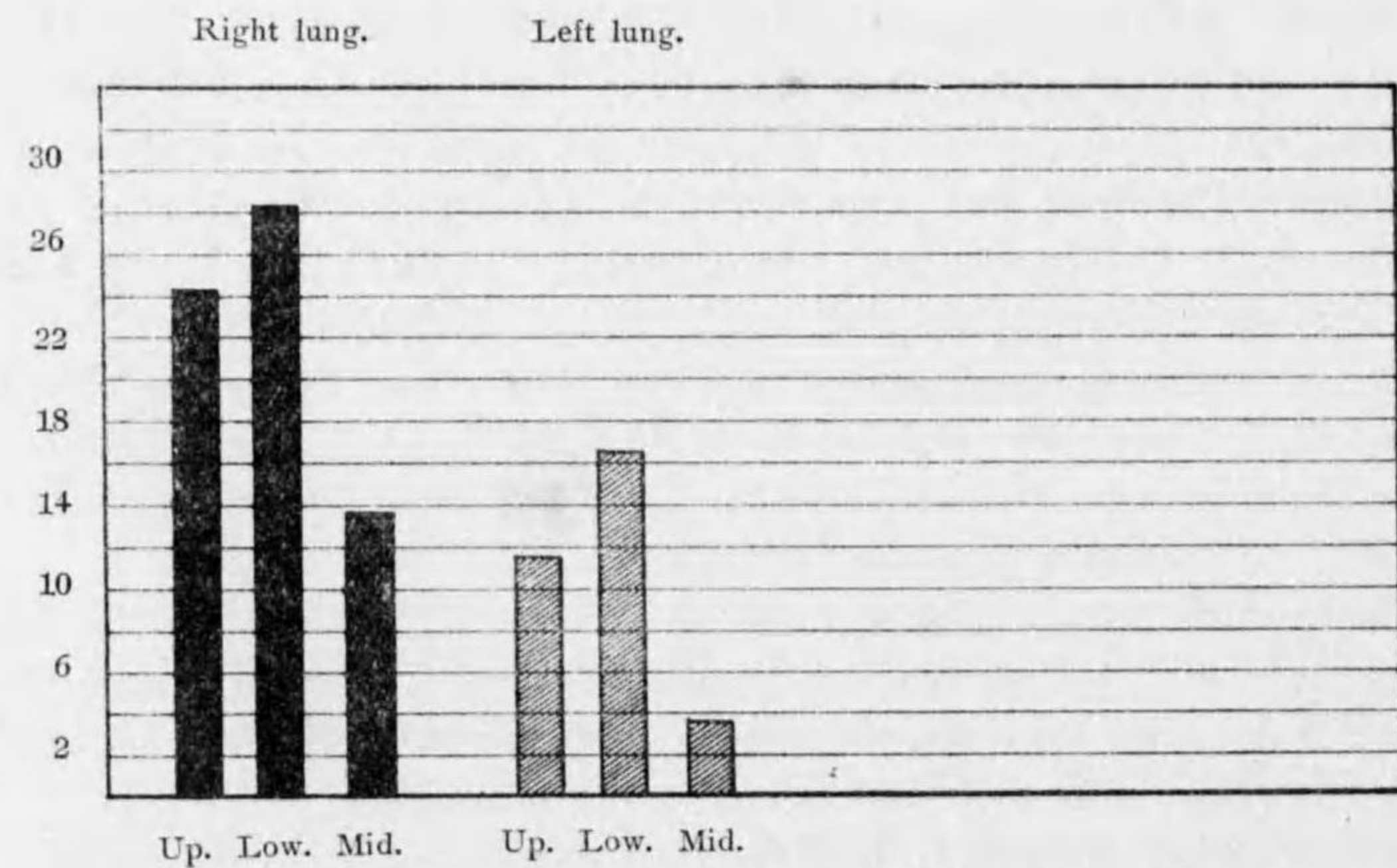


Diagram showing the distribution of lung abscesses. The figure on the left margin indicates case occurrence. Five cases were omitted from the series, 1 both upper regions involved, 3 both bases involved, and 1 whole right involved.

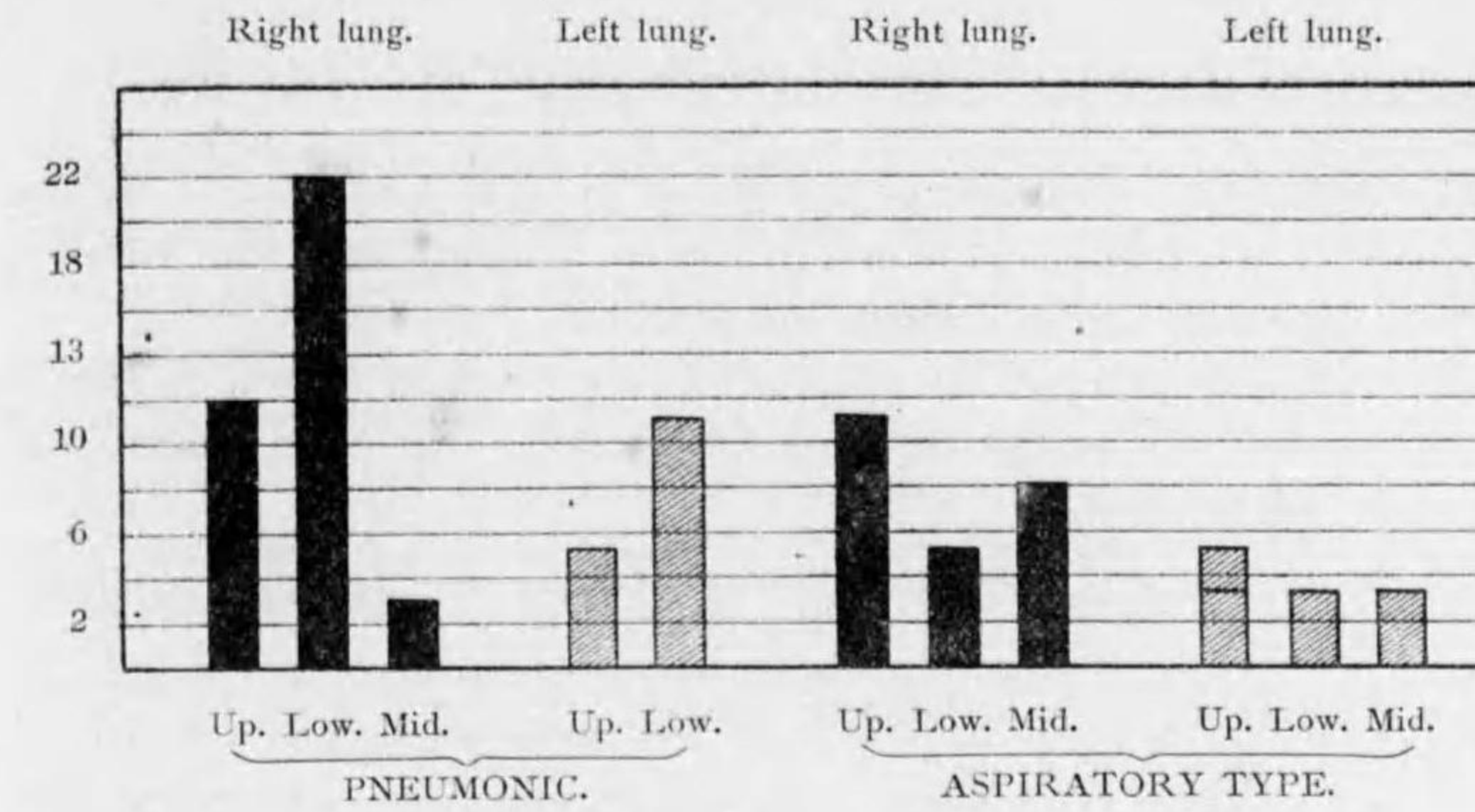


Diagram showing the relation between the pneumonic and aspiratory types of lung abscesses in the frequency of their localization. Notice the reversed frequency in the upper and lower lung field involvement in both types.

were cured, one improved and four died, all treated by artificial pneumo-thorax. In these cases of post-operative lung abscesses, the lesion occurred near the hilum of right lung in 21, and near left hilar region in four instances.

Carr (151) reported a case of pulmonary abscess following tonsillectomy, in which Roentgenogram taken 6 days after the operation, showed the lesion in right upper lobe near the root.

Chipman (101) states that it would be very convenient if we could feel as sure as Fisher and Cohen (89) that lung abscess following nose and throat surgery is of embolic origin for then it would make little difference if local or anyone of the various form of general anaesthesia were used. It is difficult to see how the cause can be frequently be otherwise than aspiration, when we consider that, out of 33 cases, the right lung was involved near the hilum, 25 times.\*

Embolic abscess is most frequently found near the edge rather than the centre of the lung, often multiple; if large, in its early stage, may cast area of infarct on the Roentgenogram. The history may show other pre-existing foci, or may be indicated by such symptoms referable to infarct. Illustration, case XII.

We have already had enough facts that post-operative lung abscesses occur more often in the upper lung field despite the fact that all kinds of lung inflammations have preponderance for the lower lobes (tuberculosis, is of course, an exception) and we are going to see further evidence which is more conclusive, to the subject.

\* The X-ray findings in aspiratory origin of lung abscess is characteristic, for example—Case XI, Fig. 78-83. The coincidence of Endo-bronchial infection and post-operative passive congestion of the lung may be seen in Case VIII, Fig. 64-69.



## SECTION II.—SERIAL ROENTGENOGRAPHIC EXAMINATION.

Serial radiographic examinations have proved to be of great value in studying the progress of all pathological lesions, but in no condition have they proved of greater advantage than in acute inflammatory conditions of the lungs.\*

Sante (152) first published the result of his study in lung abscess, in 1922 by serial Roentgenographic tracings in a number of cases. His cases indicated the following etiological factors:

- (1) Post-operatively, especially following operations on the upper respiratory tract.
- (2) After the aspiration of infected material.
- (3) After exposure to "cold."
- (4) Following influence (not the epidemic type).
- (5) Idiopathic, without apparent cause.
- (6) As a sequel in lobar pneumonia.
- (7) In septicemia from septic thrombi or following septic pneumonia.
- (8) As a result of broncho-pneumonia.
- (9) From lymphatic extension or regional drainage.
- (10) From direct introduction of infected material into the interstitial tissue of the lung as a result of destruction of the esophageal wall by carcinoma.

To obtain radiography at the inception of the disease is difficult, for most patients come after the condition is well established. Sante had opportunity to study a case six days after a tonsil operation under ether anaesthesia, attention was directed to the chest, and radiographic examination made at that time disclosed a consolidation confined to the hilum region. Subsequent radiograms taken at daily interval revealed the rapid increase in the size of the consolidated area and indicated its progression toward the periphery. Shortly after the onset a rarefied area was seen in the midst of the consolidation, establishing diagnosis of abscess formation. Such a rarefied area may be seen at a single examination and not be detected on subsequent plates. It may be seen regardless of whether the abscess cavity has ruptured into a bronchus or not. In this instance, it could be detected before rupture had occurred. When about one week later rupture of the abscess and evacuation of the pus through a bronchus did occur, the inflammatory consolidation subsided rapidly. The process did not go on to spontaneous healing, however, and considerable evidence of a persistence of the lesion was left on the radiogram. Subsequent exacerbations left the entire lower portion of the lung filled with multiple abscess cavities.

\* Illustration—Case XXXI, Fig. 200-211.

## SECTION III.—LOCATION IN RELATION TO THE PATHOGENESIS.

From the similarity of the radiographic findings in these cases and the widely varying character of the operative procedure, it seems most probable that the only common factor involved in all of the cases (namely ether anaesthesia) must be in some way responsible for, or concerned in the production of the condition. It is possible that the condition might be due to aspiration of foreign material while under an anaesthesia and the radiographic findings would seem to point to an invasion of the lung by way of the air passages. A brief review of all of the groups here represented will disclose a striking similarity. That they all represent invasion of the lung by way of the bronchi seems quite evident from the radiological evidence. All start as a hilus consolidation, and progress peripherally and without distinction to lobar involvement, often showing a rarefied area of tissue destruction early in the disease. At this stage rupture of the abscess and evacuation of the pus into the bronchus may occur or rupture may occur into the pleural cavity and empyema result.

Some radiologists or clinicians hold an opinion that usual upper lobe involvement of the lung abscess after the operation in the upper respiratory tract is to be looked upon as an evidence that the lung abscess was due to inspiratory origin, is a hasty statement. The usual accompanying pneumonitis extends periphery and abscess is formed somewhere in the pneumonic area, this may take place very close to the costal wall or it may be located in the lower lobe. The more important evidence that speaks more favorably for the aspiratory nature of the abscess lies in the fact that in the latter case, if serially studied from the beginning, will start from the hilum. It therefore occurs frequently that after the lesion has well advanced in course, the cavity may be located in the lower lobe. Mere presence of abscesses in the lower lung field following operation in the upper air tract does not tell the tale that aspiration was chiefly involving factor. The starting point of such an abscess might have been well high up, near the hilum, as shown in our cases, No. I, II, III, V, VIII, IX. (Fig. 1-8; Fig. 9-24; Fig. 25-36; Fig. 41-43; Fig. 64-69; Fig. 70-75).

Sante studied seven cases of lung abscess which followed pneumonia, and six cases which followed broncho-pneumonia. Their Roentgenograms are characteristic. In pneumonia, the consolidated area persists at least in its central portion and later an abscess cavity appears in the midst. In broncho-pneumonia the small peribronchial infiltrations become necrotic and form small abscesses. These coalesce and form larger abscesses in the mid portion of the lung.

Two of Sante's cases which were considered to be of hematogenous origin, occurred during septicemia, which followed abortion. Curettage was performed in one case, but neither was a general anaesthetic administered. He states that while neither of these cases came under observation at an early enough date to permit an accurate

statement as to the definite course of the disease, it can be said that in a general way these abscesses start as a haze, overlying the entire lower portion of the lung, much the same as septic pneumonia. This type of disease forms and Roentgenograms are shown in cases VI, XII, and XIV (Fig. 44-49, Fig. 84-91; Fig. 98-101).

Abscess of the lymphatoid tissue in the hilar region may result from the drainage of a septic process, even though the original process itself may not result in suppuration. Such a condition is seen where abscesses of the lung follow infected conditions in the esophagus, as infected carcinomatous ulcer. Or suppuration of a hilus lymph node follows a pneumonic process in the lung; the hilus abscess remains long after the primary pneumonic consolidation which caused it, had resolved. Such an instance was also given by Sante.

The other type of lung abscess which Sante discussed was that which was caused by direct extension of infectious material into the interstitial tissue of the lung, due to rupture of the esophagus by malignance, foreign body or other causes. In the case illustrating this group there was complete destruction of the esophagus by carcinoma, and a discharge of infected food material occurred directly into the interstitial tissue of the lung and formed a large abscess. In our series case No. X may be again quoted here as an illustration of this type, in which the cellular tissue around the neck was first involved. Through the pleura, both parietal and visceral, the abscess advanced downward through the interstitial tissue of the lung, until a large dissecting abscess was formed in the mid portion of the lung.

In Sante's forty-five cases, with the exception of the three upper lobe cases, two broncho-pneumonia cases, one post-operative case and one aspiratory case, all of these patients had involvement of the lower right lung.

Moore (96) stated that in his series of lung abscesses following operation in upper respiratory tract, the abscess was located in 60% in either the right or left lower lobe, right lower in 41%, and left lower in 19%; and such a statement can not be taken as an evidence whether abscesses were due to aspiration or blood stream infection, because of the well founded reasons and fact already dwelt on at length.

A too hasty conclusion is again made by Bigelow (99) who said that the last named (direct inhalation) is more usual route is indicated by the fact that the majority of these abscesses occur in the lower lobe of the right lung, the right bronchus leading almost directly downward from the trachea. A conclusion made from a single anatomical phantasm, without definite physiological testimony, ends in a fallacy of vision. As it has been already intimated in the section of etiology, page 22, other physio-anatomical facts and the physical theories must be consulted; in the case of a solid foreign body only, Bigelow's conception may fit.

The most important mechanisms concerned in the lung infection are; cough reflex, compression of lung, ciliary action, inflammation of the bronchi.

**COUGH REFLEX.** The cough reflex is the "watch dog" of the lungs (Jackson). If infective material passes the first line bechic defense, the cough reflex still is active in trying to get rid of the intruder.

**COMPRESSION OF LUNG.** To some extent, compression of the lung during cough may force up secretions from the periphery of the lung; but probably the great burden of upward sweep of this region is borne by the cilia.

**CILIARY ACTION.** If the infective material or any part of it gets deeper in the lung, the cilia responds promptly and powerfully to the "call to the colors" by sweeping the infective material and inflammatory products upward. The chief opposition to normal ciliary action is gravity. The ciliary action with the aid instead of the hindrance of gravity may drain the lung without any cough whatever.

**GERMICIDAL ACTION OF THE NORMAL LUNG.** If the first two lines of defense, the cough reflex and the cilia, fail to repel or expel the infective material, the third line of defense become active to annihilate the invader. The question as to what constitutes this annihilating mechanism and how it acts are not yet conclusively determined, but they have been studied experimentally, and that germicidal action is powerful factor in preventing lung suppuration is undoubted.

The chief pathological hindrance to ciliary action is inflammatory damage in the form of a mechanical impediment to ciliary movement, of obstructive granulations, of destruction of the cilia themselves over the involved area. Granulations have no cilia; scars have a few.

The expelling action of cough, compression of lung tissue and of cilia keep the infective material near hilum and bronchi leading to deeper or peripheral portion of the lung. Damage to the cilia and inflammatory reaction in the wall of bronchi hinder further drainage; and then stagnation, saprophytic activity and irritation in turn, resulting in increased irritation and vicious circle. Thus the infection and destruction is carried further peripherally to the least resistance of the lung tissue.

Through studies of pathological physiology and serial Roentgenological investigations, it has been made clear that localization of the lesion has great significance in the determination of the pathogenesis; and logical statement regarding the localization can only be made by the study of a given lesion at its inception under Roentgenography and physical methods.

In conclusion of this chapter the following case from the writer's series is given as a demonstration.

This case, following tonsillectomy, had cough, expectoration, difficult breathing, septic fever and sweating for the duration of five weeks. The physical signs were negative; the X-ray showed either infarct, pulmonary tbc. or consolidation. The usual characteristic of the films were cloudiness in the lower left lung and at root. Ten days after admission, he was operated on and lobectomy was performed. The

operative findings were abscess on the left lower lobe, very large, connected with root with consolidation; but base was not involved. Patient died soon after the operation.

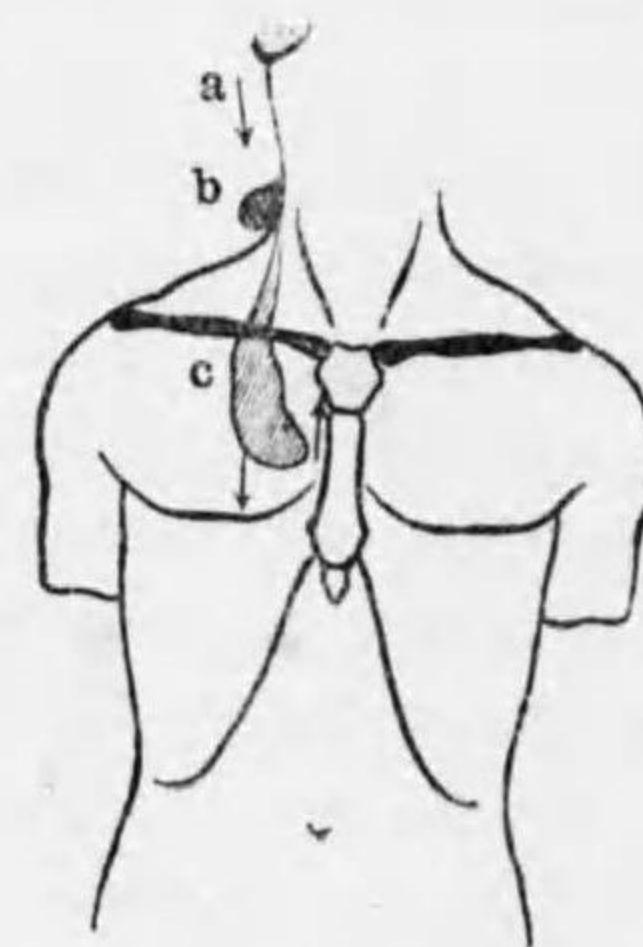
Post Mortem showed pleurisy with much thickened pleura on the left chest; the remainder of the lung was unaffected; no embolism was found.

In the above case, signs were obtained in left lower lobe legion and X-ray plates showed density covering lower 1/3 or 1/2 of the lung field, due to thickened pleura and the exudate which are very common complications of lung abscess in its later stage, while the possible initial destructive lesion was located at root region and no other lesion or metastasis was demonstrated at autopsy.

In summary, the cases of the present series showed generally four types in infectious invasion; direct extension from neighboring tissue, aspiration, extension from abdominal viscera, post-pneumonic or metastatic as indicated in the following diagram.

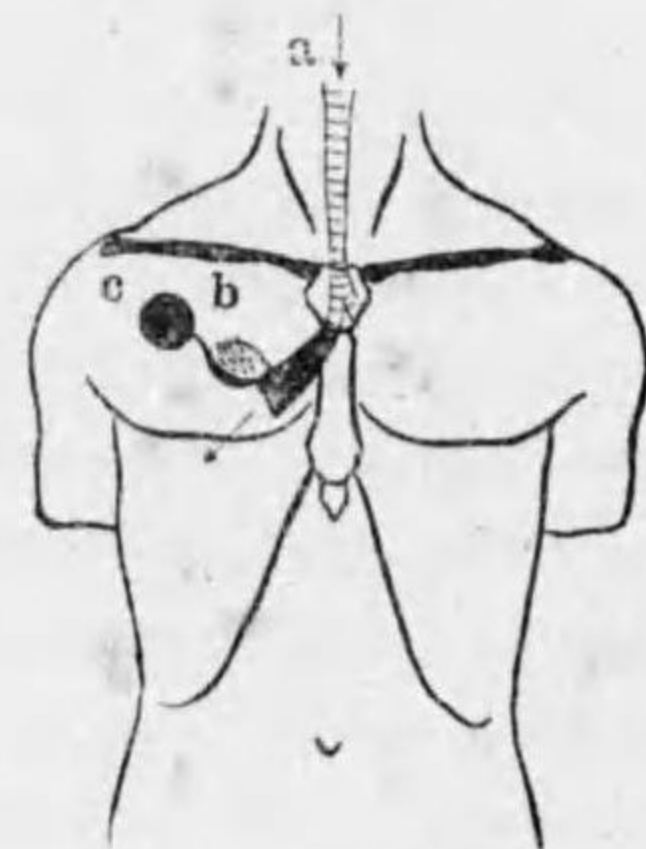
- (A) Indicating the lung tissue being invaded from outside.
- (B) Shows consecutive destruction of lung tissue from bronchus.
- (C) Invasion of the lung tissue by direct extension from abdominal viscera.
- (D) Secondary to pneumonitis or infarct.

ILLUSTRATING METHODS OF INFECTING LUNG TISSUE.



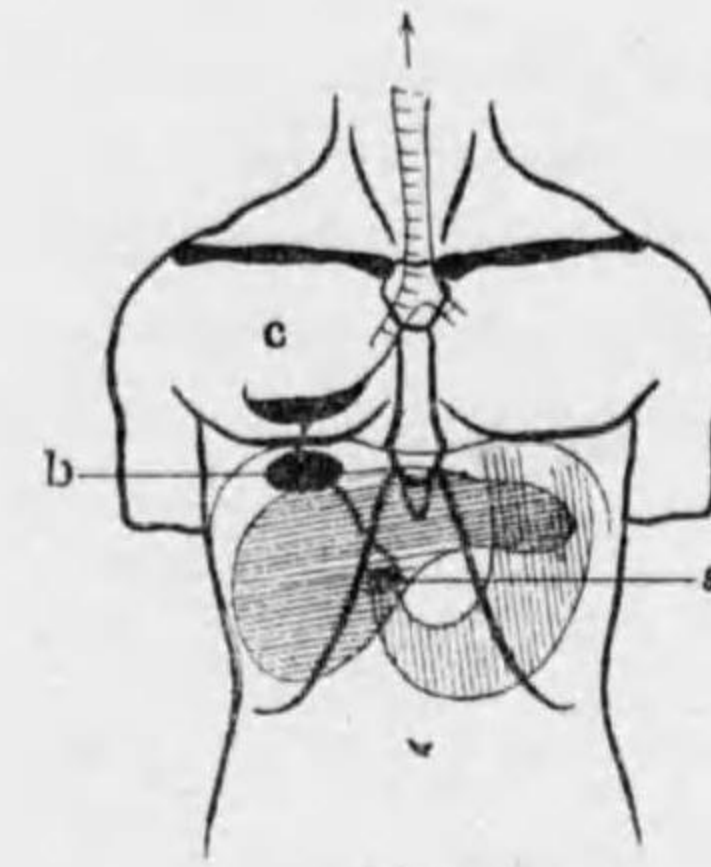
(A)

- Infection from skin lesion:
- (a) Mastoiditis.
  - (b) Cervical cellulitis.
  - (c) Lung suppuration may extend in direction of the arrows.



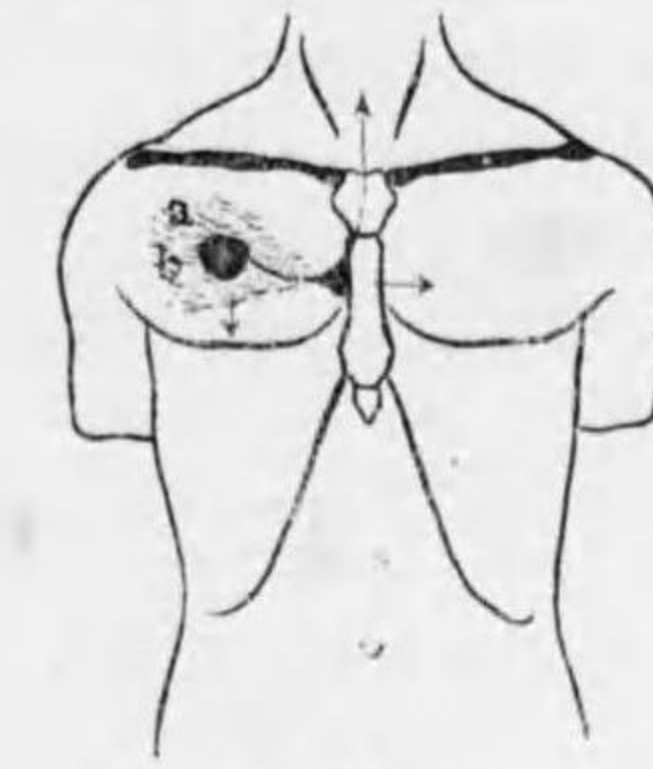
(B)

- Infection through aspiration:
- (a) General anaesthesia.
  - (b) Abscess at hilum.
  - (c) Migration of the abscess to the periphery.



(C)

- Infection from abdominal organs:
- (a) Perforating gastric ulcer.
  - (b) Infection through subphrenic space.
  - (c) Abscess at base of lung.



(D)

- Secondary to primary inflammation or metastatic infection:
- (a) Pneumonitis.
  - (b) Central suppuration.

CHAPTER X.—COMPLICATIONS.

The presence of lung abscess exposes the patient constantly to threatening and serious complications, such as acute spontaneous pneumo-thorax, emphysema, acute haemorrhage, septicemia and pyemia, or even remote danger such as brain abscess. Bassoe (153) reported a case of a man who had tonsillectomy, developed lung abscess and died a year later of brain abscess. Necropsy revealed several small empty abscess cavities in the lower lobe of the right lung and acute abscess in right temporo-frontal lobe of brain. Our case XXXV, who had idiopathic lung abscess developed multiple bronchiectasis and chronic indurative pneumonitis in the later stage, for which lobectomy was performed followed by apparent cure; but finally died of intra-cranial complication almost two years after the onset of the disease. In this case, at no stage was positive bacterial culture obtained from the blood stream. Among so many complications, those of Roentgenological interest only will be discussed here. The most common complication of lung abscess is involved with the pleura, serous or purulent effusion with adhesions, the latter being more common.

SECTION I.—PLEURISY EFFUSION.

Without the direct contamination of the pleural cavity by perforation of the lung abscess or by metastatic infection secondary to the abscess, the presence of subpleural lung abscess may invite a nonpurulent effusion which may become purulent in later stage. Many cases were found thus complicated in the early stage. Case XXIX, XVII. Figures 133-138, 191-197.

The Roentgenologic diagnosis of serous fluid is usually characteristic. Sometimes it is possible to observe on the Roentgenplate a pre-effusion engorgement of pleural vessels, which is soon followed by obliteration of costophrenic angle. Figures 250 -a, -b.

#### SECTION II.—SUPPURATIVE PLEURISY OF EMPYEMA.

Irritation from the neighboring tissue will produce reactive inflammation of the pleura resulting first in serous exudate as stated above. This serous exudate usually soon become purulent, or such exudate may be fibrino-purulent from the beginning. On the other hand, a pulmonary abscess may perforate the visceral layer of the pleura and thus empyema results. Stewart (80) described one such case. In one of the Sante's series (152), following lobar pneumonia, the patient developed an abscess in the centre of the pneumonic area, which slowly advanced peripherally and finally ruptured into the pleural cavity developing empyema. Soon after the rupture there was complete resolution of the remaining inflammatory process.

In our series, case XVII, 6 days after tonsillectomy lung abscess developed at right root region. The patient was very sick at first, but two weeks later he recovered from all ill symptoms, and was seen playing around; the physical signs and X-ray shadows remained in interscapular region for sometime. At the end of three weeks there was subacute recurrence of the symptoms gradually falling into prostration, physical signs and radiography indicated suppurative pleurisy and thoracentesis obtained pus. After thoracotomy and drain, the patient made slow but uneventful recovery.

The interesting point in this instance is that, following probable rupture of the abscess into the pleural space, there was almost sudden disappearance of acute symptoms.

Although the pleural complications of lung abscess are usually of serious import and often add to be difficulties of operation, there are cases in which they appear to exert a favorable influence, on the outcome. Thus acute abscesses, especially those following influenza, the early rupture of a parenchymal focus with the resulting empyema has often led to prompt drainage of the suppurating lung and a rapid cure of the disease. Sudden empyema is known to occur from latent pulmonary abscess such as illustrated by Case XXXV. In case XXXIV Post Mortem showed a large chronic lung abscess and recent empyema at left base.

#### SECTION III.—ENCAPSULATED EMPYEMA.

Instead of frank empyema, lung abscess may cause encapsulation of the exudate more often.

If the abscess is situated near periphery, or the slow approach of an abscess toward the pleural surface of the lung, such as in the case II, as the result of a fibrinous

exudate it may permit the formation of adhesions at the circumference of the inflammatory area thus wall off the fluid if any arises.

Such adhesions may be formed between the parietal and visceral surfaces of the pleura before the abscess perforates, and also between under surface of the lung and the diaphragm, or at any point over the antero- or postero-lateral aspects of the lung. In like manner the exudate may extend slightly into one of the fissures dividing the lobes. In the latter instance the exudate and walling off adhesions constitute interlobar encysted pus pocket.

When the abscess finally ruptures, establishing communication between bronchi and one of those pus pockets, the resulting pyo-pneumo-thorax may be entirely encapsulated and a unique Roentgen picture may be produced, such as Fig. 84-89.

Sometimes more than one localized small encysted pyo-pneumo-thorax are produced presenting still a more remarkable picture, such as mentioned by Borgherini-Scarbellen (154). The reader is referred to their descriptions on page 117 and the illustrations, Fig. 224-226.

It is said that in many instances what is believed to be a pulmonary abscess is in reality an encapsulated empyema which has ruptured into a bronchus—Norris and Landis, Diseases of Chest, page 554.

On the other hand, the lung abscess often perforates through the visceral layer of the pleura forming empyema and masking original lung abscess, or empyema may be the cause of lung abscess as it has been intimated in the section of Etiology, page 13. Pilot (116) cited a case of Fuso-Spirilen empyema secondary to lung abscess caused by the same organism, in which he successfully used neo-arsphenamin treatment. It is not amiss to point out here that there is a possibility of infecting serous exudate to convert into suppurative pleurisy by careless exploratory thoracentesis, or such needle accidentally entering the lung tissue, may be a cause of lung abscess, besides initiating other dangerous complications. The use of such a device as endothermic camila may remove some of those possible dangers.

There is another possibility (and there are not a few instances in literature) that lung abscess may be complicated by simultaneous occurrence of serous fluid effusion and encysted empyema, for the reasons already stated. Fig. 251, 252.

The Roentgenologic diagnosis of encapsulated empyema is sometimes a difficult task; it is often mistaken for lung abscess or vice versa; this matter is considered again in the section of Roentgenological differential diagnosis.

#### SECTION IV.—COMMUNICATION BETWEEN THE PLEURAL CAVITY AND A BRONCHUS.

A characteristic symptom which may arise when there is a free communication between the pleural cavity and a bronchus consists in a paroxysm of coughing and

the expectoration of a large amount of purulent sputum, when the patient changes his position, although this may take place in large lung abscess also.

If the opening of the pleuro-pulmonary fistula is situated above the level of the fluid, the latter will flow upward and be discharged through the fistula when the patient assumes the recumbent position. It may thus be possible to localize accurately the fistula by noting on the fluoroscopic screen at what position of the fluid level the patient begins to cough and expectorate pus.

If the opening between the pleural cavity and lung or bronchus is partially closed by a flap of tissue, the latter acts as a valve and acute pneumo-thorax and emphysema arise rapidly endangering the patient's life. Case X, XVIII.

#### SECTION V.—INTERSTITIAL EMPHYSEMA OF THE LUNG.

Interstitial emphysema of the lung rapidly develops into mediastinal emphysema. From the mediastinum air may find its way along the sheath of veins to the face, trunk and arms. From the mediastinum air may also travel to the back by azygos veins and to the lower extremities along the femorals. This subcutaneous edema is clinically important in that the escape of air from the mediastinum relieves tension there, and at times gives great relief to the patient.

The underlying mediastinal emphysema is a serious condition, in that it obstructs the return of blood to the right heart and produces a profound venous stasis. Torry (155) noted that this was apparently the direct cause of death in many cases of influenza pneumonia.

Interstitial emphysema of the lung has been well demonstrated by the Roentgenologists. Emphysema of the mediastinum in the course of influenza broncho-pneumonia can be demonstrated by symptoms and physical signs, and in cases of mediastinal emphysema the development of subcutaneous tissue emphysema can in some cases be foretold by characteristic pain and tenderness above the clavicles before the air becomes apparent in the tissue.

X-ray shadow in mediastinal emphysema. There is a peculiar contour of the lung root shadows. The root shadows are dense. Ordinarily the root shadows lie close to the heart shadow and extend downward and outward in a comparatively straight line. With mediastinal emphysema it is noticed that the shadows stand away from the heart and are strongly curved, with the convexity outward.

Some of the unexpected failures that were observed in artificial pneumo-thorax treatment may be attributable to the mediastinal emphysema obstructing the circulation, especially in case XXV.

#### SECTION VI.—EMPHYSEMA OF FOREIGN BODY ORIGIN.

Whenever the bronchus is obstructed by foreign body, or secondary inflammatory

product due to aspiration of infective substance, there follows obstructive emphysema which casts a characteristic Roentgenologic image. Jackson (47) states that in cases of peanut kernel and similar radio-transparent foreign bodies, the ray signs of obstructive emphysema discovered by Iglauer and developed and applied by Manges with a high degree of skill are absolutely diagnostic.

Wessler and Jaches state (Clinical Roentgenology of Disease of Chest, page 253) "We must especially keep in mind the possibility of latent suppuration of the lung in the case of children who, with no adequate antecedent disease, develop encapsulated effusions. As the basis of the suppuration there may exist a foreign body which has been aspirated into a bronchus, of which everyone, including the patient, may be ignorant. The cough, lasting for many months may be attributed to a bronchitis until the rupture of a bronchiectatic abscess and the resulting empyema lead to a closer scrutiny of the case and the discovery of the underlying infection of the lung."

#### SECTION VII.—BRONCHIECTASIS.

When drainage is insufficient, the suppurating process and nature's attempt to bar off by fibrosis go hand in hand; fibrous traveculi are found in and around the cavity, whose subsequent contraction resulting in multiple small abscesses, bronchi are much dilated and walls are thickened with here and there constrictions of the lumen, constituting well known conditions of bronchiectatic cavities which persist permanently unless surgical interference be made. The Roentgenological findings are characteristic. Our case XVI, XXXV illustrate this condition. (Fig. 121-127, Fig. 245-248. Centrally located lesion may even be missed in operation, such as the case illustrated in Case XXXIII in which later thoracentesis revealed pus.

#### SECTION VIII.—ADHESION OF PLEURA.

It is not necessary for the production of pleural adhesion to have direct intrapleural infection, but presence of lung abscess produces inflammatory reaction of the pleura. Adhesion of pleura is very common complication in almost any disease of the lung.

(a) Pleural adhesions often cast circular shadows, which are not different from those of certain cavitations, and accordingly the differentiation may be very hard, the subject will be discussed later in the chapter of Differential Diagnosis.

(b) It sometimes produces a unique Roentgenologic picture in which numerous cord-like strands of fibrous tissue stretch from the lung to the diaphragm and which the writer proposes to call "Raffian tree adhesions" (Fig. 59-63), or "Curling paper" evidenced by a.p.t., (Fig. 54-57).

(c) Thickening of interlobar pleura produces a distinct horizontal streak, such as evident in a number of our cases.

## SECTION IX.—DISPLACEMENT OF INTRATHORACIC ORGANS.

Displacement of intrathoracic organs is just as common as that of pleural adhesions. Contraction of productive fibrous adhesions and atelectasis of the lung produce displacement of mediastinal structures to the affected side, and often displaced trachea and main bronchus are visible (Fig. 200-201, Fig. 247-248), or sometimes the displacement may cause quite deceptive X-ray shadow, misinterpretation of which may result in disaster. Case XXVI, Fig. 180-181. Atelectasis of lung by obstructed bronchus casts homogeneous dense shadow not unlike that of early stage of lobar pneumonia. Case XXIV, Fig. 177. Again shadow due to displaced mediastinum may be mistaken for indurated lymphoid tissue as in case XXX, Fig. 198, 199. Case XIX, Fig. 148, shows thickened hilum, much displaced to the affected side.

## SECTION X.—ABSCESS OF LUNG PENETRATING THE DIAPHRAGM.

More (156) reported such a case in a girl who had been suffering for five weeks from a disease which had been considered to be pneumonia. On the left side there was a lessening of the chest expansion, dullness over the lower lobe, but no displacement of the heart. The vocal fremitus was feeble as it would be in a girl of her age.

There was no edema nor effacement of the intercostal spaces. The cough was insistent, and the sputum was mixed nummular and mucoid. The temperature at first was 101.6 F, the Widal test negative. No fluid was evacuated on tapping. The patient kept losing flesh, the temperature rose to 102 F, and the limbs became anasarcaous. There was pain in the right thigh due to phlegmona alba dolens in the inferior vena cava. The abdomen was slightly distended, and a small amount of clear fluid escaped on opening the peritoneal cavity. The liver was much enlarged. The cardiac end of the stomach, the spleen, and the upper pole of the left kidney were united by adhesions. This mass adhered to the diaphragm. Between the adhesions creamy pus was gathered. An incision was made through the diaphragm, and the left lung found adherent. Pus was evacuated from the liver, which contained streptococci. The right lung was normal. An abscess had formed in the base of the left lung, which had perforated the diaphragm, and then a hypophrenic abscess was formed.

## CHAPTER XI.—HEALING OF THE ABSCESS.

Roentgenogram furnishes us excellent information regarding the progress of the disease to its termination. Many lung abscesses heal spontaneously and in some indeed such healing takes place with great rapidity.

Wessler and Jaches (46) state that spontaneous cure results in approximately one third of the cases of acute abscess and gangrene, practically always within three months of their onset, according to their experience, although such statement may not be accepted in general way.

The Roentgenographic character in such curing of abscess consists of (1) gradual disappearance of inflammatory shadow, (2) more or less production of fibrous tissue and (3) later complete disappearance of all these shadows except some increased normal lung markings. These Roentgenographic tracings are best observed from time to time by serial Roentgenologic examination.

For example: Case I Fig. 1-8 Case X Fig. 76, 77  
Case IX Fig. 70-75

Radiography in later convalescent stage may fail to demonstrate any "Tell-tale" of the pre-existing grave lung condition, as illustrated by case XIII, Fig. 96, 97; case XIX, Fig. 149, 150.

## CHAPTER XII.—ROENTGENOGRAPHIC PROGNOSIS OF LUNG ABSCESS.

The Prognostic value of Roentgenogram of lung abscess, naturally depends on its portrayal; accuracy of the pathological condition.

An attempt to prognosticate a patient's outlook by merely looking at a single plate is too hazardous. There are many factors concerned in making this task difficult; all pathological processes involved in all planes are condensed into a single plane of X-ray plate, while in lung abscess there are numerous accompanying complexes, as mentioned in the previous chapter.

A true prognostic value of Roentgenology seems to lie in its ability to suggest a particular line of treatment and to depict how the lesion is evolving under such treatment. The Prognostic value of Roentgenology in the Diseases of Chest will be increased if a large number of Roentgenograms are studied collaborated by Poly-roentgenography, Fluoroscopy and well founded clinical informations.

Disregarding the question of whatever treatments were applied to these cases, the mortality rate of each group of the series was found as follows:

	Total	Cure	Improved	Unimp.	Died.
Group I	20	4 (20%)	6 (30%)	1 (5%)	9 (45%)
Group II	15	6 (40%)	3 (20%)	2 (13.3%)	4 (26.7%)
Group III	28	7 (24.1%)	10 (35%)	—	11 (40%)
Group IV	37	2 (5.45%)	4 (10.9%)	4 (10.9%)	27 (72.75%)

Mortality is highest in Group IV and also the cure was lowest in the same group. This included those cases with multiple metastatic abscesses and, almost in all cases they were complicated with pleural disease, and in some with Diabetes, Endocarditis or suppurative abdominal diseases.

With a single large cavity the prognosis is considered to be best if early surgical interference is instituted. In this series, however, the cure of Group I was less than that of Group II or III, and the mortality was above that of III. This is partially explained by the fact that Group I includes cases following Epidemic Influenza and Pneumonia plus timely surgery were not more often instituted.

The interest lies chiefly in Group III cases in which the shadow represented more fibro-indurative type and the destruction of tissue was not quite rapid, localized near hilar region directly communicated with bronchi, with better chance for drainage.

The impression obtained in the study of this series can be roughly stated as:

(1) In the cases with shadows limited in mid third of the lung field near the hilum the prognosis is good.

Unless there is rapid improvement of clinical symptoms and serial Roentgenologic evidence of improvement, bronchoscopic investigation and treatment must be resorted to.

(2) In the cases with mottled appearance occupying large area, the prognosis is bad, especially when complicated with marked pleural lesions.

(3) Even in a longstanding case, if the lesion is confined deep in the lung tissue with productive inflammation, the surgical interference is not to be encouraged, especially when there are periods of improvement from time to time. Bronchial drainage may be used with great advantage.

Even with small limited lesion, if streptococcus haemolyticus is obtained in the pus, prognosis is obscure, and surgery should be most cautiously considered.

(5) Large rapidly forming cavity, especially if peripherally situated, there is often surgical success.

(6) Limited lesions in the lung tissue with involving empyema should invite early but simple thoracotomy and drain, the result is often marvellous.

(7) Certain cases are successfully treated by a.p.t. if started early cautiously and combined with bronchoscopic drain if necessary.

(8) Surgery alone can help those delayed cases having numerous fibrous septa, adhesions and bronchiectasis; but mortality is the highest in these cases.

### CHAPTER XIII.—X-RAY RELATION TO SURGERY.

The efficient service of X-ray in lung abscess is perhaps demonstrated in its relation to the surgery. The outlook of surgical success in the lung abscess is still disheartening, although there is some encouragement in the recent report made by Hedblom (157), noted thoracic surgeon, on his 48 operated cases during the last five years, with the resulting mortality of 19.6%.

The average result based on reports from various operators, Tuffier (158), Heidenhain (159), Willy Meyer (160), Robinson (161), Lilienthal (163) and Graham (162), totaling 138 cases, is, however, found to be as high as 52%.

Lord (164) states that theoretic mortality in unoperated cases is 74%, and that of the cases which do not terminate fatally, 18%, continue to cough and expectorate and are constantly subjected to the danger of local or general septic complications with their menace of life. He declared that he never saw a patient with a history of nine months duration completely recover from abscess spontaneously.

Whittemore (40) places medical cure in 10—30%, and surgical in 60—90%, artificial pneumo-thorax in small number.

Detailed analysis of Heuer and MacGready's (49) 62 cases are of interest. These were grouped into four groups; gp. (1) 31 which followed pneumonia; gp. (2) 16 post-operative; gp. (3) 7 cases following acute abdominal infection; gp. (4) 8 miscellaneous. Out of 31 cases of first group, four died and 27 were treated by simple drainage. Of these 27 cases, 22 were treated by simple drainage, exploratory thoracotomy plus a.p.t. in 1, simple drainage operation and later lobectomy in 1, postural treatment by Garvin's method in 3, with resulting mortality of 22.2% (or six cases). Out of 21 recovered, 10 were confirmed well, 1—10 years after operation, 2 actively working but still had some cough and expectoration, in 9 late results were not known.

Out of 16 post-operative cases, 5 died; out of remaining 11 cases, simple drainage cases in 6, exploratory thoracotomy, followed by a.p.t. in 4; no operation in one, with the result of 3 deaths among operated cases and 8 patients left hospital alive. Of these 8 cases, one which was treated by a.p.t. was found to be entirely well seven years later, 3 were in good health two or more years after operation, but still had cough and slight expectoration, and the rest were not traced.

Out of 7 cases which followed abdominal operation, 2 died and 5 had drainage operation, of which one died, two were traced entirely well two or more years after, and remaining two were not traced. Out of 8 miscellaneous cases, 3 died, drainage operation in 4 with 100% death.

Lord's (164) 100 cases indicated as follows: 38 not operated, 24 died, mortality

63%, spontaneous cure, 7, unimproved 7; 62 operated, 35 died or 56%, inevitable failure 29, or 46%, surgical failure 9, complete success 10, incomplete success 14. Lord assumes, deducting for inevitable fatality, that the complete or partial success may be placed at about 38%.

Lord concludes: "The expectancy of life for patient with pulmonary abscess has never been accurately determined. It can not be estimated from a series of cases in the preoperative period, because of inadequate exclusion of tuberculosis, failure, to establish the presence of a destructive lesion by finding elastic tissue in the sputum, and the abscess of X-ray examinations. An estimate of theoretical mortality from his group of 100 cases is only approximately accurate. Excluding from consideration the two cases fatal from pulmonary tuberculosis and one dying from accident, 97 are left for consideration. The mortality without operation may then be estimated by the sum of 24 deaths in the unoperated and 32 in the operated series, plus the 16 which would probably have ended fatally without operation in the operated group, or 72 deaths in 97 cases—a mortality of at least 74%. Even this is probably a too favorable showing since in the estimate the nine cases not traced after discharge are counted, it may be erroneously as living. Of the remaining 25 patients, 18 had persistent symptoms at the time of discharge, and of these 9 cannot be traced, but a continued disability is a probability if they are alive. A permanent and distressing damage may, therefore, be calculated for the 18, or 18% who escaped death for a longer or shorter period. The fortunate few who are left for consideration are the 7 or 7% who spontaneously recovered.

As for the influence of the previous duration on the chances of operative relief, Lord states, previous experience seemed to indicate an important difference between the acute and chronic cases with respect to the expectation of relief by operation. This seems in general true, and the acute cases are more favorable for operation. Of 10 complete cure by operation, 7 had a duration of 3 to 7 weeks, the remaining cases had a duration of 9 months to three years. A consideration of the duration alone is not enough to influence the judgement concerning the desirability of operation. Owing to the great likelihood of multiple lesions, hence greater chance of partial operative failure, more dense induration with the added risk of post-operative haemorrhage, and the septic complications likely to arise with the progress of time, it is highly desirable that an early decision be reached concerning operation." In properly selected cases, an early surgical interference should be successful; even in almost hopeless case simple surgery may often save the life as well illustrated by Case X.

#### SECTION I.—SPONTANEOUS CURE.

Spontaneous cure of lung abscess has been mentioned at various occasions, in Lord's series this occurred in 7%, but it may become much higher if all cases are collected.

Out of six cases of Langenskiold (124) there were 3 spontaneous cures; Branch (165) reported another such; Funk (166) reported a case which followed bronchopneumonia, and which was finally cured after spontaneous expectoration of large amount of pus on three occasions.

Pritchard (167) appreciates the value of rest favoring spontaneous cure in a number of his cases; Jacobs (168) successfully resorted to vaccine therapy: Strouse (169) even succeeded in a case of pulmonary abscess complicated by severe Diabetes Mellitus; Hildebrandt's case (170) is of some interest, so that it is quoted as follows:

The case was that of a girl, aged 18, previously robust, became ill; appeared to have advanced pulmonary tuberculosis, in many examinations, however, tubercular bacilli were never found. Expectoration pure pus, in large quantities and foul; was then thought of empyema. Exploratory punctures gave no results. X-ray showed a very large cavity to the left of the heart, half filled with fluid, level of the fluid changed with patient's position. The large cavity in the left lung could be readily emptied when the patient lay on her right side with her thorax bent downward. (There is one advantage of X-ray used as a guide to the palliative treatment). Postural treatment was used, the patient's hands resting on the foot of the bed, and a large sputum cup being fastened to the foot of the bed. In this position the patient coughed hard four—five times a day, holding the position until nothing more was coughed up. All this time she breathed turpentine from flannel saturated with it and fastened to the thorax. After two weeks there was no further sedimentation of the sputum, the general condition improved decidedly, in time the contraction of the left lung increased and in 2 years she had only a slight amount of sputum and in four years was completely cured.

#### SECTION II.—INDICATION FOR OPERATION.

While pulmonary abscess should always be regarded as a surgical affection, the chance of spontaneous and complete recovery, as in 7 instances of Lord's series and several cases as quoted above, must always be taken into account in selecting cases for operation. With rare exceptions spontaneous cure is not to be expected, however, in cases other than mild cases with a short previous duration.

While there should be some restraint against an immediate resort to operation in such cases, yet not only the permanent and distressing disability in the chronic cases, the danger of the development of induration about the abscess, multiplicity of pulmonary lesions, other local or general septic complications and the consequent diminishing chance of cure with the lapse of time and also the probability of the patient's becoming odious to his community and a social outcast, all these factors should influence the decision.



Not only the location, but the determination of the nature of the lesion is then of great importance in dealing with a case of lung abscess, and the surgical success primarily hangs on the ability and ingenious interpretation of both clinician and the Roentgenologist.

In general, mottled increase of density is not favorable for operative interference. Even dense, circumscribed shadows with or without central areas of diminished density or the appearance of fluid level, are more favorable.

In these cases, unless the Roentgenological improvement is evidenced after palliative means were applied for a reasonable period, should be considered as major surgical cases.\*

\* Miller and Lambert (237) summarizing on the treatment of lung abscess based on the 60 cases previously reported (105) and 40 cases of the present series, total of 100 cases, state to the following effects.

The occurrence of lung abscess is more common than is generally recognized. Mortality of collected case is 15-60%, a very serious condition.

The term of "system of management" is more adequate than that of "method of treatment in this particular disease.

Regarding the system of management: 1. Absolute rest in bed with postural drainage should be first instituted. The behavior of temperature, amount of and character of expectoration, periodic Roentgenologic examinations—those are the important guides for the management. Physical examinations of the chest are, of course, carried routinely, but they yield less valuable information than those other observations.

Postural drainage: Certain position of the patient is most effective; should persist in this treatment for at least 3 or 4 weeks before disregarding it.

Surgical operation: The operation is extremely dangerous and usually unsuccessful in the acute phases, that is, during the period when there was present about the softened central suppurating focus a more or less extensive zone of edematous soggy, infected lung in which the smaller bronchi were filled with pus and the alveoli were distended with sero-purulent exudate, while the wall of the alveoli were swollen and edematous. None of these cases was seen prior to rupture and establishment of communication with a bronchus. It was believed that incision of the abscess at this time fails to drain efficiently the entire infected area, and that, with a free opening established, the effectiveness of coughing in emptying these areas is greatly reduced. In many of their cases in which the abscesses were opened during this stage, there was a pronounced improvement for a few days, expectoration was diminished; the temperature became normal, and the patient apparently was marking a satisfactory recovery. But this period was followed by a wide extension of the pneumonic process, sometimes ushered in by chills and a fatal termination in from three to five days or a week. At necropsy, there was found a wide spread, massive involvement of the entire lung or both lungs, in which the bronchi were filled with pus and the alveoli either showed the changes of an acute pneumonia or were swollen, edematous and infiltrated with leukocytes. In some cases, there were multiple small abscesses widely disseminated throughout the lungs.

After postural drain, even if it does not effect a cure in itself, there is usually a definite improvement in the constitutional symptoms and a clearing of this secondary zone of infiltration about the abscess, which renders an operation much more liable to success.

Miller and Lambert's series shows following results:

TABLE 1.—RESULTS OF OPERATION.

No. of c/s.	No. of op.	% of op.	Cured.	Impr.	Died.	Op. mortality.
100	47	47	20	8	19	40

TABLE 2.—SUMMARIZED RESULTS OF TREATMENT.

No. of c/s.	Cured.	Impr.	Not impr.	Died.	% of mortality.	% of cure or impr.
100	44	24	8	24	24	68

In any operative cases tuberculosis must be adequately excluded.

Presence of empyema should be attended by simple thoracotomy in its early period, and the same is true in the case of pleuro-plummonary abscesses, which can be relieved only by surgery. The abscess situated in periphery and without sufficient communication established with the bronchi should be treated surgically. Chronic pulmonary abscess with well formed pyogenic membranes and rigid walls also requires surgery. A short previous duration, pure purulent and not foul sputum, without abundant elastic tissue, only mild symptoms of sepsis, and a small process justify delay and estimate of progress, both clinical and Roentgenological, during a short period of observation. Through fluoroscopic examination, if it is observed that a large cavity is made to empty itself by postural drain, as so happened in the case of Hildebrandt and Genlen (170), a tentative treatment by this method may be instituted. Unless recovery, or marked improvement occurs in such cases in 3 or 4 weeks, operation should be considered.

Stewart (171) thinks that in most cases of lung abscess in which there is a large amount of induration with a small amount of softening, especially if the lesion be located in the upper lobes, surgical attention is indicated.

Although multiple abscess is not contraindication, but in such cases surgical risk is greater, and there is small chance of noticeable benefit.

In cases in which there is mottled increase of density alone, abscesses if present, are likely to be small and multiple. Some of these cases with mottling density within which there could be seen some rarefied area, of even density, or areas presenting an appearance of "geographic mottling" turned out to be abscess cases. With such picture of increasing "geographic mottling," added to definite clinical symptoms, and especially when the lesion is peripherally situated, early surgery may be considered.

It is important to be familiar with this degree of even density sufficiently to warrant interference and to appreciate the significance of uneven mottling as a deterrent to operation, according to Stewart.

### SECTION III.—BRONCHOSCOPY IN LUNG ABSCESS OF FOREIGN BODY ORIGIN.

A lung abscess of foreign body origin will never cure so long as the causative body, whether solid or debris, of infective product, be removed and proper drainage be established, such an instance was well demonstrated by one case of the writer's series. This was in a man of 44. Six months previously, he choked on a small piece of veal bone, unable to get it up or down for two days. Since then he has been very dyspneic, especially on exertion, but not cyanotic. She had frequent attacks of cough, ever since the accident, bringing up yellow sputum but he had no fever or pain. He was bronchoscoped, but result was negative. Nine days before admission to hospital

had chill lasting several minutes, followed by fever and was admitted to the hospital on June 17, 1918.

The physical signs of the chest consisted of flatness, distant breath sounds, and vocal resonance below the angle of scapula on the right; otherwise practically negative.

Roentgenological findings were: density involving lower 2/3 of right lung field, due to fluid in pleural cavity.

Exploratory thoracentesis yielded small amount of turbid fluid which was sterile on culture. 6/20/18.

On June 23, 1918 tapped 75 cc. turbid liquid. On June 25 another tap yielded 50 cc. yellow fluid, more turbid than on previous occasion, and on culture—non-haemolytic streptococci.

X-ray at this time showed suspicious area in right lower lung near the root, and patient was started on a.p.t. treatment, but without any gain.

On June 8th, resection of rib was performed, which showed about ten ounces of foul pus in the pleural cavity. She was given simple drain. The discharge first profuse, but soon became very much less, and the wound nearly healed. Patient was sent home as "healed" on Aug. 29, 1918.

At home the patient continued to have bad cough and expectoration and some pain in right lower chest. The wound did not quite heal. Had no fever, gained in weight, but dyspneic on exertion. About the middle of March 1919, his symptoms became aggravated, cough was much more productive, foul smelling, increased pain on the chest, and she became feverish. Returned to hospital on March 24, 1919.

Physical findings indicated definite cavitation in the right upper medial region. The X-ray readings were as follows. Fluid in right lower chest, also small amount in left lower. (The density near the right hilar region was not mentioned) 3/27/19: Tap at 8th i.c.s. on posterior axillary line yielded small amount of thick whitish pus. Second tap two days later was negative; the needle seemed to enter a very solid mass, and the attempted artificial pneumo-thorax treatment was not possible. On April 7, 1919, she was operated on for lung abscess: Ribs resected out, pleura opened. Needling the lung in all directions failed to obtain pus. Pleura was adherent, this was freed by finger down to the diaphragm, and the lung was fully freed and collapsed sufficiently to form a cavity two fists size. Lung surface was apparently normal and did not suggest abscess or thickening to be flat in the lung, lung closed without drainage. After operation patient coughing and vomiting large amount of bright red blood. A large discharging sinus followed and the patient coughed out some of the irrigating fluid (Bakin's solution) indicating there was a connective fistula with the bronchi. X-ray showed pneumo-thorax with well collapsed lung. Developed subcutaneous emphysema, and continued to cough out much purulent material. Finally one day patient coughed out a piece of bone triangular in shape, 1 and 1/2 cm. at base and 3

cm. in height, which she claims to be the bone which she swallowed. Recovery from this point was rapid. Now she coughed little and the wound finally healed. 5 years later she was doing very well as far as her chest was concerned. She now has chronic arthritis of her right knee, which is being treated.

Every lung abscess case or patient with chronic tuberculoid symptoms should be X-rayed. It has been mentioned several times that foreign body may be lodged for many years without any knowledge by the patient. For further emphasis of this important subject, the following cases are quoted from Bowen (172).

Woman aged 38; eight years ago began to be troubled with cough; once a week would expectorate a mass of material the size of a pea, cheesy consistency, greenish-brown in color, and of foul odor. She was thoroughly examined in a western city, no evidence of tuberculosis was found. The sputum was examined. The patient led an outdoor life for next two years. It was then necessary to have a perineorrhaphy performed. The patient went to her home in an eastern city, where, in the course of general examination, an X-ray study of the chest was made, and a report given of an open safety pin in the right bronchial region. She was advised to "leave the pin alone as long as it leaves you alone." The cough gradually increased in severity and frequency, and masses, as above described, were expectorated more frequently. Later she had repeated haemorrhages, the amount varying from 6-16 ounces. Neither she nor her family had any knowledge of the circumstance of the aspiration of the foreign body.

Another case, male, aged 8. When two and one half years old while seated at the dinner table he suddenly spat up a mouthful of blood. An attack of "broncho-pneumonia" lasting one week followed. A severe cough productive of a purulent expectoration followed, and at irregular periods the child spat blood in amount varying from a mouthful to sputum which was merely blood streaked. For about two years, or until aged four and a half years, these symptoms continued increasing in severity, finally decreasing and haemoptysis ceasing. The cough, however continued, and there was purulent expectoration at intervals. There has never been a septic temperature; no night sweats, but the child failed to grow strong. Repeated examinations were made for tuberculosis. Reports upon the sputum were always negative. At about the middle of the eighth year, the father of the child, a physician, made an X-ray examination of the chest and discovered a foreign body in the lower right lung. Two bronchoscopic examinations under ether anaesthesia were made at an interval of about one week. In both there was failure to secure the foreign body and the patient was returned to his home.

Some four months after the last bronchoscopic examination, the patient was referred to Dr. Jackson. At this time the X-ray examination showed a metallic foreign body in the base of the right lung. In the fluoroscope the diaphragm shadow

was seen to rise so as to completely cover the foreign body and fall so as to completely clear it. The foreign body is slightly less than  $\frac{3}{4}$  inch in length and about  $\frac{1}{4}$  inch in diameter at its upper large and blunt extremity, from which it tapers to a rounded point.

A guess was made that it was the steel tip which fits in a tubular umbrella stem. There was strikingly little surrounding pathology to be seen—just a slight increase in density immediately around the foreign body. The body was removed by Dr. Jackson by oral bronchoscopy under fluoroscopic control. The recovery of the patient, as every one of these cases in which the foreign body was removed, was prompt and complete.

Every suspected case of intrabronchial blockade should be sent to a Bronchoscopist. Donaldson (173) has made it a routine to take in addition to the usual Roentgenograms, films that are carefully underexposed but fully developed. Such films present convincing evidence where there is only slight emphysema. Insufficient penetration shows the unaffected side without any detail whatever, while in the affected side, the increased air content of the lung allows the penetration used to give about the same detail that one would expect to find in a normal lung field. The alteration in technique intensifies the contrast which might otherwise escape.

The writer has been in the habit of making such underexposed films and this flat negative is then printed on highly sensitive contrast paper. By doing this even very weak contrast shadow may be brought out distinctly, showing the difference of hyper-aerated and less aerated lung fields.

Jackson states that in the case of lung abscesses of foreign body origin, in the hands of efficient bronchoscopist almost a hundred per cent cure can now be obtained (174). Even in chronic, progressive cases, marked improvement was obtained after bronchoscopic drainage was established—Lukens and others (45).

#### SECTION IV.—X-RAY AND BRONCHOSCOPY IN THORACIC SURGERY.

With the development of the science of bronchoscopy, the inter-relationship between Roentgenology, bronchoscopy and thoracic surgery became more important, and recently many interesting papers have been added to the literature, such as by Jackson (47), Yankauer (175), Gelber, Kully, Forbes, Moor and Funk (176), Clendening (177) and others.

Exact localization of the lesion is of great importance in determining first what method of treatment may be best applied, whether postural, artificial pneumo-thorax, bronchoscopy or surgical. In the latter method, especially, bronchoscopy and fluoroscopy when combined will be most efficient guide to the surgeon during his procedure.

Lynah (137) first demonstrated abscess cavities on the X-ray after direct injection of Bismuth paste into the bronchi. While the localization of the lesion in the middle lobe is difficult on the X-ray alone, this can be confirmed by bronchoscopy—North American Medical Clinic, Vol. 6, No. 4, Page 1018-1020.

Lynah found that sometimes it happens that the abscess is not found at this distal portion of the bronchus from which the pus comes out, but well around the corner.

Recently Sante and Lehman (187) by the employment of the Hirtz compass for localization in three cases of lung abscesses have been enabled on the operating table to enter the cavity of the abscess with the exploring needle at the first attempt.

Stewart (171) states that Bronchoscopic treatment should be commenced just as soon as the lesion is discovered, the establishment of drainage is an immediate indication even though the patients have acute general manifestation.

Except in cases where haemorrhages is a complication,—when instrumentation is contra-indicated,—pulmonary suppuration consisting of small or medium sized abscesses located in the lower portion of the upper lobe or in the mid or lower lobes, with a moderate amount of infiltration surrounding cavitation seem to respond best to Bronchoscopic treatment.

Multiple lung abscesses, or bronchiectatic cavities do not respond well to the bronchoscopic treatment, and if complicated by general or sacculated empyema bronchoscopic treatment is out of the field.

Surgical attention is indicated in most cases of lung abscesses in which there is a large amount of induration with a small amount of softening, especially if the lesion be located in the upper lobes.

Whether successful bronchoscopic drainage is established during the course of such treatment, the X-ray will demonstrate by the fact that the area involved was relatively less dense and the structures could be outlined showing better drainage and aëration.

Again, in the case where the lesion is situated near the hilum containing liquid but which could not be adequately emptied by postural way, a bronchoscopic treatment is highly recommended, because obstruction of the bronchus by debris of productive inflammation often prevents natural drain resulting in patient's suffering unnecessarily for a long period. For example Case XV, Fig. 103-110, Case XVI, Fig. 111-132.

According to Lukens and others (45) who state that as the result of their excellent success in treating lung abscess by bronchoscopy, surgical treatment, with its high mortality and uncertainty as to cure, should be considered only as a last resort.

Jackson (179) says: "Bronchoscopy in its modern developments bears much the same relation to thoracic surgery that cystoscopy bears to genito-urinary surgery.

As the surgeon relies on the Roentgen-ray and cystoscopy, separately, and combined

in pyelography, so does the thoracic surgeon rely on the Roentgen-ray and bronchoscopy, separately and combined in pneumography."

At Jackson's clinics introduction of bronchoscope for various purposes, has been done 5000 times, and never resulted in a death which was due merely to the introduction of the instrument.\*

Death of cilia, granulations hindrance to bronchial drain is the cause of prolonged course in lung suppuration. Here the bronchoscopy comes to rescue to clear the passage and supplement defective ciliary action."

### CHAPTER XIII.—ARTIFICIAL-PNEUMO-THORAX AND X-RAY

It was about 100 years ago when Carson, a noted physiologist, through his clinical observation that pulmonary tuberculosis often improved after accidental spontaneous pneumo-thorax, suggested that pneumo-thorax artificially produced could be applied to the diseased lung. Some years later Forlanini utilized this suggestion in active trial and later J. B. Murphy introduced the work into America, and since then the work has gradually grown in favor until it is now in use in most of the institutions, not only for treating tuberculosis but for other pyogenic infection of the lung.

Both successful and unsuccessful uses of artificial pneumo-thorax treatment in the lung abscess have been mentioned by many writers.

Recent literature on this subject includes those beginning in 1914, Leuret and Aubert (180)—(182), Lemann (183), Richardson (184), Goldberg and Biesenthol (186), Genevrier and Roby (187), Singer (188), Giese (189), Harrel (190).

Harrel (190) reported his success even in metastatic case with multiple small abscesses. Out of Rich's (191) ten cases, two recovered spontaneously, 8 were treated by a.p.t. and of these eight cases, two died and the others showed prompt improvement indicating 75% success.

Among all Denechau (192), Mazza (193) and Dumarest (194) are perhaps most enthusiastic about the subject and they have published a greater number of cases treated by this method than any others.

\* Miller and Lamber (237) state that first they doubted the general applicability of the bronchoscope in the treatment of lung abscess, impressed by the fact that some fatalities occurred and that very frequently it was a most distressing ordeal for the patient; but they are now more confident in its use, and believe that the possible dangers and discomfort of this method are eliminated only if it is in the hands of very skillful operator of large experience and mature judgement.

Tewkesbury (150) reported on 35 cases. Out of ten which were not treated, six died, three recovered and one and twenty out of 25 treated by a.p.t. were cured, almost as a good result as that of Rich. Dumarest states that even in pulmonary gangrene if unilateral, the treatment of choice is a.p.t. which should be employed as early as possible; if the lesions are not ulcerating or very diffuse, and no dense adhesions are present, this method of treatment is usually entirely successful.

Denechau (195) reported successful cases treated by a.p.t. and he considers compression of necrotic areas of lung to be a priori a rational method of treatment, indicated, however, only in unilateral disease, provided an abscess opening into the bronchi has already formed and no lesions are present outside the lung. The multiplicity of foci of infection in the same lung is not an absolute contraindication even if they are at different stages of evolution, but in those he considers the danger of a.p.t. introducing haemorrhage and spontaneous emphysema. He says that suppurative pleurisy constitutes the most serious complications of this method, which is contraindicated when a sub-pleural focus of infection is suspected. The most serious complications of the operation are the puncture of an infected area of the lung and the rupture of a septic focus or adhesions into the pleural cavity. Operation must be done with great care and under repeated radioscopic examination. Denechau's reports consist of three cases of pulmonary gangrene treated by a.p.t. with combined administration of anti-gangrenous serum. The technique of the pneumo-thorax was essentially the same as that of pulmonary tuberculosis. Oxygen was used at first for the injections, then air or nitrogen; injections were repeated at intervals of three days at first, then 4 or 5 days, reaching a positive pressure only gradually. In the first two cases injection were given for 2 months, in the 3rd case retraction of the lung was not complete in that time, and treatment was prolonged. All of the patients showed improvement under the a.p.t. treatment; the amount of sputum was greatly reduced; its fetid odor disappeared; and the general condition improved rapidly. A complete cure, however, was not obtained in any case. Anti-gangrenous serum was accordingly given in 5 doses of 50 cc. each. In the first 2 cases, this resulted in a complete cure, the third case was still under treatment at the time of the report.

Regarding the method of a.p.t., according to Mazza (193), the initial injections varies from 200—400 cc., nitrogen administered every second day. The successive injections are regulated according to the extent to which the organ is collapsible, the presence or absence of pleural adhesions, and the pleura's faculty of absorption. In Mazza's cases they were repeated at short intervals without ever exceeding 500 cc. of Nitrogen at a sitting. The compression of the lung was gradual, leaving to the free lung a tolerable vicarious function and preventing possible emboli of infectious material and the dissemination of the material to other organs. The treatments were given as soon as the lesion was made evident by the most delicate methods of diag-