COLLECTED WORKS

OF

FRANCIS SIBSON, M.D.

VOL. III.

COLLECTED WORKS

OF

FRANCIS SIBSON,

M.D. LOND.,

FELLOW OF THE ROYAL SOCIETY,
HONORARY M.D. TRINITY COLLEGE, DUBLIN, AND D.C.L. DURHAM,
FELLOW OF THE ROYAL COLLEGE OF PHYSICIANS, LONDON, ETC.

EDITED
BY WILLIAM M. ORD, M.D.

WITH ILLUSTRATIONS.

IN FOUR VOLUMES.—VOLUME III.

London:
MACMILLAN AND CO.
1881.

LONDON:
R. CLAY, SONS, AND TAYLOR,
BREAD STREET HILL.

CONTENTS.

LIST OF ILLUSTRATIONS.

VOLUME III.

PERICARDITIS.

POSITION AND FORM OF THE HEART AND GREAT VESSELS.

XIII.

ON PERICARDITIS.[1]

Position of the Heart in Health.—In order to appreciate the exact changes which take place in the position of the heart, and in the superficial outlines of the pericardial sac, in pericarditis, it is necessary to know the precise position of the heart in health. This knowledge may be readily attained by the aid of the accompanying diagrams.[2]

The heart and pericardium, in health, are in immediate contact with the walls of the chest, over a space limited to the right by a line drawn through the centre of the lower half of the sternum; to the left by a line within the nipple; above, by the fourth left costal cartilage; and below, by a line drawn outwards from the lower end of the sternum. Over the superficial cardiac region, just indicated, there is absolute dulness on percussion, and complete absence of

[1] From the *London Journal of Medicine*, vol i. 1849, p. 893.

[2] These diagrams were made by the aid of a tracing-frame, suggested to me by my friend Dr. Hodgkin. This frame is described in my paper "On the Position of the Internal Organs," contained in vol. xii. of the *Provincial Medical Transactions*. I may be allowed to say, that these diagrams, and the communication just quoted, owe their value to the exactness with which the observations were made and depicted, both in life and death, in health and disease, by the aid of the tracing-frame referred to.

vocal resonance, and of the respiratory murmur; the heart's sounds are there loud, ringing, and clear, and the heart's impulse is to be felt there, if anywhere. The perpendicular diameter of this region is usually from two to two and a half inches, and its horizontal diameter from two and a half to

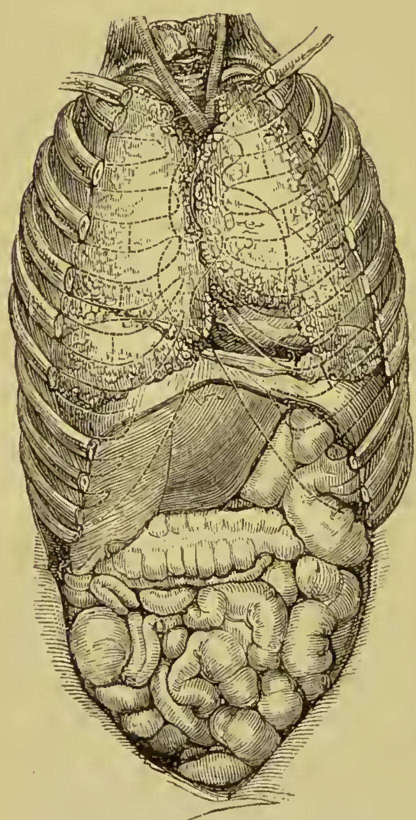


FIG. 1.—Superficial view.

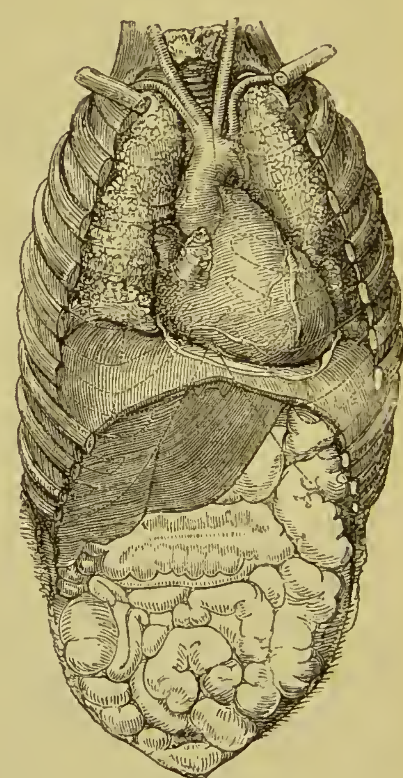


FIG. 2.—Deep view.

Position of the internal organs in a healthy adult male.

three inches. In the robust, the lungs are ample, and cover a large portion of the heart; consequently the region in question is comparatively small, the heart's impulse is generally feeble, often imperceptible, and the heart's sounds are dull and heard only over a comparatively small space. In the weak, on the other hand, the lungs, being small, cover only a small portion of the heart ; the region in question is consequently large, the heart's impulse is extensive and strong, and the heart's sounds are clear, sharp, and loud, and are usually heard over the whole chest, being readily conducted to the surface through the smaller and denser lungs. It is manifest from this, that the apparent strength of the heart's action is often in the inverse ratio of its real strength. If the cardiac region, where there is nothing but heart, be small, it is no indication that the whole heart is small. Indeed, in the robust, the heart, as well as the lungs, are larger than they are in the weak ; but the lungs are so much larger in the former, that they cover a much larger portion of the heart. This point is illustrated, in a very interesting manner, in persons affected with Laennec's emphysema or bronchitis. In such cases not only are the lungs unusually and universally enlarged, but the heart is unusually enlarged also; yet, notwithstanding its greatly increased size, a small portion of the heart only is uncovered by lung.

I shall throughout this paper, in referring to the region of which I am now speaking, where there is nothing else but heart, term it the cardiac region. It is over the cardiac region that we discover the earliest signs of pericarditis ; and, when we examine a patient to find out whether he has or has not that disease, it is of the utmost importance to bear in mind the exact seat, form, and size, of the cardiac region, and the possible variations of that region in health, and in the different forms of visceral disease.

In health, the lower end of the sternum indicates the meeting point, where the heart, the right lung, and the liver, come in contact ; the diaphragm, pleura, and pericardium, being alone interposed. I ascertained that this was so in more than 119 persons, in none of whom could I detect disease either in the lungs or the heart: these people varied from each other in sex, age, and in general health; some of them being robust, and some feeble. In all of these persons, the right boundary of the cardiac region was immediately behind the centre of the lower half or third of the sternum, and the lower boundary was indicated by a nearly horizontal line, drawn from the lower end of the sternum to the upper edge of the sixth rib. The variation in the outlines of the cardiac region takes place in the upper and in the outer or left boundaries. In the robust, the upper boundary is usually behind the space between the fourth and fifth costal cartilages, and the left boundary is from two to nearly three inches from the centre of the sternum. In feeble persons, the upper boundary of the cardiac region is often as high as the third costal cartilage, and the outer boundary may extend to the left nipple.

In the majority of persons, especially of those dwelling in towns, the upper boundary of the cardiac region is on a line with the fourth costal cartilage, and its outer boundary is within the left nipple, or about three inches from the middle of the sternum. In these persons, the left boundary is usually indicated by the impulse of the apex of the left ventricle, which is commonly felt between the fifth and sixth ribs, sometimes between the fourth and fifth. During the diastole of the heart, the margin of the left lung is interposed between the left ventricle and the thoracic parietes; but during the systole, the apex moves forcibly forwards, and to the left, pushes outwards, and from before it, the interposed portion of lung, and impinges upon, and elevates the parietes. It may be observed, that in most persons, the impulse of the apex is stronger towards the end of each expiration; and, in some, that impulse can then only be felt; this is due to the expiratory diminution of the thin couch of lung which usually shields the left ventricle from the parietes. It is well to bear in mind, that in most persons, excepting during the periods now stated, it is the right ventricle only which is in contact with the parietes. The diffused and slow impulse which is often felt over the lower half of the sternum, and the adjoining left costal cartilages, is entirely due to the systole of the right ventricle. In the first stage of pericarditis, before the effusion is considerable, the friction sounds are entirely due to the impulsive and gliding motions of the right ventricle; excepting during the instantaneous systolic blow and brush of the apex upon the parietes, when the systolic friction sound of the left ventricle is also heard.

In the robust, the impulse of the apex is seldom perceived; the right ventricle is usually alone in contact with the parietes, and its diffused impulse may generally be distinguished by the ear, and sometimes by the hand, over the left fifth and sixth costal cartilages. In the feeble, the lungs, being comparatively small, are withdrawn to some extent from between the heart and the parietes; and, in addition to the right ventricle, a portion of the ear of the right auricle, and a part of the left ventricle, are immediately behind the walls of the chest. In such persons, the impulse both of the apex and of the right ventricle is unusually strong. In some persons, who are feeble, wasted, and confined to bed, whose lungs and heart are free from disease, and in whom respiration and circulation are feeble, a still larger portion of the heart is uncovered by the lungs; the great vessels come in contact with the upper part of the sternum, the right auricle is exposed by the withdrawal of the inner margin of the right lung to the right of the sternum, and the left ventricle is to a moderate extent in contact with the ribs and intercostal spaces. In such, the impulse, both of the left and right ventricle, is extensive, sharp, and strong; and in addition to the systolic impulse, a second or diastolic impulse is felt between the second and third, and sometimes between the first and second costal cartilages. This second impulse is neither more nor less than a sign that the upper part of the right ventricle, and the origin of the pulmonary artery, over which it is felt, are in contact with the walls of the chest. This diastolic impulse, which is synchronous with the second sound, is a physiological and not a pathological phenomenon, and is due, I believe, to the sudden return forward of the walls of the right ventricle, and of the origin of the pulmonary artery, immediately after the systole; the parts in question then impinge with a short, sharp tap on the left second and third cartilages, and on the space between them. I have been thus exact in tracing the varieties in the extent to which the surface of the heart is exposed behind the walls of the chest in different persons, as in each of them there would be a distinct starting-point in the case of pericarditis. Besides this, the friction sounds would, at the outset, be heard more extensively, and there would be less difference between the normal outline of the cardiac region, and the outline of the pericardium distended by effusion, in those cases where the surface of the heart is more extensively exposed.

When the lungs are large, and the exposed portion of the heart is small, the extent to which the heart is screened by the lungs from contact with the walls of the chest is considerable. If the lungs, on the other hand, be small, the extent to which the heart is exposed being considerable, a small portion only of the heart is covered by lung.

In examining a case of pericarditis, it is well to know not only the position of those parts of the heart which are in immediate contact with the walls of the chest, but also the position, in relation to the parietes, of those parts also which are usually covered by lung. The medical man, when he places the stethoscope over the heart, ought to be able, in fact, to say over what particular portion he places it.

The position of the great vessels is easily remembered. The aorta, the central vessel, lies exactly behind that part of the sternum which is above the third cartilage; the pulmonary artery is situated just to the right of the same portion of the sternum, and the vena cava just to the left of it. The right ventricle lies immediately behind the lower half of the sternum, and the left costal cartilages from the third to the sixth; the right auricle, to the right of the ventricle, is behind the sternal half of the right costal cartilages from the third to the sixth, and its appendix lies across the sternum, narrowing from right to left, just below the third costal cartilages; the small portion of left ventricle which is in front, is just to the outside of the right ventricle.

The auricular border of the right ventricle, commonly called its base, crosses the sternum in an oblique line, from the left side of it at the third costal cartilage, to the right side of it at the lower end. As the most early, severe, and frequent seat of pericarditis is immediately along the course of this line of the right auriculo-ventricular junction, and over the right ventricle to the left of it, and the right auricle to the right of it, it is very important to have clearly in the mind the position of the parts in question.

Displacement of the Heart by Disease.—Should the heart, when displaced by disease, be affected with pericarditis, the friction sounds, and other indications of the disease will necessarily be present, not over the usual, but over the actual situation of the heart. In such cases, if we would ascertain the presence of pericarditis, we must examine the heart at the seat of its displacement.

In emphysema, the lower boundary of the heart, as well as that of the lungs, is unusually low; and the heart, although enlarged, is covered to an unusual extent by the dilated lungs. The cardiac region, that is to say the exposed portion of the heart, is consequently remarkably small and low. The exposed portion of the heart, instead of being behind, and to the left of the lower half of the sternum, is completely screened by lung from the sternum, and is seated behind, below, and to the left of the xiphoid cartilage. I possess the notes of a case of emphysema, in which pericarditis was detected by the presence of friction sounds behind the xiphoid cartilage, and the costal cartilages to the left of it.

In peritonitis with great abdominal distension, the diaphragm being pushed upwards, the cardiac region is unusually high ; indeed its lower boundary, instead of being on a line with the lower end of the sternum, may be an inch higher. Should friction sounds from pericarditis be present in such cases, their situation, even at the outset of the disease, will be unusually high.

When there is extensive effusion into the left pleura, the fluid pushes the heart over to the right of the sternum, the displacement being proportional to the amount of effusion. When the fluid disappears, the heart gradually resumes its normal position. If, after the disappearance of the effusion, the left lung fails to resume its functions, and remains condensed and unexpanding (owing, perhaps, to its being surrounded by a fibrous covering, and by strong intercostal adhesions), the heart, instead of remaining at its normal position, is drawn over unusually to the left, so that the impulse of the apex may be felt to the outside of the nipple. At the same time, the right lung, to compensate for the deficiency of the left, is enlarged, and encroaches to some extent on the left side.

Should the effusion be seated in the right pleura, the heart is pushed over unusually to the left. Should permanent condensation of the right lung be the sequel of the disappearance of the fluid, then the heart will be drawn over to the right. Indeed, in some such cases, the heart is seated behind, and to the right of the sternum ; and the left lung amplified for compensation, encroaches on the right side.

From whatever cause either lung is condensed, whether as the sequel of phthisis with cavities, or of pneumonia, the heart is drawn over to the affected side ; this side is also encroached upon by the opposite lung, which is itself usually enlarged to compensate for the impaired function of the other.

Movements of the Heart.—It occurred to me, that it would give additional precision to the knowledge of the friction sounds excited over different parts of the heart in pericarditis, if we knew accurately the exact motion of each part of the heart during its systole and diastole. In order to ascertain this, I rendered an ass unconscious by injecting into its veins the wourali poison, with which I had been kindly favoured by my distinguished friend, Mr. Waterton. I then kept up artificial respiration, and exposed the heart by removing the ribs. In order to see the exact motion of each part of the heart, I thrust pins into it in different directions, and then observed the various movements. I have given a detailed account of that experiment in my paper " On the Position of the Internal Organs " (*Provincial Medical Transactions*, vol. xii.) ; and I subjoin a summary of those observations.

The greater part of the anterior surface of the heart, both ventricular and auricular, has a diagonal gliding or friction movement, namely, during systole, from right to left, and from below upwards. The movement from right to left has, as it were, its pivot or hinge in the line of the superior and inferior venæ cavæ ; and that from below upwards, has its hinge of movement in the pulmonary veins ; the vertical axis, on which the horizontal movements turn, runs through the base of the right auricle; and the horizontal axis, on which the vertical movements turn, passes along the base of the left auricle.

During the systole, the right ventricle becomes narrower, flatter, and shorter. The lower border of the right ventricle and the outlet at the pulmonary artery, gradually approach each other during the systole; the walls everywhere move from below upwards, with a diagonal movement from right to left, until within about half an inch of the pulmonary artery; there the walls are stationary; between that point and the artery they move from above downwards. The pulmonary artery is itself dragged downwards about a quarter of an inch by the neighbouring descending fibres of the right ventricle. The right auricle, previously flaccid, becomes gradually distended during the ventricular systole; the whole auricle becomes wider, and its ventricular margin moves about half an inch from right to left; the auricular portion, before scarcely perceptible, becomes swollen, and advances boldly and rapidly forwards, and from right to left, for the extent of about two-thirds of an inch; and the tip of the right auricular portion, which, at the beginning of the systole, is behind the right margin of the sternum, moves over, during the systole, to its left margin.

The general systolic movements of that part of the left ventricle which lies to the outside of the right ventricle, are also from right to left, and from above downwards. There is, however, a singular diversity in the movements of the part in question; while the apex of the left ventricle moves forwards, upwards, and from right to left, a small portion of that ventricle contiguous to the apex moves from left to right, dragging with it the contiguous portion of the right ventricle, while the two auricular thirds of the ventricle go from right to left. The aorta, like the pulmonary artery, descends about a third of an inch during the systole.

From this it is to be observed, that the whole of the anterior portion of the heart, and the great vessels, have a gliding or friction movement during both systole and diastole—that, during the systole, the anterior walls of the heart move diagonally from below upwards, and from right to left, the horizontal movement of those portions of the right auricle and ventricle near their junction, and of the auricular appendage, being by much the most extensive—and that the aorta and pulmonary artery descend during systole, and ascend during diastole. In short, the various cavities in part exchange places during the systole and diastole ; during systole, the ventricles empty themselves, the auricles and the arteries become more full, and where they adjoin the ventricles, both the auricles and the arteries occupy a portion of space previously occupied by the ventricles ; during the diastole, the ventricles regain their position, and the auricles and arteries go back to theirs.

For a further description of the interesting phenomena in question, I refer to my own experiment just quoted, and to the valuable report of the Committee of the British Association (composed of Dr. C. J. B. Williams, Dr. Todd, and Dr. Clendinning), on the Movements and Sounds of the Heart.

Artificial Distension of the Pericardium, compared with Morbid Pericardial Effusion.—Pericardial effusion being one of the earliest results of pericarditis, I felt anxious to study, on the dead body, the effect of pericardial distension on the situation and size of the pericardium and of the heart, and on the position of the surrounding organs.

With this view, I imitated pericardial effusion, by injecting into the healthy sac as much fluid as it would hold.

M. Piorry thus describes the difficulties which he experienced when he attempted artificial distension of the pericardium : "Quelques essais tentés sur le cadavre, dans l'intention de simuler des maladies de l'enveloppe membraneuse du cœur, n'ont pas réussi. Des gaz pénétraient par les incisions que nous faisions aux parois costales ; les injections se faisaient mal ; elles pénétraient quelquefois dans les plèvres ; on ne pouvait, après les avoir faites, boucher exactement l'ouverture artificielle qu'elles avaient nécessitée ; lors même qu'il aurait pu en être ainsi, l'air qui s'était introduit dans les parties mises à découvert aurait donné lieu à des résultats qui ne pouvaient représenter l'état du péricarde avant l'ouverture du thorax." (*De la Percussion*, p. 135.) In a later work (*Du Procédé Operatoire*, p. 114), he describes the more successful results of his attempts to inject the pericardium, and impresses on the student of chest-disease the importance of repeating for himself the experiments on a dead body.

Whoever is desirous of putting this valuable advice into practice, will find that the pericardial sac may be artificially distended with perfect facility, if he make an opening into the free pericardium, just large enough to admit the injecting tube ; thrust a pin into the membrane at each side of the opening ; and then tie in the tube by passing a thread round the opening, just beyond the pins. The pericardial sac may be conveniently opened for injection, either from below, before the chest is opened, through the central tendon of the diaphragm ; or, after the removal of the sternum, through the anterior wall of the sac.

The healthy pericardium, when the size of the heart is normal, is incapable of holding a large amount of fluid.

In a boy, aged 6.		the pericardium, injected to distension, held	6oz.
——— 9.	Heart, 3¾ oz. in weight		6
——— 13.	———	about	6
In an adult male	——— 12 oz.	Right cavities distended held ... 15 oz.; Left ... 10½ — Pericardium distended held	15
In a man, aged 50	——— 13 oz.	———	22
In an adult female, whose heart was enlarged		———	26

From these and other observations, it may be inferred that in the adult, when the heart is healthy, the pericardium, when

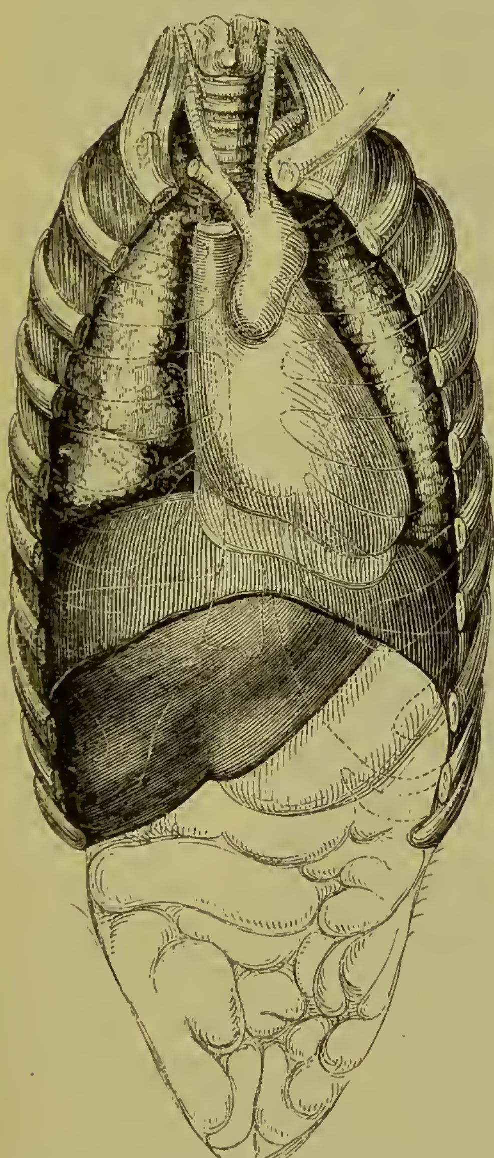


Fig. 3.—Pericardial sac not distended.

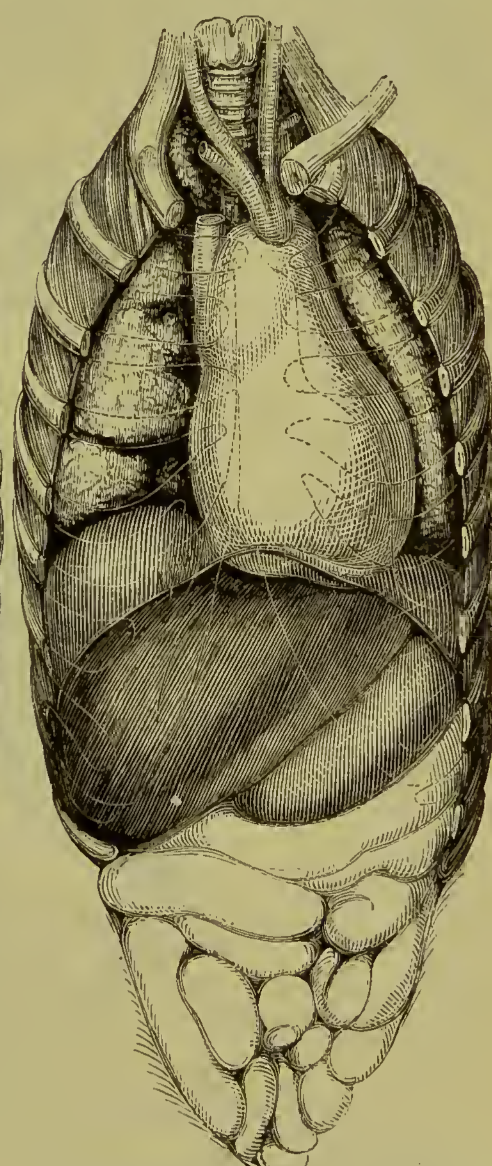


Fig. 4.—Pericardial sac distended.[1]

fully distended, can contain from 12 to 15 oz. of fluid. It is worthy of remark that the right cavities of the heart, in the

[1] The lines indicating the margins of the lungs are hypothetical.

adult male, when distended, hold the same quantity of fluid as the pericardium.

The quantity of fluid that can be injected into the healthy pericardium, falls very far short of the large quantity which it is sometimes found to contain in disease. There are

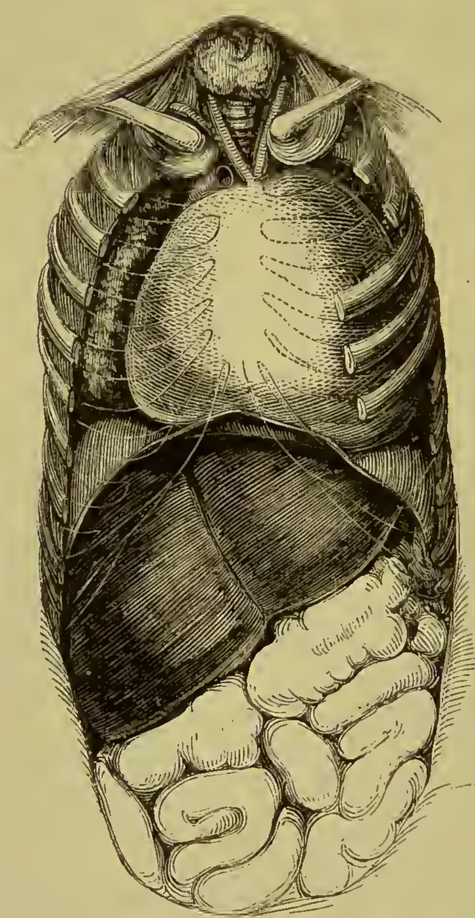


FIG. 5.—Pericarditis, with extensive pericardial effusion.

several cases of pericarditis on record, in which three pints were found in the sac; indeed Corvisart, in his commentary upon Avenbrugger, states that he has found in it seven or eight pints! (Dr. Forbes's translation, p. 57.) It is therefore manifest that not only is the pericardial fluid greatly increased in some cases of pericarditis, but that the sac itself is, in those cases, very greatly enlarged, and altered in shape. In order, therefore, to understand the physical effects of pericardial effusion, it is not sufficient to observe the effect of artificial distension, but it is also necessary to notice the increased distension which supervenes when the disease is of some standing. During the early stages of pericarditis, the comparison between artificial and morbid distension of the pericardium is exact.

The accompanying engravings illustrate very exactly the effect of artificial distension of the pericardial sac. In the first view, fig. 3, the sac not being distended, fits closely around the various parts of the heart, so that the great vessels, the auricle, and the ventricle, can be readily distinguished through the fibrous membrane. The tendinous surface of the diaphragm, on which the heart rests, forms a plane inclined from behind forwards.

When the pericardium is distended, as in fig. 4, the whole sac becomes swollen and globular, or rather pear-shaped. The outlines of the heart itself, and of its various cavities and vessels, are no longer perceptible. The whole pericardial sac is enlarged, and it consequently encroaches upon, and, to some extent, displaces all the surrounding organs. The pericardium is most distended at those parts where it is most distant from its attachments to the heart, namely, at its lower or diaphragmatic portion, and at the left side, especially in the neighbourhood of the apex.

The form of the distended sac is peculiar. It is composed, as it were, of two spheres, one larger than the other, the smaller sphere resting as an apex upon the larger. The larger sphere encloses the heart itself, and is gibbous towards the left side. The smaller sphere envelopes the great vessels, and it presents three projections, one over each vessel; that over the aorta is most prominent, and lies immediately behind the upper bone of the sternum ; that over the vena cava, just to the right of the sternum, is small ; and that over the pulmonary artery, to the left of the sternum, is large.

The effect of the distension on the form and position of the central tendon of the diaphragm is marked and characteristic—instead of being somewhat concave, and inclined from above downwards, it is perfectly convex and simi-globular on the under or peritoneal surface ; that surface being more than an inch lower than it is when the sac is empty. The liver and stomach, where they adjoin the central tendon, are necessarily displaced downwards, in exact proportion to the amount of pericardial distension. This protrusion of the central tendon of the diaphragm into the abdomen accounts for the pain so frequently observed to be present in the epigastrium, especially when pressure upwards is made over that region ; this was particularly noticed by Mr. Nairne in his communication on pericarditis, in the seventh volume of the *Dublin Journal*: in ten out of eleven of his cases, epigastric pain on pressure was a marked symptom.

Avenbrugger first noticed the swelling in the præcordia in pericardial effusion ; and Corvisart, in his commentary on Avenbrugger, correctly attributed this to the fluid of the pericardium depressing the diaphragm below the edge of the sternum. Dr. Forbes, in illustrating the observations of Avenbrugger and Corvisart, carries out those observations still farther, and accurately attributes the præcordial tumor to the left lobe of the liver, thrust forwards and downwards by the depressed diaphragm.

The great extent to which the liver and stomach may be pushed downwards by the pericardial sac, distended by morbid effusion, will be well understood by a reference to fig. 5, which was taken from a case in which the pericardial distension was very great.

The lateral expansion of the pericardium necessarily causes a corresponding lateral displacement of both lungs, where they overlap the heart. As the expansion of the left side of the pericardium is much greater than that of the right, the left side being free, while the right is attached to the venæ cavæ, there is much greater displacement and compression of the left lung than of the right.

Owing to the peculiar form of the upper part of the distended pericardium, where it forms as it were a swollen pouch over the great vessels, the lungs are, in the earlier stages, displaced at that part to each side, in a manner quite characteristic of recent effusion. The upper portion of the region of pericardial dulness has, in the cases in question, a peculiar peaked form; this is rendered apparent in fig. 4, taken from the artificially distended pericardium, and will be still farther illustrated in the figures from the living subject. It may be traced over the upper portion of the sternum, within an inch of its summit, and over the left second and third costal cartilages. The cause of this peaked form is rendered evident by the diagram. The swollen pericardial sac, as it protrudes forward, comes in contact, at its most prominent part, with the sternum, and thus presses the lungs away to each side of it.

Corvisart, Piorry, and Hope, observed that the dulness on percussion in pericarditis, is unusually high, extending to the upper portion of the sternum. M. Piorry has assigned a conical form, the base at the diaphragm, to the base of pericardial dulness. I am not aware that any observer has noticed the peculiar peaked form of the upper part of the region of pericardial dulness just alluded to. This peaked form is only present during the earlier stages of pericardial effusion. During the more advanced stages, if the effusion become more considerable than the pericardium can contain when artificially distended in health, the upper part of the region of dulness loses its peaked form, becomes more extended, and rises so as to be in some cases on a level with the left clavicle, as was accurately observed long since by Senac. This is well seen in fig. 5, taken from a case of extensive pericardial effusion of long standing. In this case it will be observed that the anterior portion of the left lung is displaced completely backwards, so as to be almost quite hidden by the pericardium, while the compression of the right lung is considerable.

In the case just referred to, the pericardial sac is broader than it is long, instead of being, as in the cases of artificial injection, longer than it is broad. It is evident that the great expansion of the pericardium takes place laterally and to the left, and that the sac, as it enlarges, loses its symmetry. The great lateral increase of the pericardium is evidently due to the resistance offered to the expansion of the sac by the ribs and sternum in front, and by the vertebræ behind. The pericardium fills up the space between the sternum and the spinal column—the aorta and œsophagus, and at the upper part, the trachea, being alone interposed; and, as the pericardium cannot expand much in front or behind, and as its expansion above and below is limited by the upper ribs and the diaphragm respectively, the sac is compelled to expand sideways, that being the only direction in which there is no impediment. It is almost certain, that the distended pericardium exerts an injurious pressure on the thoracic aorta, as it lies interposed and compressed between the pericardium and the vertebræ. This view which is forced upon us by the anatomical position of the parts, is supported by the frequency with which the lower limbs are cold and œdematous in pericarditis with extensive effusion. It is probable, that an injurious pressure is sometimes exerted on the trachea at its bifurcation, and that this circumstance in part accounts for the extreme dyspnœa so frequently present in cases of pericarditis.

The pressure of the distended pericardium being exerted in every direction, not only displaces, in proportion to the amount of distension, the adjoining viscera, but it also causes protrusion of the sternum, costal cartilages, and ribs immediately in front. If the amount of effusion be small, there is little or no protrusion; but if it be great, the protrusion is considerable. In extreme cases (such as that represented in fig. 5), the projection of the thoracic walls, caused by the distended pericardium, is very extensive—in fact, co-extensive with the sac. The thoracic projection is greatest from the fourth to the seventh left costal cartilages, those parts being over the centre of the pericardium. The prominence, however, extends, in proportion to the distension, over the lower half or two-thirds of the sternum, that bone being in the young arched forwards more and more, from the upper to the lower extremity—over the left costal cartilages, from the second downwards, those cartilages being also all of them stretched further apart, and the intercostal spaces widened—over the costal cartilages to the right of the lower end of the sternum—over the left ribs, in the neighbourhood of, and outside the nipple, from the fifth or sixth to the seventh or eighth—and over the xiphoid cartilage, the epigastrium, and the seventh and eighth left costal cartilages. As the amount of effusion increases, the degree and extent of the thoracic prominence increase also; and as it diminishes, they diminish also. The progress of the case may be happily thus indicated to the eye, when, from the application perhaps of a blister, the extent of the effusion cannot be ascertained by percussion.

I have, indeed, observed that the prominence over the cardiac region, which, in health, is usually greater than that over the corresponding region to the right of the sternum, may disappear altogether as the effusion diminishes. MM. Louis and Bouillaud give several cases, in which pericardial effusion caused thoracic prominence. It is probable, that the posterior curvature of the dorsal vertebræ is increased by the pressure of the distended pericardium backwards against the spinal column; and that the relief which some persons, suffering from pericarditic effusion, derive from the bent and forward position, is due to the increased space thus given to the pericardium behind.

The physical effect of the increased quantity of fluid in the pericardium upon the size and situation of the heart itself, its cavities and great vessels, is an important subject which did not escape the attention of the earlier observers. Senac (*Maladies du Cœur*, i. 148) remarks, that the water which fills the pericardium, neither permits the heart to dilate readily, nor to come in contact with the ribs; its cavities, being compressed by the surrounding fluid, cannot dilate sufficiently to receive the blood from the caval and pulmonary veins, and the volume of the heart is itself sometimes lessened. It therefore follows, as Lower had remarked, that in these cases the pulse is feeble or altogether imperceptible, and that even syncope may supervene.

These remarks, drawn, by observation, from living pathology, are illustrated by the effect of artificial distension of the pericardium on the size and position of the heart and its cavities. When I injected fluid into the sac, the heart was lessened by compression; the fluid contents of its cavities were in great part forced forwards into the arteries, and backwards into the veins; the lower boundary of the heart was elevated, and the whole heart and the great vessels were forced unusually upwards, evidently under the influence of the pressure of the liquid, which, lessening the volume of the heart, caused the whole organ to rise and approach more nearly to the seat of its attachment to the lungs and to the systemic vessels. During the injection, the fluid finds its way at first to the lower and back part of the pericardial sac, interposing itself between that portion of the sac, and the posterior wall of the left ventricle, gradually separating those parts farther from each other, and pushing upwards the ventricles, and downwards the central tendon of the diaphragm. As the sac becomes more and more distended, the fluid gradually rises, so as to cover the heart in front, separating successively the body of the left ventricle, the right ventricle, the right auricle, and the great vessels from the free pericardium. At length, when the distension is complete, it is probable that the left auricle, the base of the left ventricle, and the great vessels at their inlet or outlet, are alone in contact with the pericardium.

Although morbid pericardial effusion is in many respects closely imitated by artificial distension, yet the effusion is not attended throughout by the same effects as the distension. Indeed, it could not ; for while, in artificial distension, we have to deal with a dead heart—in morbid effusion it is a living heart that is acted upon. The living, unlike the dead heart, being in continual alternating motion, offers by its muscular movements, a resistance to the compression of the pericardial fluid. It is to be borne in mind, that each ventricle, during its systole, not only propels the blood, the left through the systemic, and the right through the pulmonic arteries, capillaries, and veins ; but that also, through those channels, and aided by the elasticity of the arteries, each propels the blood into, and fills the opposite auricle and ventricle. I have found in the experiment on the ass, above related, that on compressing the aorta, less blood entered the right auricle at the very next beat ; while the same effect was produced on the left auricle immediately after compression of the pulmonary artery.

Although the impulse of the heart is lessened in power by pericardial effusion, it yet retains considerable force, even when there is a great amount of effusion.

The changes in the position of the heart and the surrounding organs, progressively and gradually induced by artificial distension of the pericardium, may be accurately traced on the living subject of pericarditis with effusion, during the progressive development of the disease.

Dr. Stokes made the important observation, "that in by far the greater number of our cases, the 'friction' sounds were not audible beyond the actual region of the heart. This is a most striking character. I have often observed, that in moving the stethoscope little more than an inch from a situation where the sounds were loud, they totally ceased, although the contractions of the heart continued distinctly audible." ("On the Diagnosis of Pericarditis," *Dublin Journal*, iv. 56.)

As the friction sounds perceptible to the ear, and the vibrations and impulse communicated to the hand are, with few exceptions, only perceptible over the region of the heart affected with pericarditis, we can gain a very accurate knowledge of the progress of the disease, by observing, during its successive stages, the varying seat of the friction sounds, the vibrations and the impulse of the heart, in connection with the extent of pericardial dulness.

In the early stages of pericarditis, when the amount of fluid in the pericardium is not materially increased, the heart and lungs retain their normal position ; the extent of cardiac dulness is scarcely altered : the to and fro friction sounds, caused by the right ventricle, are heard over the lower half of the sternum and the adjoining left costal cartilages, and the rubbing sound of the left ventricle at the apex is heard only during systole, when the apex pushing aside the interposed portion of lung, rubs against the fifth rib and intercostal space; the vibrations are seldom perceived; the impulse of the heart is felt at the usual situation, between the fifth and sixth ribs. As the fluid progressively increases, it pushes aside the cardiac margins of the lungs more and more from before the heart, that organ being itself not yet notably elevated; the extent of pericardial dulness is materially increased; the right auricle is now exposed, and, while the to and fro friction sounds of the right ventricle are heard behind and to the left of the lower half of the sternum, those of the right auricle are heard to the right of that portion of the bone. The auricular tip of the right auricle, during systole and diastole, moves from side to side, first to the right and then to the left margin of the sternum, close to the third costal cartilages; and between those cartilages, the smooth, prolonged, equal double friction murmurs are distinctly audible. The friction sounds over the left ventricle are now usually both diastolic and systolic. The vibrations are sometimes communicable to the hand. The impulse at the apex is perhaps higher, and is more extensive than usual between the left costal cartilages.

When the pericardium is distended with fluid so as to push the heart materially upwards, the extent of pericardial dulness is still farther increased. The friction sounds, instead of being audible as low as the sixth costal cartilage and the lower end of the sternum, are only heard above the lower fifth of the sternum and the fifth costal cartilage. The vibrations are frequently felt by the hand, and occupy the same space as the friction sounds. The impulse of the apex is perceived over the fifth, instead of the sixth intercostal space; the impulse of the right ventricle is felt from the second to the fifth costal cartilages; and the peculiar sharp diastolic impulse may be perceptible both over the first and second intercostal spaces. When the effusion further increases, so that the ventricles are in great part separated by a layer of fluid from the parietes, the upper part of the right ventricle and the great vessels are still in contact with the first, second, and third intercostal cartilages and the spaces between them. The friction sound, the vibration, and the impulse, are now only to be perceived between the first and second, and the second and third costal cartilages.

When the sac is completely distended, and the surface of the heart is completely separated by the fluid from the parietes, then neither friction sound, vibration, nor impulse is anywhere perceptible.

As the fluid gradually disappears, and the heart comes again, by little and little, in contact with the parietes, the phenomena progressively re-appear, descending in the inverse order to that in which they disappeared and ascended; until at length, when the fluid is absorbed, the whole heart returns to its normal position, or, if enlarged, goes even beyond it. The friction sounds and vibrations, if present, are perceptible as low down as they were at first, and the impulse descends from space to space, so that at length the heart's apex beats as usual between the fifth and sixth ribs. As the heart, then, is pushed upwards by the increased effusion, the friction sounds, the vibrations, and the impulse are necessarily pushed up likewise; and as the heart descends, when the fluid diminishes, resuming its position, the friction sounds, vibrations, and impulse descend and resume theirs.

I believe I was the first to point out that the seat of the impulse is raised in pericarditis with extensive effusion; and

I here extract the passages relating to that subject, from my paper on the "Situation of the Internal Organs," published in the *Provincial Medical and Surgical Transactions* for 1844.

"In cases of pericardial effusion, where the heart is not enlarged, the volume of the heart is lessened and pushed upwards towards its point of attachment, and the ventricles being raised and seated behind the middle third of the sternum, and the third and fourth, or fifth costal cartilages.

"As the ventricles are raised, the seat of the impulse, caused by their contraction, is raised also. In a case in which the effusion was very extensive, the second and third costal cartilages, and the first and second intercostal spaces, protruded during the impulse of the ventricles, while the third intercostal space and the fourth costal cartilage fell slightly back, and the fourth intercostal space receded to a still greater extent. These movements of falling back below, while there was advance above, were visible, and gave the effect of undulation; while the upper part rose during systole, the lower part fell; towards the diastole, when the parts resumed their places, the lower parts rose while the upper parts fell. In another case, the impulse was unusually high, being seated between the third and fourth intercostal spaces; but the lower spaces and ribs did not fall back, the effect of undulation was not produced.

"As the outlines of dulness, due to effusion, diminished in the above cases, the seat of the impulse descended."

Dr. Taylor has noticed the connection of the elevated impulse with considerable pericardial effusion, in the valuable series of cases of pericarditis, published by him in the *Lancet* for 1845-46. In one case, (the seventeenth) he observed, that as the pericardial dulness diminished, the impulse at the apex fell from the fourth to the fifth intercostal space.

More recently this point has been noticed in the following words, by Dr. Walshe, in a clinical lecture on an interesting case of pericarditis, published in the *Lancet* for Feb. 10, 1849, p. 143:

"Another singularly important sign of pericardial effusion (twisting upwards and outwards of the heart's apex in such manner, that the beat of the apex is felt and seen in the fourth instead of the fifth intercostal space, and on, or a little outside, instead of inside, the vertical level of the nipple) was clearly detected in Cradock; and that the elevation of the heart's point was the effect of the recent effusion (as in ordinary cases), and not of the old inflammation, was absolutely demonstrated by the descent of that point to the fifth intercostal space a few days later."

In the second of the two cases referred to in the quotation from my paper on the internal organs, the impulse of the apex and the right ventricle was seated between the third and fourth intercostal spaces, and was somewhat more to the left than usual at the apex; a circumstance pointedly noticed by Dr. Walshe, in his case in the quotation just given. In the first of my two cases, the impulse was only present in the first and second intercostal spaces, and was evidently due to the movement of the upper part of the right ventricle, and, probably, of the pulmonary artery. In this patient, the fluid must have been in part interposed between the body of each ventricle and the free pericardium, thus shielding the parietes from the more extensive impulse.

The appearance of undulation, caused by the impulse over the first and second intercostal spaces, which was observed in the case just referred to, was noticed in the following words by Senac, one of the earliest writers on pericardial effusion:

"Parmi tant de signes incertains, j'ai cru en remarquer un qui les rendrait moins équivoques, s'il était bien constaté; il est d'autant plus facile à observer, que les yeux peuvent le saisir ; on aperçoit très clairement entre la troisième, la quatrième, et la cinquième côte, les flots de l'eau contenue dans la péricarde, lorsqu'il survient des palpitations ; ce n'est pas qu'on entrevoie quelque mouvement semblable dans celles qui ne sont pas accompagnées d'une telle hydropisie; mais elles ne produisent pas un mouvement onduleux, et qui s'étende fort loin."

Dr. Latham, in his recently published Clinical Lectures on Diseases of the Heart, thus notices the interesting subject just referred to :

"In pericarditis, while the præcordial region is dull to percussion, and the exocardial murmur is heard, an undulating motion often becomes visible to the eye in some of the spaces between the cartilages of the ribs on the left side. It has always been either between the cartilages of the second and third ribs, or of the third and fourth, or between both at the same time, that I have seen motion, and never in any other situation.

"So, too, in pericarditis, while the præcordial region is dull to percussion, and a murmur is heard, a vibratory motion often becomes sensible to the touch in some spaces between the cartilages of the ribs on the left side. As I never saw the undulation, so I never felt the vibratory motion elsewhere than either between the cartilages of the second and third, or of the third and fourth ribs, or between the cartilages of both simultaneously.

"The vibration, I believe, is the more frequent of the two, and often occurs unaccompanied by any visible undulation. But the undulation was never apparent to my eye without my finger being able to detect a sensible vibration at the very same spot.

"Again where they do appear, it is not (as far as I observe) ever at a very early period of the disease. In pericarditis (as fas as I have observed) they never occur but as accompaniments of the exocardial murmur and the præcordial dulness. And further, when they do occur (as far as I have observed), they always appear later and cease earlier than these do."

These observations of Dr. Latham render it perfectly clear that the appearance of undulation cannot be due, as Senac had supposed, to the presence of fluid at its seat. The co-existence of friction sounds and of vibrations with the undulation, necessarily forbids the supposition that fluid was present ; as the presence of fluid would have separated the two surfaces of the pericardium, and so extinguished the friction sound and the vibrations.

It is manifest, therefore, that the appearance of undulation, so often observed in cases of extensive pericardial effusion, is not due to the reality of undulation from the presence of fluid, but to the slight and peculiar impulse between the cartilages of the first, second, third, or fourth ribs—an impulse due to the slight systolic shock of the upper part of the right ventricle, and which is usually followed, at the uppermost part, by the peculiar sharp diastolic shock of which I have spoken about at p. 5.

When the anterior walls of the heart are altogether separated from the free pericardium, neither impulse, undulation, friction sound, nor vibration, can be any longer perceived. How, indeed, can they, when the heart's surface is no longer in contact with the parietes ? It is clear that if, by any means, we can, for the time, remove the fluid from between the roughened and inflamed pericardial surfaces, bring those surfaces again into contact, and so reproduce attrition between them, we shall again bring out the friction sound. This I have been able to effect in such cases, by exerting pressure upon the cartilages of the ribs and the spaces between them.

The interposed layer of fluid is usually very thin, and I have found it to be readily displaced by means even of inconsiderable pressure. In order to diffuse the pressure, and so to prevent pain, I inserted a thin plate of wood into the large end of the flexible stethoscope, and I found that when, by careful manipulation, pressure was made with this plate, it excited no uneasiness, and it also, owing to the increased extent to which the surfaces were brought in contact, still further augmented the friction sound.

I found that, by means of pressure, I was not only enabled to bring out friction sounds, previously absent, owing to the interposition of fluid between the opposite surfaces ; but that I was also able, in almost all cases where the friction sounds were present, to render those sounds louder and rougher. I wish particularly to call attention to the fact that exocardial murmurs can be heard with greater ease and clearness when pressure is applied over the region of the heart, and to demonstrate the value of the sign in question in the detection of pericarditis. I shall take a future opportunity of returning to this interesting subject.

XIV.

POSITION AND FORM OF THE HEART AND GREAT VESSELS.[1]

CONTENTS.

FRONT VIEW, AFTER DEATH.

THE following observations on the position and anatomical relations of the healthy heart and great vessels after death are founded on the examination of a number of diagrams showing the position of the internal organs after death. This examination was restricted to those instances in which the heart was healthy and was not enlarged. The diagrams were made by drawing the outlines of the organs on a piece of lace or net, stretched upon a frame and placed over the body.

The heart and great vessels present great variety in form and position both after death and during life.

During the illness or injury that ends in death, at the time of death and after death, the heart and great vessels

[1] From Reynolds's *System of Medicine*, vol. iv. p. 14.

undergo a series of changes in position and form. According to the nature and direction of these changes, the heart after death may, in different instances, be (I.) higher or lower in position; or (II.) it may deviate more to the right or more to the left.

(I.) The Higher or Lower Position of the Heart and Great Vessels.

Three main conditions may influence the higher or lower position of the heart after death: (1) The contraction or expansion of the lungs: (2) The distension or flaccidity of the abdomen: and (3) The state of the heart itself.

(1) When death is associated with bronchitis, or pneumonia, or affections of a like nature, in which the lungs are large, and are expanded after death, the chest is broad and deep, the diaphragm is low, and the heart, which is charged with blood, especially in its right cavities, is large, and occupies a low position. As a rule, however, the lungs, when they are not thus affected, lessen in size and contract during the final expirations. The cage of the chest then becomes more flat and narrow; it lengthens downwards, and the sternum and costal cartilages and ribs in front are all lowered in position. The diaphragm at the same time is elevated. While the front of the chest is thus lowered, the heart, resting on the diaphragm, is raised, and the whole organ, and the great vessels occupy a higher position. We thus have a double and contrary movement in the descent of the bony framework of the front of the chest, and the ascent of the heart immediately behind that framework. As the heart within, and the sternum and cartilages without are both thus elevated by the distension of the abdomen, the

actual elevation of the heart and great vessels is much greater than their apparent elevation, estimated as that usually is by the relation of those parts to the walls of the chest immediately in front of them.

(2) When the abdomen is distended, whether by fluid or air in the cavity itself, by an accumulation of gas in the stomach and intestines, or by other causes, the whole diaphragm is forcibly elevated, and the heart, resting as it does on the central tendon of the diaphragm, is lifted upwards. The sternum and costal cartilages in front of the heart are, at the same time, also raised in position, and the lower ribs on either side are pressed outwards. Although the actual elevation of the heart is, in these cases, often very great, its apparent elevation, which is measured by the relation of the heart to the walls of the chest in front of it, may be slight, owing to the simultaneous elevation of the heart and the sternum and cartilages in front of the heart caused by the distension of the abdomen.

When the abdomen is flaccid, owing to the stomach and intestines being empty, the reverse effects take place. The diaphragm descends, the heart drops downwards, the sternum and costal cartilages are lowered in position, and the inferior ribs fall inwards.

(3) During the final illness or injury that precedes death the heart may lessen or enlarge. Fatal hæmorrhage or wasting disease reduces the size of the heart and great vessels. On the other hand, the heart is swollen, especially on the right side, under the influence of suffocation or bronchitis; while its left ventricle may be thickened and enlarged in cases of Bright's disease with contracted kidney. Thus the right or the left side of the heart may be enlarged when the obstacle to the flow of blood is respectively in the lungs or the body.

At the time of death, the left ventricle usually closes firmly upon itself; while then or soon afterwards the right cavities of the heart become permanently swollen with blood.

After death the heart shrinks upwards to a greater or less extent. This is owing partly to the diminution of the organ, but mainly, I believe, to the contraction of the arch of the aorta, for the shortening of that vessel draws the heart upwards, just as its lengthening pushes the organ downwards.

The exact extent to which the heart is thus raised, is measured by the space that is left between the lower boundary of the heart, and the lower boundary of the *front* of the pericardium. During life these two adjoining parts fit each other exactly; but after death they are separated by a space that varies according to the degree to which the heart shrinks upwards. Thus in the body of a youth who died from hæmorrhage after fever, and in that of a man who expelled two or three pints of blood from a cavity in the left lung, an inch of space intervened between the lower edge of the heart and that of the lower bounda·y of the *front* of the pericardium. In another instance that space was only the tenth of an inch. As a rule the space varied from a quarter to seven-tenths of an inch (in 38 of 44 instances) and its average measurement was nearly half an inch (0·46 inch). (Note 1, page 179.)

The heart and the great vessels mainly occupy the centre of the chest, being protected in front by the sternum and the adjoining costal cartilages. It is, however, my present object, not so much to describe the relative bearings of those parts after death, as to indicate the *variation* in the anatomical situation of the more important boundaries or landmarks of the healthy heart and great vessels observed by myself in different instances after death.

The lower Boundary of the Heart.—In one instance, a woman who died from starvation, the lower boundary of the heart was situated behind the ensiform cartilage an inch and a half below the lower end of the sternum (that term being restricted here and elsewhere to the manubrium and blade or osseous part of the sternum), while in another it was almost as much (1·4 inch) above that end of the bone. Between these two extreme points this boundary occupied every variety of position. In one-fifth of the instances observed (15 in 71) the lower boundary of the right ventricle was just behind the lower end of the sternum, while in two-fifths of them it was above (30 in 71), and in two-fifths of them it was below (26 in 71) that end of the bone. (Note 2, page 180.)

As we have already seen, the lower edge of the heart usually shrinks upwards after death for nearly half an inch, the extent varying from one inch to one tenth of an inch. The position of the lower border of the *front* of the pericardium, which points out the position of the lower border of the heart at the time of death was indicated in four-fifths of the cases (55 in 71) in which the inferior boundary of the heart was observed after death. In one-fifth of these instances (11 in 55) the lower limit of the pericardium was on a level with the lower end of the sternum; while in two-thirds of them (37 in 55) it was below that point, being situated behind the ensiform cartilage; and in only one-eighth of them (7 in 55) was it above that point. We thus see that at the time of death, in the great majority of instances (40 in 59) the inferior border of the heart was below the lower end of the sternum, being situated behind the ensiform cartilage. (Note 3, page 180.)

The seat of the lower boundary of the apex in relation to the left fifth space is a more important landmark for the clinical observer than that of the lower boundary of the heart in relation to the lower end of the sternum.

The lower edge of the heart at the apex was on a level with the lower edge of the left fifth cartilage in one-seventh of the instances observed (9 in 69), it was below that edge in two-fifths of them (26 in 69), and it was above that edge in almost one half of them (34 in 69). In five instances the lower boundary of the apex was situated one inch above the lower edge of the fifth cartilage, and in four it was fully one inch below that edge. (Note 4, page 181.)

The lower border of the pericardium just below the apex which corresponds with the seat of the lower border of the apex at the time of death, was on a level with the lower edge of the fifth cartilage in one-sixth of the instances observed (9 in 55), was situated below that edge in three-fourths of them (41 in 55), and was above that edge in only one-eleventh of them (5 in 55). (Note 5, page 181.)

We thus see that there was a general, but not a constant correspondence between the relation of the inferior boundary of the right ventricle to the lower end of the sternum, and that of the inferior boundary of the apex to the lower edge of the fifth cartilage, both at the time of death, and after death when the examination of the body was made. This correspondence would have been more constant but for variation in (1) the comparative height of the fifth cartilage and the lower end of the sternum, (2) the degree of inclination from above downwards and from right to left of the lower boundary of the heart, and (3) the extent to which the right ventricle is situated to the right and to the left of the middle line of the sternum.

(1) In the great majority of instances (60 in 71) the inferior edge of the left fifth cartilage was lower in position than the inferior extremity of the sternum, to an extent

varying from a quarter of an inch to an inch and a quarter; in five cases those two parts were on the same level; and in six the lower edge of the fifth cartilage was higher by from a quarter to three-quarters of an inch than the lower end of the sternum.

The height of the fifth cartilage in relation to that of the lower end of the sternum is influenced by (1) respiration, (2) abdominal distension, and (3) natural and acquired formation. (1) Inspiration raises and expiration lowers both the sternum and the fifth cartilage attached to the sternum, but as the cartilage has an additional movement of its own, during the double act of breathing it is more lowered during expiration and more raised during inspiration than the sternum. The artificial distension of the lungs after death elevates the fifth cartilage from the sixth to the third of an inch more than the corresponding part of the sternum. If the chest is broad the left fifth cartilage is higher, and if the chest or the left side of it is narrow, the left fifth cartilage is lower in relation to the lower end of the sternum than it would have been otherwise. (2) Abdominal distension raises, and abdominal collapse lowers both the sternum and the fifth cartilage, but the raising or lowering of the fifth cartilage under these circumstances is greater than the respective raising or lowering of the sternum. (3) In some persons the fifth cartilage is naturally higher or lower than in others. Thus the fifth cartilage is sometimes integrally attached to the sixth cartilage and it is restrained by and shares its movements. When this is so the fifth cartilage tends to be lower in relation to the lower end of the sternum than when that cartilage is free. In robust persons with ample chests the fifth cartilage is higher relatively to the sternum than in thin persons with contracted chests, in whom the cartilage tends to be low in position in relation to the end of the sternum.

(2) In nearly all instances (67 in 70) the lower boundary of the heart inclined downwards from the auricle to the apex, in a direction from right to left. In one instance the lower boundary of the heart was an inch, and in another it was only the tenth of an inch lower at the apex than at the lower end of the sternum. Between these two extremes there was every variety, the average dip of the lower boundary of the heart from that point to the apex being about half an inch. (Note 6, page 182.)

The inclination or dip of the lower boundary of the right ventricle ceased at the apex, and thence the lower boundary of the heart curved gently upwards.

(3) The lower boundary of the heart usually extended from two inches to two inches and three-quarters to the left of the middle line of the sternum, (in 43 instances in 65) but in one-third of the cases (20 in 65) it only extended from an inch and a quarter to an inch and three-quarters, while in five instances it extended as much as three inches to the left of the middle line of the sternum. (Note 7, page 182.)

The Top of the Arch of the Aorta.—The top of the arch of the aorta, which is indicated by the adjacent origin of the innominate and left subclavian arteries, forms the upper limit of the system of the heart and great vessels. The position of the top of the arch, like that of the lower border of the heart, is subject to great variety.

In one instance the top of the arch was an inch and a half below the top of the manubrium, so that it was buried deep down in the chest and the innominate artery did not appear in the neck. In another, the top of the arch was seated in the neck, being half an inch above the top of the sternum, so that before the chest was opened the whole innominate artery was visible in the neck, coursing upwards and from left to right across the front of the trachea. The summit of the aorta occupied in different instances every variety of position between these two extreme limits. In five cases it was above, and in six it was on a level with the top of the manubrium ; while in seven, instead of being thus almost or quite visible in the neck, it was situated quite an inch below the top of the manubrium and the whole of the innominate artery was shielded by that bone. In two-thirds of the instances, (30 in 48) however, the top of the aorta occupied an intermediate place behind the upper half of the manubrium, its average position being half an inch below the top of that bone. (Note 8, page 182.)

In forty-eight instances the position both of the lower boundary of the heart and the upper boundary of the arch of the aorta was observed, and, as might have been looked for, there was a general correspondence in the position of these two boundaries in those cases in which they occupied respectively a very high or a very low position. Thus, of the five cases in which the top of the arch of the aorta rose above the top of the sternum, the lower boundary of the heart was situated above the lower end of the sternum in three, at that point in one, and less than half an inch below it in one. Again, the top of the arch of the aorta was situated below the upper end of the manubrium in the whole of six cases in which the lower boundary of the heart was from half an inch to an inch and a quarter below the lower end of the sternum. Again, of seven instances in which the top of the arch was deep in the chest, being more than an inch below the top of the manubrium, in three the lower boundary of the heart was below the lower end of the sternum, in one at that point, and in three above it. Here the correspondence of the upper and lower boundaries is rather indicated than kept up, but this correspondence can scarcely be recognized when we compare these boundaries with each other in those cases in which they occupied a less extreme position. (Note 9, page 183.)

The Boundary-line between the Upper Border of the Heart and the Lower Limit of the Great Arteries.—The origin of the pulmonary artery and the top of the auricular portion of the right auricle may be regarded as the upper boundary of the heart and the lower boundary of the great arteries. The highest position of the origin of the pulmonary artery was at the top of the second cartilage, while that of the top of the auricle was a little higher or on a level with the first space. The lowest position of the origin of the pulmonary artery was the upper edge of the fourth cartilage, while that of the top of the auricle was a little less low, or on a level with the lower border of the third space. Between these two extreme limits the origin of the pulmonary artery and the top of the right auricle occupied every variety of position, but their favourite seat was at or on a level with the second space and the third costal cartilage, which was the situation of those parts in two-thirds of the instances (36 in 49 for the pulmonary artery; 43 in 63 for the top of the auricle).

In the majority of instances there was but little difference between the height of the origin of the pulmonary artery and the top of the right auricle, the height of the two being identical in one-fourth of the instances (10 in 44), and the difference in their height being respectively less than the third of an inch or the third of the breadth of a space of cartilage in one half of them (21 and 20 in 44). Of the remaining instances, in twelve the difference of the height of those two parts varied from one-third to two-thirds of an inch or two-thirds of a space or cartilage, and in one the difference of their height amounted almost to an inch. As a rule, the origin of the pulmonary artery tended to be higher in position than the top of the right auricle, the former part being the higher of the two in twenty instances, and the latter part being the higher of the two in fourteen instances. (Note 10, page 183.)

The varying position, higher or lower, of (1) the pulmonary artery, (2) the aorta, (3) the right ventricle, and (4) the right auricle, in relation to the costal cartilages and the spaces between them, and to the sternum will next be considered.

The Pulmonary Artery.—A knowledge of the position of the pulmonary artery is important to the clinical worker, because it is near the surface of the chest, and because the signs afforded by it reveal the condition of the cavities and valves of the heart, and the ease or difficulty with which the blood finds its way from and to those cavities, the lungs, and the body. Among those signs are, the character of the first sound, whether loud and sharp, or feeble and almost silent, or presenting a pulmonic murmur; the character of the second sound, whether feeble or intense, blunt or sharp, or presenting a double sound, giving in quick succession the aortic and the pulmonic second sounds or the reverse, the later sound being the louder of the two.

The trunk of the pulmonary artery varied in length from three-quarters of an inch to two inches and a half. In more than a third of the instances (17 in 46) the artery was from an inch to an inch and a half in length, while in less than a third of them it was below (15 in 46), and in less than a third of them (14 in 46) it was above that length.

The vertical measurement of the right ventricle, from the origin of the pulmonary artery to the lower boundary of the heart, varied in these instances from two inches and a half to a little over four inches. The length of the ventricle thus measured was from three inches to three inches and a half in less than one half of the cases (20 in 46).

The proportion between the length of the pulmonary artery and the length of the right ventricle, measured from above downwards, presented great variety. In one instance the length of the artery was nearly equal to the length of the ventricle, that of the former being two inches and a half, that of the latter scarcely three inches; while in two others the vertical measurement of the ventricle was five times as great as that of the artery, the length of the latter in one instance being three-quarters of an inch, and that of the former being fully four inches. The average length of the ventricle in relation to that of the artery was as three to one. As a rule, the length of the pulmonary artery regulated the proportion in length, which that vessel bore to the ventricle; thus in the whole of the fifteen instances in which the length of the pulmonary artery was less than an inch, the length of the right ventricle was more than three times that of the artery; while in the whole of the fourteen in which the artery was an inch and a half in length and upwards, the length of the right ventricle was less than three times that of the vessel. (Note 11, page 184.)

As we have already seen, the origin of the pulmonary artery varied in position from the second to the fourth cartilage, its usual situation being the second space and the third cartilage. The top of the pulmonary artery was in one instance almost as high as the clavicle, and in almost one half of the cases (25 in 63) it was situated behind the manubrium or the first rib; while in one case it was so low as to be almost on a level with the upper edge of the third cartilage. In more than one half of the cases (33 in 63) it was seated behind the first space or the second cartilage. (Note 12, page 184.)

The situation of the pulmonary artery during its course is regulated by the length of the vessel and by the position of its starting-place and upper end. In one instance it was so high as to be entirely concealed by the manubrium, while in another it was so low as to be entirely covered by the third cartilage and third space. The artery was rarely limited in position to one space or one cartilage : thus in but one instance it only occupied the first space, and in but one it was quite covered by the second cartilage. The artery usually lay behind one space and one costal cartilage (35 times in 60), but in one-third of the instances (21 in 60) it extended to an additional space or cartilage. In two-thirds of the instances it was present behind the second cartilage (43 in 60) ; in more than half of them it lay behind the first space (35 in 60), and in nearly as many behind the second space (32 in 60) ; while in one-fourth it was covered by the third cartilage (15 in 60), and in one-sixth by the manubrium (9 in 60). (Note 12, page 184).

When the pulmonary artery was long (it was so in 14 of 46 instances), its origin occupied, as a rule, a low position. Thus in sixteen instances the origin of the artery was entirely above the second space, and in only two of these was it long, while in seven it was short. On the other hand, in thirty instances the pulmonary artery at the first part of its course was at or below the second space, and in twelve of them the artery was long, while in eight it was short. (Note 12, page 184.)

The Arch of the Aorta.—The arch of the aorta is not, like the pulmonary artery, visible in its whole course from its root to its summit, being hidden at its root by the right auricle and ventricle. I shall, therefore, not speak here of the whole of the ascending aorta, but of that portion of it which comes into view above the right auricular appendix and between it and the beginning of the pulmonary artery and the arterial cone of the right ventricle.

The arch of the aorta, from the part in its course just spoken of where it first becomes visible, to its highest point at the origin of the innominate and left carotid arteries, varied much in length. In two female subjects, one aged nine the other a few years older, the arch was an inch and a half in length, but in the adult subject its length ranged from an inch and three quarters to three inches. The arch, measured from the lower to the higher points just named, was from just over two inches to two inches and a half in length in two-fifths of the instances (19 in 47), that being about the average or standard length ; from an inch and three quarters to two inches in more than one fifth (11 in 47), and from two inches and a half to three inches in less than two fifths of them (17 in 47), (Note 13, page 184.)

Viewed in proportionate relation to the length of the body, measured approximately from the chin to the pubes, the vertical measurement of the arch varied from one seventh to one fourteenth of the vertical measurement of the body thus taken, and in one half of the instances (23 in 45) the length of the aorta was one tenth of that of the body.

In three instances the vertical measurement of the arch of the aorta was the same as the vertical measurement of the right ventricle taken from the part at which the aorta was visible to the lower boundary of the organ. In two instances the arch was longer than the ventricle in the proportion of ten to nine, but in the remainder the length of the ventricle was greater than that of the aorta, the relative proportion varying from 10 to 10·1 to 10 to 19·17, so that in the last example the ventricle was nearly twice as long as the arch. The average length of the arch in proportion to that of the right ventricle was about 10 to 14 (14 in 47).

The variation in the proportionate length of the arch of the aorta and the right ventricle, although thus considerable, is not nearly so great as the variation in the proportionate length of the pulmonary artery and the right ventricle; since that artery varied in length from more than one half to less than one fifth of the vertical measurement of the ventricle, while the arch was about the same length as the vertical measurement of the ventricle at one end of the scale, and was of half that length at the other end.

There was some correspondence between the length of the aorta and that of the pulmonary artery. Thus the pulmonary artery was short, long, or of medium length in two fifths of the instances in which the aorta was respectively short, long, or of medium length (13 in 33). In the remaining instances (20 in 33) this strict proportion was not maintained, but in only two of them was the difference in the proportionate length of the vessels great, the aorta being long while the pulmonary artery was short.

The position of the lower boundary of the heart in relation to the lower end of the sternum, whether above, at or below that point, is, as a rule, governed to a considerable extent by the length of the arch of the aorta. Thus in nine instances in which the arch was short, measuring two inches or less, the lower boundary of the heart was above the lower end of the sternum in seven instances and below that point in two. The other circumstances that regulate the position of the lower boundary of the heart in relation to the lower end of the sternum are (1) youth; (2) the distension or collapse of the right ventricle; (3) the length of the sternum; (4) the important influence of the higher or lower position of the sternum, higher when the chest is ample, being of an inspiratory type, and lower when the chest is narrow and flat, being of an expiratory type; (5) the higher or lower position of the top of the arch of the aorta which is often ruled by (4) the lower or higher position of the sternum ; (6) the extent to which the heart shrinks upwards after death, which is evinced by the space intervening between the lower boundary of the heart and the lower boundary of the *front* of the pericardium ; and (7) the elevation or depression of the diaphragm, which is the most important influence in producing respectively the elevation or depression of the heart, and which may be caused by (*a*) the contraction or expansion of the lungs, or (*b*) the distension or collapse of the abdomen. These points are illustrated by the two exceptional cases just cited, in which, although the arch of the aorta was short, the lower boundary of the heart was below the level of the lower end of the sternum. Both of these cases were quite young (1) ; in both the vertical measurement of the right ventricle was long, while in one of them that cavity was distended and large (2) ; in both of them the sternum was short, its length being less than four inches in one, while in the other it was four inches and a half (3) ; again in one of them the sternum was high, the length of the neck being only two inches, that of the sternum four inches and a half, and that of the abdomen fourteen inches, while in the other instance in which the right ventricle was large, the sternum was low in position, the length of the neck being almost four inches, that of the sternum less than four inches, and that of the abdomen only ten inches and a half (4). In neither of these examples was the position of the lower boundary of the heart lowered owing to the low position of the top of the arch, for in one of them that point was above the top of the sternum and in the other it was a little way below it (5). In fact this influence, which tended to elevate the lower boundary of the heart in relation to the lower end of the sternum, was more than counter-balanced by the combined influences of which I have just spoken, all working in the opposite direction so as to lower the inferior border of the heart.

In further illustration of this point, the influence, namely, of the shortness or length of the arch in respectively raising or lowering the lower boundary of the heart, we find that of seventeen cases in which the aorta was long, measuring two and a half inches and upwards, in ten the lower boundary of the heart was below the level of the lower end of the sternum, in four it was at that point, while in only three was it above the lower end of the sternum. The three exceptional cases in which the lower boundary of the heart was above the level of the lower end of the sternum were adults of full size (1); the right ventricle was narrow and contracted in two of them (2); and in two the heart deviated to the left so that the lower border of the right ventricle was situated to the left of the lower end of the sternum, instead of being to the right, as is usual. The sternum was long in two of them, measuring in one case over seven inches (3); in all of them the sternum was low in position, the length of the neck being five inches and a half, four inches, and three inches and a half respectively, while that of the abdomen was in each instance less than fourteen inches (4); in one of them the top of the arch was situated above the top of the sternum (5); in one of them the space between the lower limit of the heart and the lower limit of the front of the pericardium was nearly an inch, while in another it was fully half an inch in width, showing that the upward shrinking of the heart after death had been considerable (6); and finally one of them, that in which the space between the heart and the lower rim of the pericardium was small, the stomach was globose and much distended so as to push the heart upwards (7*b*).

In twenty-three cases the arch of the aorta was of intermediate length, or from a little over two inches to two inches and a half, and in these the lower boundary of the heart was in equal relative proportion above, at, and below the level of the lower end of the sternum.

It is evident and is illustrated by what has just been said that if we group the case as I have just done, according to the actual length of the arch of the aorta without relation to age or the dimensions of the body, we shall include some instances in which the arch of the aorta is relatively short or long with those in which it is respectively actually long or short. I have therefore grouped the whole cases anew, and according to the proportional length of the aorta in relation to the length of the body. It will suffice here if I say that the results thus obtained are exactly confirmatory of those that I have just related, and show that the higher or lower position of the lower boundary of the heart in relation to the lower end of the sternum is to a considerable extent governed by the proportional shortness or length of the arch of the aorta. They show those results indeed more strikingly, for the conflicting element of (1) youth has been removed.

Two exceptional instances have been brought into the group in which the arch of the aorta was long in proportion to the length of the body, that were not included in the parallel group in which the arch was actually long. In these two examples the lower boundary of the heart was above the level of the lower end of the sternum, although the aorta was proportionally long. The heart was lifted directly upwards to a great extent in both of these instances, in one of them by very great enlargement of the liver, upwards, as well as downwards, owing to the presence of malignant disease in the organ, the sternum being in this case very long (6·8 inches); and in the other by excessive distension of the stomach and intestines owing to peritonitis, the sternum in this instance being short (4·7 inches) and the top of the aorta being situated in the root of the neck, a third of an inch above the level of the top of the sternum (*7b*).

The Right Auricle.—The right auricle is, as a rule, hidden from observation by the couch of lung that is interposed between it and the sternum and cartilages. It comes, however, to the surface in cases of pericarditis when the effusion into the sac accumulates in sufficient quantity to press aside that portion of lung with which the auricle is covered. With the exception of the important point just considered, the right auricle cannot be recognized locally by the clinical observer, the condition of that cavity being in fact best told by the state of the veins in the neck. The right auricle, measured from the top of its auricular portion to its lowest point, varied in length from one inch to four inches and a half. Its length was usually from two and a half to three and a half inches (in 41 of 62 instances). In one-fifth of the cases (12 in 62) its length was less than two and a half inches; but one-half of these were youthful subjects (7 in 12). The vertical measurement of the right ventricle was longer than that of the right auricle in more than two-thirds of the cases in which the comparison was made (35 in 49); in one-fifth of them the two cavities were nearly or quite of equal length (10 in 49); and in one-twelfth of them the auricle was longer than the ventricle. (Note 14, page 185.)

The auricular portion of the auricle, which during life laps, like a tongue, to and fro, from right to left, and back again, was usually nearly on the same level as the top of the right ventricle, the top of the auricle being of the same height as that of the ventricle in ten instances, higher than that of the ventricle in fourteen instances, and lower in twenty. It was at the lower boundary that the right auricle failed. In one case, in which there was fatal hæmorrhage, the auricle, which was quite insignificant in size, was only half as long as the ventricle. Usually, however, the auricle was shorter than the ventricle by from one-tenth to one-third of its vertical measurement (in 29 of 35 instances).

The right auricle, from the variable extent to which, on the one hand it receives blood, and on the other retains or parts with it before, during, and after death, and from its passive nature, is more variable in form and size than any other cavity of the heart. This point will be briefly illustrated when the lateral dimensions of the cavities are considered.

The Right Ventricle.—The vertical measurement of the right ventricle in relation to the pulmonary artery and the aorta has already been considered.

The right ventricle, measured from the origin of the pulmonary artery to the lower boundary of the cavity, varied in length from two inches and three-quarters to four inches. In one-fifth of the instances (9 in 46) the length of the ventricle thus measured was less than two inches, the majority of these being youthful subjects (5 in 9) ; in nearly one-half of them (20 in 46) this measurement was from three inches to nearly three inches and a half; and in the remainder it was three inches and a half and upwards, being fully four inches in six of them. The variable dimensions and form of the ventricle will be briefly noticed when its lateral measurements are considered. (Note 15, page 185.)

The extent of the vertical measurement or length of the right ventricle produces a marked influence on the position of the lower boundary of the heart in relation to the lower end of the sternum. Thus, of the nine cases in which the ventricle was short, its lower boundary was above the level of the end of the sternum in five instances, and below that level in only one; while of the sixteen instances in which the ventricle was long, in ten of them its inferior border was below the end of the sternum, while in only six of them was it above that point. It is, indeed, self-evident that the lower border of the ventricle must be lower in position when the cavity increases, and higher when it lessens in size.

The extent to which the upper part of the bony sternum covers the great arteries, and the lower part of it, the heart, is very variable. In one instance, the great arteries occupied only the upper fourth of the sternum, while the heart occupied its lower three-fourths. In another instance this proportion was to a considerable extent reversed, for the vessels lay behind the upper five-eighths of the bone, the heart itself being limited to its lower three-eighths. In three-fourths of the instances (39 in 52) the greater share of the sternum lay in front of the heart, but in one-fourth the greater share of the bone was given to the great vessels. On an average, the position of the heart was behind the lower four-sevenths, and that of the great arteries was behind the upper three-sevenths of the sternum. (Note 16, page 185.)

(II.) The Position of the Heart and Great Vessels from Side to Side.

Relation of the Breadth of the Heart to the Breadth of the Chest.—The proportionate transverse diameter of the heart, compared with the transverse diameter of the chest, varied considerably. Thus in one instance, in which death was the result of hæmorrhage, the width of the heart was less than one-third of the width of the chest, on a level with the lower end of the ensiform cartilage (3·2 to 10 inches); while in another instance the measurement across the heart was nearly two-thirds of that across the chest (5·1 inches to 8·2 inches).

In a large number of the cases observed (39 in 65) the breadth of the heart was somewhat less than one-half of the breadth of the chest, the proportion varying from 10 to 4 to 10 to 5. In one-sixth of the instances (11 in 65) the width of the heart was less than two-fifths (10 to 3 to 10 to 3·9), and in one-third of them (15 in 65) it was more than one-half (10 to 5 to 10 to 6·2) of the width of the chest. The size of the chest from side to side did not appear to exercise any material influence on the proportional breadth of the heart, but the heart was more frequently of the average proportional width in those instances in which the chest was of medium breadth (9 to 9·9 inches) than in those in which it was either wide (10 to 12 inches) or narrow (6 to 8·9 inches). Thus, the heart was of the average proportional breadth in five-sixths of the instances in which the chest was of the medium breadth (10 in 12); in one-half of those in which the chest was wide (12 in 22); and in two-thirds of those in which the chest was narrow (19 in 31). The heart was comparatively wide and comparatively narrow in equal numbers in those instances in which the chest was wide (6 of each kind in 22); while the organ was more frequently comparatively wide than narrow in those in which the chest was narrow (wide in 8, narrow in 4, of 31). Great distension and great collapse of the abdomen produced a marked effect on the proportionate width of the heart in relation to that of the chest. Thus, in fully two-thirds of the instances in which the heart was proportionally narrow, the abdomen was distended (8 in 11), and in one-half of these the distension was very great (4 in 11); while in one of the three remaining cases the abdomen was large, in one it was of moderate size, and in only one was it small. Then the reverse took place in those cases in which the heart was proportionally wide, since in only one-fifth of them was the abdomen distended (3 in 15), and in but one of these was the distension very great. Distension of the abdomen seemed to produce this effect by acting in two directions, one upon the chest, by widening it, the other upon the heart itself, by lessening it. The chest is widened because the distended abdomen pushes the ribs outwards on either side, and elevates the lower border of the chest in front and at each side ; and the heart is lessened because the distended abdomen compresses the heart upwards into the contracting space of the higher part of the cone of the chest, and so lessens the amount of blood in the organ. (Note 17, page 185.)

The proportional size of the anterior transverse diameter of the combined right auricle and ventricle, compared with that of the left ventricle, exercises a marked effect on the proportional breadth of the heart in relation to the breadth of the chest. This might indeed be anticipated, for when the proportional width of the combined right auricle and ventricle is great in relation to the width of the left ventricle, the right cavities are distended with blood, and the whole heart is consequently large, measured from side to side. In more than one-half of the cases (7 in 12) in which the proportional breadth of heart to that of the chest was great, the proportional breadth of the combined right auricle and ventricle to the left ventricle in front was very great, the former being about ten times wider than the latter ; and in none of them was the proportional breadth of the right cavities small. Again, in almost one-half of the instances (5 in 11) in which the proportional width of the heart in relation to that of the chest was small, the proportional width of the right auricle and ventricle in relation to that of the left ventricle was also small, the ratio being about 10 to 4. (Note 18, page 186.)

Extent to which the Heart occupied the Right and the Left Sides of the Chest.—The extent to which the heart occupied respectively the right and the left sides of the chest varied much in different instances. Thus in one example, the heart extended one inch and a tenth to the right and four inches to the left of a vertical line drawn down the middle of the sternum ; and in another the organ extended nearly two inches and a half to the right, and only two inches and a quarter to the left of that line ; while in two other instances the heart occupied the right and the left sides of the chest in exactly equal proportions. Thus, taking the two extreme cases, in one of them one-fifth of the heart occupied the right side, and four-fifths of it the left side of the chest ; while in the other fully one-half of the heart was lodged in the right side, and less than one-half of it in the left side of the chest.

There was every gradation of difference between these two extreme examples. In fully two-fifths of the instances (27 in 67) one-third of the heart or less was situated in the right side, and two-thirds of the heart or more in the left side of the chest ; while in fully two-fifths of them (28 in 67), three-fifths of the heart or less was seated in the left side, and two-fifths of it or more in the right side (literally 16 to 10).

In twelve intermediate and standard instances, the heart was distributed to the right and to the left of the middle line of the sternum in the proportion respectively of ten and eighteen, and this was the average position of the organ in sixty-seven bodies, so that nearly two-thirds of the organ lay in the left side, and more than one-third of it in the right side of the chest. (Note 19, page 186.)

The influences that cause the deviation of the heart towards the right or the left side of the chest, are (1) before all others, the difference in size of the right lung and the left ; (2) the encroachment upwards of the liver or the stomach to an unusual extent on the right or the left side of the chest respectively ;

(3) the position of the patient before death on the right side or on the left, an occurrence that may take place in certain rare cases, such, for instance, as bed-sores and affections of one side of the chest; (4) the shrinking of the heart upwards after death, as evinced by the extent of the space intervening between the lower boundary of the heart and the lower boundary of the *front* of the pericardium; (5) the shortening of the aorta; (6) the relative size of the heart and of its cavities, measured from side to side. There are doubtless other influences at work to produce the effect in question, but I have not discovered them.

(1.) Of the small number of instances (6 in 66) in which the heart swerved very far to the left, so as to occupy that side of the chest to a greater extent by from three to four times than the right side of the chest, the two lungs were equal in size in one-third (2 in 6), while the right lung was greater than the left in the remaining two-thirds. On the other hand, of the cases in which the heart was lodged equally in the right and the left sides of the chest (3 in 66), and those in which it bore only a little more to the left than the right side of the chest (12 in 66), the two lungs were of equal size in one-fourth, and the left lung was larger than the right in the remaining three-fourths. Thus in none of the instances in which the heart deviated greatly to the left was the left lung larger than the right; and in none of those in which the heart tended towards the right side of the chest was the right lung greater than the left. In the whole of the remaining instances, with a few exceptions, an analogous condition obtained, the right lung being the larger when the heart was lodged to an unusual extent in the left side of the chest, and the left lung being the larger when the heart was lodged to an unusual extent in the right side of the chest. (Note 20, page 186.)

(2.) The position of the upper surface of the liver, covered by the diaphragm, was higher in the right side of the chest than that of the stomach in the left side of the chest in all but a fraction of the instances observed (57 in 61). On an average, the liver at this situation was higher than the stomach by more than half an inch (·6 inch). In two-fifths of the cases (25 in 61) the heart occupied the left side of the chest to an unusual extent; of these, in nearly two-thirds the height of the liver in relation to that of the stomach was above the average (14 in 25); in nearly one-third it was below the average (7 in 25); and in a fraction it was at the average (3 in 25). In all but one of the five instances in which the heart was very far to the left, the relative height of the liver was above the average. In one-fourth of the cases (14 in 61) the heart occupied the right side of the chest to an unusual extent, and in nearly three-fifths of these (8 in 14) the height of the liver was below the average, while in fully two-fifths of them (6 in 14) it was above the average. When the top of the liver encroached to an unusual proportional extent on the right side of the chest, it may be said that the unduly-elevated organ tended to displace the heart to the left. There were, however, a few remarkable exceptions to this rule. Thus, in one instance the heart occupied equally the right and the left sides of the chest, and yet the top of the liver rose higher by nearly an inch and a half into the right side of the chest than the stomach did into the left side of the chest. The reason of this was obvious. There was contraction of the right lung in this case, owing to phthisis, with the effect of drawing both the heart and the liver unduly into the space previously occupied by the right lung.

(3.) I have no after-death evidence to show that the position of the patient on the right side or the left during the period preceding death caused the heart to occupy unduly the right or the left side of the chest. We know, however, that during life the heart falls towards the side on which the person lies. At the same time that side of the chest expands less during inspiration than the opposite side, owing to the restraint offered to the movement of the ribs that bear the weight of the chest, while, to compensate for the deficient expansion of the restrained side, the free side of the chest expands to an increased extent. After death, the organs, as a rule, retain pretty nearly the place they occupied during life, and the effect of position during life in displacing the heart more towards the right side or the left, is retained after death.

(4.) When the heart shrinks upwards, so as to leave a considerable space between the lower boundary of the organ and the lower boundary of the *front* of the pericardium, the heart, as a rule, bears more towards the right than the left side of the chest. Thus the space below the heart was large in two-thirds of the cases in which that organ bore unusually to the right (8 in 12); and in only two-fifths of those in which it bore unusually to the left (8 in 19).

(5.) I am of opinion that in those cases in which the heart shrinks thus upwards, and bears unusually to the right, the contraction and shortening of the aorta is one of the principal agents that draw the apex and the body of the heart to the right as well as upwards.

(6.) The relative size of the heart and of its cavities, measured from side to side, exercised much less influence than the relative size of the right and left lung, and the relative height of the liver and stomach, on the extent to which the heart occupied after death the right and left sides of the chest respectively.

When the heart is large, the lungs necessarily make way for it, to the right and left equally if the development of the lungs is equal; but when one lung is expanded and the other is contracted, the heart when large encroaches more upon the contracted than the expanded lung, for that lung offers the least resistance. The stronger influence of the greater size of one lung overrides then the weaker influence of the size of the heart. But it is evident that the size of the heart must produce an influence supplementing and modifying the influence of the greater size of one lung. When the heart is large it enhances the influence of the greater size of one lung, and the heart encroaches more on the side containing the contracted lung; and when the heart is small it lessens the influence of the greater size of one lung, and the heart encroaches less on the side containing the contracted lung. Thus in the large group of cases in which the heart occupied the left side of the chest to an unusual extent (1 to 3·9 to 1 to 2, in 23 in 60), and in the equally large group in which the heart was distributed in the average proportion to the right and left sides of the chest (1 to 1·5 to 1 to 1·9, in 23 in 60), the heart was large in fully one-fourth of the respective instances (6 in 23 and 7 in 23), while in no instance was the heart large in the group in which that organ occupied the right side of the chest.

The heart was small in two or three instances in which the organ occupied the right and the left sides of the chest to an equal extent. The heart is attached at the centre of the chest, behind, to the roots of the lungs by the pulmonary veins and pulmonary arteries; and above and in front, to the great arteries and the descending vena cava from which it is suspended. The heart, therefore, when it does not bear to the left or to the right owing to the greater or less size of the right or left lung, hangs directly downwards from the point of its suspension at the centre of the chest, and tends to occupy a central position, bearing equally to the right and to the left.

Breadth of the combined Right Auricle and Ventricle in relation to that of the Left Ventricle as seen in front.—The breadth of the combined right auricle and ventricle in relation to the breadth of the left ventricle as seen in front, varied from 10 to 1 to 10 to $4\frac{1}{2}$. Thus the right cavities occupied almost the whole front of the heart in some examples, and little more than two-thirds of it in others. Every shade of variation existed between these two extreme instances; but the average or standard proportion between the breadth of the right cavities and that of the left ventricle in front was as 4 to 1. (Note 21, page 187.)

Breadth of the Right Auricle.—The auricular portion of the right auricle[1] varied in breadth from a little over half an inch (·55 inch) to two inches and a third (2·3 inches), its average breadth being one inch and a third (1·3 inch). (Note 22, page 187.)

The body of the right auricle varied in breadth from a quarter of an inch to an inch and a half, its average breadth being four-fifths of an inch (8·1 inch). (Note 23, page 187.)

The left edge of the auricular portion of the right auricle extended to the left of the left edge of the sternum in four instances; it was placed nearer to the left than the right edge of the sternum in twenty-four cases; it was situated about midway between the left and the right edge of the sternum in eight instances; and it was nearer to the right than the left edge of that bone in fourteen. (Note 24, page 187.)

The right edge of the right auricle extended to the right

[1] The right auricle is about half an inch wider, and the right ventricle is about half an inch narrower than the measurements given in this article. Those measurements have been necessarily taken from the right auriculo-ventricular furrow, which is the apparent boundary-line between the right auricle and ventricle, but is situated half an inch to the right of the real boundary-line between those cavities.

of the right edge of the sternum to an extent varying from a quarter of an inch to an inch and three-quarters, so that to that extent the auricle lay behind the right costal cartilages. The right auricle extended on an average from half an inch to a little over an inch to the right of the sternum. (Note 25, page 187.)

The auricular portion of the right auricle was wider than the body of the auricle in all but two instances, in which instances their breadth was the same. As a rule, the auricular portion was wider than the body of the auricle in the proportion of ten to six and a half (10 to 6·4), but in two instances that portion was nearly three times as wide as the body of the auricle. (Note 26, page 187.)

The proportional breadth of the auricular portion of the right auricle varied from two-fifths to one-fifth of the breadth of the heart itself. The width of the heart was, on an average, nearly four times as great as that of the auricular portion of the right auricle. (Note 27, page 187.)

The proportional breadth of the body of the right auricle varied from about a fourth (10 to 36) to a ninth (10 to 86) of the breadth of the heart. In one exceptional case in which death took place from hæmorrhage, the heart was twelve times as wide as the right auricle, that cavity being quite empty. The width of the heart was, on an average, nearly six times as great as the width of the right auricle. (Note 28, page 187.)

Breadth of the Right Ventricle.—The breadth of the right ventricle[1] varied from four-fifths (in 6 of 38 instances) to a little over one-half (in 11 of 38 instances) of the whole breadth

[1] The right ventricle is about half an inch narrower, and the right auricle is about half an inch wider than the measurements of those cavities given in this article, for the reason stated in the foot-note at page 58.

of the heart. The average or standard breadth of the right ventricle was two-thirds of the breadth of the heart (10 to 15), and in one-half of the cases observed the proportional width of the right ventricle in relation to that of the heart was above (19 in 38), and in one-half of them it was below that average (19 in 38). (Note 29, page 188.)

The breadth of the arterial cone of the right ventricle a little way below the origin of the pulmonary artery varied from four-fifths to two-fifths of the breadth of the right ventricle at its middle, the average width of the arterial cone being nearly three-fifths of that of the body of the right ventricle. As a rule, when the body of the right ventricle was wide or narrow in relation to the heart, the arterial cone was respectively narrow or wide in relation to the body of the right ventricle. (Note 30, page 188.)

The vertical diameter or length of the right ventricle,[1] measured from the origin of the pulmonary artery to the lower boundary of that cavity, was somewhat shorter than the transverse diameter or breadth of the ventricle in one-sixth of the cases (5 in 30). In the rest of them the length of the right ventricle was greater than its breadth. In one instance the length of the ventricle was to its breadth as 17·3 to 10, but the average or standard measurement of the length to the breadth of that cavity was as 4 to 3. (Note 31, page 188.)

The breadth of the right ventricle in relation to that of the right auricle[2] below its auricular portion varied from 10 to 1·4

[1] As the breadth of the body of the right ventricle is about half an inch narrower than the measurements of that cavity given in this article, for the reason stated in the foot-note at page 58, the actual relation of the transverse diameter or width of the body of the right ventricle here stated to that of the *conus arteriosus*, and to the vertical diameter or length of the ventricle, is half an inch narrower than the proportional measurements here given.

[2] See note, page 58.

to 10 to 5·2, the average proportion being 10 to 3. (Note 32, page 188.)

The actual breadth of the right ventricle[1] in adults, without distinction of sex, varied from two to four inches. In three-fifths of them the width of the ventricle was from three to three and a half inches (in 14 in 24); in one-fifth of them it was above three and a half inches; and in two-fifths of them it was less than three inches. (Note 33, page 188.)

In one instance the right ventricle extended further to the right than to the left of a vertical line drawn down the middle of the sternum, but in every other instance the ventricle extended more to the left than to the right of that line. In one case, nine-tenths of the right ventricle was situated in the left side of the chest, and only one-tenth of it in the right side; but, on an average, the ventricle extended nearly three times further to the left than the right of the middle line (27 to 10). (Note 34, page 188.)

The limits of the body of the right ventricle and of its arterial cone are indicated, (1) to the left by the position of the longitudinal furrow between the ventricles; and (2) to the right by the position of the transverse furrow between the right ventricle, including the right edge of the origin of the pulmonary artery, and the right auricle, including its auricular portion.

(1). As a rule, the inter-ventricular furrow takes an oblique direction outwards, or to the left from above downwards, so that the ventricle occupies a wider space below than above (in 26 out of 39 instances). In a small number of cases (6 in 39) the reverse takes place, and the furrow tends inwards, and then outwards with a peculiar double curve as it descends. In these instances the right ventricle was in a state of contraction, and the left ventricle was exposed to a large

[1] See note 1, p. 60.

extent, while in those in which the septum inclined markedly outwards during its descent the right ventricle was distended so as to cover all but a small portion of the left ventricle. The greatest inclination of the longitudinal furrow to the left was one inch, and its greatest inclination to the right was half an inch (·45 inch). (Note 35, page 189.)

In one instance, a case in which the right ventricle was contracted, the longitudinal furrow in its descent curved to the right, and the body of the right ventricle towards its left border was completely shielded by the sternum ; but in every other instance that cavity was covered in front to a greater or less extent by the cardiac costal cartilages, to the left of the lower half of the sternum. In a small proportion of the cases (6 in 36) the right ventricle lay behind the costal cartilages from end to end, from the sternum, namely, to the ribs to which they are united ; and in half of these (3 in 6) the ventricle extended to the left, beyond the cartilages and behind the ribs. In the majority of the cases (19 in 36) the longitudinal furrow extended either up to the ends of the cartilages, a little beyond them, or half an inch or less to the right of them, so that in all these cases the cardiac cartilages covered the right ventricle almost or quite from end to end. In the remaining instances (17 in 36) a considerable portion of the cartilages, varying from less than an inch to more than an inch and a half (·7 to 1·7 inch) extended beyond the right ventricle. (Note 36, page 189.)

The body of the right ventricle, starting from a vertical line drawn down the middle of the sternum, extended to the left in all the cases, from a little over half an inch (·6 inch) to almost four inches (3·8 inch). Between these two extreme instances there was every shade of difference. In the great majority of the cases (35 in 52) the right ventricle extended from one inch and a half to two inches and a half to the left of the middle line of the sternum, and behind the cardiac cartilages. (Note 37, page 189.)

(2). The transverse or right auriculo-ventricular furrow[1] was situated to the right of the right edge of the lower portion of the sternum, and behind the right costal cartilages, in fully two-thirds of the cases (36 in 51), at that edge in a fraction of them (3 in 51), and to the left of that edge, and therefore behind the lower portion of the sternum, in one-fourth of them (12 in 51). In one instance the right auriculo-ventricular furrow extended an inch and a third (1·3 inch) to the right of the right edge of the sternum, so as to lie behind the right costal cartilages to that extent, and in five instances its right limit was situated behind the middle line of the sternum. Between these two extreme limits there was every gradation in the position of the right auriculo-ventricular furrow.

The left edge of the auricular portion of the right auricle gives, as a rule, very nearly the position of the right edge of the arterial cone of the right ventricle, where it is about to end in the pulmonary artery. The right edge of the arterial cone, starting from the tricuspid orifice, invariably declines, as it ascends, from right to left. There was considerable difference in the degree of its inclination, which was measured by the distance between the right limit of the auriculo-ventricular furrow and a line drawn downwards from the right edge of the pulmonary artery. The right edge of the arterial cone swerved as it ascended from right to left in one instance, a man, to the extent of two inches, and in another, also a man, to that of a little over half an inch (·6 inch).

[1] The transverse furrow, which is the apparent boundary-line between the right auricle and the right ventricle, is about half an inch to the right of the real boundary-line between those cavities. See note at page 58.

There was every variety of inclination between these extreme instances, but in the great majority of cases (34 in 51) the curved line of the right border of the arterial cone bent downwards, with an inclination from left to right of from an inch to an inch and a half, the boundary-line starting above from the right border of the origin of the pulmonary artery, and ending below in the auriculo-ventricular furrow. (Note 38, page 189.)

Breadth and Position of the Pulmonary Artery.—As the origin of the pulmonary artery is the point of convergence towards which the right ventricle propels its blood, this is the natural place for examining the position of that artery. The pulmonary artery forms, indeed, the pointed apex of a triangle, the body of which is constituted by the front of the right ventricle, its base by the lower boundary of that cavity, resting on the central tendon of the diaphragm, its left side by the longitudinal furrow, and its right side by the auriculo-ventricular furrow.[1]

The breadth of the pulmonary artery varied from a little over half an inch (·6 inch) to a little under an inch and a half (1·45 inch). Between these two extreme limits, both of which occurred in men, there was every kind of variation in the breadth of the artery. The width of the artery depended as much on the amount of blood that it happened to contain as on the natural size of the vessel. In one-third of the cases (18 in 45) the breadth of the artery varied from three-quarters of an inch to less than an inch, and of these three were boys and four were young people; and in one-third of them (17 in 45) the breadth varied from an inch to an inch and a quarter, and of these the youngest was a girl of 16, the rest being adults. The pulmonary artery was wider

[1] Or rather by a line half an inch to the left of the furrow. See note at page 58.

than the aorta in twenty-seven cases, narrower than the aorta in eleven, and of the same width as the aorta in six. (Note 39, page 189.)

In one instance the right border of the pulmonary artery at its origin lay two-thirds of an inch to the left of the sternum, and in another it was covered by the sternum to the extent of an inch, so that a mere rim of the artery (·25 inch) appeared in the second left space. Between these two extreme instances there was every degree of difference in the position of the origin of the pulmonary artery to the right or to the left.

In two-thirds of the cases (31 in 45) the pulmonary artery was situated partly behind the sternum, and partly behind the upper cartilages and spaces to the left of the sternum; but in one-third of them (14 in 45) the vessel lay entirely to the left of that bone, and behind the upper spaces and cartilages.

Of those instances in which the artery lay completely to the left of the sternum, in three-fourths (11 in 14) the right border of the vessel was on a line with or a little beyond the left border of the bone, and in the remainder (3 in 14) it was placed from one-third to two-thirds of an inch to the left of that bone. Of the instances in which the artery lay partly behind the sternum, partly behind the cartilages and their spaces, in all but one-fifth (6 in 31) the vessel was situated to a greater extent behind the spaces than the sternum. In no single instance was the artery entirely covered by that bone. In the large majority of the cases, therefore, the greater part (in 25 of 45 instances), or the whole (in 14 of 45 instances), of the artery bore to the left of the sternum and presented itself behind the upper costal cartilages and their spaces from the first cartilage to the third space. (Note 40, page 190.)

Breadth of the Left Ventricle.—The breadth of the left ventricle as it is seen in front where it extends from the septum between the ventricles to the left border of the heart, varied from almost half an inch (·4 inch) to almost an inch and a half (1·4 inch). The average width of the ventricle was four-fifths of an inch (·8 inch). The proportion that the width of the left ventricle at its anterior aspect bore to the width of the whole heart varied from less than one-tenth (·08 to 10) to more than three-tenths (3·2 to 10). As a rule, when the ventricle was actually narrow, it was also proportionally narrow in relation to the breadth of the heart; and when the ventricle was actually wide, it was also proportionally wide in relation to the breadth of the heart. The exceptions to this rule are so few that I need not give the details here. (Note 41, page 190.)

Position of the Apex of the Heart.—The line of junction of the fourth and fifth ribs to their cartilages is a landmark of some clinical importance, for, aided by knowledge, this line may be pretty nearly ascertained during life. A downward bow is made by the descending curves of those ribs and of their cartilages, and their junction usually corresponds to the deepest part of the bow. The left boundary of the heart at the apex was situated in one instance an inch to the left, and in another instance an inch to the right of the junction of the fourth or fifth rib to its cartilage; in five cases out of forty-two this left boundary was at that junction, in eighteen it extended to the left of it, and in six it was seated to the right of it.

The relation of the lower anterior edge of the upper lobe of the left lung to the apex of the heart is a point of clinical value. The septum between the upper and lower lobes is situated a little way to the left of the apex of the heart, and this portion of the upper lobe is detached as it were from the body of the lung and dips downwards and forwards, so that it may devote itself to the protection of the apex around which it is folded, being situated outside, behind and in front of, above and slightly below the apex. A small tongue of lung, the existence of which I pointed out in 1844, frequently interposes itself between the front and under surface of the apex and the walls of the chest. This tongue of lung and the adjoining structure of the lower portion of the upper lobe play backwards and forwards with the forward and backward play of the apex of the heart. When the apex comes forward towards the ribs and spaces during the contraction of the ventricle, the tongue of lung retracts ; when the apex retracts, the tongue of lung expands ; and thus those two structures interchange with and adapt themselves to each other during the movements of the heart and the lungs. This tongue of lung that thus laps round and in front of the apex was present in two-fifths of the series of cases under observation (24 in 61), was absent in one-half of them (31 in 61), and was just indicated in the form of an inward curve in one-tenth of them (6 in 61). This tongue was strongly marked in one-third of the instances in which it existed (8 in 24), was slightly marked in another third (9 in 24), and was of intermediate form in the remaining third (7 in 24). Besides these instances, this tongue was present in eighteen additional examples in my possession : in one-half of these it was large and pronounced (9 in 18), in four of them it was of medium size, and in four it was small.

During and after death the apex contracts in one direction, or upwards and to the right towards the centre of the heart, and the left lung retracts in another direction or to the left. The heart is therefore more exposed after death than during life. This especially applies to the apex of the heart. As a rule, however, in these cases, the apex and the adjoining portion of the heart are still covered to a certain extent by lung (in 34 instances out of 58). In two of these instances the lung covered the heart from the apex towards the sternum to the extent of two inches and a half, but in the rest of them the extent of lung in front of the apex varied in breadth from an inch and a quarter to the tenth of an inch. In one-sixth of the cases (9 in 58) the edge of the lung was on a line with or crossed the apex, and in one-fourth of them (15 in 58) it was situated to the left of the heart, so as to expose the apex. The space thus left between the lung and the apex varied from one inch to the eighth of an inch. (Note 42, page 190.)

The Breadth and Position of the Ascending Aorta.—The breadth of the ascending aorta varied from half an inch to an inch and a half (1·45), its average breadth being nearly one inch (·96 inch). (Note 43, page 190.)

The aorta was usually narrower than the pulmonary artery, (in 27 of 44 cases), but it was sometimes wider than that vessel (11 in 44), and in a few instances (6 in 44), the two arteries were of equal breadth. When the aorta was less than an inch in width, it was very seldom wider than the pulmonary artery (in 2 of 36 cases); but when the aorta was an inch or more in breadth, it was more often the wider of the two arteries, in the proportion of nine to eight. (Note 44 page 190.)

The ascending aorta was completely covered by the sternum in nearly one half of the cases (19 in 45), and of these instances, in one-third the artery was central (6), in one-third (6) it inclined to the right, and in one-third (7) it inclined to the left.

In one-third of the cases (15 in 45) the ascending aorta was visible to a greater or less extent to the right of the sternum, and in six of these the exposure of the artery to the right was great, the whole artery being brought into view in one case in which there was excessive distension of the abdomen.

In one-fourth of the cases (11 in 45), the ascending aorta was partially visible to the left of the sternum, but in only one instance did the breadth of the portion of the artery thus exposed amount to more than the third of an inch. (Note 45, page 190.)

The Position of the "Root of the Aorta,"[1] *including the Orifice, Valve,*[2] *and Sinuses of the Aorta.*—I possess only seven illustrations of the position of the root of the aorta. They, however, show the aortic valve in a variety of situations, and as the anatomical relations of the "root of the aorta" to the root of the pulmonary artery, and to the visible portion of the ascending aorta, are very definite, it is easy to infer the position of the aortic valve, when we know that of the pulmonic valve and that of the ascending aorta.

The ascending aorta, as it mounts upwards, curves first to the right and then to the left. The upper and lower ends of the curve bear to the left, and the centre of the curve bears to the right. When, therefore, the visible portion of the ascending aorta is situated far to the left or far to the right, the

[1] I have adopted the term "root of the aorta" at the suggestion of Mr. Marshall, and with the approval of Dr. Sharpey.

[2] Haller, writing in Latin, correctly designates the valves of the heart under the term "valvulæ," derived from "valvæ," folding doors, thus—"valvulæ semilunares," "valvulæ mitrales," "valvulæ in quas annulum venosum diviserunt." Senac (*Structure du Cœur*), speaking of the valves of the heart, uses the terms "valvules tricuspidales, mitrales, et sigmoides:" and Douglas, in his translation of Winslow, describes the tricuspid valves," the "mitral valves," and the "semilunar valves."

Portal was apparently the first to speak of the auriculo-ventricular valves in the singular number, under the name respectively of "valvule mitrale" and "valvule triglochine," on the ground, long previously recognised by anatomists, that the flaps of each of those valves are attached to a valvular ring.

The English word "valve" has been applied by engineers and in common use to the mechanism, as a whole, for preventing the back-flow of fluid, and not to one or other of the flaps composing that mechanism. I have therefore, here and elsewhere, spoken of the semilunar flaps of the aortic or pulmonic valve, and not of the semilunar valves.

sinuses and valve of the aorta are also situated far to the left or far to the right, their bearing being always more to the left than that of the ascending aorta. The lower boundary of the pulmonic orifice corresponds with the upper boundary of the aortic orifice at the junction of the anterior and the left posterior flaps of the aortic valve. Nearly one half of the root of the pulmonary artery is situated just above the left posterior aortic sinus, and more than one half of it extends to the left of the root of the aorta. The root of the aorta extends obliquely downwards to the extent of about one inch below, and fully half an inch to the left of the pulmonary artery, the extent being greater or less in accordance with the oblique diameter of the root of the aorta.

In one instance the greater part of the anterior aortic sinus was situated behind the second left space from its upper to its lower boundary, while the remainder of the root of the aorta was covered by the left border of the sternum. In this case the ascending aorta occupied the left half or three-fifths of the sternum, the right side of that bone being occupied by the descending cava, and the pulmonic valve was situated entirely to the left of the sternum behind the second cartilage and the upper third of the second space.

In another instance the right border of the right posterior sinus of the aorta was present in the third right space close to the right edge of the sternum, and the whole of the rest of the root of the aorta was covered by the right three-fifths of the sternum, its left two-fifths being occupied by the arterial cone of the right ventricle. In that case the whole heart lay more to the right than to the left of the median line, the ascending aorta extending four-fifths of an inch to the right of the right edge of the sternum, and four-fifths of the origin of the pulmonary artery, which was on a level with the third cartilage, was covered by the sternum.

In the first of these two cases, the situation of the ascending aorta and that of the origin of the pulmonary artery were high and much to the left, and the situation of the root of the aorta was correspondingly also high and much to the left. In the second of them, the ascending aorta and the origin of the pulmonary artery were low in situation, and were placed very far to the right; and the root of the aorta was also low in situation, and was placed very far to the right.

Of the remaining five instances, in two the root of the aorta was situated for one-fifth of its breadth in the second left space, and for four-fifths of its breadth behind the sternum on a level with the second space and the third cartilage. In two other cases, the proportion of the root of the aorta behind the sternum and to the left of that bone was about the same as in the two cases just quoted; but in one of them it was situated behind the third left cartilage and the upper third of the third left space; while in the other instance it was still lower, being on a level with the lower border of the third cartilage, the third space, and the upper border of the fourth cartilage.

The root of the aorta, including, as I have said, in that term the orifice, valve, and sinuses of the artery, was oblique in direction in all instances. Its longest or oblique diameter ranged from one inch to almost an inch and a half (1·4); its vertical diameter varied from ·8 inch to 1·05 inch; and its transverse diameter from ·8 inch to 1·2 inch. In three instances the transverse and vertical measurements were equal; in two the transverse diameter exceeded the vertical; and in two the vertical diameter exceeded the transverse.

Although the observation of the actual position of the root of the aorta in health has been limited to the seven cases just examined, yet we are able to infer its proximate position by the knowledge already obtained of the situation of the right edge of the ascending aorta, and of that of the origin of the pulmonary artery. The origin of the pulmonary artery was in one case as high as the upper border of the second cartilage, and in another it was as low as the upper border of the fourth cartilage. In the former case the root of the aorta must have been on a level with the second cartilage and the upper portion of the second space, while in the latter case it must have been on a level with the fourth cartilage and the upper portion of the fourth space. The usual position of the origin of the pulmonary artery was behind the second space or the third costal cartilage, and the usual position of the root of the aorta, following in the wake of its companion great artery, must have been on a level with the third cartilage and the third space. The average situation of the root of the aorta must therefore have been on a level with the lower portion of the third cartilage and the third space. In the seven cases just examined the right edge of the ascending aorta was situated on a line to the right of the right edge of the root of the aorta, to an extent varying from the eighth of an inch to more than half an inch. In the same instances the left edge of the ascending aorta was situated on a line to the right of the left edge of the root of the aorta, to an extent varying from one-third (·3 inch) to three-fifths of an inch. The extent to which the ascending aorta bore to the right in relation to the root of the aorta was governed by two circumstances: (1) the degree to which the ascending aorta was situated to the right or to the left: and (2) the distension or collapse of the artery. (1) The root of the aorta was situated further to the left in relation to the ascending aorta when the position of the ascending aorta was far to the left than when it was far to the right. (2) The root of the aorta further to the left in relation to the ascending aorta when the breadth of the artery was great owing to distension, than when it was small owing to collapse.

In one instance, a case with great intestinal distension, the whole of the ascending aorta was situated to the right of the sternum, and in that instance the greater portion of the root of the aorta must have been also situated to the right of the sternum. In another instance, the ascending aorta was

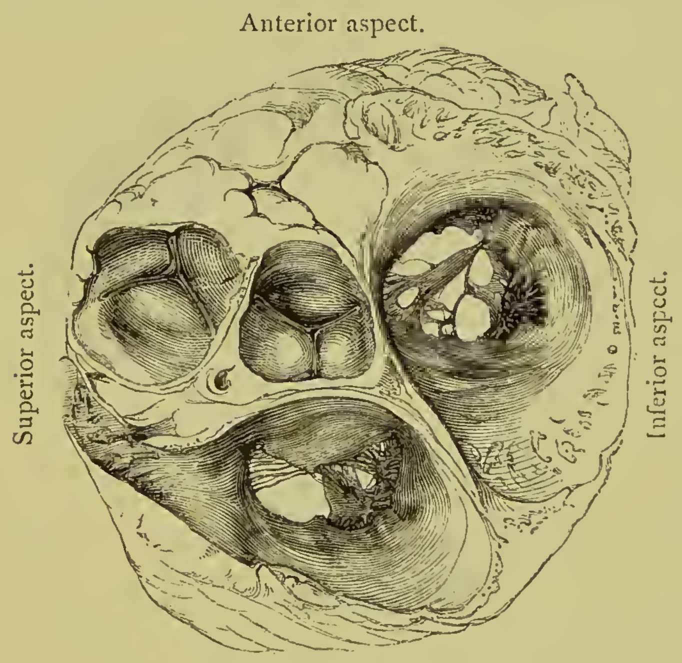


FIG. 1.—Showing the pulmonic and aortic valves closed ; the tricuspid and mitral orifices open. Period of the *diastole* of the ventricles.

situated to the extent of more than one-half of its breadth to the left of the sternum, and in that instance, the greater portion of the root of the aorta must have been also situated to the left of the sternum.

In one-half of the cases (19 in 45), the whole of the aorta was covered by the sternum, and in most of these the greater part of the root of the aorta must have been also covered by the sternum, but its left border must have usually passed a little to the left of that bone, being situated behind one of the cartilages or spaces close to the left edge of the sternum.

Under these circumstances the average or standard position of the root of the aorta must have been behind the left two-thirds or half of the sternum on a level with the third cartilage and the third space, its left border being placed behind and below that cartilage at its articulation. (Note 46, page 116.)

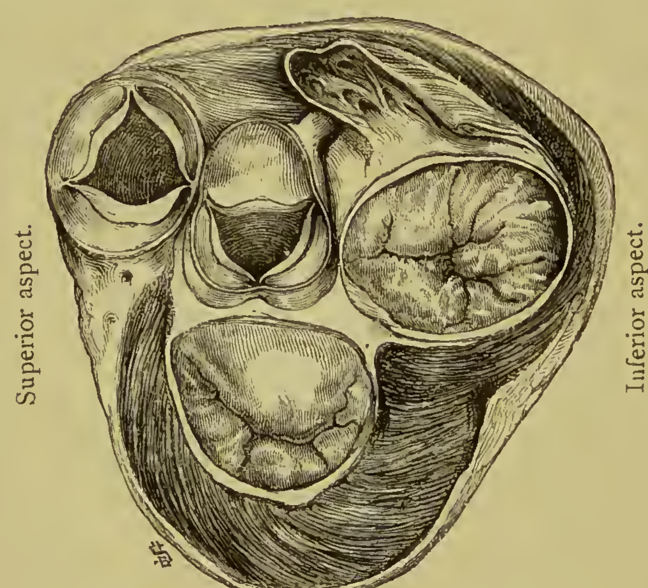


FIG. 2.—Showing the pulmonic and aortic orifices open ; the tricuspid and mitral orifices shut. Period of the *systole* of the ventricles.

The Position of the Aortic Sinuses, and the Flaps of the Aortic Valve.[1]—The aortic orifice looks towards the apex of the ventricle in a direction to the left downwards, and slightly forwards. The aspect of the orifice is therefore oblique, its obliquity being usually quite as great from above downwards as from left to right. When the heart bears unduly to the left, the downward obliquity of the aortic orifice is greater than when it bears unduly to the right.

[1] See Figs. 1, 2, and 3.

The root of the aorta, including the aortic orifice, valve, and sinuses, projects forwards, in front of the mitral valve and the cavity of the left ventricle, so as to interpose itself between the orifice of the pulmonary artery above and the tricuspid orifice below. The root of the aorta thus separates those two openings from each other, the *conus arteriosus* being situated in front of it. When a section is made through the auricles across the base of the heart, so as to expose the four great openings of the heart, the pulmonic, the aortic, and the tricuspid orifices, viewed in their *natural position*, are seen to range themselves in a line from above downwards, the mitral orifice being situated behind the lower half of the aortic and the upper two-thirds of the tricuspid orifice. This line is not, however, straight, but is somewhat convex, the convexity looking backwards, so that the pulmonic and tricuspid orifices which are situated at the upper and lower portions of the line are somewhat in advance of the aortic orifice, which occupies the central position. When the line of the three orifices is looked at in front, it is seen to take an oblique direction from above downwards, and from right to left, the pulmonic orifice at the upper end of the line being situated partly behind and chiefly to the left of the left edge of the sternum at the second left cartilage and space, and the tricuspid orifice being situated behind the right half of the sternum at its lower portion.

The "Aortic Vestibule," or Intervalvular Space of the Left Ventricle.—When the semilunar flaps of the aortic valve meet together so as to shut the aortic aperture, they fall backwards into a short space that I have described in my "Medical Anatomy" under the name of the "intervalvular space of the left ventricle." I have here, however, at the suggestion of Dr. Sharpey, adopted the appropriate name of the "aortic vestibule" for this space, which is well seen in the preparation from which Fig. 3 was taken, in which the semilunar flaps of the aortic valve are seen through an opening cut in the anterior flap of the mitral valve. The aortic vestibule bends forwards and to the right from the upper part of

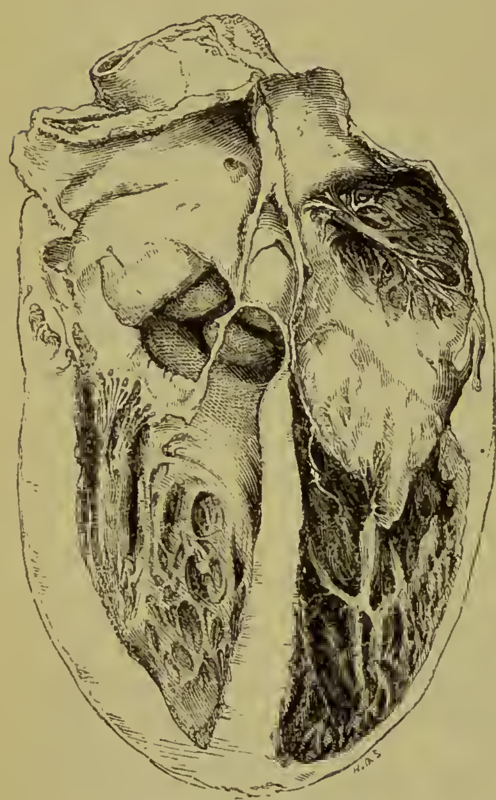


FIG. 3.—Aortic valve shut, seen in the aortic vestibule of the left ventricle, which parts are exposed by cutting a flap in the anterior cusp of the mitral valve and pinning it backwards.

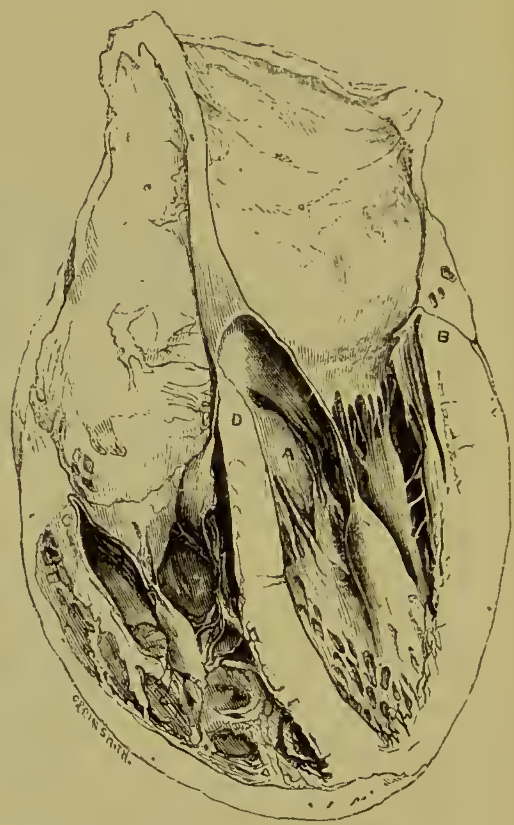


FIG. 4.—Other half of the heart represented in Fig. 5, showing the mitral and tricuspid valves and the fleshy septum (D) with its continuation in the form of a "fibrous septum," which is also seen in the companion figure.

the left ventricle, and forms the channel between the cavity of that ventricle and its outlet at the aortic aperture. The walls of the aortic vestibule are rigid and unyielding, and it therefore retains its size during every stage of the action of the heart. These walls are muscular in front and to the left, where they are lined by rigid fibrous tissue, and where the space is situated immediately behind the *conus arteriosus* of the right ventricle; fibro-cartilaginous on the right, where they are formed by the central fibro-cartilage and "fibrous septum" of the heart; and fibrous behind, where they are formed by the base of the anterior flap of the mitral valve and the adjoining wall of the left auricle, upon which the posterior sinuses of the aortic valve are implanted.

The aortic vestibule occupies the centre of the heart, and is surrounded by all the more important parts of the organ. The *conus arteriosus* and the orifice of the pulmonary artery are in front of it; the tricuspid valve and right auricle are to the right of it; and the mitral valve and left auricle are behind it. During the ventricular diastole, when the left ventricle is of full size, the aortic vestibule is the narrowest portion or bent neck of the ventricle, and it then receives the flaps of the closed aortic valve which fall back into its cavity. During the ventricular systole, on the other hand, when the ventricle has completely contracted upon its contents so as to present an almost solid mass, the aortic vestibule moves downwards and to the left towards the apex, and becomes the widest part of the small remaining cavity, and the presence of this space then allows the mitral valve to remain closed up to the end of the systole by the pressure of the blood on its anterior flap.

The "aortic vestibule," as Mr. Marshall suggests, is a short *conus arteriosus*, since it corresponds in relative position and function, though not in shape or size, or in the structure of its walls, to the *conus arteriosus* for the right ventricle, immediately behind which it is situated. These two analogous parts take opposite directions in relation to each other, and respectively to the ventricle from which they spring and the great artery to which they proceed. The right *conus arteriosus* ascends with a bearing to the left, and curves backwards to end in the pulmonary artery; while the aortic vestibule or left *conus arteriosus* ascends with a bearing to the right and bends forwards to terminate in the root of the aorta. Those two great arteries, following the direction of the *conus arteriosus* from which they respectively spring, cross each other in their onward and upward course, so that the pulmonary artery proceeds backwards to the left and then to the right, while the ascending aorta proceeds forwards to the right and then to the left. If the two cavities be looked at as a combined whole, each with its ventricle, its *conus arteriosus*, and its great artery, they resemble somewhat the curious double oil and vinegar flask that is met with so commonly in the most beautiful parts of South Germany.

The *central fibro-cartilage* and "*tendinous septum*" of the heart form, as I have just said, the right wall of the aortic vestibule. The fleshy septum terminates at its base in a strong tendinous aponeurosis or fibro-cartilage, which forms a part of great importance in the structure of the heart, and which is well seen in the preparation from which Figs. 3 and 4 have been taken. The muscular septum (D) is, in fact, converted at this region into a fibrous septum; but while the muscular septum separates the two ventricles, the fibrous septum separates the left ventricle from the right auricle as well as from the top of the right ventricle. Higher up this fibrous septum is converted into the central fibro-cartilage, which corresponds to the central fibro-cartilage and bone of the heart of the ox (Fig. 6) and which is converted into bone in a human heart in my possession. The central fibro-cartilage, as may be seen in Fig. 2, forms a firm bond of connection between the tendinous rings of the mitral and tricuspid orifices, the central or inner angles of the mitral and
tricuspid orifices, the central or inner angles of the mitral and

tricuspid valves, the right posterior sinus of the aorta, and the aortic vestibule. It also gives insertion to muscular fibres from the left and the right ventricles (Fig. 5 A), which, sweeping round from the left and the right respectively, blend together toward the base of the posterior longitudinal furrow, so as to form short central bands of fibres, which dip forwards at right angles to the circular fibres, deepening as they advance, enter and go to form the septum and end in

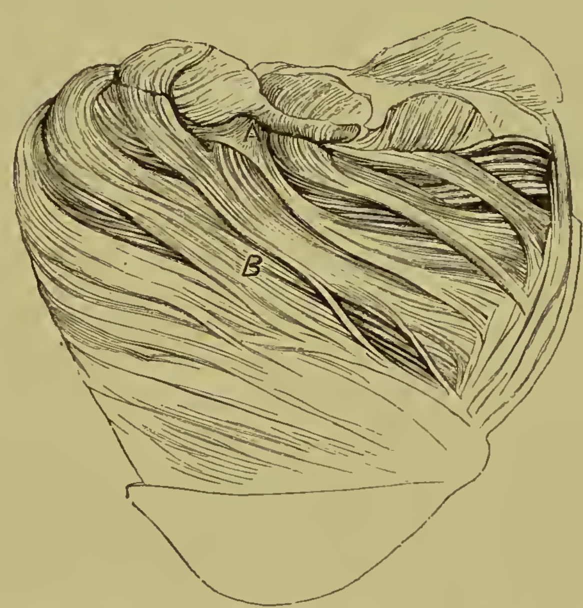


FIG. 5.—Showing the muscular fibres unravelled of the left and right ventricles. B, Fibres from the left and right ventricles going to the central fibro-cartilage of the heart, and forming a portion of the septum.

the central fibro-cartilage, which gives origin to numerous muscular fibres, to the interauricular septum, and the right and left auricles. During the ventricular systole the central fibro-cartilage, and with it the aortic vestibule and all the adjacent parts, are drawn downwards and to the left towards the apex by the contraction of the ventricular fibres inserted into the tendinous ring and especially into the central fibro-cartilage, which thus becomes the focus and movable pivot of the heart, which binds together all those important parts and gives to them a common movement.

The setting of the orifice of the aorta is muscular anteriorly and to the left, and fibrous posteriorly and to the right. The muscular setting is made by the anterior half of the base of the left ventricle, and the fibrous setting by the anterior cusp of the mitral valve and its continuation towards the left auricle and by the central fibro-cartilage. During the diastole the anterior cusp of the mitral valve divides the ventricle into two portions, each with its own aperture, an anterior or aortic portion, out of which the blood pours during the systole through the aortic orifice, and a posterior or mitral portion, into which the blood flows during the diastole through the mitral orifice.

There is one anterior, and there are two posterior and lateral aortic sinuses. The right or anterior coronary artery springs from the anterior sinus, and the left or posterior coronary artery from the left posterior sinus. The right posterior sinus is sometimes called the intercoronary sinus. Owing to the obliquity downwards, forwards, and to the right of the orifice of the aorta, the right posterior flap of the aortic valve is much lower in position than the other flaps. Thus the lower boundary of that flap was in two instances half an inch lower than the lower boundary of either of the other flaps. In another example, in which the aorta was far to the right, the lower edge of the right posterior cusp was only a quarter of an inch lower than that of the left posterior cusp, but it was half an inch lower than the lower edge of the anterior cusp.

The root of the aorta is buried in the centre of the heart, and is therefore incircled by all the cavities of the heart and the two other great vessels. The crescentic edge of the anterior sinus is attached throughout to the central fibro-cartilage which forms the summit of the interventricular septum. The anterior sinus is covered in front by the *conus arteriosus*, and, higher up, on the right side, to a varying extent, by the auricular portion of the right auricle, and on the left side by the pulmonary artery.

The left and right halves respectively of the right and left posterior flaps of the aortic valve are attached at their junction and along their lower border to the anterior cusp of the mitral valve, and to the aponeurosis that is continuous with that cusp. At this situation the two posterior sinuses of the aorta are in front of the left auricle. (Figs. 3 and 4.)

The left half of the left posterior sinus is attached at its root to the muscular base of the left ventricle, and is covered, going from right to left, first by the auricular portion of the right auricle, and then by the inner or right wall of the pulmonary artery. The junction of the anterior to the left posterior flap of the aortic valve is usually a little in front of the junction of the posterior and the left anterior flaps of the pulmonary artery, so that a pin thrust through that artery at the junction of the flaps in question into the aorta, appears about the tenth of an inch behind the junction of those aortic flaps; but in one instance the pin, thus inserted, pierced through the junction of the aortic flaps as well as through that of the pulmonic flaps. The left or posterior coronary artery at its origin is, in one of my preparations, ·25 inch from the left edge of the left posterior cusp, and ·4 inch from its right edge, and I believe it will be found that this represents the usual position of the origin of the artery.

The relations of the right posterior sinus of the aorta are of remarkable extent and importance. The centre and right side of the root of that sinus is firmly attached to or incorporated with the central fibro-cartilage and fibrous septum of the heart that crown the interventricular septum. To the left of this attachment to the fibro-cartilage the right aortic sinus is united, as we have just seen, to the anterior cusp of the mitral valve, and it is seated in front of the left auricle. To the right and in front of this attachment, it is closely connected with the inner or left angle of the tricuspid valve. The right wall of the right posterior sinus, as it advances to join the right edge of the anterior sinus, is covered first by the inner or left wall of the right auricle, and finally by the inner or posterior wall of the arterial cone of the right ventricle.

This right aortic sinus is thus closely connected with every important part of the heart, except the pulmonary artery. The right and left ventricle, the right and left auricle, the mitral and tricuspid valves are all of them attached to or in contact with it ; and the central fibro-cartilage of the heart, as we have seen, with which the base of this sinus is incorporated, acts as a tie that binds together the allied movements of those parts.[1] The descending vena cava also comes into contact with the upper portion of this sinus.

Mr. Thurnam brought into notice, thirty-three years ago, the extensive and important bearings of the sinuses of the aorta, in especial relation to aneurism of those parts.

It is customary for authors on anatomy, following the original error of the great Valsalva, unfortunately repeated by Mr. Thurnam, and more recently by that great anatomist, Henle, to describe the aortic sinuses as being two of them anterior, and one posterior. I have examined the heart *in situ* in many bodies, with regard to this point, and I have always found those sinuses and the corresponding flaps of the aortic valve in the position I have described, one being anterior, and two posterior. A little consideration as to the known relation of these sinuses to other parts, the position of

[1] See Fig. 4.

which is well ascertained and admitted, will show that two of these sinuses are posterior and lateral, and that only one of them is anterior.

The right and left posterior flaps of the aortic valve are attached in about an equal degree to the anterior mitral cusp, as is shown in drawings and many hearts now around me, and in Dr. John Reid's figure.[1] The anterior cusp of the mitral valve is on a level with the posterior wall of the root of the aorta, and it is therefore impossible that either of the aortic sinuses that are attached to that flap can be situated at the anterior aspect of the aorta; they must, indeed, both be posterior in position. Again, while the right or anterior coronary artery arises from the anterior aortic sinus, the left or posterior coronary artery arises from the left posterior sinus; and while the right artery advances to the right of the pulmonary artery, the left artery passes to the left behind the pulmonary artery. Further, the origin of the left coronary artery is nearer to the left or anterior and lateral edge than to the right or posterior edge of the left posterior sinus. I might adduce other points in illustration of what I have advanced, but these facts, which speak for themselves, are sufficient.[2]

[1] *Cyclopædia of Anatomy*, vol. i. p. 588. See also Figs. 1, 2, and 3.

[2] Valsalva's original drawing (V. Opera, tab. ii. Fig. 1; see Fig. A), in which the anterior and left posterior sinuses with their respective coronary arteries are represented in front of the root of the aorta, gives not a front but a side view of the aortic arch. The artery from which this drawing was taken shows the cut end of the vessel, and has evidently been removed from the body and placed upon its right side. The effect of this position would be to place the anterior and left posterior sinuses, each with its coronary artery, on the same anterior plain. Fig. B. is a reduced copy of a similar drawing of the arch of the aorta after its removal from the body, given by Lower (*Tractatus de Corde*, tab. i. Fig. 4) in which the two coronary arteries, as in Valsalva's drawing, spring from the front of the root of the aorta.

Nearly all the drawings of the root of the aorta that have been taken

The error has, I believe, arisen and been perpetuated from the custom of examining these sinuses, not when the heart is

from the actual body, the artery being *in situ* (reduced copies of several of which drawings are given below), represent the sinuses in the position that I have described, two of them being posterior in situation and one anterior, and the right posterior sinus being the lowest of the three sinuses. I find it thus in Tiedemann's *Tabula Arteriarum*, Plate xix. (Fig. E); John Bell's *Anatomy*, vol. ii. p. 283 (Fig. F); Charles Bell's Engravings of the Arteries, tab. ii. (Fig. G); Mr. Quain's *Anatomy of the Arteries*, anterior view, Fig. 3, and posterior view, Fig. 4, Plate xlviii. (Figs. H I); Pirogoff's *Anatomia Topographica*, in eleven different views (Figs. K L M N); and Braun's *Topographisch-Anatomisch Atlas* (Figs. O P). Henle, in a much reduced figure of the aorta *in situ*, represents one anterior and two posterior sinuses (Fig. Q), but he gives a series of drawings of the heart and aorta after their removal from the body (one of which I have given on a reduced scale, Fig. D), in all of which the sinuses are represented and described as being two anterior and one posterior.

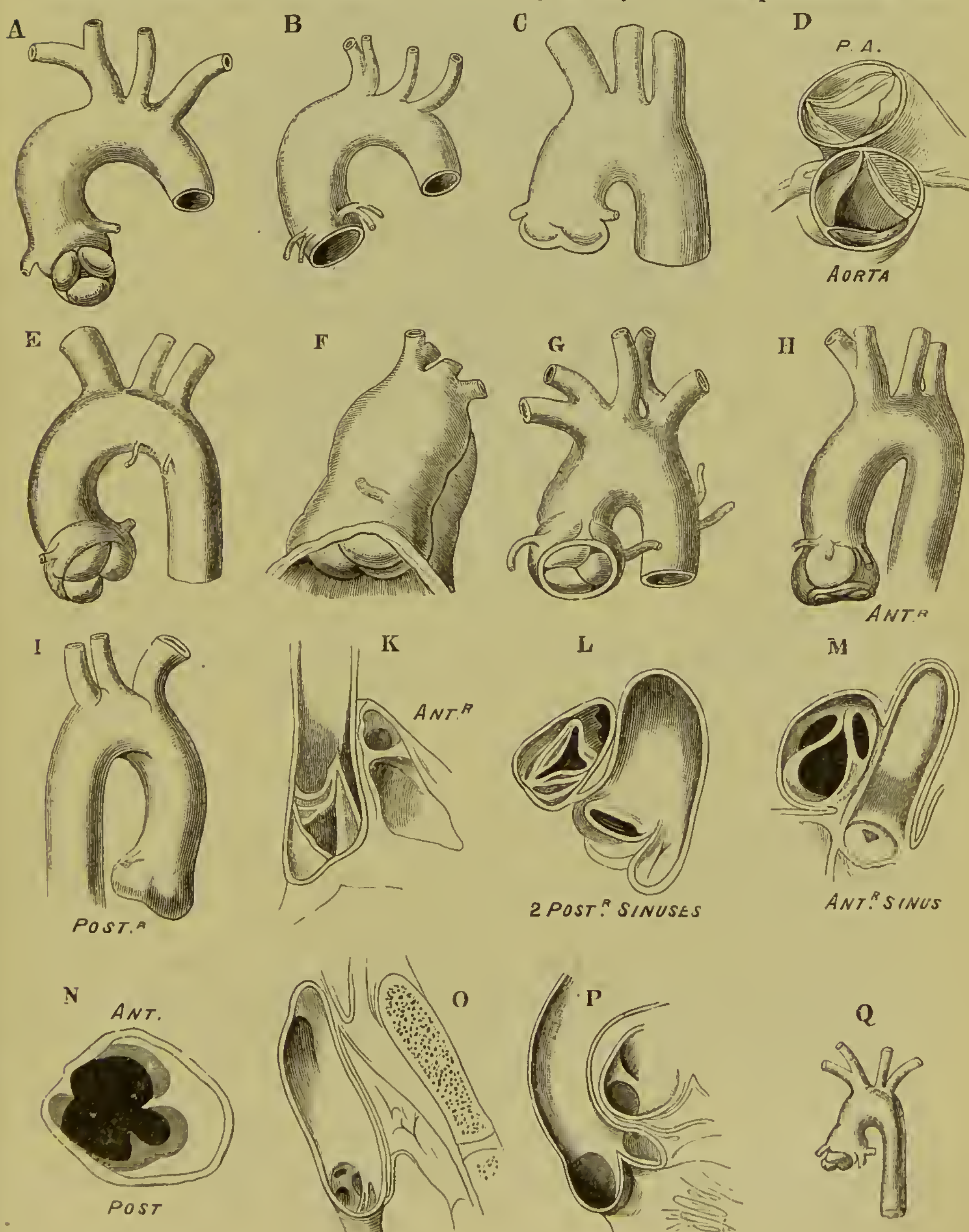
Anatomists, including Morgagni and Senac in former times, and, as I have said above, the respected names of Thurnam and Henle in our own day, have as a rule described two of the sinuses of Valsalva and their corresponding coronary arteries as being anterior, and one of them, or that which is destitute of a coronary artery, as being posterior.

On the other hand, Vesalius and P. Sylvius described the left coronary artery as arising from behind the posterior valve. Some authors give contradictory descriptions of the origin of the coronary arteries. Thus, Winslow in one passage says that there are two coronary arteries, "one of which is situated anteriorly, the other posteriorly" (vol. ii. p. 3); while elsewhere (p. 221) he says that "one of the vessels lies towards the right hand, the other towards the left, of the anterior third part of the circumference of the aorta." Portal (*Anatomie Medicale*, vol. iii. p. 152) says that the left coronary artery arises from the left posterior portion of the aorta; but elsewhere (p. 51) he states that two of the valves are anterior and lateral and the third is posterior, and that the right and left coronary arteries are situated above the two anterior valves.

The accurate Haller, *Elementa Physiologiæ*, iii. 345, speaking of the aortic valve, says: "Situs aliquantum differt, duæ enim superiori loco ponuntur, altera anterior, posterior altera; tertia inferior est. Earum eæ, quæ superiori loco ponuntur, sodales habent arterias coronarias, inferior nullum aortæ ramum vicinum habet." Here that great anatomist has given a correct description of the situation of the flaps of the aortic valve and of the origin of the coronary arteries.

In our own day, Pirogoff and Mr. Heath describe the sinuses as being *in situ*, but after it has been removed from the body. If the right ventricle with its arterial cone, and the ventricular

one of them anterior and two of them posterior. Bourgery (Fig. C), curiously figures the coronary arteries and their sinuses as being both anterior; but he describes the anterior coronary artery as arising from the anterior sinus, and the posterior coronary artery from the posterior sinus.



septum are carefully removed without disturbing the position of the heart, and without injuring the anterior wall of the aorta at its origin, the true position of the aortic sinuses and of the flaps of the aortic valve may be readily observed.

The right and left posterior aortic sinuses advance forwards on either side, and finally curve gently inwards and forwards to complete the circle of the aorta by uniting at either end with the anterior sinus. The anterior portion of the left posterior sinus is concealed by the pulmonary artery, while the anterior portion of the right posterior sinus is readily exposed by pressing aside the auricular appendix. It is rather difficult to say which of the two posterior sinuses comes forward to the greater extent of their points of attachment to the anterior sinus ; I think, however, that the right posterior sinus, which usually goes by the name of the posterior sinus, comes forward to a greater extent than the left posterior sinus, which usually goes by the name of the left anterior sinus. (Note 46, p. 190.)

The position of the Mitral Valve.—In seven instances the size and position of the mitral valve are given, and in three of them accurate details of its structure are represented. These points are further illustrated by preparations and dissections. (Note 46, p. 190.)

The setting of the mitral orifice is muscular in its two posterior thirds, and fibrous in its anterior third. In these respects the mitral and aortic orifices balance each other. The setting of the mitral orifice is muscular behind, while that of the aortic orifice is muscular in front, the two openings being separated by the interposed anterior flap of the mitral valve and its short fibrous continuation to the two posterior aortic sinuses, and by the central fibro-cartilage of the heart. When the heart is boiled for a sufficient length of time this interposed fibrous partition softens and separates from its attachments, and the aortic and mitral apertures are thrown into one large irregular opening (see Fig. 6). The base of the ventricles then presents not four but three great apertures, the tricuspid, the pulmonic, and the mitral-aortic.

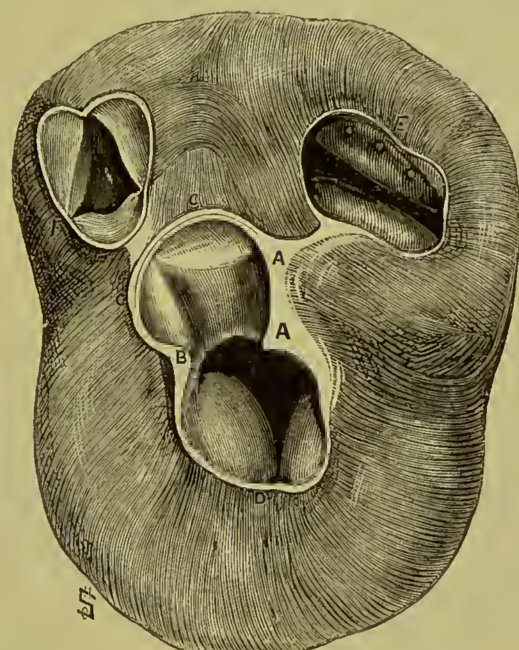


FIG. 6.—Calf's heart boiled, showing the aortic (C) and mitral (D) orifices thrown into one by the removal of the mitral valve, the lower A being the central fibro-cartilage, E the tricuspid orifice, and F the orifice of the pulmonary artery.

The apparatus of the mitral valve occupies the whole of the posterior part of the left ventricle, and when its anterior walls are removed, the whole of this apparatus is brought into view.

The anterior cusp or flap of the mitral valve is alone visible in one of the three drawings giving the anatomical details of the valve, while in the two others the lower border of the posterior cusp is likewise brought into view.

The whole apparatus of the valve takes an oblique direction from right to left and downwards. The right end or base of the apparatus of the valve corresponds with the junction of the left auricle with the left ventricle, and its left end corresponds with the interior of the apex of the left ventricle. The apparatus of the valve thus forms a long triangle, its base being at the base of the ventricle, its apex at the apex of the ventricle, its upper side being slightly curved upwards or outwards, and its lower side being slightly bent inwards or upwards at its middle. The flaps, the

FIG. 7.—Showing the mitral orifice, the anterior flap of the mitral valve, and the right and left posterior flaps of the aortic valve. Diastole of the ventricles.

FIG. 8.—Systole of the left ventricle.

tendinous cords, and the papillary muscles, which are connected by the cords to the flaps, form the three component parts of the valve. (Figs. 7, 10, 11, 12, and *Medical Anatomy* Plate VI.)

The convex base of the anterior flap of the mitral valve is attached on the one hand to the junction of the left ventricle to the left auricle, and on the other to the roots of the right and left posterior flaps of the aortic valve. This attachment of the mitral to the aortic valve is effected through the fibrous structure that extends from the base of one valve to the base of the other, and by the central fibro-cartilage of the heart, which forms a triple bond of connection that ties the mitral, the aortic, and the tricuspid valves to each other. (Fig. 2.)

When the mitral valve is shut, the anterior flap of the valve presents a convex edge, shaped like a horseshoe, which falls back upon and fits like a lid into the posterior flap of the valve, which flap, being crescentic in shape, presents a

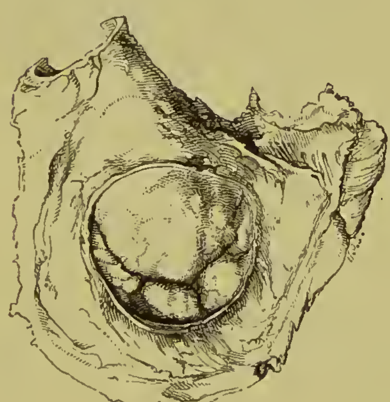


FIG. 9.—Mitral valve shut; auricular surface; anterior or convex and posterior or crescentic flaps; ventricular systole.

FIG. 10.—Mitral valve shut; ventricular surface; anterior flap, with tendinous cords and papillary muscles; two posterior flaps of aortic valve; ventricular systole.

concave edge.[1] Each flap adapts itself to the other by a notched lip, made up of small hemispherical eminences. The eminences of one lip fill up the notches of the other lip. These eminences, thus seen on the auricular surface of the valve, are cells when seen on its ventricular surface, and as these cells are distended with blood when the ventricle

[1] Figs. 2, 9.

contracts, and are exactly maintained in their places by the tendinous cords and papillary muscles, the distended cells or eminences at the opposite lips of the valve adapt themselves to and press against each other during the systole, so as to shut the valve. (Figs. 2, 9, 10, 12.)

The anterior flap is simple, and when closed is shaped like a three-quarters moon. The posterior flap is compound, and when closed is shaped like a quarter or crescent-shaped moon. The compound posterior flap is usually made up of one central and two lateral sub-segments, the latter being sometimes subdivided. These sub-segments adapt themselves so to each other, that the concavity of the crescentic border of the posterior compound flap is preserved entire; for it would have been impossible, by means of one simple fold of membrane, to fill up without a break the whole of the crescentic border.

I need scarcely give a description of the arrangement of the tendinous cords in relation to the flaps of the valve, and of the papillary muscles in relation to the cords and the flaps. It will be sufficient if I here say that they are so arranged that when the muscular walls of the ventricle contract, the papillary muscles, which are really semi-detached portions of those walls, also contract with equal steps; that as the walls shorten so as to approximate the base and the apex by a double movement to each other, the papillary muscles shorten to an exactly parellel degree; and that thus while they hold the flaps of the valve, through the medium of the cords, in apposition, they steadily draw the whole valve towards the apex, and the apex towards the valve, to exactly the same extent that the base and apex of the ventricle are drawn towards each other. The mechanical arrangements are complicated, for there are many parts to be adjusted to each other; but the principle on which those parts are adjusted to each other is simple, for it is by one single contraction of the whole single muscle of the left ventricle, made up in its component parts of walls, columns, and papillary muscles, that the base of the ventricle (including the mitral aperture and valve and the aortic aperture and valve) and the apex of

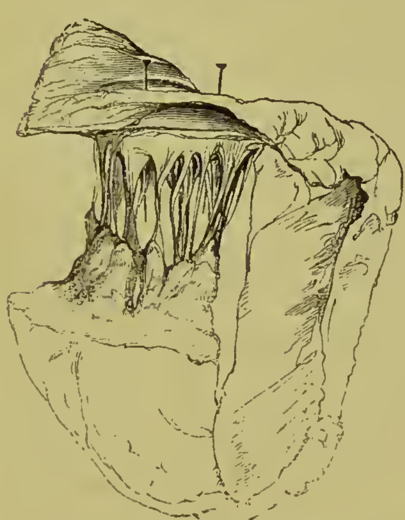


FIG. 11.—Mitral valve shut : posterior flap, with tendinous cords and papillary muscles.

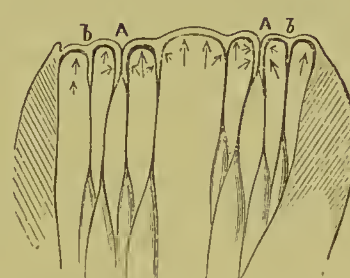


FIG. 12.—Diagram of the shut mitral valve, with the anterior cusp (A A) in close contact with the posterior cusp (*b*, *b*). The tendinous cords and papillary muscles are shown, the direction of the current and pressure of the blood being indicated by arrows.

the ventricle are approximated steadily to each other during the systole.

When the convex anterior flap of the mitral valve falls back upon and fills up the concave posterior flap of the valve, the anterior flap and its membranous continuation to the left and right posterior aortic flaps form a smooth scooped channel or hollow, along which the blood flows noiselessly from the ventricle into the aorta during the systole. (Fig. 7.)

The mitral orifice extends downwards, with an inclination to the left, immediately behind and below the aortic orifice; and, like that orifice, it looks towards the apex of the left ventricle, or to the left, downwards and slightly forwards. The line of direction of the mitral orifice, viewed from the front, is therefore from above downwards with a slight obliquity from left to right. The upper and left boundary of the mitral orifice is about half an inch above the level of the lower edge of the right posterior flap of the aortic valve. The lower border of the mitral orifice is about three-quarters of an inch below the lower border of the aortic orifice. The upper or left edge of the mitral orifice is not so far to the left, while its lower or right edge is about as far to the right, as are the left and right edges respectively of the aortic orifice. The mitral orifice is situated deep behind the sternum, a little below the middle of that bone. Its upper or left boundary, in four instances, was on a level with the third cartilage, just within the left edge of the sternum; and its lower or right boundary was on a level with the fourth cartilage, behind a line drawn down the middle of the sternum. This is probably higher than the average position of the mitral orifice after death. In one other case the top of the mitral orifice was on a level with the lower border of the second space, its situation otherwise corresponding to that in the cases just described. In two other instances, the mitral orifice was comparatively low and was situated unusually to the right, its upper border being on a level with the lower edge of the third cartilage or upper border of the fourth space, behind the middle line of the sternum, and its lower or right border being on a level with the lower portion of the fourth space, or the top of the fifth cartilage behind the right edge of the sternum. As a rule, the mitral orifice occupied a space behind the left half of the sternum, extending downwards for more than one inch below the middle of the bone; but in occasional cases it was present behind the right half of the bone.

The tendinous cords and papillary muscles of the mitral valve, as they extended to the left with an inclination downwards, retained, as a rule, their situation behind the space or cartilage that was on a level with their starting-point from the valve.

Thus in the four instances in which the upper rim of the orifice was on a level with the third cartilage, the upper or left cords lay behind the third left cartilage, and the upper or left papillary muscle behind the third space; and in the same instances the lower rim of the orifice was in two of them on a level with the third space, and in two of them on a level with the fourth cartilage; and in these two sets of cases the lower or right cords and papillary muscle lay respectively behind the third space and the fourth cartilage, with a final dip to the space or cartilage below.

In the other cases in which the position of the upper and lower edges of the mitral orifice were higher or lower in relation to the spaces and cartilages than in those just quoted, the upper and lower cords and muscles retained their bearing throughout in relation to the space or cartilage on the level of which they started, until they also usually made a final dip so as to occupy a relatively lower position.

In two of the instances there was a space of half an inch between the right and left papillary muscles, the width of the interior of the ventricle being an inch and a half; and in the other instance, in which the systole of the ventricle was more pronounced, the space between the muscles was the fifth of an inch, the width of the cavity being a little over an inch (1·2 inch).

In one instance, in which the heart and all its parts lay unduly to the right, and in which the flaps, cords and muscles of the valve took a very oblique direction downwards, the right papillary muscle was situated behind the left border of the sternum and the sternal half of the fifth cartilage, and the left papillary muscle crossed the third cartilage and space midway between the sternum and the junction of the cartilages to their ribs.

This instance was throughout exceptional in the position of the heart and all its parts, and the great vessels ; but the other instances offer fair average examples of the position of the mitral valve. I need not, therefore, further analyse additional cases. It is sufficient to bear in mind that when the origin of the pulmonary artery is high or low in position, the aortic and mitral valves are also correspondingly high or low in position ; and that when the ascending aorta and the origin of the pulmonary artery are far to the right or far to the left of their usual situation, the aortic and mitral valves are also correspondingly far to the right or far to the left of their usual situation.

The Tricuspid Valve.—The apparatus of the mitral valve occupies the whole of the posterior part of the left ventricle, but the apparatus of the tricuspid valve fills up the whole body of the right ventricle, the narrowing *conus arteriosus* being the only portion of the ventricle unoccupied by it. (Note 46, page 190.)

The reason for this diffusion of the apparatus of the tricuspid valve and this concentration of that of the mitral valve is obvious. It depends on the form of the two ventricles and the relation to each other of their apertures of ingress and egress.

The left ventricle is the central cavity of the heart, and is flask-shaped; and its walls on a transverse section are shaped like a ring, and surround a circular space, the mitral valve being behind (see Fig. 3). The right ventricle is applied upon the anterior and inferior walls of the left ventricle, which project into the cavity of the right ventricle and form its inner or posterior wall. The right ventricle on a transverse section is crescent-shaped, its inner wall being convex, while the inner aspect of its outer wall is concave or angular, for it presents at its lower border and outer aspect a projecting angle. The whole cavity of the right ventricle looked at in front is triangular in form, the base of the triangle resting on the central tendon of the diaphragm, its apex pointing to the top of the pulmonary artery, its right side being formed by the junction of the right auricle to the right ventricle and by the tricuspid orifice, and its left side by the septum between the ventricles.

The three cusps of the tricuspid valve are visible when the cavity is opened, the anterior and inferior flaps being completely exposed while the posterior flap is partially concealed (Figs. 13, 14, 15).

The whole apparatus of the tricuspid valve, like that of the mitral valve, takes a direction from right to left; but while the apparatus of the mitral valve concentrates itself as it recedes from the flaps, the papillary muscles pointing towards the apex, and the whole structure forming a long triangle, the apparatus of the tricuspid valve spreads itself out as it recedes from the flaps, like the rays of a fan.

The anterior flap gives attachment at its upper edge to a group of cords which converge upon the small superior papillary muscle, which is incorporated with the posterior wall of the cavity at the lower portion of the arterial cone. The cords from the lower edge of the anterior flap converge upon the anterior papillary muscle, which muscle also sends a radiating series of cords that attach themselves to the upper and anterior edge of the lower flap of the valve. The anterior papillary muscle is not immediately connected either with the front or the back wall of the ventricle, but is attached intermediately to both of them by fleshy columns.

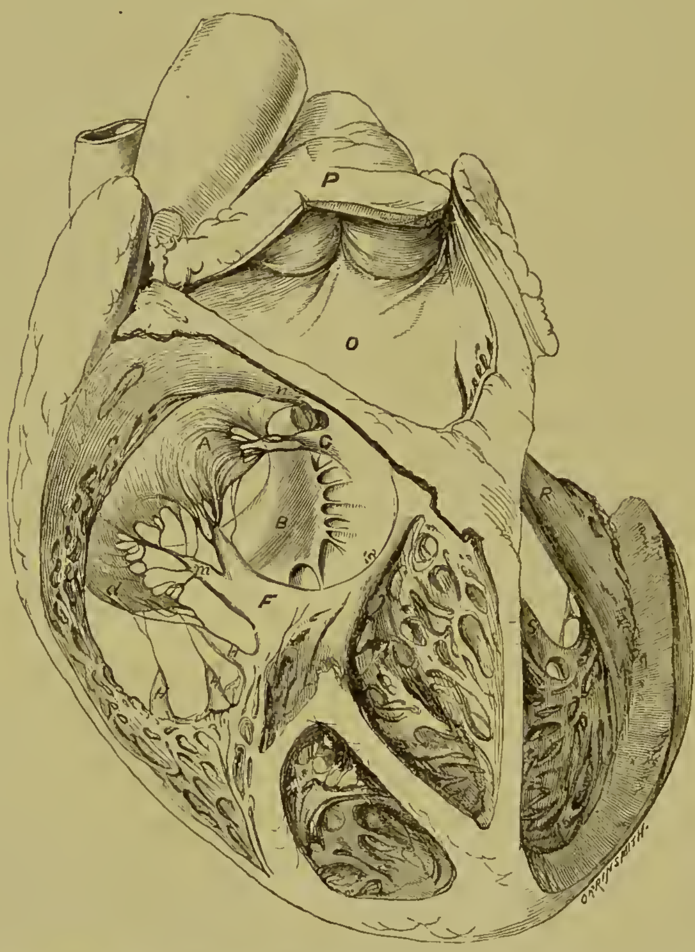


FIG. 13.—Showing the tricuspid valve open, during the complete dilatation (diastole) of the right ventricle.

Figs. 13, 14, and 15 are views of the interior of the right ventricle and of a portion of the left ventricle: A, anterior flap; B, posterior flap; C, inferior flap; and *d*, one of the long sub-segments of the inferior flap of the tricuspid valve. F, anterior papillary muscle; G, superior papillary muscle; H, H, inferior papillary muscles; *n*, sub-segment occupying the angle between the anterior and posterior flaps of the valve; *o*, *conus arteriosus*; P, pulmonary artery; R, upper or left papillary muscle, and S, lower or right papillary muscle belonging to the left ventricle and mitral valve.

A strong and rather long column curves backwards to be attached by outspreading roots to the posterior wall of the ventricle near the septum ; while an interlacement of shorter and thinner columns advances forward and to the left, extending from the base of the anterior papillary muscle to the anterior wall of the ventricle, also near the septum (Fig. 13). Thus the roots of the anterior papillary muscle spread both backwards and forwards, the base of the muscle being, however, nearer to the front than the back of the ventricle.

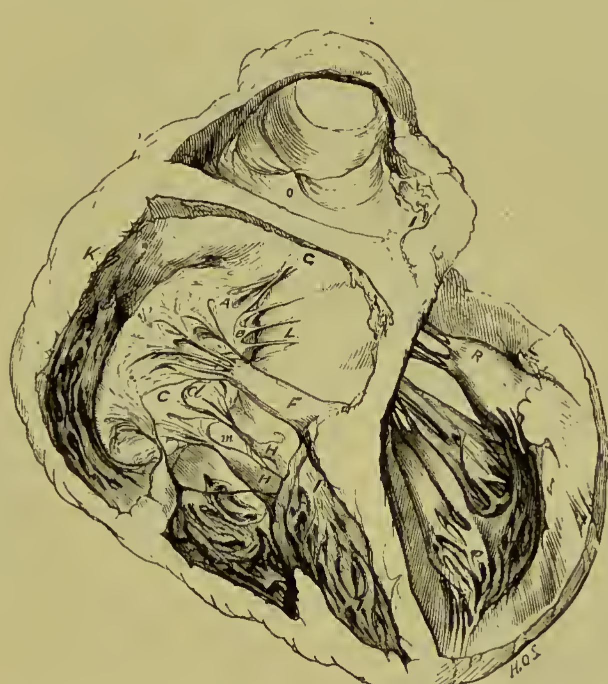


FIG. 14.—Showing the tricuspid valve shut during the early period of the contraction of the right ventricle.

By this beautiful arrangement a purchase is given for this muscle to act upon the centre of the valve from the middle of the cavity.

The inferior flap of the valve is not formed, like the anterior flap, of one sheet of membrane, but is a compound flap, which is subdivided into four or five sub-segments, two of which are longer than the rest, which, by meeting together and adapting themselves to each other, fill up the large rounded space of the tricuspid orifice, at its inferior portion. The cords from these sub-segments converge upon a series of papillary muscles that are conveniently situated around the lower portion of the ventricle, some, or one, being seated in front, some below, and some behind. The inferior papillary muscles are attached, like the anterior papillary muscle, not immediately to the walls of the ventricle, but intermediately by interlacing fleshy columns. The posterior papillary muscles of this group, which are thus connected with the inferior flap of the tricuspid valve, are immediately attached to the inner or convex wall of the ventricle.

The posterior flap is attached behind by a series of radiating cords to the inner walls of the ventricle, sometimes by means of small papillary muscles, sometimes by the immediate insertion of the cords into the walls.

The upper portion of the tricuspid orifice is narrow and angular, while its lower portion is wide and circular; and thus, therefore, the simple anterior and posterior flaps, with the intervention of one anterior and one superior sub-segment, fill up the upper and narrow part of the orifice; while the inferior and compound sub-segments adapt themselves to the large and rounded inferior portion of the orifice. (See fig. 2, p. 74.)

The whole of these segments of the valve meet together at the centre of the orifice, and hence arises the necessity for an array of papillary muscles, the points of which converge towards the centre of the valve, and that are attached at their roots by fleshy columns that connect them with both the outer and the inner walls of the ventricle.

The tricuspid orifice is situated behind the lower portion of the sternum and in front of the mitral orifice and the left ventricle. The direction of the tricuspid orifice is from above downwards with a slight inclination from left to right. The upper boundary of the tricuspid orifice is immediately below the orifice of the aorta, and in front of the mitral valve.

The four great orifices of the heart—the pulmonic, the aortic, the mitral, and the tricuspid—are situated in that order, one above another, the pulmonic orifice being the highest and the tricuspid the lowest. The lower portion of each of the first three orifices is lower than the upper

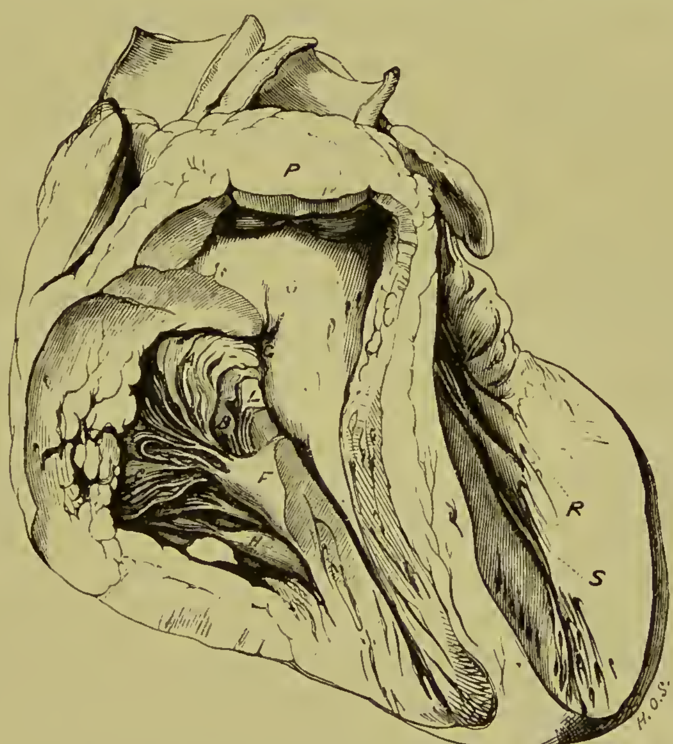


FIG. 15—Showing the tricuspid valve shut during the period of the complete contraction of the right ventricle.

portion of the orifice below it. Thus the pulmonic orifice, when looked at in front, covers the upper part of the orifice of the aorta on its left side; the lower border of the aortic orifice is lower than the upper border of the mitral orifice; and in like manner, the lower two-thirds, or three-fifths, of the mitral orifice lie behind the upper half of the tricuspid orifice, the lower half of which is below the level of the lower edge of the mitral valve.

The posterior aspect of the tricuspid orifice is attached to the anterior wall of the left ventricle, not on a level with the mitral orifice, but about half an inch nearer to the apex. The wall to which it is thus attached is convex, and the posterior surface of the tricuspid valve where it fits upon the left ventricle is therefore concave. The shape of the tricuspid orifice is, in consequence, angular above, concave behind, convex in front, and rounded and broad below. The tricuspid orifice thus maintains the crescentic form of the cavity of the right ventricle when a cross section is made through its walls.

In five of the cases, the upper and left boundary of the tricuspid valve was situated about the third of an inch to the left, and its lower and right boundary about a third of an inch to the right of a line drawn down the middle of the sternum. In two instances the lower and right boundary of the tricuspid valve extended to the right of the right edge of the sternum.

The right transverse or auriculo-ventricular furrow which corresponds with the right edge of the right ventricle, as I have already remarked, is situated about half an inch to the right of the right edge of the tricuspid valve, and when therefore we know the position of the furrow, we can infer the position of the right edge of the valve. As we have already seen (page 63) the transverse furrow was situated to the right of the right edge of the sternum in nearly three-fourths of the cases (36 in 51), at that edge in three of them, and to the left of that edge, behind the right half of the sternum, in one-fourth of them (12 in 51); and it extended in one instance for an inch and a third to the right of the right edge, and was situated in five instances behind the middle line of the sternum. The transverse furrow occupied every variety of position between these two extreme points. We may therefore infer that the right border of the tricuspid valve occupied every range of position between a line three-quarters of an inch to the right of the right edge of the lower portion of the sternum, and a line half an inch to the left of its middle line; the average situation of the right border of the valve being behind the right edge of the sternum.

In like manner we can infer approximately the position of the lower border of the tricuspid valve if we know the position of the lower boundary of the right ventricle. We have already seen that the lower boundary of the right ventricle varied in situation from an inch and a half below, to an inch and a half (1·4 inch) above, the lower end of the sternum. The lower border of the tricuspid valve is from half an inch to nearly an inch above the level of the lower boundary of the right ventricle, and we may therefore infer that the lower border of the valve varies in position from a point nearly two inches above, to a point three-quarters of an inch below, the lower end of the sternum.

The top of the tricuspid orifice and valve was situated on a level with the third cartilage in three cases, with the third space in one, and with the fourth cartilage in two; its lower edge being in those cases on a level respectively with the fourth cartilage, the fourth space, and the fifth cartilage. In each of those cases the upper edge of the tricuspid orifice and valve was lower, and its lower edge was much lower, than the corresponding edges of the mitral orifice and valve.

The tendinous cords and papillary muscles of the tricuspid valve, as they radiated to the left, slightly upwards, downwards and outwards, retained, as a rule, their situation behind the space or cartilage that was on a level with their starting-point from the valve. Thus, the inferior cords and muscles maintained their relative position throughout, behind the fourth space or fifth cartilage, which was on a level with the lower edge of the tricuspid valve, while the anterior group of cords and the anterior papillary muscles lay behind the fourth cartilage or the fourth space. The upper group of cords retained its relation to the third cartilage or space, or the fourth cartilage, on a level with which the upper edge of the valve was situated, but the superior papillary muscle radiated upwards to a somewhat higher relative position than that from which it started, so that, as, for instance, in two cases, the top of the valve being on a level with the third or fourth cartilage, the superior papillary muscle was behind, respectively, the second or third space.

In the remaining instance, that in which the heart was placed to an unusual extent to the right, the flaps of the valve were situated behind and to the right of the right portion of the sternum, the valve extending from the level of the upper edge of the fourth cartilage to that of the lower edge of the fifth. The tendinous cords, and the papillary muscles took an oblique direction downwards, and they were seated almost entirely behind the right half of the sternum.

The position of the tricuspid valve corresponds with the position of the right ventricle, the valve occupying about the lower two-thirds of the cavity.

The relation of the Lungs to the Heart.

The extent to which the lungs covered the heart varied much in different examples. In two instances the heart was almost concealed by the lungs, the edges of which were separated over the lower portion of the right ventricle by a mere chink, which widened out to three-quarters of an inch at the inferior border of the heart. In other instances the lungs had receded from before the heart to such an extent that almost the whole organ and the great vessels were exposed to view, though in no instance were they entirely uncovered.

The space where the heart comes to the surface, which is bounded above and at the sides by the lungs, and below by the liver and stomach, was sometimes triangular in shape (in 10 of 60 cases), but was usually four-sided (50 in 60).

The superficial "cardiac space" was triangular in shape in the two instances just noticed in which that space was very small, the width at the lower boundary of the heart being three-quarters of an inch ; and in an instance of an opposite kind in which the base of the triangle, which always corresponded with the lower boundary of the heart, was four and a half inches wide. In this instance the lower boundary or base of the superficial space of the heart was wider than in any other. The base of the triangular superficial cardiac space presented every intermediate gradation of breadth between the extreme instances just noticed. This triangular shape is favourable to the covering of every part of the heart with lung except the right ventricle, for, while the anterior wall of the right ventricle was laid bare to a greater or less extent in these cases, as it was in every case under observation, in but one of them was the apex of the heart exposed, while in only two of them the right auricle, the aorta, and pulmonary artery, were also somewhat uncovered.

The superficial cardiac space was in all these cases actually triangular in shape, the lower limit or base of the triangle being the lower border of the heart. If, however, the lower boundary of the heart had occupied a lower position in relation to the adjoining margins and the lower boundaries of the lungs, then that space would have been four-sided in shape in the majority of these instances (6 in 10) ; for in them the inner border of the left lung, after it had left the heart, curved in a downward direction. If, therefore, the heart had not shrunk upwards in these instances, the superficial cardiac space would, like the other cases, have been four-sided in shape.

When, as is usually the case, the superficial space of the heart is bounded by four sides,[1] the heart, which moulds for itself a place between and within the lungs, comes forwards to the surface at that part where the organ is massive and its walls are powerful. The inner edge of the right lung descends in a straight line behind the sternum, but the edge of the left lung leaves the right lung, and deviates to the left at a variable point. This deviating edge of the upper lobe of the left lung, which is suspended like a curtain above the upper margin of the superficial space of the heart, describes a double curve, first convex, where it leaves the right lung, and then concave, where it begins to dip downwards to form the outer edge of the space. It then, as I have already observed, again tends to curve inwards, and to form the tongue of lung that enfolds the apex of the heart. The breadth of the cardiac space, measured along its base at the lower boundary of the heart, varied from an inch and a half to four inches and a third (4·3 inch). The breadth of the lower boundary of the superficial cardiac space varied in three-fourths of the cases (37 in 50) from two to four inches ; it was less than two inches in one-fifth of them (9 in 50), two-thirds of these being youthful ; and it was above four inches in four of them.

The superficial cardiac space was, as a rule, narrower at its upper than at its lower boundary (in 35 of 50 cases) ; but sometimes this was reversed, the space being narrower below

[1] I have grouped the remainder of the cases, amounting to fifty, under the common heading of those in which the superficial space of the heart was bounded by four sides, but in seven of these cases the space was almost triangular in shape, and in a few other instances irregularity in outline modified the typical four-sided form of the space.

than above (in 10 of 50 cases). In a few instances (5) the space was of equal breadth above and below.

The lower boundary of the superficial cardiac space measured less than three inches in all but one of those instances in which it was narrower than the upper boundary of that space.

The inner borders of the right and left lungs were in contact with each other behind the upper portion of the sternum so as to cover the great vessels in three-fifths of the cases under examination (in 35 of 59). In the remaining two-fifths of the cases (24 in 59) a space varying in width from the eighth of an inch to an inch and a half was interposed between the inner borders of the right and left lungs at the upper part of the front of the chest. In one-third of these instances (7 in 24) the space between the edges of the lungs was less than the third of an inch, so that, practically, these cases may be added to those in which the edges of the lung were in contact, which brings up their proportion to three-fourths of the total number of cases observed (42 in 59).

The point of separation and divergence of the left and right lungs in these cases, including those in which the lungs were nearly in contact, varied from the level of the first intercostal space to that of the fifth cartilage. In three-fourths of the cases this point of separation varied in position from the level of the second space to that of the fourth cartilage.

In the seventeen cases in which the lungs were separated from each other over the great vessels to an extent ranging from almost half an inch to an inch and a half, the position of the point of divergence of the right and left lungs varied from the level of the first cartilages to that of the third, the level of the second cartilages and second spaces being the more usual situation of the point of divergence in this group of cases.

There was much variation in the relative size of the right and left lungs. The two lungs were about of equal size in more than one-fourth of the cases (17 in 59), the right lung was larger than the left in nearly one-half of them (27 in 59), and the left lung was larger than the right in one-fourth of them (15 in 59).

Although the right lung was so often larger than the left, yet the base of the left lung was lower at the side than that of the right lung three times more often than the reverse, the bases of the two lungs being on the same level in one-fourth of the cases (14 in 57).

When the right and left lungs met together behind the upper half of the sternum to form a covering over the great vessels, the margin of the right lung extended to the left of a line drawn down the middle of the bone more often than that of the left lung extended to the right of that line in the proportion of 35 to 15, while in nine instances the edges of the two lungs lay in contact behind the middle line of the sternum.

Below the point of separation of the two lungs, while the left lung deviated, as we have seen, extensively to the left, the right lung usually (in 42 of 60 cases) deviated at first very slightly and then more definitely to the right, so that at its lower anterior border the left inner margin of the right lung at the level of the lower boundary of the heart was usually situated to the right of the middle line of the sternum, the extent to which it did so varying from the tenth of an inch to an inch and three-quarters. In less than one-third of the cases (18 in 60) the left margin of the right lung, at or a little above the level of the lower boundary of the heart, extended to the left of the middle line of the sternum.

When the superficial cardiac space was small, measuring less than two inches across, the inner margin of the right lung extended to the left of the centre of the chest in three-fifths of the cases (10 in 18). When, however, the space was of medium size (2 to 3 inches wide), the right lung passed to the left of the middle line in less than one-fifth of the cases (4 in 21) ; and when the space was large (above 3 inches wide), the right lung extended thus to the left of the middle line over the superficial cardiac space in only one-tenth of the cases (2 in 21).

The upper boundary of the superficial cardiac space, which is an important landmark to the clinical worker, is formed by the lower anterior border of the upper lobe of the left lung after it deviates from its point of separation from the right lung. I have already described the direction and nature of this curve.

The margin of lung, which thus forms the upper boundary of the superficial cardiac space, lay immediately behind one or other of the left costal cartilages or their spaces, and it generally took the downward direction of the cartilage behind which it lay, or was somewhat more inclined. It generally lay behind one cartilage or space, from the point at which it left the sternum to the point where it curved downwards to form the left border of the superficial cardiac space. It sometimes, however, took a more oblique direction downwards, and crossed from behind one cartilage to behind the next space below, and then, after crossing that space, it spent itself behind the next cartilage below. The upper boundary of the cardiac space varied in position from the level of the second left costal cartilage to that of the fifth, but it was most frequently present behind the third or fourth cartilage or the fourth space, being thus situated in three-fifths of the cases (35 in 60).

In three of the cases the surface of the heart exposed below the lower edge of the left lung was a mere belt composed of the lower boundary of the right ventricle, this belt being from two inches to two inches and a half in diameter from side to side, and from a fifth to a little over one-half of an inch from above downwards. The heart had been lifted upward behind the lungs by great distension of the stomach and intestines in these three cases, and the front of the cage of the chest had been also lifted upwards by the same agency, while the lungs had expanded downwards under the influence of the forward movement of the ribs.

Extent to which the Surface of the Heart is Exposed.

In every instance more or less of the right ventricle was uncovered. A very small portion of the right ventricle was exposed in the two instances in which there was a narrow longitudinal chink over the front of the heart, and in the three in which the exposed surface of the organ was a very narrow belt extending from right to left along the lower border of the ventricle.

In nearly one-half of the cases (25 in 60) the right ventricle was the only part of the heart that was exposed at the superficial cardiac space. In five other cases the apex of the heart was the only additional part brought into view by the lateral withdrawal of the lung. In almost one-half of the cases (25 in 60) the apex of the heart was in contact with the walls of the chest, the pericardium intervening; and in one-third of them (19 in 60) the higher portion of the left ventricle was also exposed to a greater or less extent. In only one instance was the whole of the narrow anterior portion of the left ventricle laid bare. In the rest of the cases, more or less of the upper portion of the left ventricle was covered by the edge of the left lung where it overlaps the front of the heart.

The right auricle was uncovered to a greater or less extent in one-fifth of the cases (11 in 59), and in all but three of these its auricular appendix was also apparent. In one instance the whole of the auricle was exposed. The tip of the auricle was just visible in eight additional cases.

The whole of the ascending portion of the aorta was exposed to view in nine instances, and it was visible on its right side in three, on its left side in four, and at its middle in one. Thus the aorta was more or less exposed in nearly one-fourth of the cases.

The whole of the pulmonary artery was laid bare in only one instance, but in eight other cases the right side of the vessel, and in five others the left side of the vessel, was respectively exposed. The arterial cone of the right ventricle was completely covered by the lungs in one-third of the cases (20 in 59). In certain cases (10) a very small portion of the cone was uncovered just below the point of separation of the right and left lungs. These cases may practically be added to those in which the cone was completely concealed, so that, with this reservation, it may be said that the cone was covered with lung in one-half of the cases (31 in 59). In several instances, only one-fourth of the arterial cone was exposed, while in one instance the whole of it was uncovered. Between these extreme cases there was every variety in the extent to which the cone was brought into view.

FRONT VIEW; DURING LIFE.

We have just seen that after death the healthy heart and great vessels, and the different parts composing them, present great variety in position; and that although perhaps in no two instances do those parts occupy precisely the same relative situation, yet in a considerable proportion of the cases, and within certain limits, they present a standard or average position.

During life in like manner the healthy heart and great vessels vary much in relative situation, yet those parts within certain orderly limits, regulated and modified by the various demands of life, maintain a standard or average position.

It is evident that during life, when the heart is at work and in motion, sending blood to and receiving blood from the lungs and every part of the frame, the position of the heart and great vessels is different from what it is when observed in the dead body. A knowledge of the position of the heart and the great vessels during life, when in active motion, is essential to the clinical worker, and not merely that of the anatomy of the dead organ.

I shall here, therefore, endeavour to describe the average position of the heart and great vessels in the living frame, from the study of the situation of those parts after death and during life, and of the movements of the heart when in action, and when influenced by respiration.

When the exertions of the body are prolonged and powerful, the heart acts with corresponding power; it receives and distributes more blood than when the body is at rest, and its size, and that of its great vessels, become enlarged. When, however, the body is in repose the heart's action is weakened;

it receives and sends out less blood, and its size and that of its great vessels are diminished. The used power and the size of the heart, and the supply of blood to and from the organ, strictly balance the actual demands of the body, whether in action or at rest.

Under the like circumstances the lungs, answering to the demands on respiration, enlarge or lessen in size, and the volume of the cage of the chest is correspondingly larger or smaller, while the pitch of the diaphragm is lower or higher, so as directly to depress or elevate the heart. As the result, therefore, of these changes, thus induced by respiration, the heart, when it enlarges during exertion, is low and deep, and when it lessens during rest, is high and superficial.

In a corresponding manner, and for the same reasons, the heart is large, low, and deep in strong labouring men, while it is small, high, and shallow in weak youths of sedentary habits. In women and in children the heart is proportionally smaller and higher than in adult men; and in the scale of life, from infancy to old age, the heart tends proportionally to increase in size, and to become lower and deeper in position.

In order that we may have before us the movements of the heart and great vessels during the varied exercises of life, I shall, before describing the position of those parts in the living body, give a brief account of the action of the heart, of the currents of blood through the cavities of the heart, and of the movements of the heart caused by respiration.

Movements of the Heart. (See Figs. 16, 17, 22, 23.)

I have observed, with the valuable assistance of Dr Broadbent, the movements of the heart in the dog and the donkey, when under the influence of chloroform; and from those observations, and the careful examination of the human heart in many subjects, I have constructed figures 16, 17, 22 and 23, representing the heart in man in the opposite conditions of complete ventricular contraction and dilatation. In figures 16 and 17, the direction and extent of the movements of the walls during the ventricular systole are represented by arrows.

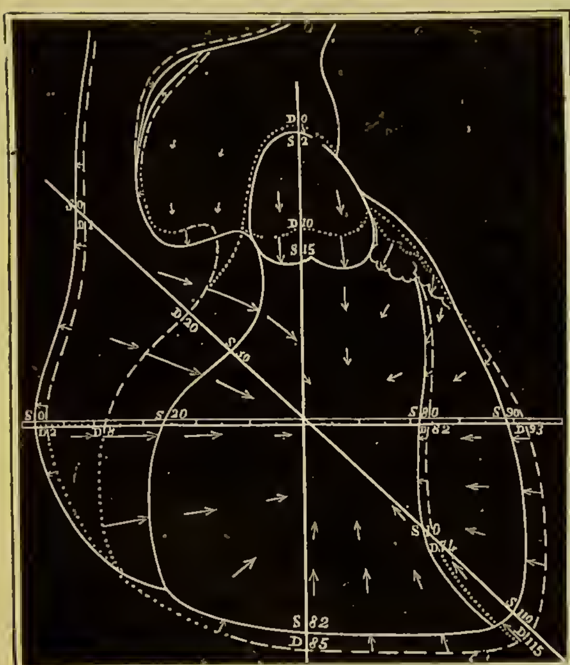


FIG. 16.—Front view.

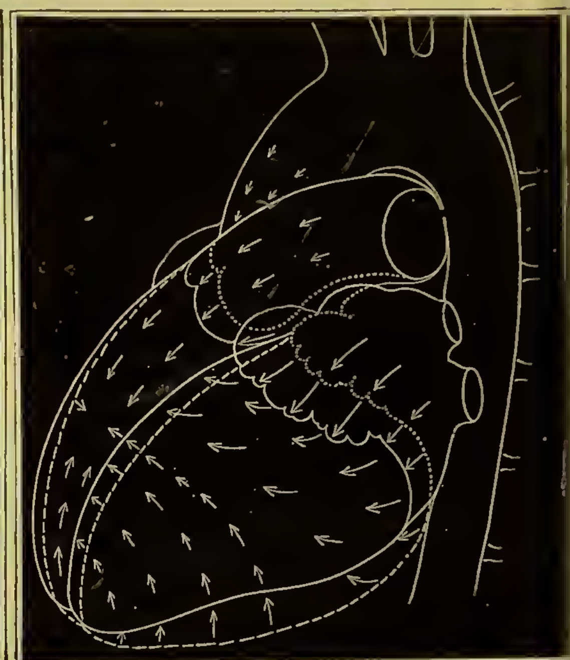


FIG. 17.—Side view.

The *continuous* lines indicate the position of the outlines of the various parts of the heart during the *systole* of the ventricles; the *interrupted* lines indicate the position of the same parts during the *diastole* of the ventricles; the arrows point out the direction and extent of the movements of the walls of the heart during the *systole*. Fig. 16 shows the transverse, vertical, and oblique measurements in millimetres during the systole and the diastole.

The appearance of the heart in motion is very striking. The ventricles during their systole contract from all sides upon their own centre and become wrinkled, and the arteries and veins on their surface are full and tortuous, while the auricles become purple, plump, and glistening. During the diastole, the aspect is reversed. The ventricles enlarge and become smooth, their superficial vessels almost disappearing, while the auricles shrink, and become pale and wrinkled.

The Systole of the Ventricles.—During the systole, the ventricles, when looked at in front, contract from all sides towards a given centre, which is situated on the right ventricle a little to the right of the septum, about midway between the origin of the pulmonary artery and the lower boundary of the ventricle, where it rests upon the diaphragm. The contraction of the right ventricle, owing to its position at the front of the heart, and its consequent complete exposure, is marked and vigorous. The whole right margin of the ventricle, at its juncture to the auricle, moves extensively from right to left; while its left margin, at the longitudinal furrow or septum between the ventricles, moves to a comparatively slight degree from left to right. At the same time the top of the ventricle, at the origin of the pulmonary artery, descends, while its lower border, where it rests on the diaphragm, ascends.

The point of rest towards which these various movements converge corresponds closely with the attachment of the anterior papillary muscle.

The right auricle and superior vena cava are distended, and the pulmonary artery is enlarged and lengthened simultaneously with the contraction of the ventricle. The auricle, which just before was wrinkled, becomes full; and its auricular portion and left edge move rapidly inwards, and to the left, so as to replace the ventricle. The movement of the auricular portion is remarkable. It suddenly enlarges and becomes purple, and its tip moves from the right to the left edge of the sternum, at the level of the third costal cartilage.

The vigorous contraction of the left ventricle is only visible at its apex and along its left border, since the rest of the cavity is hidden by the right ventricle. The apex has a revolving movement, upwards, forwards, and to the right. The left border of the ventricle, like the apex, moves forwards and to the right; but while the portion of the ventricle near the apex ascends, the portion near the base descends. The appendix of the left auricle, which during the diastole of the ventricle is scarcely visible, descends during the systole, and moves rapidly forwards and downwards, so as to replace the retreating ventricles, and to fill up the angle between them and the pulmonary artery.

When we remove the left ribs and look at the heart from the left side so as to obtain a profile view, the animal lying upon the back, we see that the whole left ventricle moves forwards during the systole, the posterior wall advancing much more than the anterior; and that the base of the ventricle descends, while the apex ascends, so that apex and base approximate. It is difficult to fix upon the precise zone of rest of the ventricular walls towards which the apex ascends and the base descends, but it is somewhere about the middle of the ventricle, nearer, perhaps, to the apex than the base. This region of stable equilibrium corresponds to a similar point of rest in the papillary muscles. Owing to this arrangement, the ventricles and their valves adjust themselves to each other during the ventricular contraction.

The left auricle, like the right, enlarges during the systole, and as the base of the ventricle then descends and advances, the ventricular attachment of the swollen auricle descends likewise, apparently, as it were, pushing the base of the ventricle before it.

When the left ventricle propels its contents into the aorta, the arch of the aorta is distended and lengthened, and its root, like that of the pulmonary artery, descends. The arch of the aorta enlarges both in length and breadth, and becomes tense and rigid. Its lateral enlargement is small, but its elongation is considerable ; and its orifice, like that of the pulmonary artery, descends during the systole.

During the systole, the auricles and great vessels enlarge, and descend into the place just left by the retreating ventricles ; there is, therefore, more blood at the base of the heart at the end of the systole than at the end of the diastole. Since, however, during the systole, both ventricles contract, the increase of the blood at the base probably balances its diminution towards the apex. During the pause which follows the dilatation of the ventricles, the blood continues to flow into the auricle so that the amount of blood in the heart and great vessels is greater just before the ventricular systole than at any other period.

Movements of the Papillary Muscles.—That I might observe the action of the papillary muscles, I removed the anterior wall of the right ventricle when the heart was beating *in situ* ; and I found that the tip of the anterior papillary muscle of the right ventricle contracted towards the septum during the systole.

I then removed the septum, so as to expose the two papillary muscles of the left ventricle, and I noticed that both the muscles, which during the diastole were wide apart, approximated and came close together during the systole. At the same time the muscles shortened towards their own centre, so that their tips and their tendinous cords descended to the left towards the apex of the ventricle, while their roots of attachment near the apex ascended to the right towards the base of the ventricle. The fixed point towards which the two ends approximated corresponded apparently to the zone of rest, or stable equilibrium, in the walls of the ventricle, towards which the base and the apex of the ventricle approximate during the systole.

Action of the Mitral and Tricuspid Valves.—In order that I might see the movements of the mitral and tricuspid valves, I cut out the heart when beating vigorously, and immersed it in water. The ventricles contracted with force, and expelled the water from the great arteries during each systole. The jet from the aorta was six inches in length. The segments of the mitral and tricuspid valves were seen to come together at their notched and bead-like margins, so as to close the valves during the systole, and prevent the efflux of a drop of liquid.

At the beginning of each diastole the margins of the valves separated quickly from each other, so as to admit the flow of water freely into the cavity.

Direction of the Currents of Blood in the Cavities of the Heart. (See Figs. 18, 19.)

In the left ventricle, the aperture of entrance, the mitral orifice, is contiguous to the aperture of exit, the aortic orifice, the two orifices being separated by a membranous septum consisting of the anterior flap of the mitral valve. In the right ventricle, the aperture of entrance, the tricuspid orifice is at a distance from the aperture of exit at the pulmonary artery, the two orifices being separated by the muscular channel of the *conus arteriosus.* In the left ventricle the current of blood inwards, which descends during the diastole behind the anterior segment of the mitral valve, is parallel in direction to the current of blood outwards, which ascends during the systole in front of that segment. (Fig. 18.) In the right ventricle the current of blood inwards is at right angles to the current of blood outwards, since the blood enters the cavity from right to left, and leaves it from below upwards. (Fig. 19.) During the systole the stream of blood in the left ventricle takes a spiral direction towards the aortic orifice, in accordance with the direction of the aorta itself. The stream of blood in the right ventricle, as it ascends, mounts over the bulging septum, being restrained by the concave anterior wall of the ventricle. This upward stream, which narrows as it ascends, thus takes the curved direction upwards, backwards, and inwards of the *conus arteriosus* and the pulmonary artery. In the left ventricle, the anterior

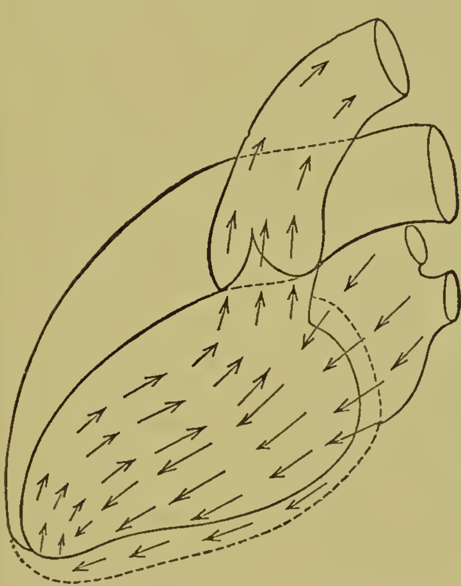


Fig. 18.—Showing the direction of the currents of the blood in the left side of the heart.

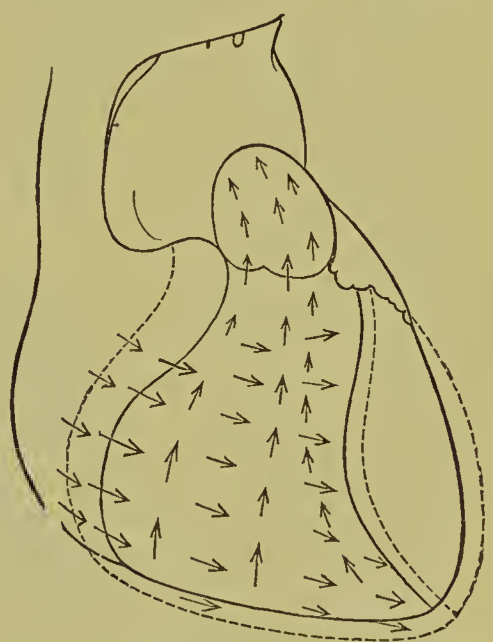


Fig. 19.—Showing the direction of the currents of the blood in the right side of the heart.

segment of the mitral valve and the right and left papillary muscles, form a hollow channel for the stream of blood, which, as it ascends to the aorta, presses upon the under-surface of the valve. In the right ventricle the stream of blood, as it ascends, sweeps onwards at right angles to the under-surface of the tricuspid valve, and rushes between and across the papillary muscles, and through the tendinous cordage that connects the muscles to the flaps of the valve.

The Movements of the Heart caused by Respiration. (See Figs. 20, 21.)

During inspiration the diaphragm in its descent draws downwards the fibrous sac and floor of the pericardium, and the whole of its contents. The heart rests upon the central tendon of the diaphragm which forms the floor of the pericardium, and it therefore necessarily rises and falls with the rise and fall of the diaphragm. The descent of the diaphragm is accompanied by the advance of the anterior wall of the chest, which produces the corresponding expansion of the lungs anteriorly. The central tendon of the diaphragm forming the floor of the pericardium presents an inclined plane, upon which the heart glides forwards and downwards during inspiration, under the combined influence of the descent of the diaphragm and the forward movement of the ribs and sternum. Whatever be the cause of the altered level of the diaphragm, whether it contracts and descends, as in inspiration, or is pushed downwards by fluid or tumours in the chest—whether it is raised during expiration, or pushed upwards by distension of the stomach and intestines, by fluid in the abdomen, by abdominal tumours, or by abscess or other affections of the liver; whatever, in short, be the cause producing the ascent or descent of the diaphragm, a corresponding ascent or descent of the heart must ensue. The only exception is the displacement downwards of the central tendon of the diaphragm by means of effusion into the pericardial sac, when the fluid interposes itself between the heart and the diaphragm, with the effect of pushing the diaphragm downwards and the heart upwards. An important part is played by the pericardium in the influence of respiration on the position of the heart. The central tendon of the diaphragm forms the base of the pericardium, upon which the heart rests as upon a floor. The aponeurotic structure of the pericardium, which takes its origin from the central tendon, ascends so as to form a strong fibrous pouch which envelopes the

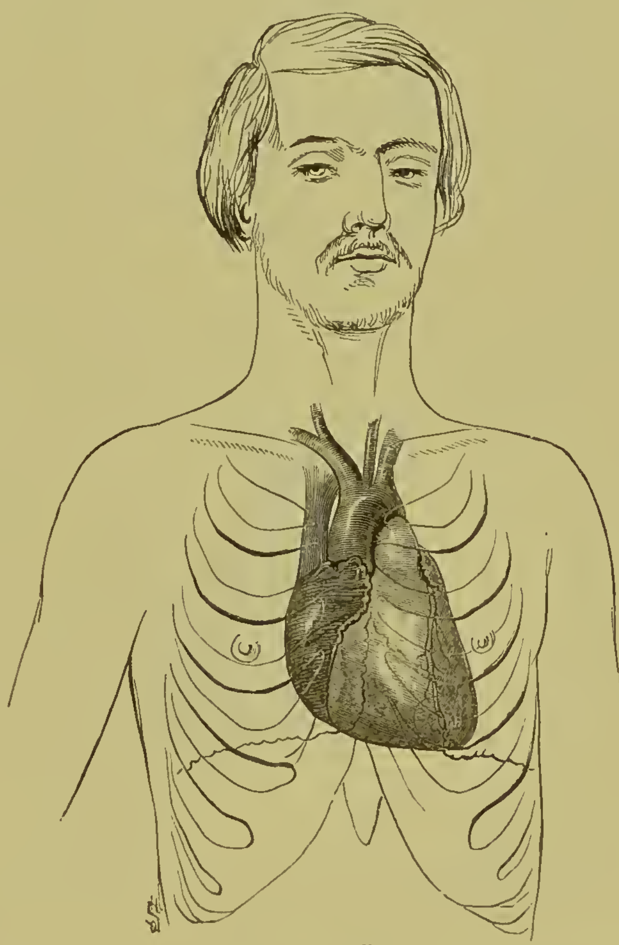


FIG. 20.—Showing the position of the heart and great vessels in relation to the walls of the chest, and the lungs in a healthy man *at the end of a forced expiration.*

whole heart and gives off a fibrous investment to each of the great vessels as they enter or leave the pericardial sac. Through the medium of this aponeurotic structure, the diaphragm during its descent, acts so as to draw downwards the great vessels simultaneously with the heart.

The respiratory movements of the heart are vertical. The organ and all its parts and great vessels move downwards

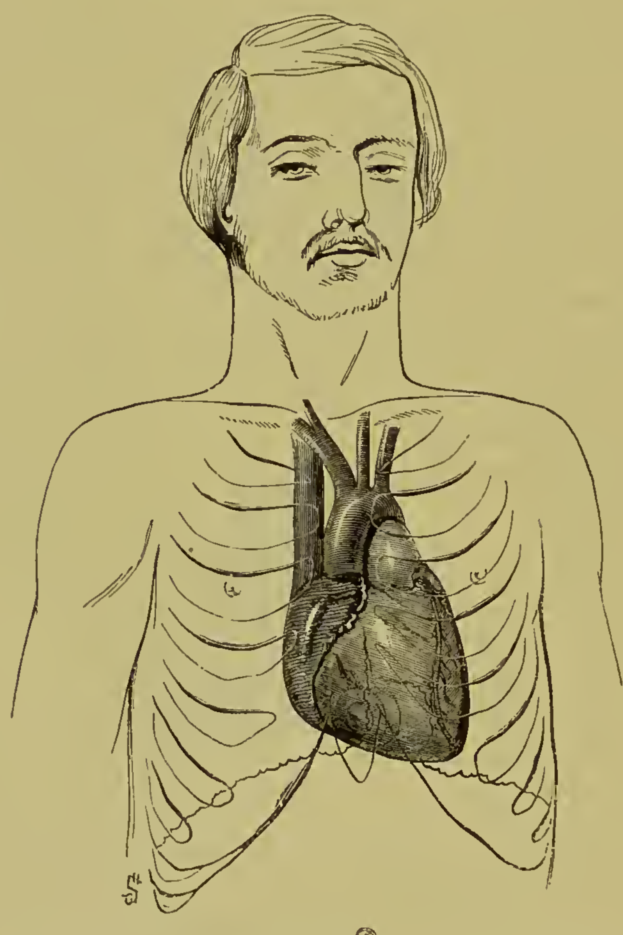


FIG. 21.—Showing the position of the heart and great vessels in relation to the walls of the chest, and the lungs in a healthy man *at the end of a deep inspiration.*

Note.—The lower boundary of the heart ought to have been somewhat lower in this figure.

during inspiration, and move upwards during expiration. While, therefore, the vertical relations of the heart and great vessels to the parietes of the chest are altered, the lateral relations of the various parts of the heart and great vessels to each other are unaltered, and their relative positions to the surrounding organs are not materially changed.

While the diaphragm descends during inspiration, carrying with it the heart, the front and sides of the cage of the chest, formed by the ribs and sternum, ascend. The change in the position of the heart in relation to the ribs and sternum is, therefore, doubled in extent by the twofold operation of the descent of the diaphragm and the heart simultaneously with the ascent of the cage of the chest.

Inspiration, besides causing the descent of the heart, produces also a lengthening and general enlargement of the organ and its great vessels. The lengthening of the heart and its vessels tells with decreasing effect from below upwards. The descent of the great vessels in the neck is much, but not completely, restrained by the attachments of those vessels. The innominate, the left carotid and the subclavian arteries, and the ascending aorta, are elongated and straightened to a considerable extent, and as less blood is sent into those vessels during inspiration than during expiration, they are lessened in width at the same time that they are increased in length. The enlargement of the cavities of the heart is limited to the right side. The right auricle receives in increased quantity the blood which has been stored up in the hepatic and portal vessels and the great veins during expiration. The space in the vessels of the expanded lungs for the reception of blood is increased ; the blood is sent with greater ease through the pulmonary artery from the right ventricle, in consequence of the enlargement of the pulmonary capillaries, and is at the same time sent in greater quantity from that cavity, because its supply of blood, derived from the auricle, is materially increased during inspiration. The venæ cavæ, the right auricle, the right ventricle, and the pulmonary artery are therefore enlarged both in length and width. The supply of blood to and from the right cavities of the heart, which is thus increased during inspiration, is then probably associated with a corresponding diminution in the supply of blood to and from the left cavities of the heart. The blood is retained in the pulmonary vessels in augmented quantity during inspiration. We may infer that less blood is sent then into the left auricle, and we know that less blood is sent then into the system through the arteries from the left ventricle, than during expiration.

The result of the various co-operating and contending forces which I have just considered are exhibited with, I believe, an approach to accuracy in Figs. 20 and 21, representing the position of the heart and great vessels in relation to the cage of the chest and the lungs at the end of a forced expiration, and at the end of a deep inspiration.

The greatest change in the relative position of the heart during inspiration takes place at its lower boundary, the descent of which is equal to that of the central tendon of the diaphragm, or at least one inch. The upward movement at the same time of the lower end of the sternum and the adjoining cartilages is about one inch also. The resulting change in the relative position of the lower boundary of the heart and the external walls ought to be, and I believe is, though I have not ascertained it by exact demonstration, about two inches. The ascertained change in the relative position of those parts is such, that the lower boundary of the right ventricle, at the end of expiration, is situated behind the lower end of the sternum, and at the end of inspiration, behind the lower end of the ensiform cartilage. The result during life, in a robust man, is that at the end of expiration, the impulse of the right ventricle may be perceptible to the left of the lower end of the sternum; while at the end of inspiration it is to be seen and felt beating with considerable force over, below, and to the left of the ensiform cartilage, or in other words, at the epigastrium. The heart has in fact descended into the space previously occupied by the liver and stomach, and instead of being protected at the part spoken of by a bony framework, is at the end of a deep inspiration only covered to each side of the ensiform cartilage by the abdominal muscles. The apex of the left ventricle descends to the same extent during a deep inspiration, or from the fifth rib to the seventh costal cartilage. The impulse at the apex, which at the end of expiration is often felt beating with force in the fourth intercostal space, is at the end of a deep inspiration quite imperceptible. I need not go through the whole of the details of the altered relative positions of the heart and great vessels in relation to the ribs and sternum during expiration, and at the end of a deep inspiration. They speak for themselves, and are exhibited in the accompanying figures. It will suffice, if I describe the altered bearings of the principal landmarks. A transverse boundary-line drawn across the top of the right auricle and right ventricle corresponds with the attachment of the great vessels to the heart. This transverse line, which marks the position of the aorta above the right auricle, and the commencement of the pulmonary artery, extends at the end of expiration across the second intercostal spaces and the intervening portion of the sternum a little below the manubrium; while at the end of inspiration it crosses the lower boundary of the third intercostal spaces and the intermediate portion of the sternum. The pulmonary artery descends from the second to the third intercostal space, and the visible commencement of the aorta makes a corresponding descent behind the sternum. The top of the arch of the aorta which at the beginning of a deep inspiration is a little below the top of the manubrium, is, at the end of it, at or a little above the lower end of that bone.

The vertical and forward respiratory movements of the heart explain the difference in the position of the heart in relation to the walls of the chest in weak persons with flat chests on the one hand, and in those who are full-chested and robust on the other. The relations of the heart and great vessels to the cage of the chest follow the type of expiration in the feeble, and the type of inspiration in the strong.

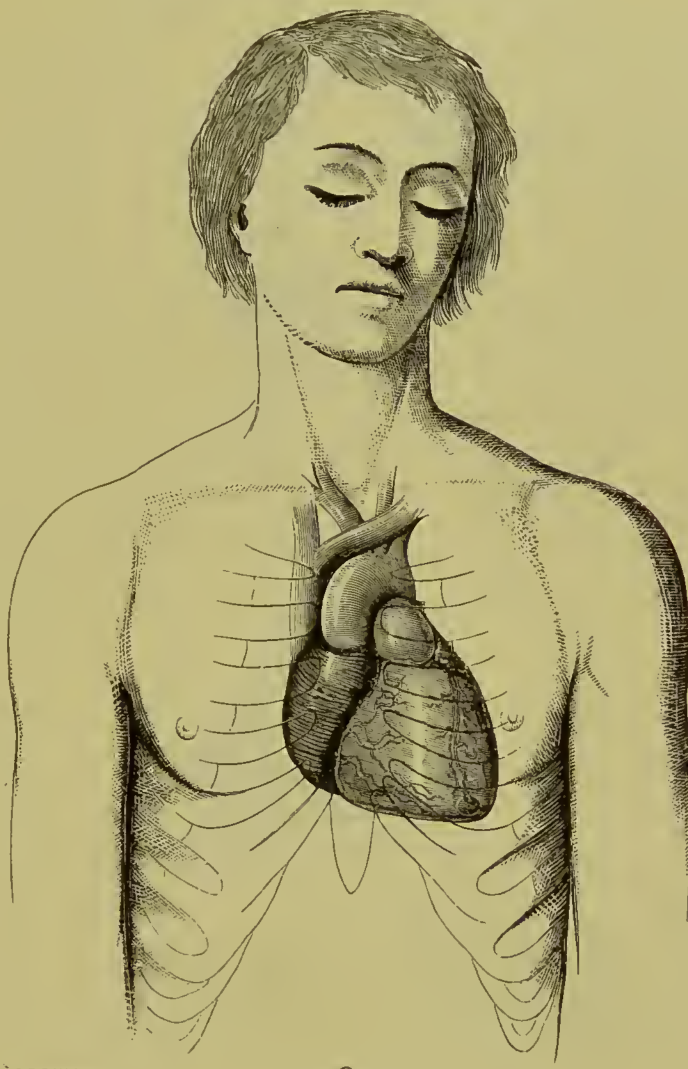
Front View of the Heart and Great Vessels in a Healthy Man with a well-formed Chest. (See Figs. 22, 23.)

The heart and great vessels occupy the central region of the chest. The lower boundary of the right ventricle is situated behind the ensiform cartilage, and is about half an inch or more below the lower end of the osseous sternum ;[1]

[1] All the works on the diagnosis of the diseases of the heart with which I am acquainted, whether published in this country or in Germany, represent the lower boundary of the heart as being situated above the lower end of the sternum. Several of these works have evidently taken their figures from Luschka's well-known drawing, which gives undoubtedly an accurate view of the heart and the surrounding parts in the dead body from which it was taken. It gives, however, on that very account, an inaccurate view of the relative position of the heart in the living man.

I have just stated that the lower boundary of the heart is situated behind the ensiform cartilage, about half an inch or more below the lower end of the osseous sternum, and have done so on the following grounds :—

(1.) At the time of death the heart is raised by the elevation of the diaphragm during the final expiration. After death the heart contracts upwards towards its higher points of attachment, so as to leave an average space of half an inch between the lower boundary of the heart and the lower boundary of the *front* of the pericardium ; that space being the exact measure of the upward shrinking of the heart after death. The lower boundary of the heart was situated behind



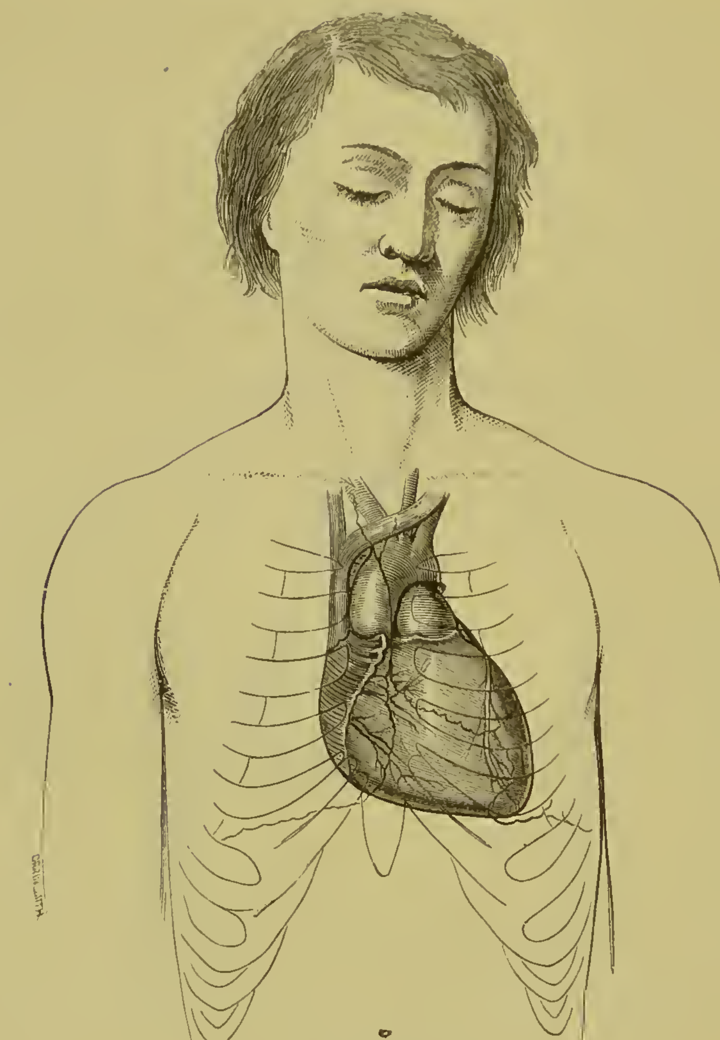
SYSTOLE.

FIG. 22.—Showing the position and relative size of the various cavities of the heart and of the great vessels during the ventricular systole in a healthy, well-formed man.

Note.—The fifth cartilages were unusually high in the body from which figures 22 and 23 were taken.

and the top of the arch of the aorta, at the origin of the innominate and left carotid arteries, is about half an inch or more below the upper end of the sternum.

the end of the osseous sternum in one-fifth, and below that point in two-fifths of my cases, while it was above that point in two-fifths of



DIASTOLE.

Fig. 23.—Showing the position and relative size of the various cavities of the heart and of the great vessels during the diastole of the ventricles in a healthy, well-formed man.

The breadth of the heart is about one-half of the breadth of the chest. The heart, at its extreme limits, extends for a

them. The lower boundary of the *front* of the pericardium, which marks the position of the lower boundary of the heart itself at the time of death, was behind the lower end of the sternum in one-fifth, and below that point (being situated behind the upper portion of the ensiform cartilage) little more than one-third of its breadth into the right side of the chest, and for a little less than two-thirds of its breadth into the left side of the chest, or in that proportion to the right and left of a vertical line drawn down the middle of the sternum.

During the systole of the ventricles the proportion of the heart in the left side of the chest lessens, owing to the inward contraction of the left border of the left ventricle, while that in the right side of the chest increases, owing to the outward expansion of the right border of the right auricle.

The boundary line across the sternum, between the upper border of the heart and the lower limit of the great vessels, is on a level with the third costal cartilages.

in two-thirds of my cases, while it was above that point in only one-eighth of them.

(2.) We have already seen (pp. 34, 35) that there is a general correspondence between the relation of the lower boundary of the right ventricle to the end of the osseous sternum, and the relation of the lower border of the apex of the heart to the inferior edge of the fifth costal cartilage and rib. The inferior edge of the junction of the fifth cartilage and rib was on a lower level than the end of the sternum by from a quarter of an inch to an inch and a quarter in sixty out of seventy-one cases, was on the same level in five, and was above that level in six instances. It is evident that, with few exceptions, the apex-beat could not be felt in the fifth space if the lower boundary of the heart were situated above the end of the sternum.

(3.) The lower edge of the anterior portion of the right lung at its left border corresponds, as a rule, with the lower boundary of the heart at the same situation. In six cases the lower edge of that portion of the right lung was behind or on a level with the lower end of the sternum; in three it was above that point to the extent of half an inch; and in twenty it was below that point to an extent varying from a quarter of an inch to an inch and a half, or, in one exceptional case, two inches. We may therefore infer that the lower boundary of the heart was situated in two-thirds of these cases behind the ensiform cartilage, in one-fifth of them behind the lower end of the osseous sternum, and in only one-tenth of them above that end of the bone.

The lower boundary of the heart extends, with a slight inclination downwards, from about half an inch below the lower end of the sternum to the fifth left space, just above or on a level with the upper edge of the sixth left cartilage. The lower boundary of the heart ascends during the systole of the ventricle, and descends during its diastole ; it descends also during ordinary inspiration, and ascends during ordinary expiration for about the third of an inch. A deep inspiration may bring down the lower border of the heart to the lower end of the ensiform cartilage, and a forced expiration may raise it to or above the level of the lower end of the sternum.

The left boundary of the heart at its apex is situated to the left of the junction of the fifth rib to its costal cartilage, and behind or to the left of a vertical line drawn downwards from the left nipple.[1] The right boundary of the heart extends about an inch to the right of the right edge of the sternum.

The Right Side of the Heart.—The right cavities occupy the whole front of the heart with the exception of its left portion, where the left ventricle comes into view from behind the right ventricle to the extent of an inch in breadth. The transverse or auriculo-ventricular furrow forms the external apparent separation between the right auricle and right ventricle. The auriculo-ventricular furrow sweeps backwards and forwards to so great an extent, to the left during the systole, and to the right during the diastole, that it presents no fixed position during life, but ranges to and fro between certain limits. The upper end of the furrow may be situated at the left edge or at the middle line of the sternum, on a level with the third cartilage ; and its lower end may be placed a little below and to the right of the lower end of the

[1] I have made comparatively few observations as to the position of the left nipple in relation to the junction of the adjoining ribs to their cartilages and the left boundary of the heart at its apex.

sternum, being behind the sternal end of the seventh cartilage, but it may extend for fully half an inch to the right of this position. The transverse furrow thus crosses behind the lower half of the sternum obliquely from left to right, and from above downwards. The upper third of the transverse furrow forms a true line of separation between the auricular appendix and the arterial cone of the right ventricle ; but the lower two-thirds of the furrow lie about half an inch to the right of the tricuspid orifice and the line of division between the right auricle and the right ventricle. The right transverse or "auriculo-ventricular" furrow is not therefore at this part of its course a true line of separation between the right auricle and ventricle, but is thrown half an inch to the right of that line by the presence there of the right coronary vessels, and the couch of fat in which they are embedded.

The Right Auricle.—The right auricle is broad above, where it widens out into the auricular appendix, especially during the systole, and lies behind the middle of the sternum, reaching from its right often to its left edge, on a level with the third cartilages ; and it is narrow below, where it appears to come to a point at the lower end of the transverse furrow, to the right of the lower end of the sternum. The real or internal breadth of the right auricle is, as I have just explained, greater than its apparent or external breadth along the line of the transverse furrow. When, therefore, the lower portion of that furrow is situated a little to the right of the sternum, the lower portion of the tricuspid orifice is covered by the lower end of the sternum, a little to the right of the middle line of that bone. The right boundary of the auricle extends behind the right costal cartilages for about an inch beyond the right edge of the sternum.

The right auricle undergoes more change in form during the action of the heart than any other portion of the organ.

During the systole of the ventricles the auricle retains its length, but it becomes twice as wide, and its whole surface, instead of being pale and wrinkled, is purple, plump, and glistening. The ventricular border moves extensively to the left, so as to pass from the right margin to the middle line of the sternum, while its right border expands a little to the right. There is a slight descent of the upper and lower borders of the right auricle during the contraction of the ventricles. During the diastole of the ventricles these appearances and movements are reversed.

The Right Ventricle.—The right ventricle forms the solid muscular front of the heart, and is flanked to the right by the right auricle, and to the left by that small portion of the left ventricle that comes into view in front of the heart, and forms its left border.

The right ventricle, when exposed to view in front of the heart presents a pyramidal shape. The base of the pyramid is formed by the lower boundary of the ventricle, which rests on the central tendon of the diaphragm, and extends, with a slight obliquity downwards and from right to left, from the right auricle to the apex of the left ventricle ; its upper border is crowned by the pulmonary artery, which forms the apex of the pyramid ; its left border is formed by the longitudinal furrow, which divides the right from the left ventricle ; and its ostensible right border by the transverse furrow which apparently separates the right auricle from the right ventricle, the actual separation of those two cavities at the tricuspid orifice being situated, as I have just stated, about half an inch to the left of the transverse furrow.

The right ventricle, in its vertical diameter or length, extends from the third left cartilage to the sixth, which are the cardiac cartilages. In its transverse diameter, or breadth, the right ventricle extends from the transverse furrow, at or to the right of the right edge of the sternum below, and somewhat to the right of the left edge of the sternum above, to the anterior longitudinal furrow, which is situated behind or a little to the right of the junction of the left costal cartilages to their ribs from the third to the fifth.

The length or vertical measurement of the ventricle is greater than its breadth or transverse measurement, in the proportion of about four to three. The body of the ventricle forms about the lower two-thirds of the cavity extending from the fourth left cartilage to the sixth, and the *conus arteriosus* forms about the upper third of the cavity extending from the third left cartilage to the fourth. The arterial cone of the right ventricle narrows from below upwards until it ends in the pulmonary artery, and the breadth of the cone a little below the origin of the pulmonary artery, in relation to that of the body of the right ventricle, is in the proportion of nearly three to five, or in other words, the width of the cone is nearly three-fifths of the width of the body of the right ventricle.

Owing to the arterial cone being so much narrower than the body of the right ventricle, especially at its right border, the transverse furrow extends further to the left at its upper than at its lower border by more than an inch. In consequence of this great deviation towards its upper end the transverse furrow presents a double curve, which, looking to the right, is concave above, where the rounded auricular appendix fits into the hollow profile of the arterial cone; and convex below, where it is situated half an inch to the right of the tricuspid orifice.

The longitudinal furrow takes a downward direction, with a slight inclination to the left, this inclination to the left increasing rapidly towards the lower end where it approaches the apex. In consequence of this, the longitudinal furrow also presents a double curve, which, looking to the left is convex above, concave below. The deviation to the left of the lower end of the longitudinal furrow is caused by the deviation to the left of the cavity of the right ventricle as it approaches the apex of the heart. The furrow between the ventricles turns to the left at its inferior extremity, and, so to speak, cuts through the apex of the heart. The apex of the heart is thus composed of the apex of the left ventricle and the adjoining left end of the lower border of the right ventricle.

During the contraction of the right ventricle its four sides approximate towards a point of rest or stable equilibrium, which is situated on the anterior wall of the cavity, over or close to the attachment of the anterior papillary muscle, a little to the left of the longitudinal furrow, and slightly nearer to the lower than the upper border of the ventricle. The movement of the transverse furrow to the left is extensive, and that of the longitudinal furrow to the right is slight; the downward movement of the upper border at the origin of the pulmonary artery is considerable, and the upward movement of the lower border of the ventricle is somewhat less. The right border of the *conus arteriosus* moves less to the left than the right border of the ventricle at the tricuspid orifice. At the same time the surface of the ventricle becomes wrinkled, and its coronary vessels start out from the surface and become tortuous. During the dilatation of the ventricle the reverse movements take place, its surface becomes smooth, glistening and rounded, and the vessels on its surface cease to be prominent. (See Fig. 16, page 112.)

The Left Ventricle.—The left ventricle, where seen in front, comes into view to the left of the right ventricle, and forms the convex left border of the heart. The left ventricle forms here a comparatively long, narrow slip, extending from the third left space down to the fifth, and from the longitudinal furrow behind or to the right of the junction of the corresponding ribs to their cartilages, to the left border of the heart, which reaches up to or just beyond the left nipple. This visible anterior portion of the left ventricle is of the greatest width at and below its middle, behind the fourth space and the fifth cartilage. Above and below this region the ventricle narrows, coming to a point at the apex below, and above bearing to the right, where it is finally hidden by the appendix of the left auricle. The breadth of the anterior visible portion of the ventricle at its widest part is about one-fifth of the breadth of the heart.

The apex of the heart occupies the fifth space, its lower border being situated just above or behind the upper edge of the sixth cartilage and rib, and its left border being at or a little beyond a vertical line drawn down from the nipple.

During the contraction of the left ventricle the right and left borders of its visible anterior portion both move a little to the right, its base and upper portion descend, and its lower portion and apex ascend, both portions moving forwards and to the right. (See Fig. 17, page 112.)

The Appendix of the Left Auricle is situated behind the third left cartilage close to its junction with the third rib, and fills up the angle or space between the upper end of the left and right ventricles, at the top of the longitudinal furrow, and the left boundary of the origin of the pulmonary artery.

The left auricular appendix is much more prominent and extensive during the contraction of the ventricles, when its right and lower borders move respectively considerably to the right and downwards, and its left and upper borders move obliquely to the right and slightly downwards, than it is during the dilatation of the ventricles, when the auricular appendix shrinks inwards upon itself.

The Great Vessels.—The great vessels lie side by side, the ascending aorta being in the centre, the pulmonary artery to the left, the superior vena cava to the right, behind the upper portion of the sternum and the adjoining costal cartilages, at and above the level of the third cartilage.

The Arch of the Aorta.—The root of the aorta, including the aortic orifice, valve, and sinuses, is hidden in the centre of the heart. The ascending aorta comes into view just above the appendix of the right auricle, on a level with the third costal cartilages, and is covered by the sternum, the right border of the artery being situated behind or a little to the left of the right edge of the sternum ; and its left border, which is partially covered by the right border of the pulmonary artery, being about a quarter of an inch or less to the right of the left edge of the sternum. As the arch of the aorta ascends, it bears to the left, and at the point where it gives origin to the innominate artery, it is exactly behind the middle line of the sternum. From this point the transverse aorta ascends slightly until it gives origin to the left carotid artery, whence it curves backwards and slightly downwards, with an inclination to the left, and gives off the left subclavian artery, the last of its three great branches. The left carotid arises just within a line drawn downwards from the sternal end of the left clavicle, and the left subclavian just without that line. The part at which the innominate and left carotid arteries take their origin is the highest point of the arch, and is situated about three-quarters of an inch or rather less below the top of the manubrium, as far as the breadth of the innominate artery to the left of a line drawn down the middle of that bone, and in the front of the lower portion of the body of the third or the upper portion of that of the fourth dorsal vertebra, which corresponds with the third dorsal spine, which is situated midway between the spines of the scapulæ. The transverse aorta, as it curves backwards, to the left and downwards, rests first on the front and left side of the trachea, and then upon the left side of the œsophagus, and is situated between the manubrium, just to the left of the middle line, from three-quarters of an inch or less below the top of the bone down to its lower end in front, and the left side of the body of the fourth and the upper portion of the fifth dorsal vertebra behind. The relations of the transverse aorta to the manubrium in front are very variable, but those to the dorsal vertebræ behind are less so.

The deep left border of the descending portion of the arch may be seen in a front view, and this border is situated in succession behind the left and lower portion of the manubrium, near its junction to the first rib, the first space and the sternal portion of the second left costal cartilage and the adjoining portion of the sternum. The relations of this important portion of the arch will be considered when the side and back views of the heart and great vessels are described.

The ascending aorta just above the right auricular appendix descends slightly during the contraction of the ventricles ; but the top of the arch, at the origin of the innominate and left carotid arteries, is scarcely moved during the contraction of the heart. Inspiration causes the descent of the ascending and transverse aorta and its great branches. This descent is slight during ordinary breathing, but is considerable on a deep inspiration. The inspiratory descent of the arch of the aorta is much less than that of the root of the aorta and heart.

The Pulmonary Artery.—The origin of the pulmonary artery is situated behind the upper portion of the third left cartilage, and its top lies behind the second left cartilage. As the artery ascends to the left of the ascending aorta, it occupies the second left space and cartilage for four-fifths of its breadth, and is covered by the left border of the sternum for the remaining fifth. The pulmonary artery, at its origin, is situated just above and within the appendix of the left auricle; and as it proceeds on its course, it makes for the hollow of the arch of the aorta, through which it sends its right branch. Its direction is therefore much more from before backwards than from below upwards. The remaining course of the artery cannot be seen in front, and will be considered when the side and back views of the heart and great vessels are described.

During the contraction of the right ventricle the pulmonary artery descends at its origin to a considerable extent, and the higher parts of the artery also descend, but less and less from below upwards, at the same time the whole artery enlarges and lengthens. The pulmonary artery descends also during inspiration, but to a less extent than the body of the right ventricle, and less at its upper part than at its origin.

The Superior Vena Cava.—The superior vena cava receives the right and left innominate veins a little below the level of the top of the arch of the aorta, behind the right portion of the manubrium, midway between the upper and lower end of the bone. The right innominate vein descends behind the sternal end of the right clavicle, and the left innominate vein crosses in front of the three great arteries, just at or above their origin from the arch of the aorta. The superior vena cava descends immediately to the right of the sternum behind the first space, the second cartilage and the second space, and it opens into the right auricle behind the third right costal cartilage.

The superior vena cava descends slightly at its point of entrance into the right auricle during the contraction of the ventricle. It descends also during inspiration, but to a greater extent.

The Relation of the Lungs to the Heart in Front.—The lungs cover the great vessels and the whole of the heart except the more prominent portion of the right ventricle which is behind the cardiac cartilages.

The inner margins of the right and left lungs in front meet together behind the upper two-thirds of the sternum, the right lung as a rule, passing to the left of the centre of the sternum, so as to encroach somewhat on the left side of the chest. The inner margin of the left lung separates from that of the right lung, and diverges to the left on a level with the fourth left costal cartilage. Thence the lower border of this portion of the lung extends to the left, lying behind the lower edge of the fourth cartilage or the upper border of the fourth space, and in front of the body of the right ventricle. Before this border of the lung reaches the longitudinal furrow and the junction of the cartilages to the ribs, it curves downwards, crossing within the fourth space and the fifth cartilage, where it again curves to the right so as to form a hollow space for the lodgment of the apex of the heart. After crossing the fifth space the inner margin ends in the lower border of the upper lobe, which is situated behind the upper edge of the sixth cartilage and rib, where it soon ends in the septum that divides the upper from the lower lobe of the left lung. Owing to the outward and inward curve thus made by the inner margin of the left lung where it crosses the heart to form the left and lower border of the superficial cardiac space, a remarkable tongue of lung is formed by the inner and lower borders of the upper lobe of the left lung. This tongue of lung, owing to its free position just in front of the interlobular septum, wraps round the apex of the heart, being above, below, outside, and in front of it, so as to adapt itself to every movement of the apex. When the apex advances it recedes, when the apex recedes it advances, and thus it allows free play to the apex at the same time that it softens the impulse of the apex upon the walls of the chest, and shields it, when it becomes again flaccid, and retires within its nest.

The inner margin of the right lung, after that of the left lung has deviated to the left, continues its course downwards, behind the sternum, being nearer to the left than the right edge of that bone. It thus completely covers the transverse furrow, the right border of the right ventricle, and the tricuspid orifice. This inner margin of the right lung inclines to the left before it reaches the lower boundary of the heart, where it soon ends in the lower margin of the right lung; which margin lies at first behind the upper part of the ensiform cartilage, then crosses behind the sternal portion of the seventh and sixth right cartilages, and afterwards takes its course to the right, behind or just above the sixth cartilage.

It is evident, from what has just been stated, that the lungs are moulded by a natural adaptation to the form and structure of the heart and great vessels. They thus cover the soft and yielding right auricle, which requires the additional protection of the soft covering in which it is thus imbedded; they thus cover the great vessels, which do not advance so far forwards as the body of the heart; they thus cover the circuit of the ventricles around the three sides of the superficial cardiac space; and they thus leave uncovered the most prominent and powerful portion of the right ventricle. Obeying this law of adaptation, the inner margin of the right lung extends inwards and to the left along its whole length, more than that of the left lung extends to the right; for the greater prominence of the pulmonary artery, of the *conus arteriosus* and of the centre of the right ventricle, parts that are situated to the left of the middle line of the sternum, offers resistance to the free inward expansion to the right of the margin of the left lung. On the other hand, the less prominence of the ascending aorta, the soft and yielding character of the right auricle and its appendix, and the less prominence of the right border of the right ventricle, parts that are situated behind and to the right of the sternum, allow and even invite the more free inward expansion to the left of the inner margin of the right lung. The inner margins of the lungs, in short, advance freely where they meet with the least resistance, and stop or even recede where they meet with the greatest resistance.

The Orifices and Valves of the Heart and the Great Arteries.—The orifices and valves of the heart may be considered in two orders : (1) As they are superficial or deep in situation, when the pulmonic and tricuspid orifices and valves would come first, and then the aortic and mitral orifices and valves : and (2) as they are ranged from above downwards when the pulmonic orifice and valve come first in order, then the aortic, then the mitral, and last the tricuspid orifice and valve. I shall consider them in detail according to the first and most natural of those orders, namely, the superficial and deep orifices and valves, which are also the orifices and valves of the right or anterior and the left or posterior cavities. After doing so, I shall briefly indicate them, for the sake of their common connexion, in their order, from above downwards.

The orifice of the pulmonary artery is the highest of the four orifices, and its anterior portion is situated mainly behind the third left cartilage, its right border being covered by the adjoining edge of the sternum. During the systole of the ventricles the anterior portion of the orifice of the pulmonary artery descends into the third space.

The root of the pulmonary artery consists of two anterior sinuses and one posterior sinus, and its valve consists of two flaps in front and one behind, each in its own sinus. The position of the anterior flaps is higher than that of the posterior flap. The anterior or superficial convex wall of the right ventricle is much longer than its posterior or internal convex wall, owing to its outer wall being a section of a much larger sphere than its inner one. When, therefore, the right ventricle contracts, its anterior and outer wall shortens and draws downwards the anterior flaps of the pulmonic valve to a much greater extent than the posterior and inner wall shortens and draws downwards the posterior flap. The result is that when the right ventricle is in a state of complete contraction, the anterior and posterior flaps of the pulmonic valve are nearly on the same level ; and that when the ventricle is in a state of distension the anterior flaps may be an inch higher than the posterior flap. This is well seen in several of Pirogoff's vertical sections.

The tricuspid orifice is the lowest as well as the most superficial of the four orifices, and is separated from the orifice of the pulmonary artery by the *conus arteriosus* of the right ventricle. In a healthy active man with a well-formed chest, the tricuspid orifice is situated behind the lower fourth of the sternum to the right of the middle line of that bone, its upper border being on a level with the lower edge of the fourth cartilage, and its lower border being behind the lower end of the sternum, and the articulation to it of the right sixth cartilage.

The tricuspid orifice is situated about half an inch to the left of the right transverse auriculo-ventricular furrow. It is impossible to assign accurately a fixed position to the tricuspid orifice owing to its extensive movement to the left during the contraction, and to the right during the dilatation of the right ventricle. The limits of the range of this movement may, however, be defined to the right by a line a little to the right of the sternum, and to the left by a line a little to the left of the middle line of that bone, the orifice playing backwards and forwards behind, and to the right of the right half of the lower portion of the sternum.

The position of the flaps, the tendinous cords, and the papillary muscles of the tricuspid valve have been already described in detail.[1] It will, therefore, be sufficient to say here that the papillary muscles radiate like a fan upwards, outwards, and downwards from the cords and flaps of the valve; that the superior papillary muscle, when present, ascends behind the fourth cartilage; that the anterior papillary muscle takes the direction outwards of the fifth cartilage; and that the inferior papillary muscles descend behind the sixth cartilage.

The root of the aorta,[2] including its orifice, valve and sinuses, occupies the space between the pulmonic and tricuspid orifices. The root of the aorta, and the aortic vestibule, which is the channel or chamber with rigid walls that leads to it from the cavity of the left ventricle, project forwards in front of that cavity and of its mitral orifice, so that the orifice of the aorta, covered by the posterior wall of the *conus arteriosus*, interposes itself, as has just been stated, between the pulmonic and tricuspid orifices. By this arrangement the aortic orifice advances more nearly to the front of the chest, the shallow *conus arteriosus* being in front of the orifice, and the deep cavity of the right ventricle being below it. Hence the murmur of aortic regurgitation, and an intensified aortic second sound, and coincident doubling of that sound, are heard loudly over and to the left of the middle third of the

[1] See pages 94—102.

[2] I have already described the anatomical relations of the root of the aorta. See pages 69—86.

sternum in front of the arterial cone and the root of the aorta; and feebly over and to the left of the lower third of the sternum, in front of the cavity of the right ventricle. The root of the aorta is somewhat overlapped above and to the left by the root of the pulmonary artery, and is situated accordingly below and to the right of the pulmonic orifice, behind the left half or three-fifths of the sternum, on a level with the third space, the left portion of the aortic orifice extending beyond the sternum so as to lie within that space. The upper and left border of the aortic orifice, especially during the diastole, is seated behind the lower portion of the third cartilage, near the sternum; and its lower and right border, especially during the systole, is situated behind the middle line of the sternum, on a level with the upper portion of the fourth cartilage.

The root of the aorta descends considerably and moves to the left, so as to approach towards the apex during the contraction of the left ventricle, and at the same time the apex moves to a less degree upwards, and to the right, so as to approach towards the aortic orifice.

The mitral orifice is situated partly behind, and partly below the level of the aortic orifice, its upper third or upper two-fifths being behind, and its lower two-thirds or three-fifths below the level of that orifice; and partly behind, and partly above the level of the tricuspid orifice, its lower two-thirds or three-fourths being behind, and its upper third or fourth being above the level of that orifice. The mitral orifice is seated behind the left half of the sternum, at the upper two-thirds of the lower third of that bone, on a level with the fourth cartilage, the fourth space, and the upper portion of the fifth cartilage. It is impossible to assign a fixed position to the mitral orifice, for it, like the tricuspid orifice, plays to and fro during the contraction and dilatation of the ventricles. The limits of its movement may, however, be approximately defined by a line a little to the right of the middle line of the sternum on the one hand and a line corresponding to the left edge of the sternum on the other. I have already described the anatomical relations of the mitral valve,[1] and it will therefore be sufficient to state here that the left or upper and the right or lower papillary muscles, starting from their attachments through their tendinous cords to the flaps of the valve, concentrate themselves towards their roots at the apex, instead of radiating from the flaps upwards, outwards, and downwards, as in the instance of the tricuspid valve. The left or superior papillary muscle usually follows the course of the fourth cartilage and space, and the right or inferior papillary muscle that of the fifth cartilage, both muscles dipping downwards towards the lower cartilage or space as they approach the apex.

It may be gathered, from what has just been said, that each of the higher orifices overlaps in position the orifice immediately below it. Thus the pulmonic orifice at its lower and right edge is situated to a slight extent in front of the upper and left edge of the aortic orifice; the right posterior or lower flap of the aortic valve is situated in front of the upper third or two-fifths of the mitral orifice; and the lower two-thirds or three-fourths of the mitral orifice is behind the corresponding upper portion of the tricuspid orifice.

The position of the orifices and valves of the heart in relation to the deeper parts of the heart and of the chest, and to the spinal column, will be considered when the side and back views of the heart and great vessels are described.

[1] See pages 86—94.

The Position of the Heart and Great Vessels in Robust and Feeble Persons.

(See Figs. 20, 21, 22, 23, 24.)

We have just seen that respiration materially alters the position of the heart and the great vessels, and that at the end of a deep inspiration the lower boundary of the heart may be two inches lower in relation to the walls of the chest than at the end of a forced expiration. Thus, the lower boundary of the heart is situated behind or even above the lower end of the sternum at the completion of a forced expiration; while it may be situated at the lower end of the ensiform cartilage at the termination of a deep inspiration. Again the top of the arch of the aorta may be situated behind the upper end of the manubrium at the end of a forced expiration, and behind its lower end on the completion of a deep inspiration.

This great change is produced by a double agency, acting in opposite directions: one, the descent of the diaphragm which lowers and lengthens the heart and great vessels, and lengthens the lungs by lowering their base; the other, the ascent and advance of the walls of the chest in front. This combined downward movement of the heart and arteries, and upward movement of the sternum and cartilages, doubles the effect on the position of the organ in relation to the cartilages and sternum.

In robust persons, who lead an active and laborious life, the amount of reserved air constantly in the lungs is great, the chest is high, deep and broad, and the heart and arteries are low in position in relation to the anterior walls of the chest. In such persons the chest and its organs present the form and position of inspiration, and they have therefore the *inspiratory* type of chest. (See Figs. 20, 21, 22, 23.)

In feeble persons, on the other hand, who lead an indoor sedentary life, the amount of reserved air constantly in the lungs is small, the chest is flat and narrow, and the heart and arteries are high in position in relation to the anterior walls of the chest. In such persons the chest and its organs assume the form and position of expiration, and they present the *expiratory* type of chest. (See Fig. 24.)

In robust persons, such as sailors, miners, labourers and smiths, the lower boundary of the heart may be situated quite an inch below the lower end of the sternum, so that the heart may be felt beating in the epigastrium to the left of the ensiform cartilage, and the apex of the heart may be situated behind the sixth left cartilage or space. The lungs at the same time enlarge forwards and downwards, so as to interpose themselves between the heart and the walls of the chest, all but a small space bounded above by the fifth cartilage, on the right by the ensiform cartilage, and on the left by the sixth and seventh cartilages near their attachment to the sternum. The heart's impulse is, therefore, quite imperceptible over the front of the chest, that of the right ventricle being sometimes transferred, as I have just said, to the epigastrium, and the apex beat is lost, being enveloped in the folds of the enlarged lung. In such persons, also, the top of the arch of the aorta is low in position, being perhaps situated quite an inch below the top of the manubrium.

The position of the lower boundary of the heart and the summit of the arch of the aorta being unusually low, the position of every part of the heart and the great arteries is also correspondingly low. It is not necessary to describe the situation of the various anatomical points in detail, but it will be well to name that of the leading landmarks of the heart and great arteries.

The boundary-line across the third cartilage that indicates the upper border of the right auricle and ventricle and the lower limit of the great arteries may be shifted downwards to the level of the fourth cartilages. The position of the origin of the pulmonary artery in front being thus given, that of the aperture and valve of the aorta, being a degree lower and to the left, may be inferred, it being situated behind and a little to the left of the left half of the sternum, on a level with the fourth cartilage and the fourth space. The mitral and tricuspid orifices in their descending order take each of them a lower position, the mitral orifice being situated behind the lower fourth of the sternum, its upper boundary being on a level with the fourth space and its lower border, a quarter of an inch above the lower end of the sternum ; and the tricuspid orifice being behind the lower sixth of the sternum and the upper portion of the ensiform cartilage.

In feeble, thin persons, of sedentary occupation, or in those who have only recently recovered from illness, the lower boundary of the heart may be situated behind the lower end of the sternum, or somewhat higher, and its apex may be present behind the fifth left cartilage, and may be felt, therefore, beating, not in the fifth, but in the fourth space. Each lung at the same time lessens at its base, and shrinks away from before the body of the heart, uncovering the apex and the left ventricle, the whole of the right ventricle, and a portion of the auricular appendix, of the pulmonary artery and even of the ascending aorta. The heart's impulse is, therefore, diffused to an unusual extent over the front of the central part of the chest, from the second space to the fourth, and from the right of the lower portion of the sternum to the apex, being felt not only over the apex, but with considerable force over the right ventricle, where it is usually feeble or absent. A double pulsation may also be often felt over the pulmonary artery, feeble and soft with the first sound, but sharp and sudden with the second sound. In such persons

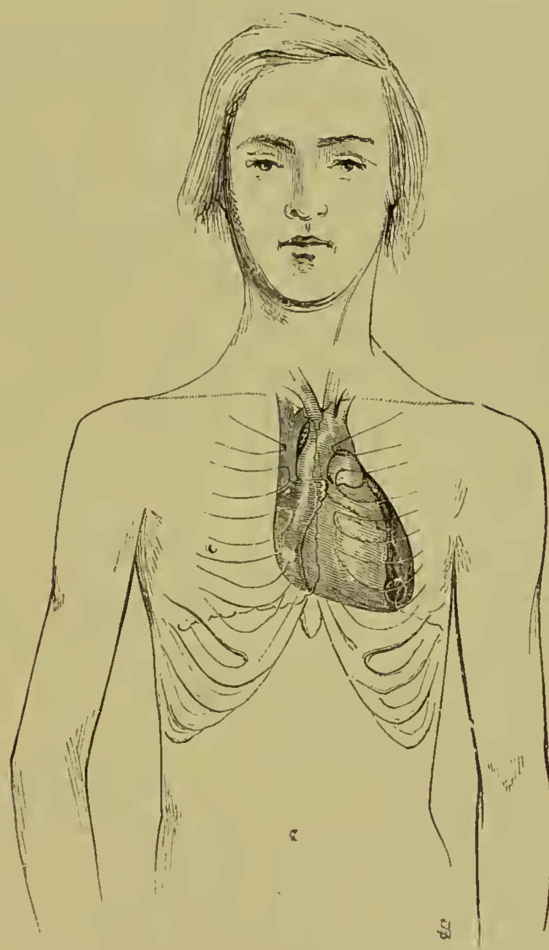


FIG. 24.—Showing the heart and great vessels in relation to the front of the chest and the lungs in a slender youth with a small chest.

also the top of the arch of the aorta is high, being situated behind or even above the top of the manubrium.

The position of the other parts of the heart and great vessels is correspondingly high. The boundary-line between the upper border of the right auricle and ventricle and the lower limit of the great arteries may be on a level with the middle of the second space, behind which the origin of the pulmonary artery may be seated. The orifice and valve of the aorta, being a stage lower and to the left, may be on a level with the lower portion of the second space and the third cartilage, behind the left half of the sternum. The mitral orifice may be situated behind the left half of the sternum, behind and just below the central portion of the bone, its upper border being on a level with the upper edge of the third cartilage, and its lower border with that of the upper edge of the fourth cartilage; and the tricuspid orifice may be situated behind the right half of the sternum just below the centre of the bone, so that its upper border may be on a level with the lower edge of the third cartilage or the upper portion of the third space, while its lower border may be on a level with the fourth space.

In many well-formed women of active, healthy habits, the heart and great vessels maintain their proper position. But this is not so in the large class of women who work indoors with the needle, and in whom the chest is wont to be flat, the position of the heart being high.

The effect of tight stays is to lessen the descent of the diaphragm, and to increase, for the sake of compensation, the expansion and elevation of the upper part of the front of the chest. In such persons a double and opposite effect may be produced. The lower boundary of the heart in relation to the lower end of the sternum may be high, but the top of the aorta in relation to the higher costal cartilage may be low.

In children of both sexes the position of the heart in relation to the walls of the chest is high.

SIDE VIEW; AFTER DEATH.

LEFT SIDE. (Fig. 25.)

The ninth plate of my Medical Anatomy represents a side view, looked at from the left side, taken from the body of a robust well-formed man. In this body the lower boundary of the heart was situated behind the ensiform cartilage, an inch and a half below the lower end of the sternum.

In this instance the top of the manubrium was on a level with the middle of the body of the third dorsal vertebra, and the lower end of the sternum was on a level with the upper border of the ninth vertebra. The middle of the sternum corresponded in level to the lower portion of the body of the fourth vertebra ; the lower end of the manubrium, to the lower portion of the fifth vertebra ; and the top of the lower third of the sternum, to the middle of the body of the seventh dorsal vertebra. The ensiform cartilage was of great length, measuring nearly 3 inches (2·8 inches), and its lower end was about on a level with the upper border of the body of the twelfth dorsal vertebra.

This drawing and Plate X. of the same work show well the great anatomical importance of the somewhat neglected ensiform cartilage, especially to the clinical worker. The front of the diaphragm, and the floor of the pericardium, which is formed by the central tendon of the diaphragm, take their origin in part from the tip of the ensiform cartilage by means of a strong slip of muscular fibres. The lower boundary of the pericardium and of the heart, and the lower boundary of the diaphragm, and with it that of the cavity of the right side of the chest and the right lung, may be brought down on a deep inspiration almost to the extremity of the ensiform cartilage, when that point forms the lower boundary of the chest. In this drawing, the lower boundary of the pericardium and the lower margin of the right lung were situated an inch above the end of the ensiform cartilage, and nearly two inches below the lower end of the sternum, and the lower boundary of the heart at the apex, as I have already remarked, was an inch and a half below the level of the lower end of the sternum.

The top of the arch of the aorta at the adjacent origin of the innominate and left carotid arteries was in this instance four-fifths of an inch (·8 inch) below the top of the manubrium, and was on a level with the upper portion of the body of the fourth dorsal vertebra.

The lower end of the descending portion of the arch of the aorta was in front of the upper portion of the body of the sixth dorsal vertebra, and was on a level with a point a little below the lower end of the manubrium.

The top of the pulmonary artery was a little higher in position than that of the lower end of the descending portion of the arch of the aorta just described; the origin of the pulmonary artery was three-quarters of an inch below the centre of the sternum, and within the third space, and was on a level with the lower portion of the body of the seventh vertebra; and the pulmonary artery occupied in its ascent the upper portion of the third space, the third cartilage, and the second space.

The top of the appendix of the right auricle was nearly half an inch below the centre of the sternum, and on a level with the cartilage between the sixth and seventh vertebræ. The top of the appendix of the left auricle, and the upper boundary of the left ventricle, which would be a little above the lower boundary of the orifice of the aorta, were about on a level with the middle of the body of the seventh dorsal vertebra behind, and the top of the lower third of the sternum, or about the fourth costal cartilage in front. The lower boundary of the left auricle, which would nearly correspond with the lower boundary of the mitral valve, was in front of the top of the ninth vertebra, and on a level with a point a quarter of an inch above the lower end of the sternum. The lower boundary of the posterior part of the left ventricle was in front of the top of the tenth dorsal vertebra, and about on a level with a point four-fifths of an inch below the lower end of the sternum; while the lower boundary of the left ventricle at the apex was on a level with the lower portion of the body of the tenth dorsal vertebra, and with a point about an inch and a half below the lower end of the sternum.

RIGHT SIDE.

The tenth plate of my Medical Anatomy represents a side view, looked at from the right side, taken from the body of a strong man with a well-formed chest of the inspiratory type. In this body the heart was distended with water, and the lower boundary of the swollen right ventricle was situated behind the ensiform cartilage, three-quarters of an inch (·7 inch) above the tip of that cartilage, and a inch and a half (1·4 in.) below the lower end of the sternum.

The top of the manubrium in this instance corresponded in level with the lower border of the body of the second dorsal vertebra; the lower end of the sternum, with the lower border of the ninth vertebra; the middle of the sternum at the level of the third cartilage, with the body of the sixth vertebra; the lower end of the manubrium, with that of the fifth vertebra; and the upper border of the lower third of the sternum corresponded in level with the body of the seventh dorsal vertebra.

The commencement of the superior vena cava in this instance was on a level with a point below the middle of the manubrium in front, and with the body of the fourth dorsal vertebra behind; and the termination of the vein in the right auricle was in front of the cartilage between the sixth and seventh vertebræ, and on a level with a point half an inch below the middle of the sternum, and with the third space.

The top of the appendix of the right auricle was on a level with the middle of the sternum and the third cartilages in front, and the body of the sixth dorsal vertebra behind; the attachment of the lower boundary of the appendix to the body of the right auricle, at the transverse furrow, which corresponds closely to the upper boundary of the tricuspid valve, was on a level with a point an inch and a quarter above the lower end of the sternum in front, and the upper border of the eighth dorsal vertebra behind; and the lower boundary of the right auricle, which corresponds closely to the lower boundary of the tricuspid orifice, was on a level with a point half an inch below the lower end of the sternum in front, and the upper portion of the tenth dorsal vertebra behind.

The origin of the pulmonary artery and the upper boundary of the right ventricle were on a level with a point half an inch below the centre of the sternum and the third space in front, and with the lower border of the sixth vertebra behind; and the lower boundary of the right ventricle in front was situated behind the ensiform cartilage, an inch and a half (1·4 in.) below the lower end of the sternum, and three-quarters of an inch above the tip of the ensiform cartilage in front, and about on a level with the lower border of the body of the tenth dorsal vertebra behind. The lower boundary of the right ventricle was about three-quarters of an inch higher behind than in front.

The lower boundary of the pericardium was about an inch and three-quarters below the lower end of the sternum, and about half an inch above the tip of the ensiform cartilage.

Although I possess other drawings showing a side view of the heart and the other internal organs, these are the only ones that give the relation of the heart and its various parts to the walls of the chest in front and the spinal column behind. Both of these drawings were taken from the bodies of men of a robust frame, with a chest of the inspiratory type, and with a heart well developed and low in position. The relations of the heart to the front of the chest in all their variety have been already abundantly illustrated, and its relations to the spinal column will be further described when the position of the heart and great vessels looked at from the back is considered. Pirogoff gives numerous sections, both vertical and horizontal, showing the position of the various parts of the heart and great vessels in relation to the anterior walls of the chest and the spinal column, and I therefore refer the reader to the notes describing those sections and two others that are figured in Braun's work. (Note 46, page 190; Note 47, page 191.)

SIDE VIEW; DURING LIFE.

In a Healthy Man with a well-formed Chest.

LEFT SIDE. (Fig. 25.)

The heart and great vessels occupy the space in the centre of the chest, between the sternum in front and the bodies of the dorsal vertebræ behind. The margins of the lungs fill up the unoccupied spaces in front of the great vessels and the heart; and the œsophagus and descending aorta are interposed between the heart and the bodies of the vetebræ behind.

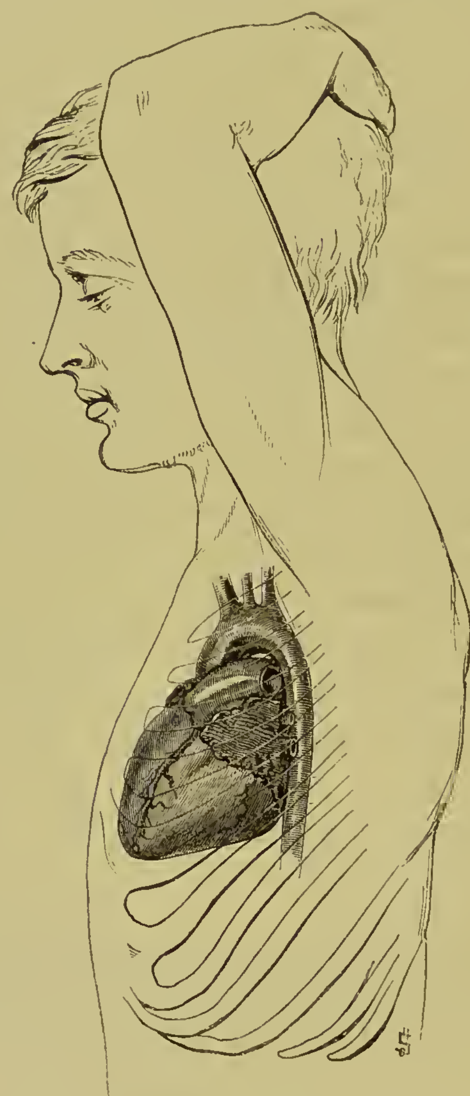


Fig. 25.—Side view, looked at from the left side, showing the heart and great vessels in relation to the walls of the chest and the spinal column.

It is evident that in the recumbent posture and during the ventricular systole, the heart would press backwards upon the œsophagus and the descending aorta so as to render swallowing difficult, and to interfere with the flow of blood to the lower part of the body, unless the heart were supported by some special contrivance. Such support is to be found in the walls of the pericardial sac. The floor of the pericardium is formed by the central tendon of the diaphragm, which is suspended in its place, in the middle of the partition between the chest and the abdomen, by means of the great converging circuit of the muscular fibres of the diaphragm, arising from the ensiform cartilage and the ribs; and is supported firmly from below by the liver and stomach. The heart rests upon the floor of the pericardium, formed by the central tendon of the diaphragm, and this supplies a smooth inclined plane, upon which the heart glides forwards and downwards during inspiration, and backwards and upwards during expiration, so as to adapt itself to the various modulations of respiration. The strong fibrous walls of the pericardium arise from the central tendon of the diaphragm. Those walls are endowed with a fibrous structure which is of especial strength posteriorly, where it is firmly incorporated with the coats of the pulmonary veins as they enter the pericardium. A fibrous covering is also contributed by the pericardium to the inferior and superior venæ cavæ where they enter the sac, and to the pulmonary artery and ascending aorta where they leave the sac. In virtue of this arrangement the posterior wall of the pericardium supports the heart forwards and prevents it from making pressure upon the aorta and œsophagus, where they are situated immediately behind the left auricle and the base of the left ventricle. By the distribution also of the fibrous pericardium to the veins entering, and the arteries leaving the sac, and to the branches of those arteries in the neck, the central tendon of the diaphragm, when it descends during inspiration, draws intermediately upon the whole of those vessels so as to save them from dragging immediately upon the heart itself.

The lower boundary of the heart is on a level with the lower end of the upper third of the ensiform cartilage and the upper edge of the sixth costal cartilage in front, and with the upper edge of the tenth dorsal vertebra behind. The top of the arch of the aorta, at the origin of the innominate and left carotid arteries, is on a level with the top of the middle third of the manubrium in front, and the lower edge of the body of the third or the upper edge of that of the fourth dorsal vertebra behind. The horizontal boundary-line that divides the upper border of the heart from the origin of the pulmonary artery and the ascending aorta, is on a level with the third cartilage in front, and the body of the sixth dorsal vertebra behind. The heart therefore extends downwards from the body of the sixth dorsal vertebra to that of the tenth, and from the third costal cartilage to the sixth; and the great arteries extend upwards from the body of the seventh to that of the third or fourth dorsal vertebra behind, and from the level of the third cartilage to the top of the middle third of the manubrium in front.

The left auricle and ventricle occupy fully as great a proportionate amount of space at the left side of the heart as the right auricle and ventricle do at the front of the heart. The left ventricle occupies by much the largest share of the left side of the heart, and its double-convex cone-shaped outline is completely exposed to view from its base to its apex when the left side of the chest is looked at. The transverse furrow, which divides the left ventricle from the left auricle, follows a direction from above downwards and somewhat backwards. The left auricle rests behind on the descending aorta and the œsophagus; and that auricle, the transverse groove, and the mitral orifice are situated in front of the seventh and eighth dorsal vertebræ and the upper border of the ninth ; and on a level with the sternal end of the third and fourth costal cartilages, the fourth space, and the upper edge of the fifth cartilage in front. The upper border of the left ventricle is nearly as high as that of the left auricle, but the lower boundary of the left ventricle which extends down almost or quite to the upper border of the body of the tenth dorsal vetebra, is considerably lower than that of the left auricle, which reaches down to the lower border of the eighth or upper border of the ninth vertebra. The left auricle and ventricle take a direction from behind forwards, to the left and downwards, and as they have a similar inclination to that of the ribs, they, as well as the transverse furrow between them, are covered throughout by the fourth, fifth, and sixth ribs. The left auricle and ventricle start from the back of the centre of the chest in front of the bodies of the seventh, eighth, and ninth dorsal vertebræ, and the left ventricle crosses from the back to the front of the chest with a definite leaning to the left, so that its apex points at the left fifth space. The left auricular appendix and the left pulmonary veins, where they enter the auricle at its higher part, are situated in front of the adjoining portions of the bodies of the seventh and eighth dorsal vertebræ and their intervening cartilage, and on a level with the third and fourth costal cartilages and the third space in front.

The anterior longitudinal furrow presents a convex outline, looking forwards towards the pulmonary artery at its upper third, and towards the right ventricle at its lower two-thirds ; and a concave outline looking backwards and downwards towards the left auricular appendix and the left ventricle. The upper end of this furrow is in front of the body of the seventh dorsal vertebra and behind the third costal cartilage or space, and the lower end of the furrow at the apex of the heart is situated behind the lower border of the fifth space, and is on a level with the body of the tenth dorsal vertebra behind.

During the ventricular systole, the left ventricle and auricle change remarkably in form, size, and position (Fig. 17). The ventricle contracts and shortens, and the auricle expands and lengthens to a great extent. The base of the ventricle and the adjoining edge of the auricle, the transverse furrow and the mitral orifice advance to a considerable extent forwards, to the left and downwards away from the spinal column and towards the apex of the left ventricle. The apex at the same time moves forwards, upwards and to the right, towards the base, so that the base and apex of the ventricle both approximate towards each other, and towards a zone of rest in the walls of the ventricle, situated nearer to the apex than the base. The anterior wall of the ventricle, at the anterior longitudinal furrow, advances forwards and becomes more convex; while the posterior wall of the ventricle also advances forwards, but to a much greater extent, especially at its middle, where it becomes hollow, the apex pointing downwards; so that the posterior wall of the ventricle, previously convex, becomes concave towards the apex and convex at the base, thus presenting a double curve. All the systolic movements of the left ventricle converge forwards, towards the point of rest on the surface of the right ventricle, about its middle and near the septum.

During the ventricular systole the left auricle becomes greatly distended and expands upwards, forwards and downwards, along its upper, anterior and lower borders respectively, the amount of movement of the auricular appendix being greater than that of the transverse furrow. The posterior wall of the auricle which rests on the back of the pericardium remains stationary.

The right ventricle extends in front from the third cartilage to the sixth, and from the middle of the sternum to the lower portion of the upper third of the ensiform cartilage, and is on a level behind with the body of the seventh dorsal vertebra at its upper boundary, and with the upper portion or middle of the body of the tenth dorsal vertebra at its lower boundary.

During the systole of the ventricles, the right ventricle advances, while the upper portion of its walls contracts downwards and the lower portion of its walls contracts upwards, those movements converging towards a point situated near the longitudinal furrow and the attachment of the anterior papillary muscle.

The pulmonary artery conceals the ascending aorta in the first half of its course, when we look at the left side of the heart. By removing the fat between the pulmonary artery and the left auricular appendix, the left posterior sinus of the aorta and the left or posterior coronary artery are brought into view, deep behind and beyond the posterior surface of the pulmonary artery. The mode in which the pulmonary artery in its progress backwards, and the ascending aorta in its progress upwards, cross each other, is now well seen. When the arch of the aorta is looked at in front, it does not present the appearance of an arch, since the left border of the ascending aorta is situated almost in front of the deep right border of the descending aorta; and the pulmonary artery covers the left edge of the ascending and almost the whole of the descending aorta, the deep left edge of which is alone visible in front. When, however, the left side of the arch of the aorta is looked at, its arched form is at once apparent, the ascending aorta forming the front, the descending aorta the back, and the transverse aorta the top of the arch.

The pulmonary artery as it ascends makes for the hollow of the arch of the aorta, through which it sends its right branch, and its direction is therefore much more from before backwards than from below upwards.

The origin of the pulmonary artery is situated just behind the third left cartilage, and is on a level with the body of the seventh dorsal vertebra. The upper boundary of the pulmonary artery, at the top of its point of bifurcation, which is also its most posterior portion, is situated in front of the lower portion of the body of the fifth, or the upper portion of that of the sixth dorsal vertebra, and on a level with the second costal cartilage ; and the left and right branches of the pulmonary artery are situated in front of the body of the sixth dorsal vertebra, on a level with the second space.

The pulmonary artery in its course from before backwards and upwards presents a convexity on its anterior and upper surface, and a concavity on its posterior and lower surface, and is on a level with the third left cartilage and the second space. The posterior sinus of the pulmonary artery is somewhat lower in position than the two anterior sinuses, and is situated behind the upper portion of the third space. The left bronchus separates the left pulmonary artery from the left pulmonary veins.

During the systole of the ventricles, the whole pulmonary artery lengthens and enlarges. The origin of the artery moves to a considerable extent downwards and forwards, the higher parts of the artery sharing this movement, but to a less and less extent from below upwards. The two anterior sinuses of the pulmonary artery descend more during the systole than its posterior sinus, so that the anterior or higher valves are then more nearly on a level with the posterior or lower valve than during the diastole.

The arch of the aorta, like the pulmonary artery, lengthens and enlarges during the systole, so that the whole arch widens.

The orifice of the aorta, which is situated at the centre of the heart, moves to a considerable extent downwards and to the left, the direction of its movement, like that of the mitral valves, being towards the apex. The walls of the ascending aorta also move downwards, but to a less and less extent from below upwards.

The position of the ascending, transverse and descending portions of the arch of the aorta in relation to the sternum, the adjoining parts, and the spinal column has already been described.

The pulmonic, the aortic, and the mitral orifices and valves are situated in their relative position on an inclined plane, each being one above and behind the other in the order named, the orifice of the pulmonary artery being the highest and most anterior, the mitral orifice the lowest and most posterior, and the aortic orifice holding an intermediate position. The upper and anterior boundary of the pulmonic orifice and valve is behind the third costal cartilage, and on a level with the lower third of the body of the sixth dorsal vertebra ; and the lower boundary of the mitral valve is on a level with the fifth cartilage, and is situated in front of the lower border of the body of the eighth or the upper border of that of the ninth dorsal vertebra. The aortic orifice, being a stage lower than the pulmonic orifice, by which it is overlapped, is in front of the body of the seventh dorsal vertebra, and the intervertebral cartilage just below it. The mitral orifice is in front of the same intervertebral cartilage, the body of the eighth and the upper border of the body of the ninth dorsal vertebra. The position of the sternum and costal cartilages in relation to those valves need not be here repeated.

The position that I have assigned to the various parts of the heart and great arteries, is that which usually exists in a healthy, well-formed man, but those parts change in position during the systole and diastole of the ventricles, and during inspiration and expiration, in the manner and to the extent that I have already described. In those who are robust and possess a broad and deep chest of the inspiratory type, the position of the heart and arteries and of all their parts are lower, while in those who are slender and possess a narrow and flat chest of the expiratory type, the position of those parts is higher, than in the average man whom I have taken as an example. During inspiration the whole of the anterior walls of the chest ascend considerably, but the spinal column, owing to the deepening of the dorsal arch, descends to a small but definite degree, the descent of the upper being greater than that of the lower dorsal vertebræ, some of the lowest of which are stationary. While, therefore, during respiration, the change in the position of the cartilages and sternum in relation to the heart and arteries is doubled by the inspiratory ascent of those cartilages during the descent of the heart, and by the expiratory descent of those cartilages during the ascent of the heart; the slight respiratory movement of the dorsal vertebræ is in the same direction as the movement of the heart, that of both of them being downwards during inspiration, and upwards during expiration. The result is, that the position of the heart and great arteries in relation to the bodies of the dorsal vertebræ during respiration is more stable than their position in relation to the sternum and cartilages. For a twofold reason, the position of the great arteries in relation to the superior dorsal vertebræ changes less during respiration than the position of the heart in relation to the lower dorsal vertebræ. The first reason is the greater respiratory movement downwards and upwards of the higher than of the lower vertebræ. The second reason is the attachment of the descending aorta by means of the intercostal arteries to the spinal column, as well as that of the great branches of the arch to the head, neck, and arms, which hold the movements of the great arteries in check. The heart itself, on the other hand, is suspended so freely in the centre of the chest that it yields without restraint to every definite influence, being thus moved readily upwards and downwards by respiration, and by the distension and collapse of the abdomen, and from side to side by changes in position, or by effusion into or tumours in the chest, or by contraction or expansion of either lung singly.

RIGHT SIDE.

The position of the heart and great vessels viewed from the right side is much more simple than that of their position viewed from the left side. When the right side of the heart is looked at, the right auricle and ventricle, the descending vena cava, the ascending aorta, and the pulmonary artery are visible, but every other part is concealed. The relative position of the lower boundary of the heart, of the top of the arch, and of the boundary-line separating the great vessels from the heart is necessarily the same on the right side of the chest as on the left side. The upper boundary of the right ventricle is on a level with the body of the seventh, and its lower boundary with that of the tenth dorsal vertebra. The right ventricle occupies the anterior portion of the space between the sternum and the spinal column; and the right auricle, including its appendix, occupies the posterior portion of that space; so that its posterior surface is situated in front of the right side of the bodies of the dorsal vertebræ from the seventh to the upper portion of the tenth, the right pulmonary arteries and pulmonary veins and the right portion of the left auricle being interposed.

The tricuspid orifice is the most anterior and the lowest in position of the four orifices of the heart and great vessels, and is separated from the spinal column by the left ventricle and auricle. The tricuspid orifice is situated, as we have already seen, behind the right half of the lower fourth of the sternum, and is on a level with the bodies of the eighth and ninth dorsal vertebræ.

The descending vena cava is situated to the right of the ascending aorta and on a deeper plane. The commencement of the vein, at the confluence of the two innominate veins, is on a level with the body of the fourth dorsal vertebra, and it enters the right auricle behind its appendix in front of the body of the seventh dorsal vertebra, the right pulmonary artery being just above its termination, the superior right pulmonary vein just below it, and the œsophagus just behind it or to its left. The vein, as it descends, rests upon the right side of the trachea near and at its bifurcation, and upon the right bronchus.

BACK VIEW; AFTER DEATH.

I made observations some years ago on the position of certain parts of the heart and great vessels in relation to the spines of the dorsal vertebræ in eleven different bodies.

The top of the arch of the aorta was situated in front of a point below the spine of the second dorsal vertebra in one instance, just above the spine of the third dorsal vertebra in seven instances, and below the spine of that vertebra in three instances. In other words, in one instance the top of the arch was in front of the upper portion of the body of the third dorsal vertebra, in seven cases it was in front of its lower portion, and in three it was in front of the body of the fourth dorsal vertebra. The lower boundary of the left ventricle was on a level with the spine of the ninth dorsal vertebra in one instance, with a point just above that spine or below that of the eighth vertebra in eight cases, with the spine of the eighth vertebra in one, and above it in one. In other words, the lower boundary of the left ventricle varied in position from the level of the lower edge of the body of the eighth to that of the upper third of the tenth dorsal vertebra. In five instances the upper boundary of the left auricle was on a level with the spine of the fifth dorsal vertebra (in one), or just above that spine (in one), or just below that spine (in three); and its lower boundary was on a level with (in one), above (in one), or below (in three) the spine of the seventh dorsal vertebra. In other words, the upper border of the left auricle was situated in front of the upper part of the seventh dorsal vertebra, or just above it, and its lower border in front of the body of the eighth vertebra.[1]

BACK VIEW; DURING LIFE.

In a Healthy Man with a well-formed Chest. (See Fig. 26.)

When the back of the heart and great vessels is exposed, the left cavities of the heart are brought into view, the lower boundary of the left ventricle resting upon the floor of the pericardium, which conceals the under surface of the heart. When the floor of the pericardium is withdrawn, the under surface of the heart is visible from behind. The under surface of the heart inclines from behind downwards and forwards, and it presents, posteriorly, the lower border of the left ventricle from base to apex; anteriorly, the lower surface

[1] Note 46, p. 190; Note 47, p. 198.

of the right ventricle ; and intermediately, the posterior longitudinal furrow.

The lower boundary of the left ventricle is on a level with or higher than the spine of the ninth and the upper portion of the body of the tenth dorsal vertebra ; the top of the arch of the aorta at the origin of the innominate and left carotid arteries is in front of the spine of the third and the lower edge of the body of the third or the upper edge of that of the fourth dorsal vertebra, or it may be somewhat higher ; and the boundary-line between the heart and the great arteries, at the lower border of the division of the right and left pulmonary arteries and the upper border of the left auricle, is in front of the spine of the fifth and the lower border of the body of the sixth dorsal vertebra. The level of the boundary-line between the heart and the great arteries is somewhat higher behind, where it follows the line of the lower border of the division of the pulmonary artery, than it is either in front or at the sides, where it follows the line of the origin of the pulmonary artery or that of the top of the right auricle.

The Left Auricle and Ventricle.—The left auricle and ventricle maintain the same relation to each other and to the spinal column at the back of the chest that the right auricle and ventricle do to each other and to the sternum at the front of the chest, but each portion of the left side of the heart bears more to the left behind, than the corresponding portion of the right side of the heart does in front.

The left auricle at its upper and posterior portion, which includes the auricular appendix, is central, being situated in nearly about equal proportions to the right and left of the middle line of the spinal column. The auricular appendix, which is a semi-detached wing of the auricle, leaves the body of the auricle at its left upper corner and advances forwards and to the left, so as to fill up the deep furrow between the pulmonary artery and the base of the left ventricle. The lowest portion of the left auricle lies entirely to the right of the middle line of the spine, while the left ventricle lies almost completely to the left of it, and the transverse furrow where it separates the two cavities occupies an intermediate position, its upper portion lying considerably to the right, and its lower portion slightly to the left of the middle line of the spine. The left auricle at its anterior aspect lies, when at rest, almost entirely to the right of the middle line of the chest, but its left boundary moves to the left of the middle line when the ventricles contract, and to the right of that line when they dilate. The transverse furrow takes an oblique direction from above downwards and from right to left, and as it sweeps to and fro from one side to the other and back again, during the contraction and dilatation of the ventricle, it occupies a position in front of the spines of the fifth, sixth and seventh, and the bodies of the seventh and eighth dorsal vertebræ, and the upper part of that of the ninth.

The heart is attached to the roots of the lungs by the entrance of the right and left pulmonary veins into the upper part of the left auricle at either side of the spine. The left pulmonary veins are as a rule higher in position, and enter the auricle nearer to the centre of the spine than the right, while the right lower pulmonary vein is larger and lower in position than the left, the right lower vein being sometimes double. The greater size of the lower lobe of the right lung compared with that of the left, evidently accounts for the greater size of the right lower pulmonary veins. The higher position of the left side of the auricle owing to the presence on that side of the base of the ventricle, and the general inclination downwards of the heart, its longitudinal parts following the line of the longitudinal furrows from right to left, and its transverse parts following the oblique direction of the transverse furrow from left to right, explain, I consider, the lower position of the right than the left pulmonary veins. The pulmonary veins have, in short, more room to deploy on the right side of the left auricle, where no object interferes with their freedom, than on the left side of the auricle at its upper angle, where the veins and the auricular appendix are pushed up into a corner by the close proximity of the upper border of the left ventricle. The downward inclination from left to right of the upper boundary of the left auricle, between the left and right pulmonary veins, although quite definite, is very much less than the downward inclination from left to right of the posterior transverse furrow. The right pulmonary veins are on a level with the spines of the fifth and sixth dorsal vertebræ, and the two left pulmonary veins, holding a higher position, are respectively just above the level of those two spines.

The left ventricle lies to the left of the spinal column, and extends in a direction to the left, downwards and forwards, from its base at the back of the chest where it is in front of the spinal column, on a level with the sixth and seventh dorsal spines, to its apex at the front of the chest where it is behind the fifth left intercostal space. The upper boundary of the left ventricle is more rounded and more inclined from above downwards than its lower boundary along the line of the posterior longitudinal furrow, where it is more nearly straight and horizontal.

The posterior and left border of the mitral orifice is situated about or fully half an inch to the left of the posterior transverse furrow. This orifice looks towards the apex of the left ventricle, or in a direction to the left, forwards and slightly downwards. Its superior or left angle is a little behind the auricular appendix, on a level with a point above the spine of the sixth, and with the middle of the body of the seventh dorsal vertebra, and about half an inch, more or less, to the

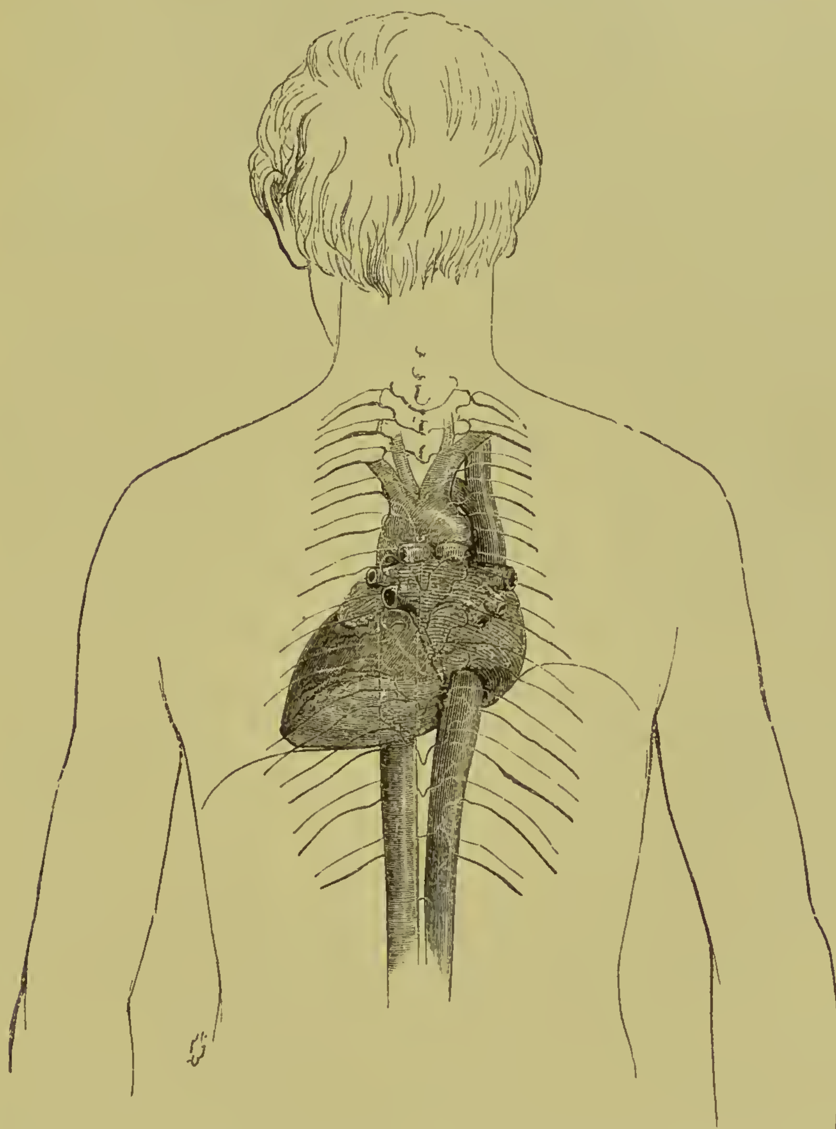


FIG. 26.—Back view, showing the heart and great vessels in relation to the spinal column, the ribs, and the diaphragm.

left of the middle line of the spine. Its inferior or right boundary is on a level with the spine of the seventh, and the lower portion of the body of the eighth dorsal vertebra, and with a point between the scapulæ, just above their lower angles, and a little to the left or right of the middle line of the spine. The space between the mitral orifice and the apex of the left ventricle is occupied by the flaps of the mitral valve, their tendinous cords, and the papillary muscles, the apparatus of the mitral valve occupying the space at the back of the left ventricle between its base and its apex. The apparatus of the mitral valve is always in action. The transverse furrow and the mitral orifice oscillate to and fro extensively, moving to the left, forwards, and slightly downwards towards the apex during the contraction of the ventricle, and in the reverse direction during the dilatation of the ventricle (see Fig. 17, p. 112). The mitral portion of the left auricle and the base of the left ventricle necessarily share in the movements of the mitral orifice and of the transverse furrow in extent and direction, but the movements of the walls of both cavities, as they recede from the orifice, gradually lessen, and at a zone or transverse circuit of stable equilibrium around each cavity, the walls both of the auricle and ventricle maintain a state of rest. This zone of rest in the left ventricle is probably more near to its apex than its base, while the position of the zone of rest in the left auricle is probably to the left of and just below the termination of the right and left inferior pulmonary veins. The apex moves towards the zone of rest of the ventricle during the contraction of that cavity, but the upper and right boundary of the left auricle moves away from, or to the right of, the zone of rest of the auricle during the dilatation of that cavity. Thus during the systole of the ventricle there is a movement, both of the base and the apex of the cavity towards a common centre, tending to its complete contraction; while during the same period the auricle dilates in all directions, and its left and right portions both diverge from the zone of rest of the cavity. The movement of expansion to the left, forwards and downwards, of the mitral portion of the auricle, is much greater than the movement of expansion to the right and upwards of the right portion of the auricle. During the contraction of the left auricle and the expansion of the left ventricle, the reverse movements take place at the mitral orifice, the transverse furrow, and both cavities at all points. The play of all these parts is constant, and they are always undergoing a series of regulated and co-ordinate changes in position. For this reason, although the range of movement of each part, so far as we know it, can be assigned within certain limits, yet the exact position of each part cannot be stated.[1]

The position of the mitral orifice, which is oblique in direction from above downwards, and from left to right, is, as I have just said, in front and to the left of the spines of the sixth and seventh dorsal vertebræ, and between the scapulæ, a little above their lower angles. This region forms a landmark for the position of the mitral orifice and valve over the dorsum. The left ventricle is situated to the left of this region, and extends below its level. During the diastole of the ventricle, the stream of blood from the auricle into the ventricle pours across this region in a direction from right to left, forwards and somewhat downwards. To the right of, and rather above this region, is situated the left auricle; and in cases of mitral incompetence, the reversed stream of blood pours across this region from left to right and somewhat upwards, as it regurgitates from the left ventricle into the left auricle.

In cases of mitral regurgitation, one might be led, *à priori*,

[1] I have frequently observed the movements of the heart in animals at the front and the side but never at the back of the organ, so that the movements of the left auricle described above have been derived from inference and not from observation.

to expect that the mitral murmur would be always audible over the back at the region of the mitral orifice, or midway between the scapulæ, just above the level of their lower angles. This is, however, not usually the case, and especially when the mitral murmur is soft in character, the lungs and chest are of full size, and respiration is free. This is, I believe, to be explained by the great space that intervenes, owing to the presence of the vertebræ, between the mitral orifice and the ear when applied over that region, by the extent to which the lungs envelope the heart and fill the chest backwards, and by the position of the descending aorta and the œsophagus between the mitral orifice and left auricle in front and the spinal column behind. When, however, the mitral murmur is grave, vibrating or musical in character and loud, and when the lungs and chest are contracted and respiration is limited, then the mitral murmur is audible over the back at the region of the mitral valve, and in many cases with great intensity.

The Right Auricle and Ascending Vena Cava.—The inferior and posterior portion of the right auricle, and the entrance of the ascending vena cava into that portion of the auricle, are situated at the back of the heart. The right auricle is here separated at its upper boundary from the left auricle below the entrance of the lower right pulmonary vein by a septum, which often makes but little mark externally. The lower boundary of the right auricle is defined by the continuation backwards of the posterior transverse furrow between the base of the left ventricle and the right auricle, until it reaches the posterior longitudinal furrow. The posterior and inferior portion of the right auricle thus fills up the angle formed between the lower border of the left auricle and the base of the left ventricle posteriorly. This angle is formed by the downward prominence and thickness of the muscular wall of the left ventricle at its base.

The ascending vena cava penetrates the diaphragm on a level with the eighth or ninth dorsal spine, where it is situated nearly half an inch to the right of the descending aorta, and of the middle line of the spine; and after ascending to the extent of an inch or less, it enters the right auricle on a level with the seventh dorsal spine, about three-quarters of an inch to the right of the descending aorta.

The Under Surface of the Heart; the Longitudinal Furrow and the Right Ventricle.—The posterior longitudinal furrow divides the left ventricle behind from the right ventricle in front, on the under surface of the heart, and when that organ rests upon the floor of the pericardium, the transverse furrow and the right ventricle are hidden. When, however, the floor of the pericardium is lowered so as to bring into view the under surface of the heart, which inclines from behind, forwards and downwards, the posterior longitudinal furrow, and the under surface of the right ventricle beyond and in front of it, are rendered visible. The posterior longitudinal furrow, resting upon and adapting itself as it does to the floor of the pericardium, is comparatively horizontal in direction; but it is slightly convex near the base of the ventricle, owing to the shoulder formed there by the muscular walls. During the contraction of the ventricle, when its base and apex approximate, the transverse furrow changes in direction both toward the base and the apex. The furrow then becomes more convex than before at the base, because the base of the ventricle itself becomes more convex, and it turns or twists downwards in a peculiar manner towards the apex, because the apex itself twists downwards, so as to form a concavity towards that end. The longitudinal furrow then presents, therefore, an outline with a double curve.

The posterior longitudinal furrow at its auricular extremity comes very close to the posterior border of the heart, and I think that it is visible from behind at that point, even when the heart rests upon the floor of the pericardium. Thence the furrow advances forwards and to the left to the apex of the heart, where it divides the left ventricle from the right, and where it joins the anterior longitudinal furrow.

The under surface of the heart contracts gradually from its auricular portion or base, where it is wider than at any other part, to its apex, where it is narrower than at any other part. The under surface of the right ventricle is thus triangular in form, the base of the triangle being at the auriculo-ventricular furrow, and its apex at the apex of the heart. The posterior longitudinal furrow which is straight, forms the posterior side of the triangle, and the lower boundary of the right ventricle, which is somewhat convex, forms its anterior side. This lower boundary of the right ventricle at the front of the heart, which is on a level with the body of the tenth and the spine of the ninth dorsal vertebra, is lower in position than the lower border of the left ventricle at the back of the heart, which is situated in front of the cartilage between the bodies of the ninth and tenth dorsal vertebræ, or a little lower, and is on a level with the space between the eighth and ninth dorsal spines.

The apex of the heart is lower in position than the lower boundary of the right ventricle, and is on a level with the body of the tenth, and with a point above the spine of the ninth dorsal vertebræ, and with the lower angle of the left scapula.

The Great Vessels.—The position of the boundary-line between the upper border of the heart and the lower limit of the great vessels is, as I have already stated, higher at the back than at either side or in front. The boundary-line dividing the upper border of the left auricle from the lower border of the right and left pulmonary arteries is situated in front of the cartilage below the body of the sixth and the spine of the fifth dorsal vertebra ; and the lower end of the descending portion of the arch of the aorta and of the vena cava, where it is lost behind the right pulmonary vein, are nearly on the same level.

The great arteries of the neck, the descending portion of the arch of the aorta, through the medium of the transverse and ascending portions of the arch, the right and left pulmonary arteries, and the right and left pulmonary veins, form in succession a series of central attachments for the heart, which are situated, so to speak, in tiers one below the other. To these must be added, but on a different plane, the descending vena cava. The heart is suspended forwards and downwards from these various attachments. Two of them, those formed by the pulmonary veins and the pulmonary arteries, connect the heart intimately with the roots of the lungs, so that the roots of the lungs and the heart at that position enjoy a common movement of descent during inspiration, and of ascent during expiration, a degree of movement that is measured by the respiratory movements of the descent and ascent of the larynx.

The descending portion of the arch is maintained at its lower end in a fixed position in relation to the spinal column by the sixth intercostal arteries. The higher intercostal arteries, those which go to the third, fourth, and fifth intercostal spaces, arise in succession from the descending portion of the arch, in front, in their descending order, of the fifth and sixth dorsal vertebræ. These vessels all ascend from their point of origin to the spaces they respectively supply, the higher arteries making a greater ascent than the lower ones, because they have to reach a higher point in relation to their respective origins; and the right arteries mounting upwards to a greater extent than the left arteries, because they arise from a lower part of the aorta, owing to the right side of the descending portion of the arch being otherwise occupied by the passage behind it of the œsophagus, and, under and in front of it, of the right bronchus. The intercostal arteries to the sixth spaces pass directly to the right and left from their point of origin. It is evident, therefore, that the lower end of the descending portion of the arch, which is braced down to the spinal column by the direct origin of the sixth intercostal arteries, is more fixed in position than its upper part, the intercostal arteries from which have a free ascent, and where the œsophagus is interposed between the artery and the spine; that the descending portion of the arch has less range of movement than the transverse portion, the great arteries from which are comparatively long and capable of being put on the stretch; and that the ascending portion of the arch enjoys a still more free play of movement than the transverse portion, for it is weighted at its root by the heart, and it is long, curved, and free from vascular connexions.

The descending portion of the arch lies in front of the left half of the bodies of the fourth and fifth dorsal vertebræ, and that of the upper border of the sixth, on a level with the third and fourth, and the space between the fourth and fifth dorsal spines, and with the inter-scapular space at and below the spines of the scapulæ. This region forms a landmark at the back for the position of the descending portion of the arch of the aorta; over this region direct and even regurgitant aortic murmurs, especially if they are loud, grave, and musical, are often audible, and that with great intensity; and in this region, the signs of aneurism of the descending aorta most frequently betray themselves. It is sufficient if I allude here to the effect in such cases of the pressure of aneurism affecting this artery on the left recurrent laryngeal nerve, which winds underneath this portion of the arch on its way to the larynx; on the œsophagus, where it passes behind the artery; on the left bronchus, where it passes underneath it; on the left pulmonary artery, which is situated in front of the artery; on the bodies of the vertebræ, upon which it rests; and on the intercostal nerves that pass between and to the left of those vertebræ.

I have already described the position of the transverse aorta. The right and left pulmonary arteries are situated in front of the body of the sixth and the spine of the fifth dorsal vertebra, and they, as I have just said, form one of the two great points of attachment of the heart to the roots of the lungs. The principal points of clinical interest with regard to those arteries is the one I have just alluded to in relation to the pressure of aneurism of the descending aorta on the right or left pulmonary artery, which interferes with the supply of blood to the lungs; of the analogous effect of aneurism of the transverse aorta, below which the division of the pulmonary artery is situated; of aneurism of the ascending aorta on the right pulmonary artery, which often leads to secondary affections of the right lung; and on the effects of the pressure of an intra-thoracic tumour or enlarged bronchial glands on either of those arteries.

The right pulmonary artery is somewhat lower in position than the left pulmonary artery, in the same way and for the same reasons that the right pulmonary veins are lower than the left pulmonary veins.

The descending vena cava is seen from behind, winding round the right side of the ascending aorta; and its great affluent, the left innominate vein, lies in front of the upper border of the transverse aorta and the great arteries that spring from it. Aneurisms of the ascending aorta tend therefore to make pressure on the descending vena cava so as to impede or arrest the flow of flood through that vein to the heart, and the same may be said with regard to the effects of the pressure of aneurisms of the transverse aorta in impeding or arresting the flow of blood through the left innominate vein.

The descending aorta, being attached by the intercostal arteries to the spinal column, is situated in front of the bodies of the dorsal vertebræ at their centre and left side, and it is therefore interposed between the mitral orifice and the base of the left ventricle in front and the spine behind. The œsophagus lies in front of the right side of the spinal column until it reaches the bodies of the eighth, ninth, and tenth dorsal vertebræ, which are on a level with the seventh, eighth and ninth dorsal spines, where it gradually passes over the front of the aorta. It is thus interposed between the left auricle and the right side of the spinal column, and finally between the base of the left ventricle in front and the aorta and spinal column behind.

The right and left lungs at the back of the chest fill up the deep hollow in front of the angles of the ribs, and their inner margins overlap respectively the right and left borders of the bodies of the dorsal vertebræ.

The lungs at the back and both sides completely envelope the heart and great vessels, with the exception of those parts that lie at the very centre of the chest, in front of the anterior portion of the bodies of the dorsal vertebræ.

NOTES.

NOTE I.—Pirogoff, in his valuable "*Anatomia Topographica,*" Braun, in his beautiful "*Topographisch-Anatomischer Atlas,*" and Le Gendre, in his "*Anatomie Chirurgicale Homolographique,*" give drawings taken from sections of the frozen dead body representing the position of the internal organs. In this and the following notes I shall briefly describe the position of the heart as it is represented in those various drawings. I may remark that many of these drawings are evidently not of the size of nature.

Pirogoff represents vertical sections of twelve different bodies, the section being made either through the centre of the sternum in front and the spinal column behind or to the right or left of the centre. In these instances the front of the pericardium was lower in position than the front of the heart to an extent varying from ·8 or ·9 inch to ·02 inch. Between these two extreme instances there was every variety of difference from ·2 inch to ·7 inch, the average extent to which the front of the pericardium was lower than the front of the heart being ·4 inch, or less than half an inch.

These drawings of Pirogoff represent, which mine do not, the relation of the whole under surface of the heart to the floor of the pericardium. In two of them, the whole lower surface of the heart, including both ventricles and the longitudinal furrow between them, rested upon the pericardium; while in one of these, with healthy organs, the front of the pericardium was ·7 inch, and in another with ascites it was ·35 inch below the front of the right ventricle. In the latter case the fluid in the abdomen pressed the pericardium upwards into close contact with the heart, and elevated that organ. In four other cases the right ventricle rested upon the pericardium, while in all of these the interventricular furrow was separated by fluid from the pericardium from ·2 inch to ·65 inch, and in three of them the left ventricle was higher than the pericardium from ·3 inch to ·4 inch. In the six remaining cases, a film of fluid, varying from ·1 inch to ·5 inch, separated both ventricles and the longitudinal furrow from the pericardium; in two of those cases the separation of the two surfaces was equal throughout; in two it was greater at the furrow than the ventricles, and greater below the left ventricle than the right; and in two it was greater below the right ventricle than the left.

NOTE 2.—Pirogoff represents the exact position of the lower boundary of the front of the heart in relation to the lower end of the bony sternum in five instances in which a vertical section was made through the centre of the sternum in front and the spinal column behind. In two of these instances the lower boundary of the heart was above the lower end of the sternum to an extent varying from ·8 inch to ·7 inch, and in three of them it was below the lower end of the sternum to an extent varying from one inch to half an inch. He also gives thirteen cross sections of the body that show whether the lower boundary of the heart was higher or lower than the lower end of the sternum. In three of these cases the heart was below, in four it was above, and in six it was either at, a little above, or a little below the lower end of the sternum. In one instance the lower border of the heart was very much below, and in another it was very much above the lower end of the sternum. The latter case stood alone. The section was made through the lower margin of the nipples and the middle of the third space, and only a small piece of the ventricles towards the apex remained frozen in the pericardial fluid; the heart being absent from behind the centre of the sternum. The stomach and the œsophagus were enormously distended with food, and both the stomach and the liver rose high into the cavity of the chest, above the level of the section. In eight other cases the section was made, as in this one, through the third cartilage, in nine others through the fourth, and in four others through the fourth space; and in all of these, amounting to twenty-one, the heart was present in the section of full size.

Braun gives vertical sections of the body through the centre of the sternum and the spine in two instances, in one of which the lower boundary of the heart is half an inch above, and in the other is an inch and a third below the level of the lower end of the sternum.

NOTE 3.—The position of the lower boundary of the pericardium in relation to the lower end of the sternum is represented by Pirogoff in the two groups of sections, vertical and transverse, referred to in Note 2. In two of the vertical sections the lower boundary of the front of the pericardium was above the level of the lower end of the sternum from the tenth to the third of an inch, and in three of them it was below the lower end from 1·2 inch to ·88 inch. In the thirteen cross sections the lower border of the pericardium was above the level of the lower end of the sternum in only one case, and below it in twelve cases.

NOTE 4.—Pirogoff represents the position of the apex in relation to the fourth, fifth, and sixth spaces and cartilages in the two groups of vertical and transverse sections. In one of the vertical sections, a case of ascites, the apex was situated in the fourth space; in another, it was situated behind the fifth rib, and in a third behind the sixth rib; while of the cross sections, in five the apex was situated in the fifth space, in five behind the fifth cartilage, and in one behind the fourth cartilage or the third space. Five vertical sections also represent the relation of the lower boundary of the right ventricle to the cartilages and spaces, at a point intermediate between the lower boundary of the sternum and the apex; in two of these the inferior margin of the right ventricle was behind the seventh cartilage, in one behind the sixth cartilage, in one behind the fifth space, and in one behind the fifth cartilage.

NOTE 5.—Pirogoff, in the three vertical and eleven cross sections referred to in Note 4, shows the relation to the cartilages and spaces of the lower boundary of the pericardium below the apex. In two of the three vertical sections representing the apex, the inferior border of the pericardium was lower than the inferior border of the apex from two-thirds of an inch (·7 inch) to half an inch (·4 inch); and in the remaining one the pericardium fitted close upon the apex. In two of these cases the lower boundary of the pericardium below the apex was behind the sixth cartilage, and in the third, that affected with ascites, behind the fifth cartilage. In three of the cross sections the lower boundary of the pericardium below the apex was situated behind the sixth cartilage, in five of them it was behind the fifth space, in two behind the second cartilage, and in the remaining one behind the fourth cartilage. In two of the five vertical sections in which the relation of the lower border of the right ventricle to the cartilages and spaces is shown, the lower boundary of the pericardium below the ventricle was situated behind the seventh cartilage, in two behind the sixth space, and in one behind the sixth cartilage.

NOTE 6.—Pirogoff gives a series of deepening sections made downwards and from side to side, presenting a front view of the organs. In two of the more superficial of these sections there was an inclination of two-thirds of an inch (·7 inch) from right to left, extending from the lower boundary of the right auricle to the apex of the heart. In a third section, a case of ascites, there was no inclination, the apex being on the same level as the lower border of the right auricle. When the sections deepened, the inclination was still maintained, but the dip from auricle to the apex was less great. Thus in three sections in which the lower border of the left ventricle was exposed, the dip from auricle to apex was respectively one-half (·4 inch), one-third (·3 inch), and one-sixth (·15 inch) of an inch, the latter section being progressively deeper than the former. In like manner, but with a different effect, in two other sections of the case of ascites, the lower boundary of the apex was higher than that of the auricle, in one section by the fifth of an inch (·2 inch), and in a deeper section by half an inch (·5 inch).

NOTE 7.—Pirogoff shows the extent to which the heart extends to the left of the middle line of the sternum in four (or five) vertical, and in eighteen (or seventeen) cross sections. The heart extended to the left of the centre of the sternum from two inches to two and three-quarters (2·8 inch) in two-thirds of these cases (14 in 22); from an inch and a third (1·4 inch) to an inch and three-quarters (1·85 inch) in one-third of them (7 in 22); and three inches and a third (3·4 inch) in one additional instance.

NOTE 8.—Pirogoff indicates approximately the position of the top of the arch in five vertical and four cross sections. In two of the vertical sections the top of the arch appeared to be respectively a quarter and a tenth of an inch above the top of the manubrium, on a level in one with the top of the second, and in the other with the top of the third dorsal vertebra. In the three other vertical sections the top of the arch was three-quarters of an inch (·6 to ·8 inch) below the top of the manubrium, and on a level with the lower portion of the third dorsal vertebra. In one of the four cross sections the top of the arch at the origin of the innominate and left carotid arteries was on a level with the lower edge of the sterno-clavicular articulation, and with the lower border of the second or upper border of the third dorsal vertebra; while in three of them it was on a level with the first space, and in the individual cases respectively with the lower border of the second, the lower border of the third, and the upper border of the fourth dorsal vertebra. Braun gives two vertical sections, in one of which the top of the arch of the aorta was from a quarter to half an inch below the top of the manubrium and on a level with the third dorsal vertebra, while in the other it was more than an inch below the top of the sternum and on a level with the fourth vertebra.

NOTE 9.—The lower boundary of the heart was from two-thirds of an inch (·6 inch) to an inch below the lower end of the sternum in Pirogoff's three vertical sections in which the top of the aorta was three-quarters of an inch (·6 inch to ·8 inch) below the top of the manubrium; and was an inch and a quarter below the end of the sternum, reaching, indeed, to the tip of the ensiform cartilage in Braun's case, in which the top of the aorta was more than an inch below the top of the sternum. On the other hand, the lower boundary of the heart was three-quarters of an inch (·8) above the lower end of the sternum in one of Pirogoff's cases, in which the top of the aorta was above the top of the sternum, and was fully half an inch above that bone in Braun's case, in which the top of the aorta was from a quarter to half an inch below the top of the sternum.

NOTE 10.—Pirogoff shows in his vertical sections the position of the origin of the pulmonary artery in eight instances, and that of the top of the auricular portion of the right auricle in seven. The origin of the pulmonary artery was situated behind the second cartilage in one instance, and behind the fourth cartilage in another; in three cases it lay behind the third cartilage, and in one behind the second space; while in two it lay from two to two and a half inches below the top of the manubrium. The top of the right auricle was seated behind the second cartilage in two cases, behind the third cartilage in two, and below the top of the manubrium from an inch and a half to an inch and three-quarters in three. In one of the instances in which it lay behind the third cartilage, it was three inches below the top of the manubrium.

NOTE 11.—In five of Pirogoff's vertical sections referred to in Note 10 the vertical length of the pulmonary artery and the right ventricle is shown. In two cases the vertical length of the pulmonary artery was about half an inch, and in these two cases the vertical length of the right ventricle was respectively three inches (3·2 inch) and two and a third (2·3 inch). In the three other cases the vertical length of the pulmonary artery was about one inch (·9 inch, 1·05 inch, 1·2 inch), that of the right ventricle in those cases being about three inches (2·8 inch, 3·1 inch, 3·5 inch). In the three latter cases, in which the pulmonary artery was relatively long, the length of the ventricle to that of the artery was as three to one; while in the two others in which the vessel was short, the ventricle was from four and a half to six times the length of the artery.

NOTE 12.—In one of Pirogoff's transverse sections, referred to in Note 11, the top of the pulmonary artery was situated just above the second cartilage, and the artery, in its short upward course (·4 inch) was covered by the second cartilage; in another, the top of the artery lay behind the third cartilage, and the artery ascended within the third space. In the three other cases the artery took an intermediate and average position within the second space, its top being seated behind the second cartilage, and its origin behind the third cartilage, or, in one instance, the second space.

The origin of the pulmonary artery was the lowest in position, being behind the fourth cartilage, in the one among these five cases in which the vessel took the longest upward course (1·2 inch); while, on the other hand, the origin of the artery was the highest, being behind the second cartilage, in the one in which the vessel was the shortest (·4 inch).

NOTE 13.—The arch of the aorta, measured from the point at which it came into view above the right auricle to the adjacent origin of the innominate and left carotid arteries, in Pirogoff's vertical sections, varied in approximate vertical length from about one inch to more than two inches (about 2·2 inch), its average length being about an inch and a half. In two cases, in which the vessel was short (about 1 inch), the vertical length of the arch, from the point at which it came into view, was less than that of the heart, measured from the same point, in the proportion of 10 to 25; while in three cases, in which the vessel was long (1·8 inch, 2 inch, 2·2 inch), the ratio of the length of the vessel to that of the heart was about 10 to 18.

NOTE 14.—Pirogoff shows the vertical length of the right auricle in six sections. In three of these the length of that cavity was two inches and three-quarters (2·6 inch, 2·7 inch, 2·8 inch); and in three it was from three inches and a third to almost four inches (3·3 inch, 3·4 inch, 3·8 inch).

NOTE 15.—Pirogoff represents the vertical length of the right ventricle in eleven cases. In two of these the cavity was two inches and a third (2·3 inch), and in one it was four inches in length. There was considerable variation in the other cases between these limits, the average length of the cavity in the eleven cases being three inches.

NOTE 16.—The great vessels occupied the upper half of the sternum, and the heart its lower half, in two of Pirogoff's and in one of Braun's sections. In one of Braun's sections the great vessels lay behind the upper third of the bone, and the heart behind its lower two-thirds; in three of Pirogoff's sections the great arteries were covered by the upper three-sevenths of the sternum, and the heart by its lower four-sevenths (1·5 inch to 2·1 inch; 2·7 inch to 3 inch; 1·4 inch to 2·3 inch); while in one of Pirogoff's the great vessels occupied the sternum to a greater extent than the heart in the proportion of eight to seven (3·1 inch to 2·7 inch).

NOTE 17.—The width of the healthy heart was one-half of the width of the chest in two of Pirogoff's cross sections (7·8 inch to 3·9 inch and 7·2 inch to 3·5 inch); it was one-third of that of the chest in four of them (7·4 inch to 2·4 inch, 9·4 inch to 3·2 inch, 9·2 inch to 3·2 inch, 7·2 inch to 2·6 inch), and in six of them the proportion between the width of the heart and that of the chest varied from 10 to 3·9 to 10 to 4·6. In no instance was the breadth of the healthy heart greater in proportion than one-half of that of the chest. In this respect Pirogoff's cases differ from mine, for, as I have said above, in one third of my cases the width of the heart was greater than one-half of that of the chest (10 to 5 to 10 to 6·2). This may partly be accounted for that in Pirogoff's drawings the section was not as a rule made across the widest part of the heart, and that the breadth of the heart was measured from precisely opposite points; whereas in mine the measurement was taken from the point of the heart furthest to the left, which was near the apex, to the point of the heart furthest to the right, which was about the middle of the right auricle; and I need scarcely say that these points were never precisely opposite to each other.

NOTE 18.—In some of Pirogoff's sections the right ventricle and auricle were proportionally broad in relation to the front of the left ventricle when the heart itself was wide in relation to the width of the chest, while the right cavities were relatively narrow when the heart itself was relatively narrow. In other instances, however, it was the reverse, the heart being relatively narrow or wide, when the right cavities were respectively relatively wide or narrow.

NOTE 19.—In one of Pirogoff's cross sections the heart extended one inch and a tenth into the right side of the chest, and nearly three inches (2·8 inch) into its left side; while in another of them the heart occupied the right side of the chest for a little less than two inches (1·85 inch), and its left side for a little more than two inches (2·15 inch). In one of these extreme instances nearly three-fourths of the heart occupied the left side, and over one-fourth of it the right side of the chest; while in the other more than one-half of the organ lay in the left side, and less than one-half of it in the right side.

In twenty-five cross sections nearly two-fifths of the heart occupied, on an average, the right side, and fully three-fifths of it the left side of the chest (10 to 17). These sections were made across the heart at all levels, from just below the origin of the great vessels to a little above the lower boundary of the organ. In at least four instances more sections than one were made through the same body at different heights, and in these instances the heart, as a rule, lay more to the right in the higher than in the lower sections. This was due to the greater proportionate prevalence of the right auricle in the higher and middle sections; and of the right and left ventricles in the lower sections of the heart. There were, however, three marked exceptions to this rule, which seemed to be due to the greater extension of the right auricle to the right at its middle than at its higher region.

NOTE 20.—The right lung was more developed in front than the left in eight out of nine cases, in which two-thirds of the heart or more occupied the left side, and one-third of it or less the right side of the chest; and the development of the two lungs was about equal in seven out of eight cases in which two-fifths of the heart or more lay in the right side, and three-fifths of it or less in the left side of the chest, the right lung being, however, larger than the left in the two exceptional cases.

NOTE 21.—The breadth of the combined right auricle and ventricle in relation to that of the left ventricle as seen in front in fifteen of Pirogoff's cross sections, varied from 10 to 1·4 to 10 to 4·4, the average proportion being 10 to 3·3.

NOTE 22.—The auricular portion of the right auricle varied in breadth in Pirogoff's cases from nearly an inch and a half (1·4 inch) to four-fifths of an inch (·8 inch), its average breadth in ten cases being one inch.

NOTE 23.—The body of the right auricle varied in breadth in Pirogoff's cases from neariy an inch and a half (1·4 inch), to the fifth of an inch (·2 inch), its average breadth in twenty-one cases being two-thirds of an inch (·66 inch).

NOTE 24.—The left edge of the auricular portion of the right auricle extended almost to the left edge of the sternum (·1 inch from left edge) in one instance; almost or quite to the centre of the sternum, so as to lie behind its right half, in four instances; and in one instance it was covered by the right third of that bone.

NOTE 25.—The right edge of the right auricle extended to the right of the right edge of the sternum from the third of an inch to an inch, and, on an average, for two-thirds of an inch in sixteen of Pirogoff's cross sections.

NOTE 26.—The auricular portion of the right auricle was from one-third to two-thirds wider than the body of the auricle in five hearts represented by Pirogoff.

NOTE 27.—The width of the heart in ten of Pirogoff's sections varied from a little more than twice (22 to 10) to almost four times as great as that of the auricular portion of the right auricle; the heart being on an average fully three times as wide as the auricular appendix.

NOTE 28.—The heart was from three to nine times wider than the exposed portion of the body of the right auricle in twenty of Pirogoff's cases; the heart being on an average nearly six times as wide as the auricle.

NOTE 29.—The breadth of the right ventricle varied from four-fifths (10 to 12·5) to a little less than one-half (10 to 20·5) of the breadth of the heart in twenty-one of Pirogoff's drawings, sixteen of which were from cross sections of the body, and five from front views of the heart. The average breadth of the right ventricle in these drawings was two-thirds of the breadth of the heart (10 to 15), and in one-half of them (10 in 21) the proportionate width of the heart was at or above, and in one-half of them (11 in 21) it was below that average. The average proportionate breadth of the right ventricle in relation to that of the heart was 10 to 16 in the sixteen cross sections, and 10 to 14 in the five front views of the heart.

NOTE 30.—The breadth of the upper part of the *conus arteriosus* varied from one-half (10 to 20) to three-fifths (10 to 17·2) of the breadth of the right ventricle at its middle, in Pirogoff's five front views of the heart; the average width of the *conus arteriosus* being in those cases fully three-fifths of that of the right ventricle (10 to 18·6).

NOTE 31.—The length of the right ventricle was equal to that of its breadth in one, and was greater than that of its breadth in four of Pirogoff's five front views of the heart, the average proportion of the length to the breadth of the right ventricle being in those four cases as 5 to 6 (10 to 11·75).

NOTE 32.—The breadth of the right ventricle in relation to the right auricle in Pirogoff's five front views of the heart varied from 10 to 1·3 to 10 to 3·4, the average proportion being 10 to 2·2.

NOTE 33.—The breadth of the right ventricle varied from an inch and two-thirds (1·65 inch) to nearly three inches (2·9 inch) in sixteen of Pirogoff's cross sections, its average breadth being just over two inches (2·1 inch); while in his five front views of the heart, its breadth varied from two inches and a half to three and a third, its average breadth being almost three inches (2·9 inch). The cross sections were somewhat reduced in size, while the front views appeared to be of the natural dimensions.

NOTE 34.—In one of Pirogoff's sections the right ventricle extended further to the right than the left of the middle line of the sternum (1·4 inch to 1· inch to left); in one it occupied the right and left sides of the chest in equal proportions (1·2 inch to 1·2 inch); but in fourteen other sections the right ventricle extended more to the left than the right of the vertical centre of the sternum. In two instances six-sevenths of the ventricle lay to the left, and one-seventh of it to the right of the central line; but on an average, two-thirds of the ventricle occupied the left, and one-third of it the right side of the chest.

NOTE 35.—In three of Pirogoff's five front views of the healthy heart, the longitudinal furrow during its descent took a direction slightly to the left or outwards during its whole course, so that it was about half an inch more to the left at its lower than its upper portion; but in two of them the furrow curved first to the right for the third of an inch (·3 inch), and then to the left for, in one instance, the same, and in the other for a greater extent (·5 inch).

NOTE 36.—In one of Pirogoff's cross sections the right ventricle extended for only a quarter of an inch to the left of the sternum; but in every other instance that ventricle was covered to a greater or less extent by the costal cartilages. The exact extent to which they were so is not indicated, but I judged that in one-fifth of the cases (3 in 16) the right ventricle extended almost as far to the left as the junction of the cartilages to their ribs; that in one-fourth of them (4 in 16) the ventricle was covered by the two sternal thirds of the cartilages; that in two of them it extended to midway between the sternum and the ribs; and that in one-third of them (6 in 16) it was only covered by the sternal third of the cardiac costal cartilages.

NOTE 37.—The body of the right ventricle extended to the left of the middle line of the sternum from four-fifths of an inch (·85 inch) to two inches (2·1 inch), and on an average for an inch and a half (1·45 inch), in sixteen of Pirogoff's cross sections.

NOTE 38.—The right auriculo-ventricular furrow, starting from the right edge of the origin of the pulmonary, as it descended extended to the right to an amount varying from one inch to one inch and four-fifths, and on an average for an inch and a half (1·45 inch), in Pirogoff's five front views of the healthy heart.

NOTE 39.—The breadth of the pulmonary artery at its origin varied from an inch to an inch and a half, and was on an average an inch and a quarter, in Pirogoff's five front views of the healthy heart; and in the same cases the breadth of the pulmonary artery a little above its origin varied from three-quarters of an inch to an inch and a quarter, and was on an average about one inch. The pulmonary artery was wider than the aorta in four of these instances, and narrower than the aorta in one of them.

NOTE 40.—The right edge of the pulmonary artery was covered by the sternum to the extent of the third of an inch in one instance, and the tenth of an inch in another, and the remainder of the artery, amounting to three-fourths of its diameter in one instance (·8 inch, ·11 inch), and six-sevenths of its diameter in the other, occupied the second left space or the second costal cartilage.

NOTE 41.—The *approximate* breadth of the left ventricle as seen in front of the heart varied from almost half an inch (·4 inch) in two instances to an inch and one-fifth (1·2 inch) in three cases, and was on an average three-quarters of an inch in nineteen of Pirogoff's cross sections and five of his front views of the heart. The proportion that the width of the left ventricle at its anterior aspect bore to that of the whole heart in those cases varied from one-eighth (10 to 1·25) to one-third (10 to 3·2).

NOTE 42.—The apex was covered by the inner margin of the left lung to the extent of from half an inch to three-quarters in three of Pirogoff's cross sections, and to the extent of the tenth and the fifth of an inch respectively in two of them; while in two others the outer edge of the lung was not covered by the lung, which, however, was close to it; and in one other instance the apex was completely exposed, the left edge of the lung being ·6 inch to the left of the apex, and ·3 inch to the left of the outer left border of the pericardium.

NOTE 43.—The ascending aorta varied in breadth from three-quarters of an inch (·7 inch) to an inch and a fifth (1·2 inch) in Pirogoff's five front views of the healthy heart, its average breadth being one inch.

NOTE 44.—The aorta was narrower than the pulmonary artery in four and wider in one of Pirogoff's cross sections.

NOTE 45.—The ascending aorta was covered by the sternum in four of Pirogoff's five cross sections showing that vessel, and of these instances, in three the artery was central and in one it inclined to the right. In the remaining case the ascending aorta extended a quarter of an inch to the left of the sternum, being present to that extent within the left second space.

NOTE 46.—Pirogoff, whose work is rich in illustrations of the root of the aorta, including its valve and sinuses, represents those parts in eight cross sections, five vertical sections, made through the sternum or cartilages in front, and the spinal column or adjoining ribs behind, and two vertical sections made from side to side. In the eight cross sections the root of the aorta, including its sinuses and the flaps of its valve, was in part covered to a very varying extent by the sternum, and was in part situated behind the corresponding cartilage or space to the left of the sternum. In one of them four-fifths of the artery lay behind the sternum (·8 inch), and one-fifth of it extended to the left of that bone (·2 inch); while in one of them only one-fifth of the vessel (·8 inch) was covered by the sternum, while four-fifths of it occupied the adjoining third left space. There was every gradation between these two extreme instances; and, on an average, less than three-fifths of the root of the aorta lay behind the left portion of the sternum, and more than two-fifths of it behind the corresponding left cartilage or space.

The upper part of the root of the aorta, including its sinuses and the flaps of its valve, was situated in two of the cross sections on a level with the second space, its lower portion being on a level with the third cartilage; in three of them its upper portion was on a level with the middle or lower edge of the third cartilage, its lower portion extending to a greater or less extent to the level of the third space; in one of them its lower border was on a level with the upper half of the third space; and in two of them its upper portion was on a level with the third space, at and above its middle, while its lower portion extended to the level of the upper part of the fourth cartilage. In an additional cross section made through the third space the lowest portion of the right posterior flap of the aortic valve remained, showing its attachment to the anterior flap of the mitral valve.

Pirogoff shows the root of the aorta, including its sinuses and the flaps of its valve, in five vertical sections, of which, (1) two sections were made through the left costal cartilages in front, close to their articulation to the sternum, and the ribs behind near their attachment to the transverse processes of the vertebræ; (2) one through the left side of the sternum and the fifth and sixth cartilages near their attachment in front, and the bodies of the vertebræ behind;

and (3) two through the centre of the sternum and ensiform cartilage in front, and that of the spinal column behind.

The relations of the anterior and left posterior flaps of the aortic valve were shown in three of those sections (1, 2), and those of the three flaps, including in addition the right posterior flap, in two others (3). In one section the top of the angle of junction of the anterior and left posterior flaps was situated behind the left third cartilage, in one of them the tenth of an inch (·1 in.) below its upper edge, and in another of them the third of an inch (·3 in.) above its lower edge. In two of them the lower boundary of the section of the aortic valve was half an inch (·5 in. and ·45 in.) below the lower edge of the third cartilage or about the middle of the third space. As, however, in these instances the right posterior flap had been removed, the lower boundary of the valve and of the origin of the aorta must have been about half an inch lower than the lowest point of the section, or behind the upper portion of the fourth left costal cartilage. In the third instance (2), in which also the inferior flap had been removed, the top of the angle of junction of the two superior flaps lay behind the sternum, three-quarters of an inch (·7 in.) below the lower end of the manubrium, or about on a level with the lower border of the second space; and the lowest portion of the section through the aortic valve was situated behind the sternum an inch and a half (1·5 in.) below the lower end of the manubrium, or about on a level with the top of the third space, so that in this instance the lower boundary of the aortic valve would be about on a level with the lower border of the third space. In these three cases the measurement of the section of the aortic valve, the lower portion of those valves being removed, varied from two-thirds of an inch in one instance (·6 in.) to almost an inch (·9 in.) in two instances. In the two remaining sections, however, in which the whole valve was exhibited, its measurement from above downwards amounted to a little over an inch (1·1 in.) in one instance, and to an inch and a half (1·5 in.) in the other. In one of these cases in which the lower boundary of the heart was four-fifths of an inch (·8 in.) above the lower end of the sternum, the upper boundary of the aortic valve was situated about half an inch (·4 in.) above the middle of the sternum, or about on a level with the second space, and its lower boundary about three-quarters of an inch (·7 in.) below the middle of the sternum, or about on a level with the lower edge of the third cartilage or upper border of the third space. In another case, in which the lower boundary of the heart was situated behind the ensiform cartilage, about an inch (·95 in.) below the lower end of the sternum, the upper boundary of the aortic valve was situated behind the sternum four-fifths of an inch (·8 in.) below the middle of the bone, or about on a level with the lower edge of the third cartilage or upper border of the third space, and the lower boundary of the valve was situated behind the sternum, fully two inches (2·2 in.) below the middle of the bone, and two-thirds of an inch (·65 in.) above its lower end, or about on a level with the fifth cartilage. Keeping out of view this unusual case, it may be said that in Pirogoff's sections, on an average, the root of the aorta, including its sinuses and the flaps of its valve, was situated on a level with the third cartilage and the third space.

Mitral Valve.—In one of Pirogoff's vertical sections the top of the mitral valve was fully half an inch (·55 in.) and in another of them it was a third of an inch (·3 in.) above the lower border of the right posterior flap of the aortic valve. In three other sections, the right inferior flap of the aortic valve had been removed, the other flaps being retained; and in one of these sections the top of the mitral valve was the third of an inch, in another it was the fifth of an inch (·2 in.), and in the third it was about the tenth of an inch above the lower edge of the left posterior flap of the aortic valve.

The lower border of the mitral valve was about an inch below the lower border of the left posterior or the anterior flap of the aortic valve in the three instances in which the right posterior flap had been removed; and it was from fully half an inch to fully three-quarters of an inch below the lower edge of the right posterior flap in the two other instances. In one of Pirogoff's front vertical sections the top of the mitral valve was fully half an inch (·6 in.) above the level of the lower border of the right posterior flap of the aortic valve.

In two of Pirogoff's vertical sections, and probably in a third, the top of the mitral valve was about half an inch (·6 in.) below the level of the middle of the sternum, but it was an inch and three-quarters below that point in another instance in which the lower boundary of the heart was an inch below the lower end of the sternum.

In one of Pirogoff's vertical sections the top of the mitral valve was on a level with the lower edge of the third cartilage; and in three of them it was behind the third space, these occupying respectively the upper, the middle, and the lower portion of that space. If we combine the cases in which the vertical section was made through the cartilages with those in which it was made through the sternum, and estimate in the latter cases the approximate relative position of the valve to the cartilages by its position in relation to the sternum, we find that in two cases the top of the mitral valve was on a level with the lower portion of the third cartilage; in three, with the upper third of the third space; in two, with the middle or lower portion of the third space; and in one, with the fourth space.

In one of Braun's vertical sections (a woman aged 25), in which the lower boundary of the heart was half an inch above the lower end of the sternum, the top of the mitral valve was half an inch (·4 in.) below the centre of the sternum; and in another section (a soldier aged 21), the lower boundary of the heart was an inch and a fifth (1·2 in.) below the lower end of the sternum, and the top of the mitral valve was nearly an inch and a half (1·4 in.) below the middle of the sternum.

The lower border of the mitral valve was situated an inch and a half above the lower end of the sternum in one vertical section, and in two it was as low as half an inch above that point; while in three other vertical sections it was on a level with the fourth space, and in two with the fifth cartilage. If we group the two sets of cases together, it may be estimated that in four of them the lower end of the valve was behind the fourth space, and in four behind the fifth cartilage.

In one of Braun's vertical sections, from a woman aged 25, in which the lower boundary of the heart was half an inch above the lower end of the sternum, the lower boundary of the mitral valve was an inch and a half (1·4 in.) above that end of the bone; and in another, from a soldier aged 21, in which the lower boundary of the heart was an inch and a fifth below the lower end of the sternum, the lower border of the mitral valve was less than half an inch (·4 in.) above the end of the bone.

Pirogoff represents nine cross sections through the second space, the whole of which were above the mitral valve; four through the third cartilage, two of which were above the mitral valve, and two were made through the upper part of the valve; eight through the third space, one of which was above and one below the mitral valve, while five were made through the upper portion of the valve, and one through the middle of the mitral orifice; nine through the fourth cartilage, of which two were made through the upper portion and two through the middle of the valve, while five were made below the valve; six through the fourth space, of which one was made through the top of the valve, and three through its middle, while two were made below the valve; and seven through the fifth cartilage, of which six were below the valve, and one was made through the middle of the mitral orifice.

It is self-evident that, in these cases, the top of the mitral valve occupied the space or cartilage above that in which the section passed through the middle of the mitral orifice, and that the top of the valve was relatively still higher in those cases in which the section was made below the mitral valve.

Estimating the position of the top of the mitral valve approximately in these sections on this view, I consider that the upper boundary of the valve was situated in one case on a level with the second space; in nine, on a level with the third cartilage; in two, with the third cartilage or third space; in nine with the third space; in two, with the third space or fourth cartilage; in three, with the fourth cartilage; in six, with the third cartilage or space or the fourth cartilage; and that in one instance the top of the mitral valve was on a level with the fourth space.

In these cases, on the basis of the calculation just made, it may be approximately estimated that the average position of the top of the mitral valve was about on a level with the upper half of the third intercostal space.

In the same transverse sections, on a similar approximate calculation, the lower border of the mitral valve was situated about on a level with the third cartilage in one instance; the third space in six instances; the fourth cartilage in two; the fourth space in four; the third space, fourth cartilage, or fourth space in six; the fifth cartilage in four instances; and below that cartilage in one.

The average position of the lower boundary of the mitral valve in these cases appears to me, from as close an estimate as I can make, to be about on a level with the lower edge of the fourth cartilage and the upper border of the fourth space.

Pirogoff represents the mitral valve or orifice in seven cross sections, and in all of them the anterior wall of the mitral orifice was situated more to the right than its posterior wall to an extent varying from one-third (·35 inch) to four-fifths (·8 inch) of an inch.

In four of these sections the mitral orifice was situated behind the left half of the sternum; and in three of them it was placed partly behind the left portion of the sternum, partly behind the cartilages and spaces to the left of that bone. In no instance was the anterior wall or border of the mitral valve seated to the right of the middle line of the sternum.

Tricuspid Valve.—In two of Pirogoff's vertical sections the top of the tricuspid valve was nearly the third of an inch (·3 inch), and in two others it was nearly half an inch (·4 inch and ·45 inch) below the level of the top of the mitral valve.

The lower border of the tricuspid valve was below the level of the lower border of the mitral valve from half an inch, in the first two cases noted above, to three-quarters of an inch (·65 inch and ·75 inch) in the other two cases.

The top of the tricuspid valve was situated, in one of Pirogoff's vertical sections, half an inch, and in two of them one inch, below the centre of the sternum; in another instance it was an inch above the lower end of that bone. In one of Braun's vertical sections, in which the lower boundary of the heart was high, the top of the tricuspid valve was on a level with the centre of the sternum.

The top of the tricuspid valve was on a level with the top of the third space in one vertical section, with the fourth space in another, and with the fifth cartilage in a third instance.

The lower border of the tricuspid valve was one inch above the lower end of the sternum in two of Pirogoff's vertical sections, and an inch and a half above that point in one of Braun's vertical sections, in which the lower boundary of the heart was above the lower end of the sternum; and it was a third of an inch (·3 inch) below the lower end of that bone in two of Pirogoff's sections, in which the inferior boundary of the heart was behind the middle of the ensiform cartilage. The lower border of the valve was on a level with the fourth space in one of Pirogoff's sections, and with the sixth cartilage in two of them.

Pirogoff represents four cross sections through the third cartilage, all of which were above the tricuspid valve; eight through the third space, four of which were above that valve, three were made through its upper portion, and one below it; nine through the fourth cartilage, of which three were above the valve, one was made through its middle, three through its lower portion, one through the bottom of the valve, and one below it; six through the fourth space, of which one was above the valve, three through its upper portion, one through its lower portion, and one below it; and seven through the fifth cartilage, of which one was made through the middle of the tricuspid orifice and six below it.

Estimating approximately the position of the top of the tricuspid valve in these cross sections, I consider that the upper boundary of the valve was situated on a level with the second space, or third cartilage in one instance; with the third cartilage or space in two; with the third space in seven; with the third space or fourth cartilage in ten; with the fourth cartilage in three; with the fourth cartilage or space in four; and with the fourth space in two.

I think that we may estimate that in these sections the top of the tricuspid valve was on an average situated behind the lower portion of the third space, or the upper edge of the fourth cartilage.

In the same cross sections, and on a similar approximate calculation, the lower border of the tricuspid valve was about on a level with the third cartilage in one instance; with the third space in one; with the third space or fourth cartilage in one; with the fourth cartilage in one; with the fourth cartilage or space in six; with the fourth space in seven; with the fifth cartilage in three; and with the fifth cartilage or space or lower in ten.

The approximate average position of the lower boundary of the tricuspid valve in these transverse sections appears to me to be about on a level with the lower portion of the fourth space, or upper portion of the fifth cartilage.

Pirogoff represents the tricuspid orifice in eleven cross sections, and in all of them the anterior edge of the tricuspid orifice was more to the right than its posterior edge to an extent varying from a quarter (·25 inch) to four-fifths (·85 inch) of an inch.

The left edge of the tricuspid valve was situated more to the right than the right edge of the mitral valve in six or seven instances in which the section went through both valves, to an extent varying from the tenth to the third (·3 inch) of an inch; while in the seventh instance the left edge of the tricuspid was immediately in front of the right edge of the mitral valve.

In five of the eleven sections the tricuspid valve was situated behind the right half of the sternum; in one of them it was behind the right third of that bone; in one it lay partly behind the right portion of the sternum and partly to the right of it; in two it was central, occupying equally the right and left sides of the sternum, and in the remaining two it lay to the left of the middle line of that bone.

NOTE 47.—Pirogoff shows the relation of the sternum and costal cartilages in front to the vertebræ behind in twelve antero-posterior vertical sections and in sixty-two cross sections.

In five of the vertical sections the top of the sternum was on a level with the lower border of the body of the second or the upper border of the third dorsal vertebra, or the cartilage between these two vertebræ; in one of them it was on a level with the top of the fourth dorsal vertebra; and in one of them, an instance that stands alone, it was according to Pirogoff's description on a level with the upper portion of the first dorsal vertebra. This description is however evidently an accidental error, and I, therefore, for the first, read the second vertebra. In Braun's two vertical sections the top of the sternum was on a level with the cartilage between the second and third dorsal vertebræ.

I examined eleven human skeletons in the Museum of the Royal College of Surgeons, with the valuable assistance of Mr. Wright, of the Museum, and I found that in eight of them, including one in the Hunterian Museum, the top of the manubrium was on a level with the second dorsal vertebra,[1] the point varying from its upper to its lower border; and that in three of them it was on a level with the first dorsal vertebra.

[1] The *body* of the dorsal vertebra is referred to here and elsewhere, unless it is otherwise specified.

In two of Pirogoff's vertical sections the top of the sternum was on a level with the lower border of the third rib, near the spine, in one of them it was on a level with the upper border of the fourth rib, and in one it was above the level of the first rib. In this last instance there was evidently an accidental error.

The lower end of the osseous sternum was on a level with the middle of the eighth dorsal vertebra in two of Pirogoff's vertical sections, in one of which the sternum and ribs had been elevated by a large accumulation of fluid in the abdomen; in one of them it was on a level with the middle of the ninth vertebra, and in one with the cartilage between the ninth and tenth vertebræ.

In Braun's two sections the lower end of the sternum was on a level respectively with the middle and lower border of the ninth vertebra.

In one of the skeletons in the Museum of the Royal College of Surgeons the lower end of the sternum was on a level with the seventh dorsal vertebra, in one with the cartilage between the seventh and eighth vertebræ, in three with the middle of the eighth vertebra, in two with the cartilage between that vertebra and the ninth, and in three with respectively the top, middle, and lower border of the ninth vertebra, the last instance being the skeleton in the Hunterian Museum.

The middle of the sternum which corresponds with its articulation to the third costal cartilages was on a level with the middle of the fifth dorsal vertebra in one of Pirogoff's vertical sections, with the cartilage between the fifth and sixth vertebræ in two of them, and with the middle of the sixth vertebra in another of them, and in Braun's two sections.

The bottom of the manubrium, which corresponds with the second cartilage and with the lower end of the upper third of the sternum, was on a level with the lower half of the body of the fourth dorsal vertebra in two of Pirogoff's vertical sections, and in two of them and in Braun's two sections with the middle of the fifth vertebra.

The lower end of the middle third of the sternum, which corresponds as a rule with its articulation to the fourth costal cartilages, was on a level with the lower half of the body of the sixth dorsal vertebra in two of Pirogoff's vertical sections and with the middle of the seventh vertebra in two of them and in Braun's two sections.

In one of Pirogoff's cross sections the sternum at the junction to it of the first costal cartilages was on a level with the upper border of the body of the fourth dorsal vertebra; in four of them the sternum at the spaces between the first and second cartilages was on a level respectively with the upper and lower borders of the second vertebra and the upper border of the third; the sternum was on a level—at the second cartilages, in three instances, with the fifth vertebra;—at the second space, in eight instances, with respectively the fourth, fifth, and sixth vertebræ;—at the third cartilage, in four instances, with the top of the fifth vertebra in one and with the seventh in three;—at the third space, in eight instances, with respectively the cartilages between the fifth, sixth, and eighth vertebræ, and with the bodies of the seventh, eighth, and ninth vertebræ; at the fourth cartilage, in ten instances, with respectively the cartilages between the sixth, seventh, eighth, and ninth vertebræ, and with the seventh and eighth vertebræ and the top of the ninth;—at the fourth space, in six instances with the cartilages between the sixth, seventh, eighth, and ninth vertebræ, and with the bodies of the seventh and eighth;—at the fifth cartilage, in eight instances, with respectively the lower border of the seventh vertebra, the upper border of the tenth, and the two intermediate vertebræ; at the fifth space, in two instances, with respectively the eighth and tenth vertebræ; and finally, in four instances, the lower end of the osseous sternum or base of the ensiform cartilage at the sixth cartilage, was on a level respectively with the lower third of the ninth vertebra, the cartilage between that and the tenth, and the upper border of the body of the eleventh dorsal vertebra.

The lower boundary of the front of the heart was situated in one of Pirogoff's vertical sections on a level with the middle of the body of the eighth or, according to an evidently erroneous reference, the seventh dorsal vertebra, behind, and the sixth cartilage in front; in two of them on a level with the cartilage between the eighth and ninth vertebræ; in three of them with the top, and in one of Braun's sections with the middle of the ninth vertebra; and in one of Pirogoff's sections with the lower border, and in one of Braun's with the middle of the body of the tenth vertebra. In the last two instances the lower boundary of the heart was situated behind the ensiform cartilage, an inch below the lower end of the sternum, in another instance it was half an inch below, and in two others from half to three-quarters of an inch above the lower end of the sternum.

The lower boundary of the pericardium was on a level in one of Pirogoff's vertical sections with the cartilage between the seventh and eighth dorsal vertebræ; in three of them with the cartilage between the eighth and ninth vertebræ; in one with the upper, and two with the lower portion of the ninth, and in one with the top of the eleventh vertebra.

In these cases the lower boundary of the pericardium was situated from a third of an inch above to fully one inch below the lower end of the sternum, and from a third of an inch above the level of the sixth cartilage to that of the lower portion of the seventh cartilage.

The top of the arch of the aorta was about on a level with the upper portion of the body of the third dorsal vertebra in three of Pirogoff's vertical sections, and with its middle in one of his and in one of Braun's sections, and with respectively the top and middle of the fourth vertebra in one of Pirogoff's and the other of Braun's vertical sections. In these seven cases the top of the arch of the aorta was about on a level with a point varying from a quarter of an inch above the top of the manubrium to an inch and a half below it. In one of Pirogoff's cross sections the top of the arch, at the origin of the innominate and left carotid arteries, was in front of the upper portion of the third dorsal vertebra, and in two of them the arch a little below its top was on a level respectively with the lower border of the third and the upper border of the fourth vertebra.

The top of the pulmonary artery was on a level with the cartilage between the fourth and fifth dorsal vertebræ in one of Pirogoff's vertical sections, with the space between the fourth and fifth ribs near the vertebræ in another of them, with that between the fifth and sixth ribs near the space in a third instance, and in a fourth with the lower border of the seventh rib at the same situation. In these four cases the position of the top of the pulmonary artery varied from the level of the middle of the second left cartilage to that of the lower border of the third.

The origin of the pulmonary artery was on a level with the body of the fourth dorsal vertebra in one instance, and with respectively the lower border of the fifth and the upper border of the sixth vertebra in two others of Pirogoff's vertical sections; and it was on a level with the top of the sixth vertebra or the cartilage above it in four of Pirogoff's cross sections.

The lower boundary of the body of the left ventricle, not including its apex, in three of Pirogoff's vertical sections was respectively on a level with the middle of the eighth, the top of the ninth, and the two upper fifths of the tenth dorsal vertebra.

The lower boundary of the body of the left ventricle was on a level with the upper border of the ninth vertebra in one of Braun's vertical sections, and with the cartilage between the ninth and tenth vertebræ in the other.

The section passed through the left ventricle a little above its lower border at the apex in Pirogoff's cross sections, in one instance on a level with the cartilage above the ninth vertebra, in another of them on a level with that vertebra, in two others with the cartilage below it, and in one on a level with the upper portion of the tenth vertebra.

The upper boundary of the root of the aorta, including its orifice, valve, and sinuses, at the attachment of the angle of junction of the anterior and left posterior flaps of the aortic valve, was situated in one of Pirogoff's vertical sections as high as the upper third of the fourth vertebra, in two of them it was in front of the sixth, and in one of them the upper portion of the seventh vertebra. The lower boundary of the root of the aorta, including the aortic orifice, valve, and sinuses, was on a level in two instances with respectively the middle and lower border of the sixth vertebra, in one with the upper third of the seventh, and in one with the lower border of the eighth vertebra. In one of Braun's vertical sections the upper boundary of the root of the aorta was in front of the cartilage between the fifth and sixth vertebræ, and its lower boundary was in front of the cartilage between the sixth and seventh vertebræ; and in his other vertical section the lower boundary of the root of the aorta was on a level with the lower border of the seventh vertebra. The upper portion of the aortic valve, including the anterior and left posterior flaps and sinuses, was situated in three instances in front of the cartilage above the sixth vertebra, and the top and middle of that vertebra; in six instances in front of the top of the seventh vertebra or the cartilage above it; and in one in front of the body of that vertebra.

The lower portion of the aortic valve, or its right posterior flap, was situated in four instances in front of the middle or top of the seventh vertebra or the cartilage above it, and in one in front of the middle of the eighth vertebra.

The upper boundary of the mitral valve was situated in six of Pirogoff's vertical sections in front respectively of the middle of the sixth dorsal vertebra, the cartilage between the sixth and seventh vertebræ, the seventh vertebra, and in one instance the eighth; and its lower boundary was situated in three of his vertical sections in front of the eighth, and in one it extended down to the top of the lower third of the ninth vertebra. In one of Braun's vertical sections the mitral valve extended from the level of the cartilage below the sixth vertebra down to that of the upper third of the eighth, and in the other it extended from the cartilage below the seventh vertebra down to the upper third of the ninth vertebra.

The mitral valve was situated in front of the cartilage above the seventh dorsal vertebra in two of Pirogoff's cross sections, the seventh vertebra in probably nine of them, the cartilage between that vertebra and the eighth in two of them, and in front of the eighth vertebra in four of them.

The upper boundary of the tricuspid valve was situated in seven of Pirogoff's vertical sections on a level respectively with the upper and (in a case of ascites) lower borders of the sixth dorsal vertebra, the cartilage between that vertebra and the seventh, and the upper border of the seventh vertebra, the lower portion of the eighth vertebra, and the cartilage below it. The tricuspid valve in one of Braun's sections extended from the level of the top of the seventh vertebra to that of the middle of the eighth.

The tricuspid valve was on a level with the eighth vertebra in five instances, with the cartilage below it in two, and with the ninth vertebra in two.

XV.

MALPOSITIONS OF THE HEART.[1]

THE displacements of the heart may be conveniently divided into the Vertical, Lateral, Forward, and Backward displacements.

THE VERTICAL DISPLACEMENTS OF THE HEART.

CASES IN WHICH THE HEART IS LOWERED.—The cause of the vertical lowering of the healthy heart is in all cases, with the exception of aneurisms of the arch of the aorta, an unusual lowering of the diaphragm. Pulmonary emphysema, bronchitis, and spasmodic asthma; croup, laryngitis, and laryngismus stridulus: collapse of the stomach and intestines; aneurism of the arch of the aorta—all tend to lower the heart. To these may be added certain cases of mediastinal tumour, and pleuritic effusion into the left side during the middle period of its increase.

Pulmonary Emphysema, Bronchitis, and Spasmodic Asthma.—In Pulmonary Emphysema the right cavities of the heart and the pulmonary artery are greatly enlarged. The right ventricle often completely covers the left ventricle. The diaphragm is remarkably low, its standard position being often lower than it is in health at the end of the deepest possible inspiration. The enlargement of the lungs is so extensive that they cover the heart within the chest; and

[1] From Reynolds's *System of Medicine*, vol. iv. p. 125.

they are consequently everywhere interposed between the heart and the walls of the chest, with the exception of the border of the seventh costal cartilage (Fig. 27). The heart is invariably enlarged, the enlargement being almost limited

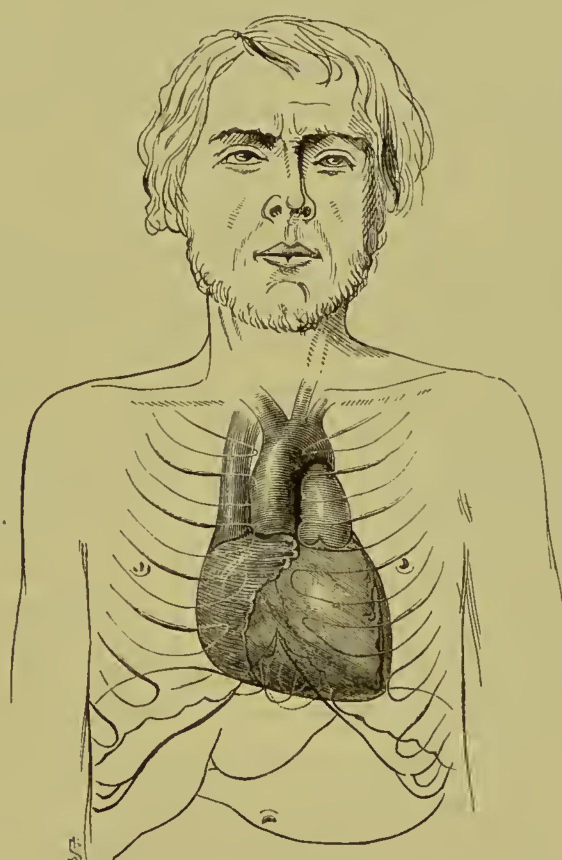


FIG. 27.—Position of the heart and great vessels in *Pulmonary Emphysema*. The heart is displaced downwards, and is covered with the over-developed lungs. The apex-beat is imperceptible, but the impulse of the right ventricle is seen and felt in the epigastrium.

to the right side. The venæ cavæ and right auricle are usually distended and of great size; the right ventricle is so much increased in volume that it almost or altogether conceals the left ventricle, its walls being hardened and hypertrophied; and the pulmonary artery is greatly increased in length and breadth. Notwithstanding the enlargement of the heart, its impulse is imperceptible over the walls of the chest; and in some cases its sounds are so muffled that they are scarcely audible over the usual cardiac region, owing to the great development of the lungs in front of the heart. In no instance, however, is the heart absolutely covered by the dilated lungs. The central tendon of the diaphragm descends almost or quite to the level of the lower end of the ensiform cartilage, and necessarily draws downwards the enlarged heart. It is customary to speak of the displacement of the heart downwards as being caused by the expansion of the lung. This may be so in some cases, but as a rule the unusual descent of the heart, like that of the base of the lungs, is caused by the unusual descent of the diaphragm. The lower boundary of the right ventricle is brought downwards into the epigastrium, so that it is situated behind and to each side of the ensiform cartilage. In that position, and to the left of it, the heart is not covered with lung, and it is therefore in contact with the ensiform cartilage, with the neighbouring margin of the seventh left costal cartilage, and with the intermediate abdominal muscles, the pericardium intervening. The result is that, as Dr. Stokes has pointed out, the impulse of the right ventricle may be felt in the epigastrium; and as the right ventricle is hypertrophied, " the heart may be felt pulsating with a violence that we would not expect from the examination of the pulse at the wrist, which is often small and feeble, while the impulses of the right ventricle are given with great strength."[1] The form of the chest, the great expansion of the lungs, the low position of the diaphragm, and the enlargement, elongation, and lowering of the heart and great vessels, all correspond, though to an exaggerated degree, with the

[1] Dr. Stokes *On the Diseases of the Chest*, p. 178.

condition of those parts at the end of the deepest possible inspiration in health. The presence of the impulse and sounds of the heart over the epigastrium, and their absence over the walls of the chest, are the signs that often first direct attention to the morbidly enlarged condition of the lungs.

In cases of severe bronchitis, the diaphragm is invariably lowered, the right cavities of the heart are enlarged, and the lungs are amplified. In those cases, therefore, as in emphysema, the heart is lowered, its impulse is obliterated over the intercostal spaces by the interposition of the lung, and the beat of the right ventricle is felt and seen in the epigastrium. The extent to which the heart is enlarged, lowered, and covered by lung is by no means so great in bronchitis as in emphysema.

When, as is often the case, the patient affected with emphysema is attacked by bronchitis, the extent to which the heart is lowered, and enveloped by the lungs is increased.

During an attack of spasmodic asthma, the diaphragm descends, the lungs are expanded to the utmost, and the impulse of the right ventricle is lowered into the epigastrium, just as in cases of true pulmonary emphysema. After the seizure is over, its effect upon the size of the lungs and the position of the heart does not immediately disappear. Gradually, however the organs resume their healthy size and position. The asthmatic seizure that often attacks those affected with emphysema, is accompanied by an excessive amplification of the lungs and descent of the impulse ; but in such patients the lungs and heart do not regain their normal size and position after the cessation of the attack, and in this important respect true spasmodic asthma is to be distinguished from the asthmatic seizure of a person affected with true pulmonary emphysema.

Croup, Laryngitis, Laryngismus Stridulus.—In all those cases in which there is excessive narrowing of the fauces, larynx, or trachea so as to contract the channels through which air is admitted into the lungs and render inspiration exceedingly difficult, the inspiratory efforts are laborious but ineffectual. Every muscle of respiration is brought into powerful action. The diaphragm descends as low as possible. The lungs are consequently lengthened and the heart is drawn downwards. As air, in spite of the laboured breathing, can scarcely enter the air tubes, the lungs, being lengthened downwards, instead of expanding, collapse during inspiration, and the walls of the chest fall inwards. The lungs recede from before the heart, which is in immediate and extensive contact with the walls of the chest as well as the ensiform cartilage. The heart is, therefore, in such cases to be felt beating with force over and to the left of the lower sternum and in the epigastrium.

Collapse of the Stomach and Intestines.—When the abdomen is unusually spare, the stomach and intestines being comparatively or quite empty, the abdominal organs shrink downwards, and the diaphragm is permanently lowered. This was well seen in the poor woman from whom Fig. 28 was taken. She had been unable to swallow, owing to cancer of the œsophagus, for a fortnight before her death. Her emaciation was extreme. The stomach and intestines were absolutely empty of gas as well as of food. The liver, though not enlarged, had dropped downwards, so that its lower border rested on the bones of the pelvis. The diaphragm necessarily followed the liver and stomach in their descent, and as the result, the lungs at their base, and the heart where it rested on the diaphragm, were unusually lowered, and both organs were remarkably lengthened. The elongation of the ascending aorta and the pulmonary artery was very marked.

This was an extreme case, but in all instances of abdominal

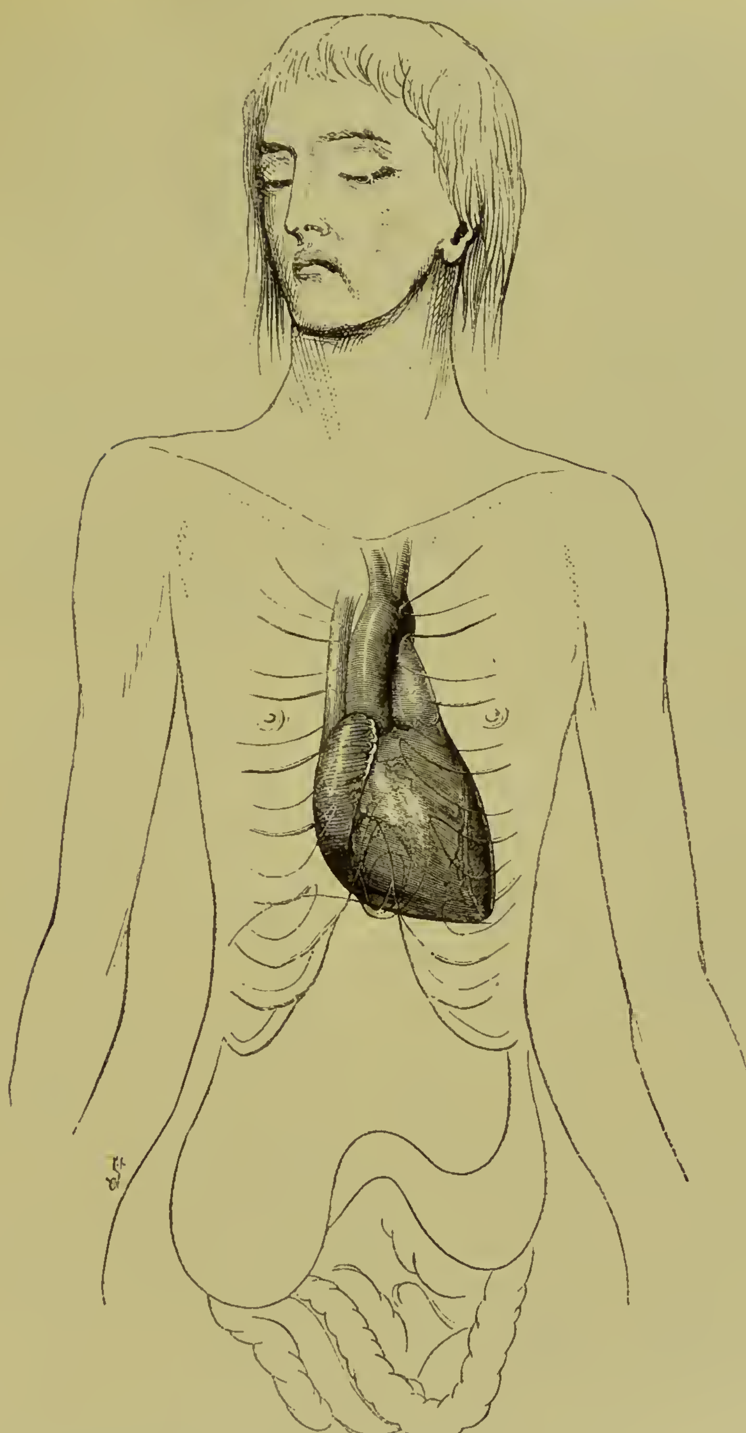


FIG. 28.—Position of the heart and great vessels in a case with *Collapse of the Stomach and Intestines.* The heart is displaced downwards, and covered with lung to the fifth cartilage. The apex-beat is present in the fifth space, and perhaps in the sixth, and the impulse of the right ventricle is seen and felt in the epigastrium.

collapse, the diaphragm descends in exact proportion to the descent of those organs upon which it rests, and the lungs and heart are lengthened downwards to a corresponding degree. In some of those cases the transfer of the impulse from the intercostal spaces to the epigastrium may give rise to the suspicion of pulmonary emphysema on the one hand, or aneurism of the abdominal aorta on the other. In emphysema the chest is unduly developed, and the abdomen, instead of being retracted, is usually of more than average size. In aneurism of the lower thoracic or higher abdominal aorta, the impulse or pulsation in the epigastrium is strong during expiration, but it lessens and even disappears during a deep inspiration. In cases of abdominal collapse, it is the reverse, for the impulse in the epigastrium becomes lower and stronger when the patient takes a deep breath.

Aneurism of the Arch of the Aorta.—One would have expected *à priori* that aneurisms affecting the arch of the aorta, especially when they are of large size, would cause considerable displacement of the heart downwards. Dr. Townshend saw an instance of aneurism of the arch thrusting the heart downwards, so that it pulsated in the epigastrium.[1] I possess drawings taken from thirteen cases of aneurism of the arch of the aorta. In one of these the lower boundary of the right ventricle was situated more than an inch below the lower end of the sternum. In four there was effusion of blood into the left pleura, displacing the heart to the right. In the remaining seven instances the lower boundary of the right ventricle was from one-third to three-quarters of an inch below the lower end of the sternum. It is clear that in the majority of these cases, although the aneurism was in nearly all of them large, varying from three to five inches in diameter, the descent of the heart into the epigastrium was

[1] *Cyclopædia of Medicine*, ii. 391.

definite, but not proportionately great. In two of the instances there was cylindrical aneurism or dilatation of the ascending aorta. In these the transverse diameter of the aorta was only two inches, while its vertical measurement was four inches. They must, therefore, be included with the others in estimating the influence of aneurism of the arch of the aorta in displacing the heart downwards. The aneurismal sac displaces not so much the whole heart as those parts of it upon which it makes immediate pressure, and which are subjected thereby to compression. This applies especially to the aneurisms of the ascending aorta, which amount to nine among my cases. In all of these the right ventricle, and in most of them the right auricle, were compressed from above downwards, the compression starting from a point at the top of the transverse furrow between those cavities, where the aorta comes into view. The difference in the vertical diameter of the right ventricle below the part in question and just below the pulmonary artery, amounted in one instance to two inches, the actual measurements being respectively three and five inches. As a rule the difference was much less, but this was mostly due to the right ventricle being compressed downwards in its whole breadth by the sac. In five of the cases the auricular appendix was displaced downwards and to the right.

The downward displacement of the apex in aneurism of the arch of the aorta is not considerable, being in fact mainly due to co-existing hypertrophy of the left ventricle. That condition, however, is not usual, except in those cases of cylindrical aneurism or dilatation of the ascending aorta, in which there is free aortic regurgitation, when the left cavity is greatly enlarged, and when the descent of the apex is much more due to that cause than to the aneurism.

Mediastinal Tumours.—Dr. Bennett gives a case of mediastinal tumour, which will be more fully noticed at page 234, in which there was considerable displacement downwards and to the right of the heart, which was seen and felt beating in the epigastrium.

Pleuritic Effusion into the Left Side.—In the middle period of these cases, when the fluid is steadily increasing, but has not yet reached to its height, there is displacement downwards and to the right of the heart, which may be felt beating in the epigastrium. A full account of such cases, and an explanation of their phenomena, will be found at page 220.

CASES IN WHICH THE HEART IS RAISED.—Abdominal enlargement from gastro-intestinal distension, ascites, the presence of gas in the cavity of the abdomen, abdominal tumours, ovarian dropsy, aneurism of the abdominal aorta at the cœliac axis, and enlarged liver and spleen, all tend to elevate the heart. To these may be added certain cases of mediastinal tumours.

We have just seen that when there is collapse of the abdomen the diaphragm descends, drawing after it the heart and lungs. When there is distension of the abdomen, whatever be the cause, the reverse of this takes place. The diaphragm is raised, the cavity of the chest is shortened, and the heart and lungs are elevated and compressed upwards.

Distension of the Stomach and Intestines.—By far the most frequent, distressing, and often fatal cause of the elevation of the diaphragm and compression upwards of the heart and lungs, is the distension of the stomach and intestines with gas. The effect of this condition is well shown in Fig. 29, which was taken from a youth affected with diabetes, who, for months before his death, suffered from great abdominal distension. The cavity of the chest was materially lessened. The lower ribs, especially on the left side, were pressed outwards so as to restrain their movements, and the whole

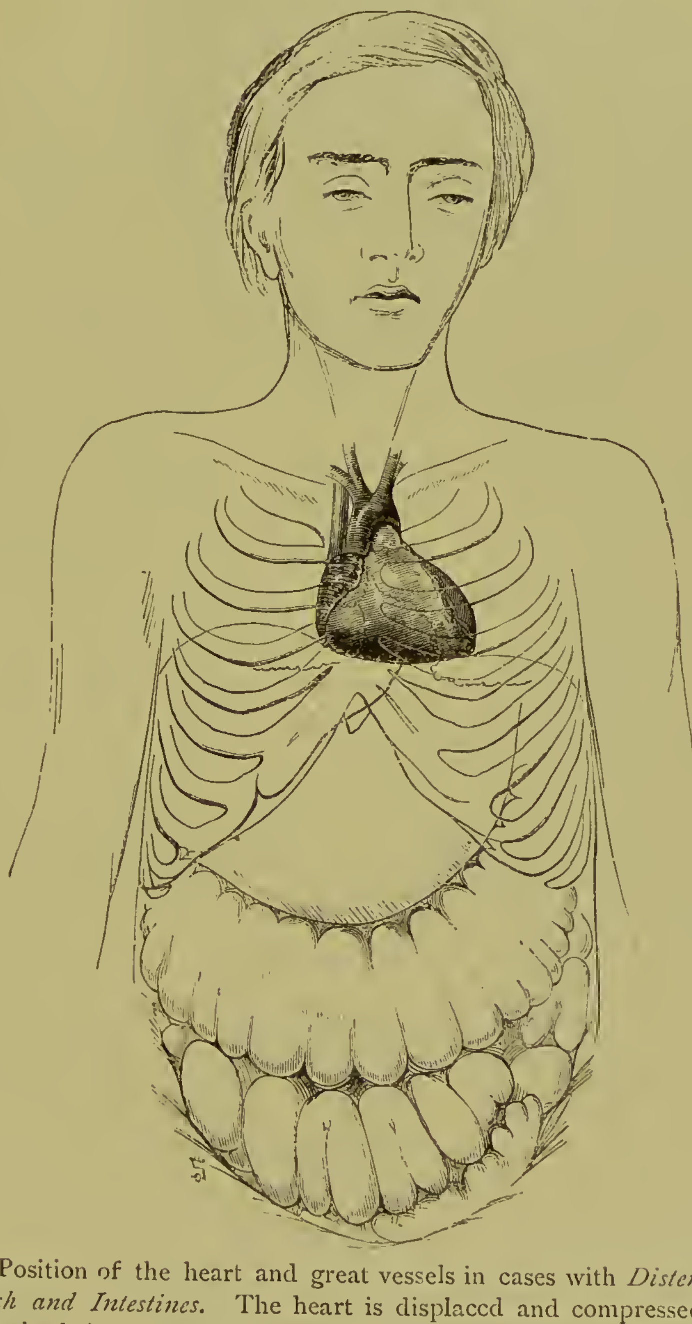


FIG. 29.—Position of the heart and great vessels in cases with *Distension of the Stomach and Intestines.* The heart is displaced and compressed upwards, its impulse being present in the second and third spaces, and perhaps in the fourth.

cage of the chest was elevated in front and at the sides. The heart and lungs were compressed upwards and lessened in size, so as to impede respiration and circulation.

When the abdomen is enlarged, it is enlarged in two directions, one outwards and downwards by the expansion of the walls of the abdomen, the other upwards by the elevation of the diaphragm. When the abdomen is extremely distended, the whole cavity becomes oval in form, or shaped like a balloon ; the outer part of it presses outwards, and the upper part of it presses upwards. The cage of the chest is raised by this double movement of distension upwards and outwards. The wide irregular cone formed by the upper part of the swollen oval abdomen, acting upon the lower ribs, forces them asunder to the right and to the left, and lifts up the whole front of the cage of the chest. The more important effect of this distension of the abdomen is to lift up the diaphragm, and with it the heart at the centre of the chest, and the right and left lung on each side of it. When these organs are thus raised, as the walls of the chest in front of them, by which their relative position is measured, are raised also, the apparent elevation of the heart is much less than its real elevation. The heart and great vessels are compressed upwards, and displaced somewhat to the right, so that the heart takes a central position in the chest, while the great vessels often bear unduly to the right. The shape of the heart is altered. It is shortened from below upwards, and is proportionally though not actually widened. Its apex is especially tilted upwards, and instead of being, as in health, lower than the inferior boundary of the right ventricle at the end of the sternum, is higher than that point by from a third to one-half of an inch. It is to be observed that the heart and lungs are compressed upwards into the highest part of the cavity of the chest, and as that cavity is a cone narrowing from below upwards, those organs, to their great additional inconvenience, are pushed up into the narrowest part of the space that they naturally occupy.[1]

Intestinal distension is usually present in peritonitis, and it becomes in many cases the most distressing symptom. As Dr. Stokes has shown, muscles are paralysed by inflammation. The inflamed muscular coat of the intestines, being paralysed, yields before the gaseous distension, which is no longer restrained by the peristaltic contraction of the intestines. In peritonitis, abdominal respiration is suspended and the diaphragm is passive. It therefore yields without resistance to the upward pressure exerted upon it by the distended intestines, and the heart and lungs are compressed upwards to a greater degree than in those cases of abdominal distension in which the diaphragm retains its power. Distension of the stomach and intestines is very frequent in the dying. It was present to an excessive degree in either the stomach or intestines, or both, in 63 out of 122 dead bodies observed by me indiscriminately; and in 28 of these the stomach and intestines were very much distended. In such cases the abdominal distension, which is usually one of the secondary effects of the original disease, produces compression of the heart and lungs, and thereby often hastens death or becomes its immediate cause. The introduction of the œsophageal tube from above, or of O'Beirne's tube from below, or the insertion of a small aspiration tube through the abdominal walls into the stomach, will in some of these cases give vent to the flatus and so produce material relief.

Many persons, especially those who have become stout, are subject to habitual distension of the stomach and intestines,

[1] For additional details as to this subject, see a lecture by the author on the "Influence of Distension of the Abdomen on the Functions of the Heart and Lungs," in the *British Medical Journal* for August 2, 1873, p. 108.

with the effect of compressing the diaphragm upwards, curtailing its power to descend freely during inspiration, and so encroaching on the cavity of the chest. Those so affected do not, in many instances, suffer when they are at rest, but on any exertion, respiration becomes hurried and difficult and the circulation of the blood is impeded. Such persons generally present themselves in two classes. One class, complain of shortness of breath, the other, of pain or distress in the heart when they make exertion, especially after a full meal. In many cases of angina pectoris, the distress is most easily excited after food. Some stout people are unusually subject to distress in breathing or in the heart or both from comparatively slight distension of the abdomen. In these persons the cavity of the abdomen is naturally incapable of great expansion owing to its walls being firm and resisting. The abdominal fulness, when it passes certain limits, cannot make way forwards and outwards, and the result is that the diaphragm is pushed upwards and the lungs and heart are subjected to a distressing amount of pressure.

In dyspeptic persons, the most distressing symptoms induced by the fulness of the stomach after food are often referred to the heart. This is apt to be the case also whenever the stomach is greatly distended. The reason is obvious; the stomach is immediately subjacent to the heart, the diaphragm being interposed, so that the heart, in fact, rests upon the stomach. Whenever, therefore, the stomach is greatly swollen by an accumulation of gas and food, the heart is compressed upwards in an especial manner, and the distress experienced is often, therefore, almost limited to the heart. I do not of course lose sight of the additional physiological influence exerted by the stomach upon the heart through the medium of the eighth pair of nerves.

Ascites.—In ascites, the accumulation of the fluid is gradual. The patient is usually in bed, and the distress in breathing and in the heart experienced by the patient, owing to compression of the heart and lungs, is by no means proportionate to the amount of the distension. Indeed, those cases of ascites that suffer great distress in the organs of the chest usually have in addition distension of the stomach and intestines as well as enlargement of the liver. When this is so a small amount of fluid in the peritoneal cavity will produce serious discomfort, and the removal even of a little of it by tapping will give immediate and unusual relief. Some years ago I had a patient in St. Mary's Hospital who was affected with aortic and mitral regurgitation. The heart was enlarged and the pericardium was adherent. He breathed with difficulty, owing to the great size of the abdomen, which was produced by the triple combination of great enlargement of the liver, distension of the stomach and intestines, and ascites. The quantity of urine was scanty, being about eleven ounces daily. The amount of fluid in the peritoneal cavity was small, but with the view of affording relief tapping was resorted to. The intestines were so near the surface that an incision was made in the parietes of the abdomen, and the trochar and canula were introduced in a downward direction. At first only half a teaspoonful of fluid escaped, but by passing a female catheter through the canula, so as to press the intestines gently away from the end of the tube, about ninety ounces of serum were withdrawn. The relief to breathing was complete. The urine, before so scanty, now began to flow freely, and from fifty to eighty ounces were passed daily. By drawing off the fluid the extreme distension was relieved, and the ligature, so to speak, on the circulation, caused by the compression of the heart, was removed. Ultimately the fluid re-accumulated, and the patient died. The result was unfavourable, but the case was none the less instructive, for it demonstrated that the encroachment of the abdomen upon the chest checked the circulation of the blood and so prevented the free secretion of urine.

In all cases of abdominal distension the seat of the impulse of the heart is a ready and exact measure of the extent to which the cavity of the abdomen encroaches upwards on the cavity of the chest. The progress of such distension, whether on the ascending or descending scale, may be exactly ascertained by noticing the varying position, upwards or downwards, of the impulse of the heart. It must however be borne in mind that, when the heart and lungs are raised by distension of the abdomen, the walls of the chest in front of those organs is raised also, and that the apparent elevation of the heart, measured by its relation to the walls of the chest, is much less than its real elevation.

Escape of Gas into the Cavity of the Abdomen.—The escape of gas into the cavity of the abdomen, owing to perforation of the stomach or intestines, produces rapid distension of that cavity and great elevation of the diaphragm and the heart and lungs, with the effect of inducing great distress in breathing and difficulty in the action of the heart.

Abdominal Tumours, even when they are of considerable size, rarely produce any material disturbance either in the action of the heart or in the performance of respiration.

Ovarian Dropsy.—The same may be said of cases of ovarian dropsy, even when the sac is of very large size, and rises upwards so as to encroach on the chest, unless that affection be accompanied by intestinal distension. In the female the walls of the abdomen are capable of great forward expansion, and the result is that large ovarian cysts as well as the gravid uterus at the full time tend rather to protrude forwards so as to distend the abdominal parietes anteriorly, than to rise upwards so as to elevate the diaphragm and encroach upon the heart and lungs.

Simple Enlargement of the Liver and Spleen.—When the liver is universally enlarged, even when it assumes a very great size, it does not rise upwards so as to raise the diaphragm and compress the heart and lungs, but it tends to grow downwards, so as to displace the stomach and intestines. The same may be said of the spleen in cases of leucocythemia, even when that organ attains to a very large size.

The result is, that simple enlargement of the liver or spleen does not as a rule encroach upon the chest so as to produce serious disturbance in the functions of the heart or lungs.

It is quite otherwise when the upper part of the right lobe of the liver is occupied by large abscesses or hydatid cysts or malignant growths. These morbid conditions produce a peculiar displacement of the heart upwards and towards the left subclavicular region, and I shall therefore consider them under the lateral displacements of the heart.

Mediastinal Tumour.—Dr. Bennett[1] gives a case of mediastinal cancer involving the bronchial glands and spinal column, in which the heart was found displaced, being drawn upwards. During life there was very little impulse to be felt or seen immediately to the left of the sternum just above the nipple.

THE LATERAL DISPLACEMENTS OF THE HEART.

Pleuritic effusion, empyema, and pneumo-thorax of one side of the chest; hæmorrhage into either cavity of the chest from the rupture of an aneurism of the aorta; thoracic

[1] *Intra-thoracic Tumours*, p. 127.

tumours; aneurisms of the arch of the aorta; aneurisms of the abdominal aorta at the cœliac axis; and large abscesses or hydatid cysts or malignant tumours in the upper part of the liver; all tend to displace the heart towards the side of the chest opposite to that which is affected. Contraction or cirrhosis of one lung with adhesions of the pleura tends to displace the heart towards the affected side. To these may be added lateral curvature of the spine and congenital transposition of the viscera.

The lateral or transverse displacements of the heart, which are sometimes called dislocations, unlike the displacement of the heart upwards by the encroachment of the cavity of the abdomen upon that of the chest, do not as a rule produce much distress in the heart itself or disturbance of the circulation. The lateral displacements of the heart are, however, valuable and decisive indications of disease, since by the evidence they afford they often render our diagnosis accurate and certain.

Pleuritic Effusion, Empyema, Pneumo-thorax.—The effusion of serum into either cavity of the chest, owing to pleuritis, acute or chronic, is the usual cause of the lateral displacement of the heart.

When extensive effusion takes place into the left side, the heart is pushed over towards or into the right side of the chest, as may be seen in Fig. 30. This figure, unlike the others, does not represent an actual case, but is a diagram, made from drawings of six cases, one of effusion of serum into the pleura, one of empyema, and the four others of extensive effusion of blood into the left pleura from the rupture of a thoracic aneurism. In one of these the clot measured three pints and a half.

The displacement of the heart from the increasing effusion of fluid into the pleura is usually gradual. It may, however, be rapid, and Dr. Walshe states that thirty-six hours will

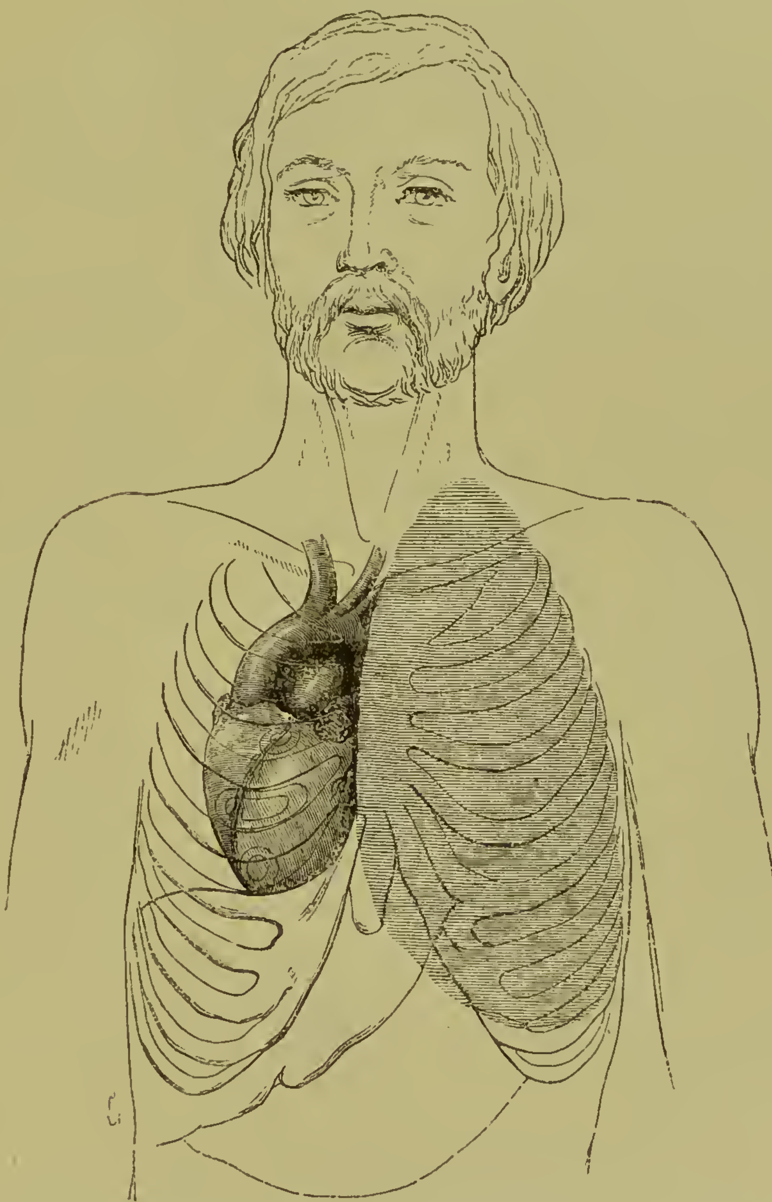


Fig. 30.—Position of the heart and great vessels in cases of *Pleuritic Effusion into the Left Cavity of the Chest.* The heart is displaced into the right side of the chest, its impulse being felt in the third, fourth, and fifth spaces.

sometimes suffice for the heart's impulse to find its way beyond the right nipple. When the quantity of fluid is so small as to occupy only the back part of the left side of the chest, the heart is scarcely displaced. When the fluid increases the left ventricle and its apex are at first thrown a little forwards, and towards the centre of the chest. The pressure of the effused fluid is not made directly upon the heart, but upon the strong fibrous sac of the pericardium, and, through its medium, upon the heart. If the heart had no sac of its own, and was present without restraint in, say, the left cavity of the chest, it would not be forced forward and to the right when the left cavity of the chest is filled with fluid, but it would, I consider, gravitate backwards owing to its own dead weight, and sink to the back of the cavity, just as the liver sinks to the back of the fluid in cases of ascites. The presence of the pericardium completely prevents such a state of things. The accumulated fluid distending the left cavity of the chest presses equally in every direction. It displaces the ribs backwards, forwards, and especially outwards, so that they draw the lower end of the sternum somewhat to the left ; it displaces the left wing of the diaphragm, the spleen, stomach and left lobe of the liver downwards and to the right ; and it displaces the pericardium and the heart and great vessels inwards and to the right. The lower end of the pericardium at its attachment to the central tendon of the diaphragm is stretched downwards by the traction upon it of the lowered left wing of the diaphragm, to which it is attached by its central tendon.

The apex forms throughout the lowest part of the heart, and it describes a segment of a circle or arc as it sweeps round from its natural position in the left side of the chest to the position of extreme deviation to which it may attain in the right side of the chest. When the apex describes this curve, instead of being raised by the resistance offered by the abdominal organs, it is lowered during the first two-thirds of its course. The reason for this is obvious. The fluid in the left pleura, which displaces the pericardium and the heart to the left, displaces at the same time, as I have just explained, the left wing of the diaphragm and its central tendon and the subjacent organs downwards, forwards, and to the right. Under these circumstances, as the central tendon forming the base of the pericardium is lowered, there is a free space downwards into which the apex of the heart, suspended from the arch of the aorta, necessarily drops, so that it may be felt beating in the epigastrium over, beyond, and even below the ensiform cartilage. At length, however, the heart, as it advances further into the right side, meets with increasing resistance from the solid convexity of the liver; and the heart, consequently, again rises, so that it is at length about as high on the right side as it is in health on the left. The displaced heart may indeed attain to a higher position if it deviate still farther to the right, when, as in a case of Wintrich's,[1] it may approach the axilla, and be felt beating from the second to the fourth spaces.

Information of some diagnostic value is to be obtained by observing the position of the heart in comparatively early stages in cases of pleuritic effusion, at a time when the impulse of the apex has already moved from its natural position and is on its way towards the central line. To quote Dr. Stokes, we observe, first, that the apex strikes in a situation about midway between its natural position and the upper portion of the ensiform cartilage.[2] It is not, however, until the apex beat presents itself in the epigastrium that much notice is taken of the altered position of the heart. In four of my cases of displacement of the heart towards the right from effusion into the left side of the chest, the apex presented

[1] *Krankheiten der Respirationsorgane.*

[2] Dr. Stokes *On the Diseases of the Heart and Lungs*, p. 500.

itself in the epigastrium, being in one of these behind the lower end of the ensiform cartilage, and in two behind its middle. As Dr. Townshend remarks, in speaking of empyema in the left side, the heart is thrust from its natural position down into the epigastrium, where it may be seen and felt beating. There is no difficulty in distinguishing the impulse of the apex from that of the right ventricle in the epigastrium. When the latter is present the whole heart has been lowered, owing to the lowering of the diaphragm. This may occur, as we have already seen, in cases either of pulmonary emphysema, or croup, or with collapse of the stomach and intestines, when the presence of *pulmonary* resonance over the left side will at once enable us to distinguish the case. In cases of pleuritic effusion the existence of dulness, and in those of pneumothorax the presence of amphoric resonance, over the whole of the left side, and the absence of impulse to the left of the sternum, will generally suffice to make the case clear. Cancerous tumours occupying the whole of the left side may also give rise to displaced impulse and to general dulness on percussion, when that disease cannot be distinguished from pleuritic effusion or empyema on those grounds alone. In cases of pneumonia of the whole of the left lung, it is possible that owing to the enlargement of the pneumonic lung from consolidation and the development of the right lung to compensate for the disablement of the left lung, the impulse of the apex may disappear from the walls of the chest, while that of the right ventricle may descend into the epigastrium. In such cases, however, the impulse is comparatively slight, and it always extends rather to the left than the right of the ensiform cartilage, while in cases of pleuritic effusion the impulse is usually strong and marked, and tends rather to the right than the left side of that cartilage. As soon as the seat of the impulse disappears from the left side of the chest and extends to the right of the sternum, every difficulty of the kind just stated vanishes.

As the heart passes over from the left to the right side of the chest it gradually and necessarily turns over upon itself, hinging, so to speak, upon the vessels by which the heart is attached to the lungs and the system, so that the right auricle is hidden, all but the top of its appendix, and instead of the right ventricle being in front of the left ventricle, all but its left border, it is the reverse, for the left ventricle hides a large portion of the right ventricle (see Fig. 30). The part of the right ventricle exposed is, however, not that near the apex, but that near the pulmonary artery. The ascending aorta and pulmonary artery change their direction ; they move to the right at their respective origins, but higher up they are retained in their places, the arch of the aorta at the end of its transverse portion, and the pulmonary artery at its bifurcation. The aorta and pulmonary artery, therefore, present not a front but a profile view, with a direction to the right.

I published a case with a diagram showing the position of the internal organs in the *Provincial Medical Transactions* for 1844 (p. 162), in which effusion in the left side of the chest was limited to the lower two-thirds of the cavity, owing to the upper lobe of the left lung being adherent down to the third rib. In this case the heart was simply displaced to the right, the front of the organ being still occupied by the right ventricle, and its right and left sides by the right auricle and the left ventricle. This case shows that the heart does not turn over upon itself so as to present the left ventricle instead of the right in front, unless the fluid presses upon the left side of the pericardium for its whole length, so as to bear upon the great vessels as well as upon the body of the heart.

The impulse to the right of the sternum is sometimes limited to the fourth and fifth intercostal spaces, while sometimes it is also present over the third and even the second space. In the latter case the impulse is double, and is due to the pulsation, followed by the second beat coincident with the second sound of the pulmonary artery or aorta, or both. When pulsation is present in the first, second, and third right spaces, and also in the normal position to the left of the sternum, the case is one of aneurism of the aorta; and the distinction of this impulse or pulsation from that of displaced heart presents therefore no difficulty.

Wintrich[1] states that sometimes, when the effusion is in the left side, the heart is displaced backwards (and to the right) being covered by lung, when the displacement of the heart can by no means be discovered. He saw one such case in which an able clinical physician mistook the disease for pericarditis with very great effusion.

When effusion of fluid takes place into the right cavity of the chest, the heart is displaced towards the left side. As the impulse, however, is already seated on that side, the change in position of the impulse of the heart is not nearly so marked or diagnostic as in cases in which the heart is displaced to the centre or right side of the chest, owing to effusion into the left side. Important information, however, is to be obtained in such cases from the position of the impulse on the left side.

In a patient under my care, who had extensive effusion into the right pleura, the impulse was felt in the sixth space, two inches farther to the left, and somewhat lower than the natural position. In two cases of seropurulent effusion in moderate quantity into the right pleura, of which I possess drawings, the heart was displaced to the left, and lowered to a slight extent. In one the apex of the heart was situated behind the seventh rib, more than an inch to the left of the natural

[1] *Krankheiten der Respirationsorgane*, p. 255.

site, and nearly an inch lower. In the other, the displacement of the heart downwards and to the left also existed, but to a less degree.

Since the above was in type I have seen three cases of extensive effusion of fluid into the right side of the chest. In two of these cases the apex-beat was felt as far to the left as about the seventh rib, the position of the impulse being somewhat lower than natural. In the third case, a young woman, whom I saw through the kindness of Dr. Wane, the amount of fluid in the right side of the chest was very great. The impulse of the heart was not perceptible to the right of the mamma, but prevailed along its upper left border from the third or fourth to the seventh space where it was unusually low in situation. There was a double impulse over the great arteries at the left upper border of the mamma, and doubling of the second sound, the second of the two sounds being that made in the pulmonary artery. There was also a loud mitral murmur around the region of the apex. A large quantity of fluid was drawn off, by means of a glass syringe through a fine tube, by Mr. James Lane, who performed the same operation for the two other cases. I watched the position of the impulse when the fluid was being withdrawn, and noticed that it soon disappeared from the seventh space, and more slowly from the sixth, the beat moving steadily to the left and somewhat upwards. When the full amount of fluid had been withdrawn, the impulse was present in the fourth and fifth spaces, and perhaps in the third, being situated to the right of the mamma. The doubling of the second sound at once disappeared, and later I believe that the mitral murmur also vanished. In the drawing of an instance of great cylindrical dilatation or aneurism of the ascending aorta, in which there was considerable effusion of fluid in the right side of the chest, the heart, which was greatly enlarged and lowered in position, was displaced to the left as far as the ribs would allow, the apex extending to the seventh spaee, fully two inches below the level of the lower end of the sternum.

In two cases related by Dr. Gairdner[1] of effusion into the right pleura, the apex-beat in both was displaced to the left; in one (p. 329) the impulse probably retained its usual level, being displaced about one inch to the left. In the other (p. 354), before paracentesis, the apex-beat was felt in the fifth space, one inch and a half to the left of the normal site; after the operation it was present in the fourth space. In this case the impulse was probably lowered. Dr. Townshend, who was the first to observe the displacement to the left in such cases, felt the apex striking against the stethoscope between the fourth and fifth ribs in the axilla in two cases of empyema of the right side.[2] It is evident, then, that when considerable effusion takes place into the right side the apex-beat is always pushed further to the left, and that it is usually lower, sometimes on the same level as, and sometimes higher than the natural position. I attribute the lowered position of the impulse to two causes, the displacement downwards of the central tendon of the diaphragm by the effusion, and the inspiratory lowering of the diaphragm to enlarge the left lung, and so to compensate for the disuse of the right lung.

I do not find that the displacement of the heart from empyema differs in any respect from that caused by the effusion of serum into the pleura.

In pneumo-thorax of the left side, the displacement of the heart is the same as in cases of fluid effusion into the pleura. In general, fluid is combined with the air in those cases, but air without fluid will produce displacement of the heart, and it must do so when it is in sufficient quantity to distend the

[1] *Clinical Medicine.* [2] *Cycl. of Med.*, vol. ii. p. 38.

sac of the pleura, press down the diaphragm, and so push the pericardium and the heart over to the opposite side. Dr. Douglas Powell[1] relates a case in which the right side of the chest was filled with air, and the right border of the heart was situated to the left of the left sterno-clavicular line.

Wintrich[2] states that displacement of the heart takes place in pneumothorax as in pleuritic effusion ; the only difference being that in pneumothorax the heart is more frequently displaced from before backwards.

Hæmorrhage into either Cavity of the Chest from the rupture of an aneurism of the aorta displaces the heart, as a rule, to the opposite side, in the same manner, and to the same extent, the quantity of fluid being alike, as in cases of pleuritic effusion. Two circumstances, however, tend to modify this result, one, the size and position of the aneurismal sac ; the other, the lessening of the size of the heart that may be induced by the hæmorrhage. Mr. Sidney Coupland[3] gives a case in which a diffuse aneurism of the thoracic and abdominal aorta ruptured into the left cavity of the chest, which contained twenty-four ounces of clot. During life the apex was tilted upwards, and was felt beating in the fourth space, one inch within, and on a line with the left nipple.

Contraction or Cirrhosis of the Lung with Adhesion of the Pleura.—When pleuritis with effusion, whether chronic or acute, ends in the permanent condensation of the lung, fibroid thickening of the pleura, and binding adhesions, the whole of the affected side contracts and the ribs are crowded together. That side of the chest, however, is not obliterated ;

[1] *Path. Trans.*, xix. 77.

[2] *Krankheiten der Respirationsorgane*, p. 344, 347.

[3] *Path. Trans.*, xxiv. 54.

it is still much larger than the condensed lung, and the result is that if, for instance, the right be the affected side, the heart is permanently drawn over into the right side.

Dr. Stokes was the first to draw attention to the displacement of the heart to the right side, in consequence of the absorption of an effusion into the right pleura.[1]

When the left is the affected side, the heart may be drawn quite over into the left side, the right auricle being situated to the left of the median line. This is well seen in Fig. 31, which was taken from a man in whom, owing to the complete contraction of the left lung, the heart entirely occupied the left side of the chest in front, no portion of the left lung being interposed between the heart and the walls of the chest. The heart is raised towards the infra-clavicular region and the axilla, and the ribs fit closely upon the heart from the second to the fifth. In this man the impulse must have extended from the first intercostal space to the fourth.

It may be observed that here also, as in displacement of the heart into the right side, the heart revolves upon itself and turns over, but in the reverse direction. In displacement into the right side, the left ventricle and auricle are situated in front, the right ventricle being partially and the right auricle all but its tip being wholly concealed. In displacement to the left, the right ventricle entirely hides the left side of the heart. The aorta and pulmonary artery are twisted to the left, both venæ cavæ are completely exposed when the right lung is turned aside, and are situated behind the sternum, and the whole heart seems to turn to the left upon the two venæ cavæ as upon a hinge or pivot.

In cirrhosis of either lung the heart is drawn towards the affected side. Dr. Hilton Fagge[2] relates a case of cirrhosis

[1] *On the Diseases of the Chest*, p. 501.
[2] *Path. Trans.*, xx. 35.

of the right lung in which the impulse was seen and felt two

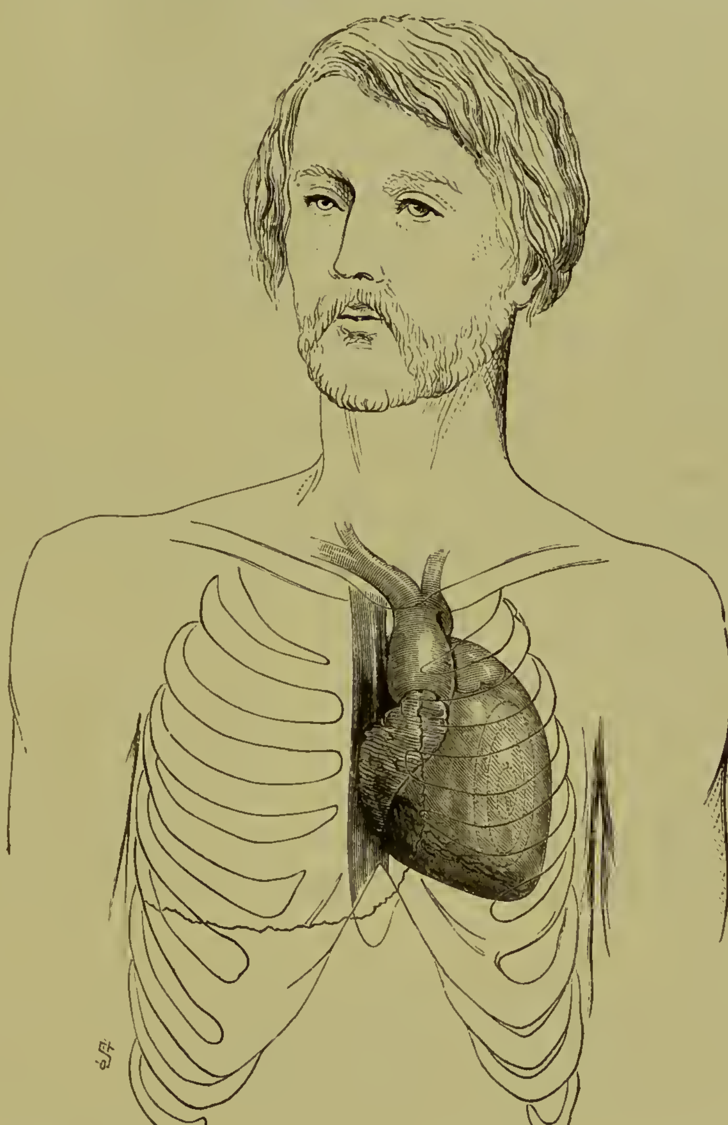


FIG. 31.—Position of the heart and great vessels in a case with *contraction of the left lung*. The heart and great vessels are drawn completely over into the left side of the chest, so that it is much farther to the left and higher in situation than in the healthy chest. They are partially covered by the right lung, but not at all by the left, and the impulse of the heart is present in the second, third, and fourth spaces, and perhaps in the fifth.

inches below and one inch to the left of the right nipple. The heart deviated more to the right during life than after death, when the apex was two inches to the left of the middle line, being situated between the fifth and sixth (cartilages); and one half of the heart was to the left, and one half of it was to the right of the middle line. Dr. Greenhow[1] gives a case of contraction of the right lung, the precise condition of which was unknown, observed by him during life, in which the heart was displaced very far to the right and upwards, and was felt beating in the third and fourth spaces over an area of three inches by three and a half, of which the right nipple formed the central point.

Dr. Wilks[2] communicates a case of cirrhosis of the left lung, in which that lung was contracted and hard, and had to be cut out. The right lung was enlarged, and was the only organ observable on removing the sternum. The heart was drawn towards the left side, "owing to the pericardium being firmly united to the pleura."

Dr. Bastian[3] gives an analysis of thirty cases of cirrhosis derived from various sources. The heart was much displaced towards the affected side in twelve of these, and slightly in three; while in three of them there was no displacement, and in the remaining twelve there was no notice of the position of the heart.

When the left bronchial tube is obliterated by compression, by its own contraction, or by the admission of a foreign body, the left lung shrinks, the left side contracts, and the heart is displaced towards the clavicle and axilla, exactly as in cases of complete contraction with adhesions of the left lung. Dr. Stokes publishes a case of Dr. Mayne's of aneurism arising from the front of the transverse portion of the arch of the aorta, which extended downwards towards the left lung, compressing and flattening the left bronchial tube. The left

1 *Path. Trans.*, xix. 159.

2 *Ibid*, viii. 39.

3 *Ibid*, xix. 47.

side of the chest was less than the right by two inches, the ribs were crowded together, and the heart was displaced towards the left axilla.[1]

There are many cases of partial contraction of a portion of the upper lobe of the left lung, whether from phthisis, cirrhosis of the lung, gangrene of the lung, or other cause, in which the upper part of the heart and the great vessels, especially the pulmonary artery, are drawn upwards and to the left towards or into the former seat of the contracted portion of the lung. In such cases the presence of the pulmonary artery, elevated in position and drawn to the left, may be immediately ascertained by its peculiar double impulse. I cannot say that I have strictly observed the analogous displacement of the ascending aorta towards the seat of the upper lobe of the right lung, in cases of contraction of that lobe, but I have noticed cases of this class in which the vessel evidenced itself by very loud superficial first and second sounds, which communicated themselves to the ear, if not to the hand, like a double shock or impulse. Dr. Stokes has given an interesting account of the displacements of the heart from the diminished volume of the lung, in his work on *Diseases of the Heart*, p. 458.

Intra-thoracic Tumours.—Large cancerous growths in the cavity of the chest, when they press upon the heart without penetrating into its structure, necessarily displace it in the direction of the pressure. The heart is simply pushed aside by the tumour, and its displacement is in no way influenced by the relation of the heart to the central tendon of the diaphragm.

"In the year 1856 I saw," writes Dr. Cockle, in his paper on intra-thoracic cancer, "a case of intra-thoracic cancer occupying the whole of the left side of the chest, and en-

[1] Dr. Stokes *On Diseases of the Heart and Aorta*, p. 566.

croaching slightly on the right side, in which the tumour carried the heart before it as far as the right nipple. The impulse was felt pulsating between the second and third ribs, and down to, and at a later period beyond, the right nipple."

Dr. Bennett [1] relates the case, communicated to him by Dr. Sutton, of a little girl, in whom the entire left side was occupied by a mass of medullary cancer which had pushed the heart considerably to the right. During life the heart was displaced and was felt beating at the right nipple. The diagnosis was "*very great effusion into the left pleural cavity*," and the chest was twice punctured.

In a case published by Dr. Andrew [2] in which a large malignant growth occupied the upper lobe of the left lung, the heart was displaced downwards and to the right. Dr. Bennett [3] gives a case of cancer of the anterior and posterior mediastinum involving the anterior portion and root of the right lung on which the heart was pushed downwards and towards the right side, so that rather more than half of the organ was to the right of the median line. A fortnight before death there was manifest and considerable displacement of the heart, which was beating in the epigastrium. Dr. Douglas Powell [4] relates a case in which the left cavity of the chest was occupied by a solid mass, displacing the heart to the right, and the lung posteriorly. After death it was found that this tumour was intimately connected with the heart at its left and posterior aspects. I might cite other cases of intra-thoracic tumour, published by Dr. Townsend, Boerhaave, quoted by him, and others, in which the heart was displaced.

On the other hand, cases are recorded in which there was

[1] *Intra-thoracic Growths*, p. 100.
[2] *Path. Trans.*, xvi. 51.
[3] *Loc. cit.* p. 92.
[4] *Ibid.*, xxiv. 28.

little or no marked displacement of the heart, although the extent of the disease was great.

Dr. Graves and Dr. Stokes[1] have published a well-known instance of this disease, in which there was found, in place of the right lung, a solid mass, weighing more than six pounds. It encroached upon the left side of the chest, enveloping and nearly concealing from view the pericardium, great vessels, and trachea. Notwithstanding the extent and position of the disease, the heart pulsated in its natural situation.

Dr. Wilks describes a case in which the whole right lung was converted into one mass of medullary cancer which protruded into the pericardium, ran along the great vessels at the base of the heart, and pierced the auricles of the organ itself. The superior cava was almost destroyed by the cancer, the inferior vena cava was closely surrounded by it but was free, the right pulmonary artery was a mere slit in the midst of it, and it had entered the heart through the pulmonary veins. There is no notice of displacement of the heart, although it is stated that the sounds of the heart were very feeble.

Dr. Quain[2] exhibited before the Pathological Society an encephaloid mass of the size of a large cocoa-nut, which was situated between the root of the left lung and the heart. When the patient was first seen, six weeks before his death, the heart was little displaced. Afterwards effusion took place into the left side, and the heart became much displaced towards the right side.

It is evident from these cases, that a large intra-thoracic tumour occupying one side of the chest may in some instances displace the heart into the opposite side, while in other instances, in which the tumour is equally large, there may be no displacement of the heart whatever. The reason is

[1] Dr. Stokes *On the Diseases of the Chest*, p. 371.

[2] *Path. Trans.*, viii. 54.

obvious. In those instances in which there is no displacement, the cancer penetrates into or surrounds the organ, without pushing it aside.

It is evident, then, that the displacement or non-displacement of the heart, and the mode and extent of its displacement, in instances in which there is complete dulness of one side, may sometimes help us to discover whether the case is one of intra-thoracic cancer or of simple effusion into the pleura.

Large abcesses, hydatid cysts, or malignant tumours in the upper or convex portion of the Liver.—The patient from whom fig. 32 was taken was affected with jaundice. On post-mortem examination several large abcesses were found in the upper portion of the liver where it ascends into the right side of the chest. He also had peritonitis, and excessive intestinal distension. The whole diaphragm was raised, and with it the heart was pushed upwards and to the left in a remarkable manner. The liver encroached upon the right side of the chest to such an extent that its highest point was on a level with the lower edge of the second rib. The convexity of the liver consequently encroached on the left side of the chest as well as the right, and carried the heart, resting upon its upper surface, completely over into the upper portion of the left side of the chest.

If this figure be compared with fig. 29, in which the diaphragm is excessively raised by means of distension of the stomach and intestines, it will be seen that while in both the diaphragm is raised to an excessive degree, there are important points in which they differ materially from each other. In that figure as well as in this we find that the abdomen is distended, the diaphragm is pushed upwards, the lower ribs are prominent, and the heart and lungs are pressed upwards and lessened in size, being encroached on by the

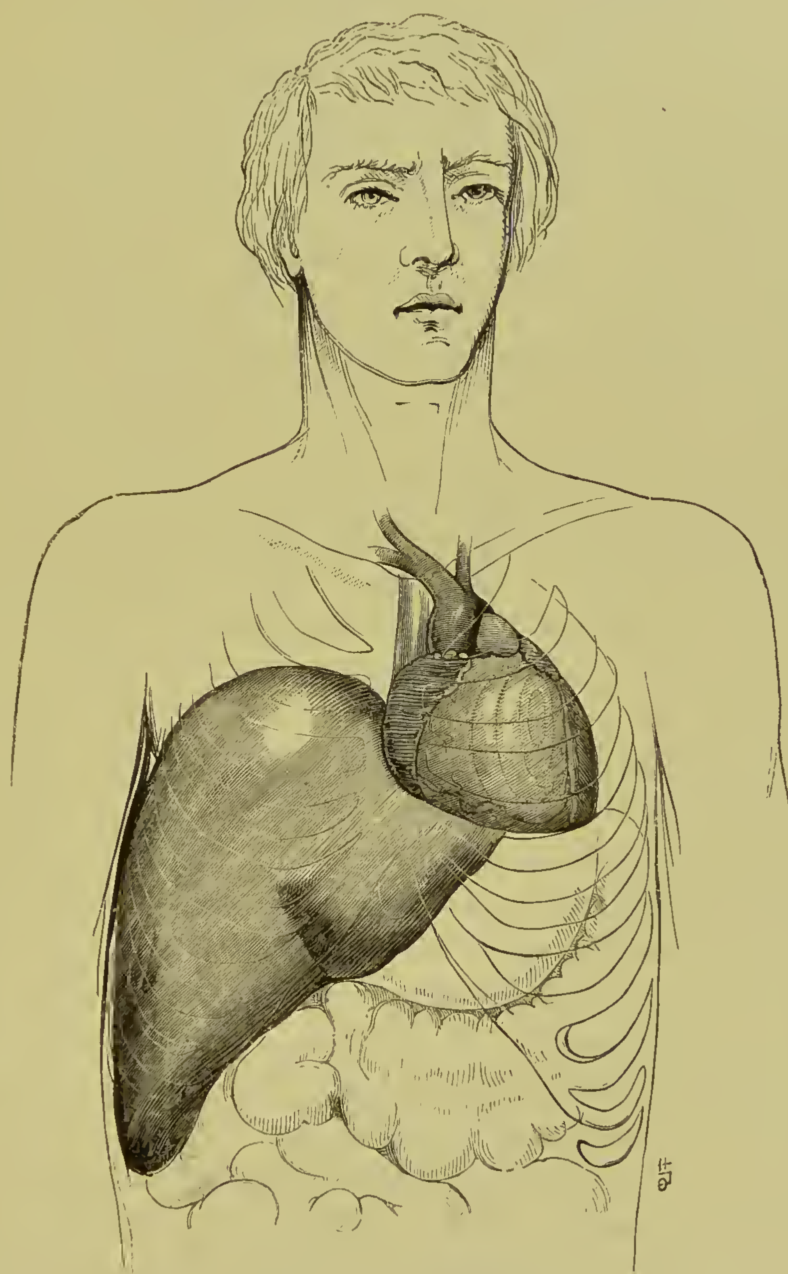


FIG. 32.—Position of the heart and great vessels in a case with *large abscesses in the upper portion of the liver*. The heart and great vessels are displaced extensively upwards and to the left towards the left axilla, so as completely to occupy the left side of the chest. The impulse is present in the second and third left spaces.

abdominal organs. In universal distension of the abdomen, the heart, while it is compressed upwards, retains a central position, as it rests on the central tendon of the diaphragm. It deviates rather to the right than to the left. But in those cases in which there are large abscesses or hydatid cysts, or cancerous growths in the upper portion of the liver, the heart, as it is pushed upwards, deviates extensively to the left, and occupies a space to the left of the upper half of the sternum, behind the first, second, third, and fourth ribs. It is to be remembered that in this case there was peritonitis and great intestinal distension, consequently the compression of the heart upwards was effected by a double cause.

The deviation of the heart to the left side of the chest from extensive abscesses in the upper portion of the liver, differs thus from the deviation caused by effusion of fluid into the right side of the chest—in effusion into the right side of the chest, the heart and the impulse at the apex are either lowered or only slightly raised ; while in cases with abscesses in the upper portion of the liver they are pushed upwards, being above the fourth rib. The position of the heart in enlargement of the liver from abscess, and in great contraction and adhesions of the left lung, corresponds very closely. (Compare Figs. 31 and 32.) In both the heart and great vessels are situated behind the second and two or three upper ribs, in both the heart is pushed entirely into the left side, the venæ cavæ being behind the sternum. But in the following respects they differ. In enlargement of the liver from abscesses, the anterior aspect of the heart is unchanged ; the left upper ribs are widened apart and the ribs on both sides are raised and pushed outwards ; the dulness on percussion is more extensive on the right side than the left, especially behind, and the heart and its impulse scarcely appear below the fourth rib. In contraction of the left lung, these conditions are reversed. The heart turns upon the venæ cavæ as upon a hinge over towards the left, the right auricle, and both venæ cavæ being completely exposed, and the left ventricle being hidden by the right; the ribs are crowded together, the whole of the left side of the chest being contracted ; there is dulness on percussion over the whole left lung, while the whole right side of the chest is very resonant, the area of resonance being increased, owing to the encroachment of the right lung upon the left side of the chest to the left of the sternum ; and the impulse of the heart is felt down to the fifth rib.

Extensive effusion in the pericardium in *acute* pericarditis is an additional cause of displacement of the heart towards the axilla. Of this displacement I shall speak in the article on pericarditis.

DISPLACEMENT OF THE HEART FORWARDS.

Dr. Hope relates a case in which the thoracic aorta, extending from an inch below the left subclavian artery down to the diaphragm, was enlarged into an aneurismal sac which lay across the spine, and projected on the right side three inches beyond the vertebræ without reaching the ribs, while on the left it extended to the ribs, causing destruction of three and caries of two or more of them, and at last formed a considerable tumour on the back. This tumour necessarily compressed the heart forwards against the front of the chest. The impulse of the heart was exceedingly vigorous, and was double, consisting of a diastolic as well as a systolic impulse, each of a jogging character. It was agreed that there must be considerable hypertrophy of the heart to account for so strong an impulse, and yet the organ was found by Mr. Cæsar

Hawkins, who drew up the autopsy, only "slightly enlarged and thickened."[1] Dr. Hope quotes without reference, a case mentioned by Dr. Todd, in which the heart was pushed forward and outwards, and, as it were, compressed against the ribs by an enormous aneurism of the thoracic aorta. The sounds of the heart were so modified by this compression as to lead to the erroneous diagnosis of concentric hypertrophy.

I possess a drawing taken from a case of extensive aneurism of the abdominal aorta at the cœliac axis, in which the aneurismal sac extended upwards, behind the diaphragm, in front of the lower dorsal vertebræ, so as to displace the heart forwards and probably somewhat upwards.

DISPLACEMENT OF THE HEART BACKWARDS.

When abscesses or tumours form in the anterior mediastinum, behind the lower portion of the sternum, the heart must be displaced backwards.

The displacement of the heart backwards is also induced by the very extensive effusion that gradually takes place into the pericardium in cases of chronic pericarditis.

Wintrich states, as we have already seen, that sometimes when there is pleuritic effusion in the left side, the heart is displaced backwards and to the right, so that its displacement can by no means be discovered.

[1] Dr. Hope *On the Diseases of the Heart*, p. 447.

XVI.

PERICARDITIS.

Clinical History of Pericarditis as it occurred in the Author's practice in St. Mary's Hospital.[1]

INFLAMMATION of the surface of the heart and the lining of the pericardial sac occurs so very rarely by itself, and is so generally one of the attendant affections of a general disease, such as acute rheumatism, Bright's disease, and pyæmia or the secondary inflammations; or of a local affection, such as aneurism of the aorta or cancer; or of a local injury; that we cannot practically regard it as a distinct disease. Pericarditis is indeed, with very rare exceptions, one of the inflammations attendant upon those diseases or injuries.

Pericarditis occurs so much more frequently in acute rheumatism than in any other disease, that I shall first consider the affection as it exists in connection with that disease; and in so doing shall examine the proportion of my cases of acute rheumatism that were affected with pericarditis, and shall describe the progress of that affection in those cases.

Rheumatic Pericarditis.

I possess notes of 326 cases of acute rheumatism that were admitted under my care into St. Mary's Hospital during the fifteen years ending in the autumn of 1866. This number

[1] From Dr. Russell Reynolds's *System of Medicine*, Vol. iv.

does not include fourteen patients in whom it was doubtful whether the affection was acute rheumatism or acute gout.

One-fifth of those cases[1] (63) were attacked with pericarditis, which was accompanied in all but nine instances (54) by endocarditis, and fully one-third of them with simple endocarditis (108), while in only one-fourth of them was there no evidence of either endocarditis or pericarditis (79). There was, however, an intermediate group, amounting nearly to one-fourth of the whole number (76), in which endocarditis, though not established, was either threatened or probable, the signs of that affection being either transient or imperfect. I think that we may class this intermediate group arbitrarily into two divisions, and consider that in one-half of them there was endocarditis, and that in the other half there was no endocarditis.

If we add the cases of pericarditis that were also affected with endocarditis (54), and half of those in which endocarditis was threatened or probable (38), to those in which simple endocarditis was present (108), we shall find that in my patients inflammation of the interior of the heart (200) was fully three times as frequent as inflammation of the exterior of the heart (63).

This summary, otherwise stated, stands thus :—

Cases of acute rheumatism with pericarditis . .	63	
Cases in which the pericarditis was accompanied by endocarditis		54
Cases of simple endocarditis	108	
Cases of threatened or probable endocarditis .	76	
Cases in which there was no sign of endocarditis	79	
Total number of cases of acute rheumatism .	326	

[1] In two of those cases (59, 61) the evidence of pericarditis was slight and perhaps doubtful, but I am of opinion that in both of them the

I.—Sex, Age, and Occupation in Acute Rheumatism in especial relation to Pericarditis.

Sex.—Acute rheumatism affected the female sex somewhat more frequently than the male sex in the proportion of 168 to 158.

Pericarditis attacked 35 male and 28 female patients, so that nearly one in four of the former (35 in 154), and only one in six of the latter (28 in 166) were affected by it. Endocarditis was also present in 31 of the male and 23 of the female patients affected with pericarditis.

Simple endocarditis, on the other hand, attacked 47 male and 61 female patients, while, in addition, endocarditis was threatened or probable in 32 male and 41 female patients.

The cause of the greater proportional frequency of pericarditis, usually accompanied by endocarditis, in the male sex, and of simple endocarditis in the female sex in these cases, will, I think, be in part explained by the influence of age and occupation on acute rheumatism and its complications.

Age.—One-half of the male (17 in 34)[1] and more than one-half of the female patients (17 in 27)[1] affected with pericarditis, were below the age of 21: while two-fifths of the male (13 in 34) and only one-seventh of the female patients (4 in 27) were above the age of 25.

If we group these two classes of cases separately in relation to age, and compare them with each other, we find that acute rheumatism attacked 70 male and 77 female patients *below the age of* 21, and that of these 17 of each sex were affected

affection existed, though in a slight and transient form. The numbers thus given here and elsewhere refer to the individual cases of pericarditis as they occur in my records, so that the reader may trace for himself each of the cases as it appears from part to part of this analysis.

[1] The age of one of the 35 male patients and that of one of the 28 female patients was not stated.

with pericarditis, combined with endocarditis in all but one or two cases, and 25 of the males and 32 of the females with simple endocarditis ; that in 12 of the males and 20 of the females endocarditis was threatened or probable, and that in 15 of the males and in only 8 of the females there was no sign of inflammation of the heart, within or without.

On the other hand, we find that acute rheumatism affected 53 men and 53 women *above the age of* 25, and that of these 13 men (13 in 53 or one-fourth) and only 4 women (4 in 53 or one-thirteenth) were affected with pericarditis which was usually accompanied by endocarditis, and 13 men and 17 women with simple endocarditis ; that in 11 men and 11 women endocarditis was threatened or probable ; and that the residue, or 16 men and 21 women, gave no sign of inflammation of the heart.

The accompanying Table shows the proportion in which endocarditis and pericarditis were absent or present in the cases of acute rheumatism, and the influence of age and sex in the proportionate production of those affections of the heart in that disease.

	No Endocarditis.			Endocarditis threatened or probable.									Endocarditis.			Pericarditis.			Total.		
				Threatened.			Probable.			Total.											
Male . .
Female .	42 / 37 } 79			26 / 37 } 63			8 / 5 } 13			34 / 42 } 76			47 / 61 } 108			35 / 28 } 63			158 / 168 } 326		
Ages.	Male.	Female.	Total.	Male.	Female.	Total.	Male.	Female.	Total.	Male.	Female.	Total.	Male.	Female.	Total.	Male.	Female.	Total.	Male.	Female.	Total.
10 to 15	5	3	8	2	1	3	0	1	1	2	2	4	10	9	19	6	3	9	23	17	40
16 to 20	11	5	16	9	14	23	1	4	5	10	18	28	15	23	38	11	14	25	47	60	107
21 to 25	10	8	18	6	9	15	4	0	4	10	9	19	8	11	19	4	6	10	32	34	65
26 to 30	8	13	21	3	5	8	2	0	2	5	5	10	8	6	14	5	1	6	26	25	51
31 to 40	5	4	9	6	5	11	0	0	0	6	5	11	4	10	14	6	2	8	21	21	42
41 to 50	3	3	6	0	1	1	0	0	0	0	1	1	1	0	1	2	0	2	6	4	10
51 and –	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	3	3
? . . .				0	2	2	1	0	1	1	2	3	1	1	2	1	1	2	3	4	7
Total .	42	37	79	26	37	63	8	5	13	34	42	76	47	61	108	35	28	63	158	168	326

We thus see that in these cases of acute rheumatism, inflammation of the heart, grouping together those in which it attacked the interior and the exterior of the organ, affected the young below 21 (91 in 147) more frequently than the adult above 25 (47 in 106); that the heart was more frequently free from signs of inflammation in the adult above 25 (37 in 106), and especially in women (21 in 53), than in the young below 21 (24 in 147), and especially in girls (8 in 77); that endocarditis was threatened or probable as often in the young below 21 (32 in 147) as in the adult above 25 (22 in 106); and, this being the point to which I would especially call attention, that pericarditis—while it affected the two sexes in nearly equal proportions below the age of 21, the male patients (17 in 70) a little more frequently than the female patients (17 in 77)—attacked men above the age of 25 (13 in 53) three times more frequently than women above that age (5 in 53).

Occupation.—The study of the influence of occupation on the occurrence of acute rheumatism and on the production of inflammation of the heart, both outside and in, throws light in two directions, one on the influence of sex, the other on that of age in producing those affections.

The accompanying Tables show (I. pages 246—9) the influence of occupation in acute rheumatism in relation to age; the presence or absence of endocarditis and pericarditis; the degree of the affection of the joints, and that of the heart: and (II. pages 250—53), for the sake of comparison, of ages (1) of 1,000 patients, taken consecutively, with an occasional break, from my hospital books, affected with all other internal diseases besides acute rheumatism and acute gout, and (2) of 326 cases of acute rheumatism with its attendant pericarditis and endocarditis, in relation to occupation.

I take female domestic servants first, since they formed nearly one-third (101 in 326) of the whole number of those

ACUTE

TABLE I. (*See p.* 245).—OCCUPATION IN RELATION TO AGE, THE DEGREE

Male Patients.	Patients in whom: There was no indication of Endocarditis. Number. Years.	Joint affection.	Endocarditis was threatened or probable. Number. Years.	Joint affection.
Out-of-door Employments. Engaged in *laborious employments in the open air*, including labourers (17), gardeners (5), bricklayer, brickmaker, sawyer (in twice), mason, dustman, carter, plasterer. seaman, smiths (4), butchers (6), carpenters (4)	9 { 2 æt. 20 1 " 24 2 " 26 to 27 2 " 32 " 37 2 " 42 " 46	1 + 6 — + 2, O +	11 { 3 æt. 20 4 " 22 to 25 1 " 26 " 29 3 " 31 " 38	6 + 4 — + 1 O, +
Engaged in *employments chiefly on foot, in the open air*, including porters (4), watchman, errand boys (4), milkmen (2), hawker, cowkeeper, out of work — "on tramp" (1)	7 { 2 æt. 10 to 12 3 " 16 " 20 1 " 28 1 " 38	1 + 3 — + 1, O + 1 — 1 ?	2 { 1 " 14 1 " 21	2 — +
Employed *with horses and in stables*, including grooms (6), riding-master, horsekeeper, coachmen (9), cabmen (5)	7 { 2 æt. 19 1 " 23 2 " 26 1 " 38 1 " 43	3 + 4 — +	7 { 4 " 16 " 19 2 " 21 " 24 1 " 27	4 + 3 — +
TOTAL of those employed in the above laborious *out-of-door* employments . .	23 { 2 æt. 10 to 12 7 " 16 " 20 2 " 23 " 24 5 " 26 " 28 4 " 32 " 38 3 " 42 " 46	5 + 13 — + 3 O + 1 — 1	20 { 1 " 14 7 " 16 " 20 7 " 21 " 25 2 " 26 " 29 3 " 31 " 38	10 + 9 — + 1, O +
Painters (3), plumber, gas-fitter. .	2 { 1 æt. 17 1 " 26	1 — + 1 O +	2 { 1 " 16 1 " 21	1 + 1 — +
Commercial traveller	...	...	...	...
In-door Employments. Including servants (12), bakers (3), paperhanger, french-polishers (4), boot and shoemakers (3), "shopman," greengrocer, drapers (4), cheesemonger, slop-cutter, tailor, teacher, silversmith, chair-maker, bath attendant, and 2 others . .	7 { 1 æt. 14 2 " 16 to 18 2 " 25 2 " 27 " 28	3 + 2 — + 1, O + 1 —	9 { 2 " 19 1 " 25 3 " 29 3 " 33 " 37	1 + + 4 + 4 — +
Waiters (6), potmen and barmen (5)	8 { 1 æt. 19 6 " 21 to 23 1 " 40	2 + 5 — + 1, O +	1 " 21	1 — +
Schoolboys (5)	...	...	...	...
Had no employment, including one discharged from the navy (12). .	2 æt. 14 to 15	1 — + 1 —	2 { 1 " 14 1 not stated	1 + 1 —
Occupation not stated	...	...	...	...

RHEUMATISM.

OF JOINT AFFECTION AND THAT OF HEART AFFECTION.

Patients in whom there was							
Simple Endocarditis.		Pericarditis, usually with Endocarditis (54 in 63).			Total		
Number. Years.	Jt. aff.	Number. Years	Jt. aff.	Hrt. aff.	Number. Years.	Joint affection.	
15 { 6 æt. 16 to 20 4 ,, 21 ,, 24 3 ,, 26 ,, 29 2 ,, 35 ,, 38	10 + 5 — +	10 { 1 æt. 17 to 19 1 ,, 22 ,, 24 4 ,, 27 ,, 28 3 ,, 31 ,, 39 1 ,, 42	4 + + 4 + 2 — +	♡ 1 ⬭ 3 + + 2 + 3 — + 1 ○ +	45 { 12 æt. 17 to 20 10 ,, 21 ,, 24 10 ,, 26 ,, 30 10 ,, 31 ,, 40 3 ,, 42 ,, 46	4 very severe 21 severe 17 rather severe 3 not severe	+ + + — + ○ +
3 { 1 ,, 12 1 ,, 17 1 ,, 22	1 + 1, ○ + 1 —	2 { 1 ,, 17 1 ,, 25	1 + 1 ○ +	♡ 2 +	14 { 4 ,, 10 ,, 14 5 ,, 16 ,, 20 3 ,, 22 ,, 25 1 ,, 28 1 ,, 38	3 severe 5 rather severe 3 not severe 2 slight 1 doubtful	+ — + ○ + — ?
8 { 3 ,, 18 ,, 20 2 ,, 21 1 ,, 26 1 ,, 33 ,, 38 1 ,, 42	2 + 5 — + 1, ○ +	1 ,, 22	1 +	♡ 1 +	23 { 9 ,, 16 ,, 20 6 ,, 21 ,, 24 4 ,, 26 ,, 28 2 ,, 33 ,, 38 2 ,, 42 ,, 43	10 severe 12 rather severe 1 not severe	+ — + ○ +
26 { 1 ,, 12 10 ,, 16 ,, 20 7 ,, 21 ,, 24 4 ,, 26 ,, 29 3 ,, 33 ,, 38 1 ,, 42	13 + 10 — + 2, ○ + 1 —	13 { 2 ,, 17 ,, 19 3 ,, 22 ,, 25 4 ,, 27 ,, 28 3 ,, 31 ,, 39 1 ,, 42	4 + + 6 + 2 — + 1 ○ +	♡ 1 ⬭ 3 + + 5 + 3 — + 1 ○ +	82 { 4 ,, 10 ,, 15 26 ,, 16 ,, 20 19 ,, 21 ,, 25 15 ,, 26 ,, 30 13 ,, 31 ,, 40 5 ,, 41 ,, 46	4 very severe 34 severe 34 rather severe 7 not severe 2 slight 1 doubtful	+ + + — + ○ + — ?
...	...	1 ,, 35	1 + +	♡ 1 +	5 { 2 ,, 16 ,, 18 1 ,, 21 1 ,, 26 1 ,, 35	1 very severe 1 severe 2 rather severe 1 not severe	+ + + — + ○ +
...	...	1 ,, 18	1 +	♡ 1 + +	1 ,, 18	1 severe	+
9 { 5 ,, 18 ,, 19 1 ,, 22 2 ,, 29 ,, 30 1 ,, 38	4 + 3 — + 2, ○ +	13 { 2 ,, 14 8 ,, 17 ,, 20 1 ,, 23 1 ,, 38 1 ,, 50	6 + 4 — + 2 ○ + 1 —	♡ 1 ⬭ 2 + + 4 + 4 — + 2 ○ + 1 —	38 { 3 ,, 14 17 ,, 16 ,, 20 5 ,, 21 ,, 25 7 ,, 27 ,, 30 5 ,, 33 ,, 38 1 ,, 50	1 very severe 17 severe 13 rather severe 5 not severe 2 slight	+ + + — + ○ + —
2 ,, 27 ,, 30	1 — + 1 ○ +	1 ,, 39	1 +	♡ 1 — +	12 { 1 ,, 19 7 ,, 21 ,, 23 2 ,, 27 ,, 30 1 ,, 39 1 ,, 40	3 severe 7 rather severe 2 not severe	+ — + ○ +
3 ,, 9 ,, 15	2 — + 1 ○ +	2 ,, 11 ,, 15	1 — + 1 ○ +	♡ 1 + 1 — +	5 ,, 9 ,, 15	3 rather severe 2 not severe	— + ○ +
6 ,, 9 ,, 15	3 + 3 — +	2 ,, 14 ,, 15	2 — +	♡ 1 — + 1 —	12 { 11 ,, 9 ,, 15 1 not stated	4 severe 6 rather severe 2 slight	+ — + —
1 not stated	1 — +	2 { 1 ,, 26 1 not stated	2 — +	♡ 1 + 1 — +	3 { 1 ,, 26 2 not stated	3 rather severe	— +

TABLE I. (*cont.*), ACUTE

Female Patients.	Patients in whom: There was no indication of Endocarditis. Number. Years.	Joint affection.	Endocarditis was threatened or probable. Number. Years.	Joint affection.
Active In-door Employments. Servants	13 { 3 æt. 19 to 20 4 ,, 21 ,, 25 6 ,, 26 ,, 30	4 + 5 — + 4 O +	26 { 1 æt. 15 14 ,, 16 to 20 4 ,, 22 ,, 23 3 ,, 26 ,, 30 3 ,, 31 ,, 40 1 not stated	9 + 11 — + 6 O +
Cooks (5), charwomen (2), nurses (5), laundresses (9), washerwoman	6 { 2 æt. 26 to 28 1 ,, 36 2 ,, 42 ,, 50 1 ,, 52	2 + 1 — + 3 O +	7 { 3 ,, 19 ,, 20 2 ,, 21 ,, 24 1 ,, 26 1 ,, 40	3 + 4 — +
Sedentary In-door Employments. Needlewomen (3), milliners, dress-makers (3), tailoress, shoebinder, shoemaker	4 { 1 æt. 20 2 ,, 26 1 ,, 49	1 + 2 — + 1 O +	1 ,, 44	1 — +
Kept a stall	...	—	1 ,, 21	1 +
Married women, without special occupation, including two widows	8 { 3 æt. 25 2 ,, 28 to 30 3 ,, 36 ,, 40	4 + 2 — + 2 O +	5 { 2 ,, 25 1 ,, 30 1 ,, 32 1 not stated	2 + 3 — +
Of no occupation	5 { 3 æt. 13 to 15 1 ,, 16 1 ,, 25	1 + 1 — + 2 O + 1 —	2 { 1 ,, 6 1 ,, 18	1 + 1 — +
Occupation not stated	1 æt. 29	1 — +	...	...
Male Patients. TOTAL .	42 { 5 æt. 10 to 15 11 ,, 16 ,, 20 10 ,, 21 ,, 25 8 ,, 26 ,, 30 5 ,, 31 ,, 40 3 ,, 41 ,, 46	10 + 22 — + 6 O + 3 — 1 ?	34 { 2 ,, 14 10 ,, 16 ,, 20 10 ,, 21 ,, 25 5 ,, 26 ,, 30 6 ,, 31 ,, 38 1 not stated	1 + + 16 + 15 — + 1, O + 1 —
Female Patients. TOTAL	37 { 3 æt. 13 to 15 5 ,, 16 ,, 20 8 ,, 21 ,, 25 13 ,, 26 ,, 30 4 ,, 31 ,, 40 3 ,, 42 ,, 50 1 ,, 52	12 + 12 — + 12, O + 1 —	42 { 2 ,, 6 ,, 15 18 ,, 16 ,, 20 9 ,, 22 ,, 25 5 ,, 26 ,, 30 5 ,, 31 ,, 40 1 ,, 44 2 not stated	16 + 20 — + 6, O +
GRAND TOTAL of the Male and Female Patients . . .	79 { 8 æt. 10 to 15 16 ,, 16 ,, 20 18 ,, 21 ,, 25 21 ,, 26 ,, 30 9 ,, 31 ,, 40 6 ,, 41 ,, 50 1 ,, 52	22 + 34 — + 18, O + 4 — 1 ?	76 { 4 ,, 6 ,, 14 28 ,, 16 ,, 20 19 ,, 21 ,, 25 10 ,, 26 ,, 30 11 ,, 31 ,, 40 1 ,, 44 3 not stated	1 + + 32 + 35 — + 7, O + 1 —

4 of these cases died.

RHEUMATISM—(*continued*).

Patients in whom there was						
Simple Endocarditis.		Pericarditis, usually with Endocarditis (54 in 68).			Total	
Number. Years.	Jt. aff.	Number. Years.	Jt. aff.	Hrt. aff	Number. Years.	Joint affection.
43 { 4 æt. 12 to 15 21 ,, 16 ,, 20 10 ,, 21 ,, 25 4 ,, 26 ,, 30 3 ,, 31 ,, 40 1 ,, 55	2 + + 19 + 13 — + 7 O + 1 — 1 ?	19 { 1 æt. 15 13 ,, 16 to 20 4 ,, 21 ,, 25 1 ,, 26	6 + + 9 + 3 — + 1 O +	♡ 2 ⊂⊃ 8 + + 6 + 2 — + 1, O +	101 { 6 æt. 12 to 15 51 ,, 16 ,, 20 22 ,, 21 ,, 25 14 ,, 26 ,, 30 6 ,, 31 ,, 40 1 ,, 55 1 not stated	8 very severe + + 41 severe + 32 rather severe — + 18 not severe O + 1 slight — 1 doubtful ?
4 { 1 ,, 21 1 ,, 27 2 ,, 33 ,, 40	2 + 2 —	5 { 1 ,, 20 1 ,, 21 1 ,, 35 1 ,, 60 1 not stated	1 + 2 — + 1 O — 1 ?	1 + 2 — + 1 O + 1 —	22 { 4 ,, 19 ,, 20 4 ,, 21 ,, 25 4 ,, 26 ,, 30 5 ,, 31 ,, 40 2 ,, 42 ,, 50 2 ,, 52 ,, 60 1 not stated	8 severe + 9 rather severe — + 4 not severe O + 1 doubtful ?
4 { 1 ,, 18 3 ,, 31 ,, 38	3 — + 1 O +	...	...	...	9 { 2 ,, 18 ,, 20 2 ,, 26 3 ,, 31 ,, 38 2 ,, 44 ,, 49	1 severe + 6 rather severe — + 2 not severe O +
1 ,, 33	1 +	...	...	...	2 { 1 ,, 21 1 ,, 33	2 severe +
2 { 1 ,, 30 1 ,, 40	1 + 1 — +	2 { 1 ,, 24 1 ,, 34	1 + + 1 — +	♡ 1 + 1 —	17 { 6 ,, 24 ,, 25 4 ,, 28 ,, 30 6 ,, 34 ,, 40 1 not stated	1 very severe + + 7 severe + 7 rather severe — + 2 not severe O +
7 { 5 ,, 13 ,, 15 1 ,, 18 1 not stated	3 + 3 — + 1 O +	2 ,, 13 ,, 14	1 + 1 —	1 + + 1 —	16 { 11 ,, 6 ,, 15 3 ,, 16 ,, 20 1 ,, 25 1 not stated	6 severe + 6 rather severe — + 3 not severe O + 1 slight —
...	...	...	...	...	1 ,, 29	1 rather severe — +
47 { 10 æt. 9 to 15 15 ,, 16 ,, 20 8 ,, 21 ,, 25 8 ,, 26 ,, 30 4 ,, 33 ,, 38 1 ,, 42 1 not stated	20 + 20 — + 6 O + 1 —	35 { 6 ,, 11 ,, 15 11 ,, 16 ,, 20 4 ,, 22 ,, 25 5 ,, 27 ,, 28 6 ,, 31 ,, 39 2 ,, 41 ,, 50 1 not stated	5 + + 14 + 11 — + 4 O + 1 —	♡ 2 ⊂⊃ 6 + + 12 + 11 — + 2 O + 2 —	158 { 23 ,, 9 ,, 15 47 ,, 16 ,, 20 32 ,, 21 ,, 25 26 ,, 26 ,, 30 21 ,, 31 ,, 40 6 ,, 41 ,, 50 3 not stated	6 very severe + + 60 severe + 68 rather severe — + 17 not severe O + 6 slight — 1 doubtful ?
61 { 9 ,, 12 ,, 15 23 ,, 16 ,, 20 11 ,, 21 ,, 25 6 ,, 26 ,, 30 10 ,, 31 ,, 48 1 ,, 55 1 not stated	2 + + 26 + 22 — + 9, O + 1 — 1 ?	28 { 3 ,, 13 ,, 14 14 ,, 16 ,, 20 6 ,, 21 ,, 25 1 ,, 26 2 ,, 34 ,, 35 1 ,, 60 1 not stated	7 + + 11 + 7 — + 2 O + 1 ?	2 ⊂⊃ 9 + + 9 + 4 — + 2 O + 1 — 1 ?	168 { 17 ,, 6 ,, 15 60 ,, 16 ,, 20 34 ,, 21 ,, 25 25 ,, 26 ,, 30 21 ,, 31 ,, 40 4 ,, 42 ,, 50 3 ,, 52 ,, 60 4 not stated	9 very severe + + 65 severe + 61 rather severe — + 29 not severe O + 2 slight — 2 doubtful ?
108[1] { 19 ,, 9 ,, 15 38 ,, 16 ,, 20 19 ,, 21 ,, 25 14 ,, 26 ,, 30 14 ,, 31 ,, 41 1 ,, 42 1 ,, 55 2 not stated	2 + + 46 + 42 — + 15, O + 2 — 1 ?	63[2] { 9 ,, 11 ,, 15 25 ,, 16 ,, 20 10 ,, 21 ,, 25 6 ,, 26 ,, 30 8 ,, 31 ,, 40 2 ,, 41 ,, 50 1 ,, 60 2 not stated	12 + + 25 + 18 — + 6 O + 1 — 1 ?	4 ⊂⊃ 15 + + 21 + 15 — + 4 O + 3 — 1 ?	326 { 40 ,, 6 ,, 15 107 ,, 16 ,, 20 66 ,, 21 ,, 25 51 ,, 26 ,, 30 42 ,, 31 ,, 40 10 ,, 41 ,, 50 3 ,, 55 ,, 60 7 not stated	15 very severe + + 125 severe + 129 rather severe — + 46 not severe O + 8 slight — 3 doubtful ?

[1] 1 of these cases died. [2] 5 of these cases died (1 from Bright's disease).

TABLE

Ages of (*I.*) 1,000 *Patients affected with all other Internal Diseases except Acute Rheumatism Pericarditis and Endocarditis; and* (*III.*) 58 *Patients*

Male Patients.		Below the Age of 21 Years.	From 21 to 25 Years.
Workers out of doors. Laborious employments	Other diseases except acute rheumatism and acute gout	21, or 10 per cent. of those whose ages are stated.	31, or 15 per cent.
	Acute rheumatism	12, or 26·6 per cent.	10, or 22·2 per cent.
	Ditto with pericarditis	1, *or* 8 3 *per cent. at that age.*[1] 1, *or* 10 *per cent. of whole.*[2]	1, *or* 10 *per cent. at that age.* 1, *or* 10 *per cent. of whole.*
	Do. with simple endocarditis	6, *or* 50 *per cent. at that age.* 6, *or* 40 *per cent. of whole.*	4, *or* 40 *per cent. at that age.* 4, *or* 27 *per cent. of whole.*
	Acute gout	0	2
Workers on foot	Other diseases except acute rheumatism and acute gout	6, or 17·7 per cent.	4, or 11·7 per cent.
	Acute rheumatism	9, or 64 per cent.	3, or 21·4 per cent.
	Pericarditis	1, *or* 11 *per cent. at that age.* 1, *or* 50 *per cent. of whole.*	1, *or* 33·3 *per cent. at that age* 1, *or* 50 *per cent. of whole.*
	Endocarditis	2, *or* 22 *per cent. at that age.* 2, *or* 66·7 *of whole.*	1, *or* 33·3 *per cent. at that age.* 1, *or* 33·3 *per cent. of whole.*
	Acute gout	0	0
Workers among horses	Other diseases except acute rheumatism and acute gout	1, or 1·5 per cent.	4
	Acute rheumatism	9, or 39 per cent.	6, or 26 per cent.
	Pericarditis	0	1, *or* 16·6 *per cent. at that age.* 1, *or* 100 *per cent. of whole.*
	Endocarditis	3, *or* 33·3 *per cent. at that age.* 3, *or* 37·2 *per cent. of whole.*	2, *or* 30 9 *per cent. at that age.* 2, *or* 25 *per cent. of whole.*
	Acute gout	0	1
Painters, plumbers	Other diseases besides acute rheumatism and acute gout	2, or 5 per cent.	9, or 22 per cent.
	Acute rheumatism	2, or 40 per cent.	1, or 20 per cent.
	Pericarditis	0	0
	Endocarditis	0	0
	Acute gout	0	0
In-door employments	Other diseases besides acute rheumatism and acute gout	20, or 16 3 per cent.	20, or 16·3 per cent.
	Acute rheumatism	20, or 52·5 per cent.	5, or 13·5 per cent.
	Pericarditis	10, *or* 50·6 *per cent. at that age.* 10, *or* 77 *per cent. of whole.*	1, *or* 20 *per cent. at that age.* 1, *or* 7·7 *per cent. of whole.*
	Endocarditis	5, *or* 25 *per cent. at that age.* 5, *or* 55·2 *per cent. of whole.*	1, *or* 20 *per cent. at that age.* 1, *or* 11 *per cent. of whole.*
	Acute gout	0	2
Waiters, barmen, and one commercial traveller	Other diseases besides acute rheumatism and acute gout	2, or 16·6 per cent.	2, or 16·6 per cent.
	Acute rheumatism	2, or 15·3 per cent.	7, or 54·1 per cent.
	Pericarditis	1, *or* 50 *per cent. at that age.* 1, *or* 50 *per cent. of whole.*	0
	Endocarditis	0	0
	Acute gout	0	0
Of no occupation and at school	Other diseases except acute rheumatism, &c.	37, or 100 per cent.	0
	Acute rheumatism	16, or 100 per cent.	0
	Pericarditis	4, *or* 25 *per cent. at that age.*	0
	Endocarditis	9, *or* 56·6 *per cent. at that age.*	0
Total of Male Patients	Other diseases except acute rheumatism and acute gout	89, or 17 per cent.	70, or 13·4 per cent.
	Acute rheumatism	70, or 45 per cent.	32, or 20·8 per cent.
	Pericarditis	17, *or* 24·3 *per cent. at that age.* 17, *or* 51·5 *per cent. of whole.*	4, *or* 12 *per cent. at that age.* 4, *or* 12 *per cent. of whole.*
	Endocarditis	25, *or* 35 7 *per cent. at that age.* 25, *or* 54·3 *per cent. of whole.*	8, *or* 24·2 *per cent. at that age.* 8, *or* 17·4 *per cent. of whole.*
	Acute gout	0	5

[1] Here and elsewhere in these columns add after "age" of those with acute rheumatism who were so affected and who were engaged in the class of employments indicated in the column headed "Male Patients."

[2] Here and elsewhere in these columns "whole" applies to the whole number of all ages of those with acute

II. (*see p.* 245).

and Acute Gout; and (*II.*) 326 *Patients affected with Acute Rheumatism, with its attendant affected with Acute Gout, in relation to Occupation.*

Above 25 Years.	Age and Occupation not stated.	Total.	
155, or 75 per cent.	Age not stated 14	221	Or {40·4 per cent. of the males. 22·1 per cent of the whole.[3]
23, or 51 per cent.	... ...	45	Or {29 per cent. of the males. 14 per cent. of the whole.
8, *or* 35 *per cent. at that age.* 8, *or* 80 *per cent. of whole.*	... ...	10	{*Or* 22 *per cent. of those with acute rheumatism.*
5, *or* 21 *per cent. at that age.* 5, *or* 33 *per cent. of whole.*	... ...	15	{*Or* 33·3 *per cent. of those with acute rheumatism.*
13	... ...	15	
24, or 70·6 per cent.	 4	38	Or {6·9 per cent. of the males. 3·8 per cent. of the whole.
2, or 14·3 per cent.	... ...	14	Or {9 per cent. of the males. 4·3 per cent. of the whole
0	... ...	2	{*Or* 14 *per cent. of those with acute rheumatism.*
0	... ...	3	{*Or* 21·4 *per cent. of those with acute rheumatism.*
2	... ...	2	
61, or 93 per cent.	 3	69	Or {12·6 per cent. of the males. 6·9 per cent. of the whole.
8, or 35 per cent.	... ...	23	Or {14·8 per cent. of the males. 7·1 per cent. of the whole.
0	... ...	1	{*Or* 4·3 *per cent. of those with acute rheumatism.*
3, *or* 37 *per cent. at that age.* 3, *or* 37·5 *per cent. of the whole.*	... ...	8	{*Or* 35 *per cent. of those with acute rheumatism.*
14	... ...	15	
30, or 73 per cent.	... ...	41	Or {9·5 per cent. of the males. 4·1 per cent. of the whole.
2, or 40 per cent.	... ...	5	Or {3·2 per cent. of the males. 1·5 per cent. of the whole,
1, *or* 50 *per cent. at that age.*	... ...	1	*Or* 20 *per cent. of those with ac. rh.*
0	... ...	0	
4	... ...	4	
83, or 67·4 per cent.	 6	129	Or {23·6 per cent. of the males. 12·9 per cent. of the whole.
13, or 34 per cent.	... ...	38	Or {24·5 per cent. of the males. 11·4 per cent. of the whole.
2, *or* 15·3 *per cent. at that age.* 2, *or* 15·3 *per cent. of whole.*	... ...	13	{*Or* 35 *per cent. of those with acute rheumatism.*
3, *or* 23 *per cent. at that age.* 3, *or* 33·3 *per cent. of whole.*	... ...	9	{*Or* 24·3 *per cent. of those with acute rheumatism.*
11	... ...	13	
8, or 66·6 per cent.	... ...	12	Or {2·2 per cent. of the males. 1·2 per cent. of the whole.
4, or 30·6 per cent.	... ...	13	Or {8·4 per cent. of the males. 4 per cent. of the whole.
{1, *or* 25 *per cent. at that age.* 1, *or* 50 *per cent. of whole*	... ...	2	{*Or* 8·3 *per cent. of those with acute rheumatism.*
{2, *or* 50 *per cent. at that age.* 2, *or* 100 *per cent. of whole.*	... ...	2	{*Or* 16·6 *per cent. of those with rheumatism.*
3	... ...	3	
0	... ...	38	Or {6·9 per cent. of the males. 3·8 per cent. of the whole.
0	 1	17	Or {11 per cent. of the males. 5·3 per cent. of the whole.
0	... ...	4	*Or* 24 *per cent. of those with ac. rh.*
0	... ...	9	*Or* 53 *per cent. of those with ac. rh.*
361, or 69·4 per cent.	Age not stated 27	547	
{52, or 33·7 per cent. + 1 occupation not stated.	{Age (?) 1 + 2 occ. not stated}	{155 + 3 occ. not stated}	
12, *or* 25 *per cent. at that age* 12, *or* 36·3 *per cent of whole.*	{*Age* (?) 1 + 1 *occ. not stated*}	{33 + 2 *occ. not stated*}	
13, *or* 25 *per cent. at that age* 13, *or* 28·2 *per cent. of whole.*	{*Age* (?) *and occ. not stated* 1}	{46 + 1 *occ. not stated*}	
47, + 1 occupation not stated.	{*Age* (?) — 3 *occ. not stated*}	52	

rheumatism whose ages were stated, and who were so affected, who were engaged in the class of occupations indicated in the column headed "Male Patients."

[3] Here and elsewhere in this column "whole" applies to the whole number of patients of both sexes.

TABLE II.

Female Patients.		Below the Age of 21 Years.	From 21 to 25 Years.
Servants	Other diseases except acute rheumatism	64. or 32·8 per cent. of those whose ages are stated.	60, or 30·8 per cent.
	Acute rheumatism	57, or 57 per cent.	22, or 22 per cent.
	Pericarditis	14, *or* 24·5 *per cent at that age.*[1] 14, *or* 73·7 *per cent. of the whole*[2]	4, *or* 18·2 *per cent. at that age.* 4, *or* 22·2 *per cent of the whole.*
	Endocarditis	25, *or* 44 *per cent. at that age.* 25, *or* 58·5 *per cent. of whole.*	10, *or* 45·5 *per cent. at that age.* 10, *or* 23·2 *per cent. of the whole.*
Other in-door active employments	Other diseases except acute rheumatism	1, or 1·4 per cent.	9, or 12·5 per cent.
	Acute rheumatism	4, or 18·2 per cent.	4, or 18·2 per cent.
	Pericarditis	0	1, *or* 25 *per cent at that age.* 1, *or* 25 *per cent. of the whole.*
	Endocarditis	0	1, *or* 25 *per cent.*
	Acute gout	0	0
Sedentary in-door employments	Other diseases except acute rheumatism	1, or 2·7 per cent.	5, or 13·8 per cent.
	Acute rheumatism	2, or 22·3 per cent.	0
	Pericarditis	0	0
	Endocarditis	1, *or* 50 *per cent. at that age.* 1, *or* 25 *per cent. of whole.*	0
Married women without special employment	Other diseases except acute rheumatism	3, or 4·3 per cent.	9, or 12·6 per cent.
	Acute rheumatism	0	6, or 37·5 per cent.
	Pericarditis	0	1, *or* 16·6 *per cent. at that age.* 1, *or* 50 *per cent. of the whole.*
	Endocarditis	0	
Out-of-door employment. Kept a stall	Other diseases except acute rheumatism	0	0
	Acute rheumatism	0	1, or 50 per cent.
	Pericarditis	0	0
	Endocarditis	0	0
Of no occupation, including girls at school	Other diseases except acute rheumatism	57, or 100 per cent.	0
	Acute rheumatism	14, or 93 per cent.	1, or 7 per cent.
	Peri arditis	2, *or* 14·4 *per cent. at that age.*	0
	Endocarditis	6, *or* 43 *per cent. at that age.*	0
TOTAL of FEMALE PATIENTS	Other diseases except acute rheumatism and acute gout	126, or 29 per cent.	83, or 19 per cent.
	Acute rheumatism	77, or 47·2 per cent.	34
	Pericarditis	17, *or* 22 *per cent. at that age.* 17, *or* 63·3 *per cent. of the whole.*	6, *or* 17·6 *per cent. at that age.* 6, *or* 22·2 *per cent. of the whole.*
	Endocarditis	32, *or* 41·5 *per cent. at that age.* 32, *or* 53·3 *per cent. of the whole.*	11, *or* 32·3 *per cent. at that age.* 11, *or* 18·3 *per cent. of the whole.*
	Acute gout	0	0
GRAND TOTAL of MALE and FEMALE PATIENTS	Other diseases except acute rheumatism and acute gout	215, or 22·5 per cent. of the whole with ages stated	153, or 16 per cent. of whole, with ages stated.
	Acute rheumatism	147, or 46·7 per cent.	66, or 20·8 per cent.
	Pericarditis	34, *or* 33 *per cent. at that age.* 34, *or* 56·6 *per cent. of the whole.*	10, *or* 15 *per cent. at that age.* 10, *or* 16·6 *per cent. of the whole.*
	Endocarditis	57, *or* 38·8 *per cent. at that age.* 57, *or* 53 *per cent. of the whole.*	19, *or* 28·8 *at that age.* 19, *or* 18 *per cent. of the whole.*
	Acute gout	0	5

[1] Here and elsewhere in these columns add after "age" of those with acute rheumatism who were so affected, and who were engaged in the class of employments indicated in the column headed "Male Patients."
[2] Here and elsewhere in these columns "whole" applies to the whole number of all ages of those with acute

—(*continued.*)

Above 25 Years.	Age and Occupation not stated.	Total.	
71, or 36·4 per cent.	Age not stated 9	204	Or {42 per cent. of the females. 20·4 per cent. of the whole.[3]}
21, or 21 per cent.	 1	101	Or {60·5 per cent of the females. 31·3 per cent. of the whole.}
1, *or* 4·7 *per cent. at that age.* 1, *or* 5·2 *per cent of whole.*	... ...	19	*Or* 18·8 *per cent. of those with acute rheumatism.*
8, *or* 38 *per cent. at that age.* 8, *or* 18 *per cent. of whole.*	... ...	43	*Or* 42·5 *per cent. of those with acute rheumatism.*
62, or 86·1 per cent.	 5	77	Or {15 per cent. of the females. 7·7 per cent. of the whole.}
13, or 62 per cent.	 1	22	Or {13·7 per cent. of the females. 6·8 per cent. of the whole.}
3, *or* 37·7 *per cent. at that age.* 3, *or* 75 *per cent. of whole.*	 1	5	*Or* 22·7 *per cent. of those with acute rheumatism.*
3, *or* 75 *per cent.*	... ...	4	*Or* 18 *per cent. of those with acute rheumatism.*
3	... ...	3	
31, or 84·5 per cent.	 1	38	Or {8·4 per cent. of the females. 3·8 per cent. of the whole.}
7, or 77·7 per cent.	... ...	9	Or {5·4 per cent. of the females. 2·8 per cent. of the whole.}
0	... ...	0	
3, *or* 43 *per cent. at that age.* 3, *or* 75 *per cent. of whole.*	... ...	4	*Or* 44·4 *per cent. of those with acute rheumatism.*
59, or 83 per cent.	 4	75	Or {16·3 per cent. of the females. 7·5 per cent. of the whole.}
10, or 62·5 per cent.	 1	17	Or {10·2 per cent. of the females. 5·3 per cent. of the whole.}
1, *or* 10 *per cent. at that age.* 1, *or* 50 *per cent. of whole.*	... ...	2	*Or* 11·8 *per cent. of those with acute rheumatism.*
2, *or* 20 *per cent. at that age.* 2, *or* 100 *per cent. of whole.*	... ...	2	*Or* 11·8 *per cent. of those with acute rheumatism.*
2, or 100 per cent.	... ...	2	Or {0·4 per cent. of the females. 0·2 per cent. of the whole.}
1, or 50 per cent.	... ...	2	Or {1·2 per cent. of the females. 0·6 per cent. of the whole.}
0	... ...	0	
1, *or* 100 *per cent. at that age.*	... ...	1	*Or* 50 *per cent. of those with ac. rh.*
0	... ...	57	Or {12·5 per cent. of the females. 5.7 per cent. of the whole.}
0	 1	16	Or {9·6 per cent. of the females. 5 per cent. of the whole.}
0	... ...	2	*Or* 12·5 *per cent. of those with ac. rh.*
0	 1	7	*Or* 44 *per cent. of those with ac. rh.*
225, or 51·8 per cent.	 19	453	
53 + 1 occupation not stated.	 3	167 + 1 occ. not stated	
4, *or* 7·5 *per cent. at that age.* 4, *or* 15 *per cent. of whole.*	 1	28	
17, *or* 32·7 *per cent. at that age.* 17, *or* 28·3 *per cent. of whole.*	 1	61	
3	... ...	3	
586, or 61·4 per cent. of those with ages stated.	 46	1,000	
104 + 2 occupation not stated, or 32·8 per cent.	Age (?) 5 + 2 occ. not stated	322 + 4 occ. not stated	
16 + 1 *occupation not stated, or* 15·4 *per cent. at that age, or* 26·6 *per cent. of the whole.*	*Age* (?) 1 + 2 *occ. not stated*	61 + 2 *occ. not stated*	
30, *or* 29·4 *per cent. at that age.* 30, *or* 28·3 *per cent. of whole.*	*Age* (?) 1 + 1 *occ. not stated*	107 + 1 *occ. not stated*	
50	Age and occ. not stated 3	55 + 3 occ. not stated	

rheumatism whose ages were stated, and who were so affected, who were engaged in the class of occupation indicated in the column headed "Male Patients."

[3] Here and elsewhere in this column "whole" applies to the whole number of patients of both sexes.

of both sexes, and nearly three-fifths of those of the female sex (101 in 168) who were affected with acute rheumatism. Among those patients affected with other diseases than acute rheumatism, female servants formed one-fifth of the whole number (204 in 1,000) and two-fifths of the female patients (204 in 453). Nearly two-thirds of the female patients affected with acute rheumatism were below the age of 21 (57 in 100), while of those affected with other diseases, only one-third were below that age (64 in 195, or 33 per cent). Table II. p. 252.

The influence of that employment in causing pericarditis and endocarditis in acute rheumatism, especially below the age of 21, is remarkable. Of the whole number of 101 servants only 13—one-eighth—presented no sign of inflammation of the heart, while one-fifth of them (19) were attacked with pericarditis, accompanied in all but one instance with endocarditis also, and two-fifths of them (43) with simple endocarditis, while in the remaining fourth part (26) endocarditis was either threatened or probable. Servants formed fully two-thirds of the whole of the female patients affected with pericarditis complicated usually with endocarditis (19 in 28), and with simple endocarditis (42 in 60) ; and three-fifths of those in whom endocarditis was threatened or probable (26 in 42) : while they formed only one-third of those who gave no sign of affection of the heart (13 in 37).

The influence of age in inducing inflammation of the heart in servants affected with acute rheumatism is still more remarkable. Of the whole number of servants (101) attacked with that disease, 57 were below the age of 21. In only 3 of these was there no mark of affection of the heart, but one-fourth of them (14) were attacked with pericarditis, all of whom had endocarditis also, and nearly one-half of them (25) with simple endocarditis, while endocarditis was either threatened or probable in the remaining 15. Three-fourths of the servants attacked with pericarditis and endocarditis (14 in 19) and three-fifths of those with simple endocarditis (26 in 42) were below the age of 21, while only one-fourth of those who were quite free from symptoms of heart affection were below that age (3 in 13).

Girls engaged in the hard labour of a servant, at work, at a tender age, from morning to night, when attacked with this disease, to which they are so subject, are all but certain to have inflammation of the heart without or within. Servant-girls below the age of 21, keeping in view their time of life and constitution, are more exposed to the causes of acute rheumatism and its attendant inflammation of the heart than persons of any other class. They are growing, their frame is not yet knit, they are sensitive to cold and wet, and they are subject to palpitation. Before all, in these young women their joints are not yet perfected, the ends of the bones forming them being still united to their shafts by cartilage; their growth is active so that the blood circulates in them freely; their structures are sensitive; and while they are supple, and their play is free and lively, they are tender and do not bear undue pressure; they are liable to strains, are unequal to labour and fatigue, and are easily affected by draughts, and by exposure to wet and cold, especially after undue and prolonged exertion. Then the labour of these poor girls, especially in hard places of service, is great and constant; they carry weights up and down stairs, often in lofty houses; they are constantly on foot, standing rather than walking, so that full pressure is continuously made on the joints; or what is worse, they are kneeling sometimes on cold and even wet stone floors, hard at work, scrubbing and brushing.

The joint affection was, as a rule, more severe in servants suffering from acute rheumatism than in the rest of those so affected, the joints being attacked with severity in one-half of the servants (49 in 101), and a little over one-third of the rest (91 in 225). Among those servants who suffered from pericarditis, the joint affection was severe in fully three-fourths (15 in 19), and in a large proportion of these (6) it was very severe. If we compare these cases with the rest of the servants affected with acute rheumatism, we find that the severity of the joint affection rose in the scale in exact proportion to the severity of the heart affection. The joint affection was severe in less than one-third (4 in 13) of those servants who presented no sign of inflammation of the heart, while it was so in a little over a third (9 in 26) of those in whom endocarditis was threatened or probable, and in one-half of those who were attacked with simple endocarditis (21 in 42); while, as I have just said, it was severe in three-fourths of the cases with pericarditis (15 in 19).

In the servants who were attacked with pericarditis, the severity of the joint affection bore a strict relation to the severity of the heart affection in the great majority of the cases.

In one-third of them (6 in 19) the joint affection was very severe; and in the whole of these the heart affection was very severe, while in one of them it was fatal.

In nearly one-half of these patients (9 in 19) the joint affection was severe in the second degree, and in two-thirds of these (6 in 9) the heart affection was severe; in two cases it was rather severe; and in one it was slight. In three patients the joint affection was rather severe, and of these the heart affection was severe in one, rather so in a second, and not so in a third.

The last case is a notable exception to this rule. The attack in the joints was slight, but the attack at the heart was very severe, and proved fatal.

The accompanying Tables show (1) the proportion in which female domestic servants affected with acute rheumatism were attacked by endocarditis and pericarditis, and the influence of age in the proportionate production of those affections of the heart in that disease; and (2) the relation of the degree of the joint affection to the degree of the heart affection in those cases.

1. *Degree of the Joint Affection in Servants affected with Acute Rheumatism, in relation to Age and Heart Affection.*

Joint Affection.	No Endocarditis.				Endocarditis threatened or probable.					Endocarditis.				Pericarditis.				Total.				Grand Total.
	Below 21.	21 to 25.	Above 25.	Total.	Below 21.	21 to 25.	Above 25.	? age.	Total.	Below 21.	21 to 25.	Above 25.	Total.	Below 21.	21 to 25.	Above 25.	Total.	Below 21.	21 to 25.	Above 25.	? age.	
Very severe + +	0	0	0	0	0	0	0	0	0	2	0	0	2	5	1	0	6	7	1	0	0	8 + +
Severe + . . .	1	0	3	4	5	0	4	0	9	10	5	4	19	7	1	1	9	23	6	12	0	41 +
Rather severe – +	1	3	1	5	7	3	1	1	12	7	4	1	12	2	1	0	3	17	11	3	1	32 — +
Not severe o + .	1	1	2	4	3	2	1	0	6	5	0	2	7	0	1	0	1	9	4	5	0	18 o +
Slight — . . .	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	1 —
Doubtful . . .	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	1 ?
Total.	3	4	6	13	15	5	6	1	27	25	9	8	42	14	4	1	19	57	22	21	1	101

2. *Degree of the Joint Affection in Servants in relation to the degree of the Heart Affection in the cases of Rheumatic Pericarditis.*

Degree of the Joint Affection.	Degree of the Heart Affection.						Total Degree of the Joint Affection.
	Fatal.	Very Severe. + +	Severe. +	Rather Severe. — +	Not Severe. o +	Slight. —	
Very severe + + .	1	5	0	0	0	0	6 + +
Severe + ...	0	1	5	2	0	1	9 +
Rather severe — + .	0	0	1	1	1	0	3 — +
Not severe o + . .	1	0	0	0	0	0	1 o +
Heart affection .	2 ⬭	6 + +	6 +	3 +	1 o +	1 —	19 .

I will now briefly consider the occupations of the remaining *female patients* who were attacked with acute rheumatism. I have thrown into one group the cooks, charwomen, nurses, and laundresses, who numbered altogether 22. Of these 5 had pericarditis, 4 of whom had endocarditis also, and 4 had simple endocarditis; in 7 endocarditis was threatened or probable; and in 6 the heart gave no evidence of being affected. Of the whole number less than a fifth were younger than 21 (4 in 21[1]). Of the five cases with pericarditis, in one the attack was severe but transient, and in that patient the joint affection was severe. In two others the heart affection was rather severe, and in the remaining two it was slight, while in none of these was the joint affection severe.

Nine of the women followed sedentary employments, using chiefly the needle; and in none of these was there pericarditis; four of them, however, had endocarditis.

The married women numbered 17, and of these only two had pericarditis and endocarditis, one severely, the other slightly. In both the joint affection was rather severe. Of the remainder, 2 had simple endocarditis, and 5 were threatened with it, while one-half (8) gave no sign of heart affection. These patients were all older than 23.

Sixteen of the female patients had no occupation, only one of whom was above the age of 20. Only two of them had pericarditis, one of whom had endocarditis also; in one of these the heart affection was fatal and in the other it was severe; and in one of them the joint affection was severe, while in the other that ended fatally it was so only to a moderate degree. Seven of these cases had simple endocarditis and two were threatened with it; while five of them presented no indication of endocarditis.

These cases taken as a whole show that those women who

[1] In one of the 22 cases belonging to this group the age of the patient is not stated.

followed at a mature age occupations as laborious as the young servants, were affected in but a moderate proportion with pericarditis, and that in a comparatively mild form. They also show that those of tender age who followed no occupation were not attacked with inflammation of the heart with anything like the same frequency as young female servants. We thus see, in brief, that in acute rheumatism affecting the female sex, youth with labour is nearly always attacked or threatened with endocarditis or pericarditis, or both ; that youth without labour is thus attacked with comparative infrequency ; and that mature age with labour is attacked less frequently and much less severely with inflammation of the heart than youth with labour.

The *male patients* give us two great illustrations. One of these is supplied by those working *in-doors,* and they naturally run in the same grooves as the female patients, who were all but two, occupied in-doors. The other is supplied by those following *out-of-door* occupations ; and they stand completely apart in kind of labour, age, and character of disease, as well as in sex, from the female patients whose cases have just been considered.

I have brought the male patients working *in-doors,* including ten servants, into one group, numbering 37. In several features this group presents a remarkable agreement as regards age and the frequency of heart affection, and especially of pericarditis, with the important and large analogous group of female servants. Thus in each group more than half of the patients were below the age of 21 (of the male patients 19 in 37, of the female servants 57 in 100) ;[1] in each, the proportion of cases with pericarditis was great, amounting among the males to one-third (13 in 37), among the female

[1] In one of the 99 female servants affected with acute rheumatism, the age of the patient is not stated.

servants to one-fifth (19 in 101); in each three-fourths of those thus affected with pericarditis were below the age of 21 (10 of the 13 male patients, and 14 of the 19 female servants); in each the proportion of those in whom the heart presented no sign of inflammation was small, amounting to one-sixth of those male patients (6 in 37), and one-eighth of the female servants (12 in 101); and in each few of the patients whose hearts were thus unaffected were below the age of 21, amounting to fully one-third of those male patients (3 in 7) and to one-fourth of the female servants (3 in 13). Here, however, this close parallel ends, since among the patients affected with acute rheumatism above the age of 25, pericarditis attacked the men working in-doors more frequently (2 in 13) than the female servants (1 in 22), and among those with pericarditis, less than one-half of the males (6 in 13), and almost as many as three-fourths of the females (15 in 19) were attacked with severity; while the proportion of cases affected or threatened with simple endocarditis was much smaller among the male patients (9 and 9 respectively in 37) than the female servants (42 and 26 in 101).

Looking at these two sections of the patients in their larger and more vital relations, it is evident that in both sexes the same causes produce, under like conditions, the same effects; and that a very large proportion of the young persons who work on foot in-doors during many hours daily, are attacked with inflammation of the heart when affected with acute rheumatism, while a very small proportion are thus attacked of the men and women of mature age who are engaged in the same manner.

If we looked solely to the kind of employments just considered it would be natural to infer that overwork in-doors in young people of both sexes was the main cause of acute rheumatism and of its attendant pericarditis and endocarditis. While, however, as we have just seen, the whole of the female patients with occupations were engaged in-doors, save two poor women, who each kept a stall, only about one-fourth of the male patients worked in-doors.

The larger proportion of the male patients affected with acute rheumatism, amounting nearly to three-fifths (82 in 154), excluding those working with lead, worked *out-of-doors.* More than one-half of these (45 in 84) were engaged in hard labour. Pericarditis attacked nearly one-fourth of these patients (10 in 45). We here find, what is at first sight an unexpected result, that of these laborious workers out of doors thus attacked with pericarditis only one in ten was below the age of 21; whereas of the male in-door workers thus affected, fully three-fourths (10 in 13) were below that age. If we look at those of older age, we find the scale exactly reversed; since of those labouring out-of-doors four fifths (8 in 10) were above the age of 25; while of those working in-doors only one-sixth (2 in 13) were above that age. We here, I consider, find the explanation, that I promised when considering age, of the twofold fact, that the male cases of pericarditis usually combined with endocarditis outnumber the female cases by one-fifth (35 to 28); and that the number of the men so affected above the age of 25 is three times as great as that of the women so affected (men with pericarditis 13 in 53, women 4 in 53). I think we may infer from these facts that excessive labour in the open air in men of mature age is a frequent cause of acute rheumatism having a strong tendency to pericarditis.

Male patients with acute rheumatism, whose occupation was chiefly on foot, such as watchmen and porters; and those employed with horses and in stables, whose habits make them liable to gout, including coachmen, cabmen, and grooms; did not suffer from pericarditis so frequently as those who were engaged in hard labour: since of those working on foot only one-seventh (2 in 14) and of those employed with horses only one-twenty-third (1 in 23), while of those whose work was laborious nearly one-fourth (10 in 45), were thus attacked.

These facts support the view that pericarditis tends to attack men of mature age affected with acute rheumatism when their work is hard, but not when it is comparatively easy.

It remains to me to speak of two other classes of employments, painters and plumbers on the one hand, and waiters and barmen, on the other, who tend to have gout much more frequently than acute rheumatism. I find, however, that 11 waiters and barmen, and 5 of those working with lead were attacked with acute rheumatism. One of each of those classes was attacked with pericarditis, both of whom were above 30 years of age. Seven of the waiters and barmen and two of the workers in lead presented no sign of heart affection. These were all but one below the age of 24, and in none of them was the great toe affected.

It would thus appear that when barmen, painters, or workers among horses, whose employments tend to induce gout, are attacked with acute rheumatism, especially when young, they do not tend to have pericarditis or endocarditis.

II.—The Affection of the Joints in Rheumatic Pericarditis.

The inflammation of the joints and the inflammation of the heart in acute rheumatism form one disease. We know that in a certain proportion of the cases the heart shows no sign of being touched by the disease, and here and there perhaps in a very rare instance the heart is attacked with inflammation when the joints are free from it. The unity of the two phases of the disease, the external phase, in the joints, and the internal in the fibrous structures of the exterior and the interior of the heart being established, we have to inquire what was the relative intensity of the inflammation of the joints and the inflammation of the heart in my cases of acute rheumatism, and especially in those affected with pericarditis.

We have just seen that in servants attacked with acute rheumatism, the joint affection was, as a rule, only of moderate severity when the heart gave no sign of being affected; that the joint affection was more severe when the heart was threatened or probably attacked with endocarditis; and that the severity of the joint affection increased in a direct ratio with the increased certainty and severity of the heart affection; the joint affection being greater when simple endocarditis was actually present than when it was threatened or probable, and much greater when the heart was attacked with both endocarditis and pericarditis.

I find that the same rule applies to the whole body of the cases of acute rheumatism; as may be seen in the accompanying Table, showing the degree of intensity of the joint affection in relation to the absence or presence of endocarditis and pericarditis in cases of acute rheumatism.

Degree of intensity of the Joint Affection in relation to the absence or presence of Endocarditis and Pericarditis in cases of Acute Rheumatism.

Joint Affection.	No Endocarditis.	Endocarditis threatened or probable.	Endocarditis.	Pericarditis.	Total.	Female servants.	Other employments.
Very severe	0	1	2	12	15 −	8 =	7
Severe	22	32	46	25	125 −	41 =	84
Rather severe	34	35	42	18	129 −	32 =	97
Not severe	18	7	15	6	46 −	18 =	28
Slight	4	1	2	1	8 −	1 =	7
Doubtful	1	0	1	1	3 −	1 =	2
Total	79	76	108	63	326 −	101 =	225

Thus the joint affection was severe in one-fourth (22 in 78)[1] of those patients in whom the heart gave no sign of inflammation; in two-fifths (32 in 76) of those in whom endocarditis was threatened or probable; in more than two-fifths (48 in 107)[2] of those affected with simple endocarditis, and in three-fifths (37 in 62)[3] of those who were attacked with pericarditis, all but 9 of whom (54) had endocarditis also.

The inflammation of the joints was very intense in 12 of the 37 patients with pericarditis, usually coupled with endocarditis, in whom the inflammation of the joints was severe, whereas in only 3 of the 184 patients in whom simple endocarditis was present or threatened, and in none of the 79 in whom the heart gave no evidence of being affected, was the joint affection of this great degree of intensity.

In the cases of Pericarditis, there was a close correspondence in severity between the inflammation of the joints and the inflammation of the heart. The accompanying Table [see opposite page] shows in detail the degree of the joint affection in relation to the degree of the heart affection in sixty-two cases of rheumatic pericarditis.[4] The joint affection was very severe in 12 cases, and in three-fifths of those cases (7) the heart affection was very severe, being fatal in one; in one-fourth of them (3) it was severe; and in only one-sixth of them (2) was it of moderate severity. The joint affection was severe in 25 cases, and in one-third of those cases (9) the heart affection was very severe; in less than one-half of them

[1] The degree of the joint affection was not stated in one of the 79 cases belonging to this group.

[2] The degree of the joint affection was not stated in one of the 108 cases belonging to this group.

[3] The degree of the joint affection was not stated in one of the 63 cases belonging to this group.

[4] In one of the 63 cases of pericarditis the joint affection was not described.

TABLE GIVING THE ACTUAL NUMBER OF THE JOINT AFFECTION IN RELATION TO THE DEGREE OF HEART AFFECTION IN 62[1] CASES OF RHEUMATIC PERICARDITIS.

JOINT AFFECTION.	HEART AFFECTION. Fatal. ⬭	Very severe. + +	Severe. +	Rather severe. — +	Not severe O +, or slight —	Total.
The *joint affection* was *very severe* (+ +) in **12** cases	... ...	... ...	... ...	... ...	... ...	12
Of these the *heart affection* was fatal (⬭) in	1 ⬭					
,, ,, very severe (+ +) in	... ...	6 + +				
,, ,, severe (+) in	... ...	... ...	3 +			
,, ,, rather severe (— +) in	... ...	... ...	... ...	2 — +[2]		
The *joint affection* was *severe* (+) in **25** cases	... ...	... ...	... ...	... ...	... ...	25
Of these the *heart affection* was fatal (⬭) in	2 ⬭					
,, ,, very severe (+ +) in	... ...	7 + +				
,, ,, severe (+) in	... ...	... ...	11 +[3]			
,, ,, rather severe (— +) in	... ...	... ...	... ...	3 — +[4]		
,, ,, not severe (O +) in	... ...	... ...	... ...	... ...	2 O +[4]	
The *joint affection* was *rather severe* (— +) in **18** cases	... ...	... ...	... ...	... ...	... ...	18
Of these the *heart affection* was fatal (⬭) in	0 ⬭					
,, ,, very severe (+ +) in	... ...	2 + +				
,, ,, severe (+) in	... ...	... ...	5 +			
,, ,, rather severe (— +) in	... ...	... ...	... ...	6 — +[4]		
,, ,, not severe 2 (O +) or slight 3 (—) in	... ...	... ...	... ...	... ...	5 {2 O +, 3 —}	
The *joint affection* was not severe 6 (O +) or slight 1 (—) = **7**	... ...	... ...	... ...	... ...	... ...	7
Of these the *heart affection* was fatal (⬭) in	1 ⬭[5]					
,, ,, very severe (+ +) in	... ...	0 + +				
,, ,, severe (+) in	... ...	... ...	2 +			
,, ,, rather severe (— +) in	... ...	... ...	... ...	4 — +		
,, ,, not severe (O +) or slight (—) in	... ...	... ...	... ...	... ...		
The *joint affection* was not described (?) in **1**. In this case there were no signs of endocarditis	... ...	... ...	... ...	... ...	... ...	1
Of the total of the above **63** cases of pericarditis,[1] the heart affection was fatal (⬭) in	4 ⬭					
The heart affection was very severe (+ +) in	... ...	15 + +				
,, ,, severe (+) in	... ...	... ...	21 +			
,, ,, rather severe (— +) in	... ...	... ...	... ...	15 — +		
,, ,, not severe (O +) or slight (—) in	... ...	... ...	... ...	... ...	7 {3 O +, 4 —}	
TOTAL Number of cases	... ...	... ...	... ...	... ...	... ...	64

[1] In 1 of the 63 cases of rheumatic pericarditis the condition of the joints is not described. [2] In these 2 cases the signs of endocarditis were absent or doubtful. [3] In 2 of these cases the signs of endocarditis were absent or doubtful. [4] In 1 of these cases the signs of endocarditis were absent or doubtful. [5] In this case endocarditis was absent or doubtful.

(11) it was severe, and in one-fifth of them (5) it was of moderate severity, or slight. If we combine these two groups of cases, amounting to 37, that were marked by the severity of the joint affection, we find that in four-fifths of them (30) the affection of the heart was severe, while in one-fifth of them (7) it was not severe or only moderately so. Endocarditis was present in all but two of the 30 cases in which the affection both of the joints and the heart was severe; while the signs of endocarditis were either absent or doubtful in 4 of the 7 cases in which the affection of the joints was severe, while that of the heart was either of moderate severity or slight.

If we examine those cases, amounting to 25, or two-fifths of the whole number, in which the degree of the joint affection was below the line of severity, we find that in 18 of them the affection of the joints was only of moderate severity, while in 7 of them it was slight; and that in two-fifths of these (10) the heart affection was severe, while in three-fifths of them (15) it was either slight or of moderate severity. We find, then, that in the 37 cases of pericarditis in which the joint affection was more severe, the heart affection was more severe in four-fifths (30) and less severe in one-fifth (7); while in the 25 cases of pericarditis in which the joint affection was less severe, the heart affection was more severe in two-fifths (10) and less severe in three-fifths (15).

III.—The Degree of the Joint Affection during the Acme of the Effusion into the Pericardium.

When the exterior of the heart is attacked by inflammation in cases of acute rheumatism, the distress and oppression in the region of the heart and in the chest is often so great as to call the patient's attention away from the seat of suffering in the joints. At the same time the physician or the clinical clerk is so much interested in the state of the central organ that he readily overlooks that of the joints. I find that in 12 of the 45 cases given in the accompanying plans (see pages 257, 265), the condition of the joints was not reported during the acme of the pericardial effusion, and in one other case the joint affection was not noted until the attack of pericarditis had declared itself.

The state of the joints during the period of the acme of the inflammation of the exterior of the heart, marked by the extent of fluid in the pericardium being then at its height, is shown in 32 of the 45 patients under examination. These cases divide themselves naturally into two groups; in one of these, amounting to 12, the pericarditis was at its acme at the time of admission, or on the following day; while in the remaining 20 cases the effusion into the pericardium reached its acme after the admission of the patient. In the latter set of cases, the intensity of the joint affection had been, as a rule, modified and lessened by rest and soothing treatment, and, especially in four-fifths of the cases, by opium given at repeated intervals; while in the former set of cases in which the pericarditis was at its height at the time of admission, the joint affection had been, as a rule, somewhat aggravated by the removal of the patient from home to the hospital. The set of cases, therefore, that were admitted with pericarditis at its height show the natural relation of the degree of the joint affection to that of the heart affection during the period of the acme of the disease, in a manner less affected by other influences than the set in which the pericarditis came on and reached its height after admission.

The inflammation of the joints was severe at the time of admission in more than one-half of the patients (7 in 12) who came in with the pericarditis at its height, and in six (16, 18, 12, 51, 55, 35,) of these seven cases the joint affection was of about equal severity before admission and at the time of the acme of the effusion into the pericardium ; while in one of them (56) the joints were less severely affected before than during the period of the height of the pericarditis.

In two-fifths of this group of cases (5 in 12) the joint affection was not severe when the pericarditis was at its height, at the time of admission or on the next day, and in three (6, 43, 40) and perhaps in four (42) of these the inflammation of the joints was more severe before admission than after it and during the period of the acme of the effusion into the pericardium. The remaining case (13) stands alone, since in it, although the affection of the heart proved fatal, that of the joints was but slight, both before and after admission.

The second group consists of twenty cases in which the effusion into the pericardium reached its acme after admission ; and it will be seen that the relation of the joint affection to the heart affection was very different in this group from what it was in the former one in which the patients came in when the pericarditis was at its height.

The inflammation of the joints was more severe at the period of the acme of the pericardial effusion than before that period in one-fifth of these cases (4 in 20) (3, 4, 30, 49), and it was of equal severity during the two periods in one other case (19).

The affection of the joints became less severe during the period of the acme of pericarditis than before that period in three-fourths of these cases (15 in 20).[1] Four-fifths of these patients (12 in 15) took repeated doses of opium, with lessening joint affection during the acme of pericarditis, while only one of the four patients with increasing joint affection during the acme was placed under the influence of opium.

It is evident that if we looked only to the first group, or only to the second group of these cases, we should arrive at opposite conclusions with regard to the relation of the degree

[1] 8, 15, 20-22, 24, 26, 28, 31, 33, 34, 36, 44a, 50, 54.

of the joint affection to that of the heart affection during the acme of pericarditis. Thus the joint affection lessened during the acme of the disease in one-third of the first group (4 in 13) and in three-fourths of the second (15 in 20). The influence of repeated doses of opium evidently told on the second group of cases, and the movement of the patients from their homes to the hospital, on the first group of cases, to modify the relation of the joint affection to the heart affection.

I think that we may safely draw an inference midway between these two extreme illustrations, and consider that in about one-half of the cases of pericarditis the joint affection was of equal severity during the period of the acme of the disease, and before that period; and that in about one-half of them the joint affection became less severe when the pericarditis was at its height. The general conclusion may be drawn from this inference, that the joint affection tends to lessen in severity when pericarditis is at its height in about one-half of the cases.

IV. Time in the Hospital.

The accompanying Table shows the average time that the patients remained in the hospital in relation to the absence or presence of endocarditis or pericarditis in acute rheumatism :—

Time in the Hospital in relation to the absence or presence of Endocarditis and Pericarditis in cases of Acute Rheumatism.

In the Hospital.	No Endocarditis.	Endocarditis threatened or probable.	Endocarditis.	Pericarditis.	Total.
From 6 to 20 days	33	22	14	7	76
,, 21 ,, 30 ,, ...	23	21	31	8	83
,, 31 ,, 50 ,, ...	15	21	37	16	89
Over 50 days	3	8	21	28	60
An uncertain number of days	2	2	3	4	11
Total	76	74*	106*	63	319*

* Since this table was drawn up, seven cases have been added, making the total number 326.

The time that the patient remained in the wards measures the duration and severity of the disease. Two-fifths of the patients in whom the heart gave no sign of being affected left the hospital before the end of the third week (33 in 76), three-fourths of them during the first month (56 in 76), and one-fourth of them after the first month (20 in 76). Those who had pericarditis usually accompanied by endocarditis remained in the wards for a much longer period, since only one-ninth of them (7 in 63) left the hospital before the end of the third week, and one-fourth of them (15 in 63) during the first month, while three-fourths of them remained in the hospital longer than a month (48 in 63), and one-half of them more than fifty days. Those with simple endocarditis remained in the house much longer than those whose hearts were healthy, but not nearly so long as those with pericarditis usually combined with endocarditis.

V.—Occurrence or Non-Occurrence of one or more Previous Attacks of Acute Rheumatism.

The accompanying Table shows the proportion in which the patients affected with acute rheumatism had been previously attacked by that disease in fully three-fourths of the patients (243 in 319 cases). Less than one-third of those who gave no sign of endocarditis (23 in 76) and nearly one-half of those who were affected with endocarditis (48 in 106,) had suffered from one or more previous attacks of acute rheumatism; so that in my cases the occurrence of a previous attack evidently favoured the presence of endocarditis. This did not, however, appear to be the case with pericarditis, for only one-third of the cases with that affection had been previously attacked by acute rheumatism. The previous occurrence of acute rheumatism implies in a certain proportion of the cases the presence of valvular disease of the heart, a condition that promotes the occurrence of endocarditis in acute rheumatism. It is open to inquiry why valvular disease should have more frequently influenced the production of endocarditis than of pericarditis in my cases.

Occurrence or Non-Occurrence of Previous Attacks of Acute Rheumatism in relation to the Absence or Presence of Endocarditis and Pericarditis.

Joint Affection.	No Endocarditis.	Endocarditis threatened or probable.	Endocarditis.	Pericarditis.	Total.
No previous attack . . .	37	23	31	26	117
No note of previous attack .	16	17	27	16	76
One previous attack . . .	17	24	35	15	91
More previous attacks than one	6	10	13	6	35
Total	76	74	106*	63	319*

* Since this table was drawn up, seven cases have been added, making the total number 326.

VI.—The Time of the First Observation of Friction Sound and of the beginning of Rheumatic Pericarditis in Relation to the beginning or Relapse of the affection of the joints.

In a large proportion of the cases of acute rheumatism affected with pericarditis, friction sound was heard over the heart either at the time of admission or very soon after it. Thus in more than one-third of the total number of the cases, the rubbing noise was noticed on the day that they entered the hospital (22 in 63); in all but one-half of them (29 in 63) it was heard on that or the following day; and in fully two-thirds of them (41 in 63) it was observed either at the time of admission or during the three days following it. In nine-tenths of the whole number of cases affected with pericarditis (55 in 63) the frottement was distinguished during the first nine days of the patient's residence in the hospital.

These facts do not, however, point out how soon pericarditis occurred after the commencement of the attack of acute rheumatism. To ascertain this, we must add the number of days from the commencement of the attack to the time of admission, to the number of days from that time to the period at which the to-and-fro sound was heard. This plan answers with those cases in which the friction sound was observed on or after the third day from the date of admission, since in all but four of them the heart had been previously examined. It does not, however, apply to those patients in whom the frottement was detected during the day of admission or on the next day, since in those cases we do not know how long the rubbing sound may have been in existence before the patient came in. This applies to one-half of the patients affected with rheumatic pericarditis, since they had suffered from acute rheumatism for a period varying from two days to three weeks before entering the wards. These cases are, however, of use in showing how early in the disease, and how late, pericarditis may declare itself by friction sound in full play. Thus out of the twenty-nine cases in which frottement was heard during the first two days, more than one-fourth (8 in 29) had been affected with acute rheumatism for a period of from two to four days; while on the other hand one-fifth of them (6 in 29) had been ill for from two to three weeks before admission.

If we bring together the whole of the 63 cases of pericarditis, we find that in one-sixth of them (10 in 63) the rubbing sound was audible as early as from the third to the sixth day after the commencement of the disease; while in one-half of them (30 in 63) that sound was audible on or before the eleventh day of the illness.

In only seven of the cases did the heart affection show itself so late as the 25th day and from that to the 63rd after the onset of the acute rheumatism.

These facts point, I think, to the conclusion that in a certain small proportion of the cases, amounting perhaps to one-eighth (8 in 63), the onset of the inflammation both of the exterior and the interior of the heart took place at the very commencement of the disease, and at the same time with the onset of the inflammation of the joints.

It is scarcely needful to say that the first appearance of the rubbing sound is later than the beginning of the inflammation of the surface of the heart. In this respect the inflammation of the outside of that organ corresponds with the inflammation of the joints, since, as in inflammation of the joints, pain and tenderness precede exudation and swelling, so in pericarditis, in at least some instances to which I shall now refer, pain and exquisite sensitiveness over the heart preceded the notable increase of effusion into the pericardium and the existence of a rubbing sound.

In five of the cases in which friction sound was heard on the day of admission (13, 15, 44*a*, 53, 61), pain had existed over the region of the heart, or in the left side, or in the chest, for one or more days before the patient entered the hospital. In one of these cases (44*a*) pain was present over the heart from about the beginning of the illness, the precise time of which is not stated.

In nearly one-half of the patients in whom the frottement was heard for the first time from one to fifty-three days after admission (16 in 39), there was pain over the region of the heart or in the chest from one to seven days before the rubbing noise was observed. In seven (51, 8, 26, 28, 50, 29, 5) of them the pain was noticed one day; in three (57, 56, 23), two days; in one, three days (14); in two, four days (55, 36); in two, six days (123, 30); and in one, seven days (20) before the first observation of the friction sound.

The patient (24), in whom friction sound was heard on the 53rd day after admission, presenting a chain of symptoms interesting in two points of view, one, that the attack of pericarditis was immediately preceded by a relapse of the joint affection; the other, that pain over the heart preceded the frottement. The patient was a labourer, aged 27, and had almost passed through a severe attack of acute rheumatism with endocarditis, resulting in permanent injury to the mitral and aortic valves. On the 36th day, he being stronger and of better colour, was allowed to get up. On the 42nd his general health was good, his pains were diminished, and he walked about. On the 45th he felt stiffness in the right hip-joint on walking, that joint having been affected for eight months previously; and on the 48th the pain in the hip was worse, though he was otherwise free from complaint, and his appetite was good. On the 50th day, however, his neck was stiff, and he had flying pains about the knees; and on the next day his face was flushed, he perspired copiously, and complained of great pain over the region of the heart and palpitation. On the 52nd he suffered from a terrible pain in the neck and head, the wrists were swollen and painful, and the heart's action was so loud that the mitral and aortic murmurs were inaudible; and on the following day a loud and harsh double friction sound was heard over the heart. Here the attack of pericarditis immediately followed the relapse in the joint affection, and the pain over the heart preceded the rubbing sound by two days.

In four other cases in which the friction sound appeared some time after admission, the pericarditis followed closely upon a *relapse* of the joint affection. In one of these (36), a woman, aged 20, who was motionless on admission from the affection of the joints, the pain was worse on the 6th day, she was still powerless on the 7th from the pain in the joints, and on the 8th a harsh grating frottement, chiefly systolic, was heard over the apex of the heart. In another patient (3), a man, aged 26, who was re-admitted with a severe relapse of the affection of the joints six days after leaving the hospital, the hands and hips were better on the 5th day after his readmission, but on the 8th there was again pain in the hip, and on the 9th there was excessive pain and tenderness in the fascia of the thigh. On the next day (the 10th) there was pain, and increased dulness on percussion over the heart, and a double friction brush was audible at the apex. In a third case (30), a man, aged 31, all the joints were swollen and painful when he came in, but were so much better on the 8th day that they only pained him when he moved. The pain in the joints returned, however, on the 9th, being better next day, when a harsh double friction sound was audible over the heart.

In the last case of this group (17), a female servant, aged 20, the joints were painful and swollen on admission, they were less so on the 4th day, and on the 7th they were almost of the natural size. On the 9th a little pain returned in the joints, and there was oppression over the heart. On the 13th the pain had increased, and she suffered much in the chest, the first sound being rough and prolonged. On the 16th there was a murmur all over the heart, which was the seat of pain; and on the 17th a soft double friction sound was established over the region of the pericardium.

To these cases must be added one of a series that were treated by rest during the years 1866-68. In this patient, a man, aged 20, the pain in the joints, which was considerable on admission and which lessened on the 4th day, again increased in the arms and neck on the 5th, when a pain, beginning at the lower portion of the breast bone, shot through the region of the heart to the back. This symptom and pain in the region of the apex were relieved by leeches. The joints also improved, but on the 10th, after he had been using his hand, pain returned in the finger, and on the 14th, the next report, pericarditis had fully declared itself.

VII.—The Presence or Absence of Endocarditis in Rheumatic Pericarditis.

I. *Cases where Endocarditis was present.*—There was evidence of inflammation in the interior of the heart in all the cases excepting nine (54 in 63).

The heart was healthy at the time of the attack in 46 of the cases with endocarditis, and the mitral, or mitral and aortic valves were crippled by previous disease in the remaining 8 cases, including one just alluded to (24), in which pericarditis followed a relapse of the affection of the joints, the aortic and mitral valves having become affected during the earlier part of the attack of acute rheumatism.

A tricuspid murmur was alone present in three of the 46 cases of endocarditis: in two of these cases that murmur was persistent, and in one of them it disappeared. These cases were comparatively free from serious symptoms, the heart affection being severe in only one instance, and the inflammation of the joints being very severe in another. The proportion of cases of this class with simple tricuspid murmur was much smaller in these cases of combined endocarditis and pericarditis than in those of simple endocarditis; 1 in 18 of the former, as we have just seen (3 in 54), and 1 in 8 of the latter (13 in 108) being thus affected.

The mitral valve was affected in 42 of the 46 patients with pericarditis in whom endocarditis attacked the heart when previously healthy, in 6 of whom the aortic valve was affected as well as the mitral. The aortic valve was attacked in one other case in which the mitral valve was not involved.

I have divided these 43 cases with mitral (36), aortic (1), and mitral and aortic (6) incompetence into three groups; in the first group, containing 16 cases (11 mitral, 5 mitral and aortic incompetence), valvular disease was finally established, or, in two instances, the disease proved fatal when the murmur was in full play; in the second group, which numbered 8 cases with mitral regurgitation, the murmur was lessening when the patients were discharged; while in the third group, amounting to 19 (17 mitral, 1 aortic, and 1 mitral and aortic incompetence), the murmurs disappeared on the recovery of the patients from acute rheumatism, and the heart was restored to a healthy condition.

The accompanying Table shows the relation of the degree of the affection of the joints and that of the affection of the heart to the occurrence and degree of endocarditis in cases of acute rheumatism affected with pericarditis.

If we compare the cases of endocarditis thus combined with pericarditis with the cases of uncomplicated or simple endocarditis, we find that valvular disease was finally established, that the murmur lessened in intensity, and that the murmur finally disappeared in nearly the same proportion in the two sets of cases. Thus in 70 cases of simple endocarditis, either mitral (53), aortic (10), or mitral and aortic (7) incompetence was present. If we divide these cases, like those with pericarditis and endocarditis, into three groups, we find that in the first group, containing 26 cases (16 mitral, 5 aortic, and 5 mitral and aortic incompetence), valvular disease was finally established, or, in two instances, the disease proved fatal; in the second group, which numbered 11 cases (11 mitral incompetence), the murmur was lessening when the patients were examined for the last time; while in the third group, amounting to 31 cases (24 mitral, 5 aortic, and 2 mitral and aortic incompetence), the murmur had disappeared on the recovery of the patients from acute rheumatism, and the heart became again healthy. A tricuspid murmur was alone audible in 13 additional cases of simple endocarditis: in 7 of these the murmur disappeared, but in 6 of them it was still audible when the heart was listened to for the last time.

I am of opinion, notwithstanding the remarkable correspondence in the effects of the inflammation of the valves in the three parallel groups of each of these two sets of cases, that when inflammation attacks the interior of the heart alone, it is less likely to induce permanent valvular disease than when the heart is inflamed both without and within. This, I think, is *à priori* self-evident, and it is supported by two pieces of clinical evidence that I shall now adduce. (1) Disease of both the mitral and aortic valves, which is the most extensive form of valvular disease, was established in 5 of the 43 cases affected with both endocarditis and pericarditis, and in 5 only of the 70 cases affected with simple endocarditis. (2) Simple endocarditis was present in 28 out of 74 cases of acute rheumatism that were treated by me in St. Mary's Hospital on a careful and rigid system of *rest.* Valvular disease of old standing existed in 7 of those patients, and a recent mitral murmur, accompanied in one instance by aortic incompetence, affected the remaining 21 cases. The heart regained its healthy condition in 14 of these patients, the murmur was lessening or doubtful in 4 of them on their recovery from acute rheumatism, and valvular disease was established in 3 only of the whole series of 21 cases.

The inflammation both of the joints and the heart was more often severe in those cases in which the valves became permanently diseased, than in those in which the recovery of their function was complete. The heart affection was severe in 12 of the 16 cases in which the valves were permanently disabled, being fatal in two and very severe in six of them; while it was severe in 13 of the 19 in which the valves were restored to health, being very severe in four of them. The relative intensity of the joint affection was even greater than that of the heart affection; since, in the former class of cases, it was severe in 12 of the 16 in which the organ became diseased, and in only 10 of the 19 in which its recovery was perfect.

There was mitral regurgitation in the whole of the group of cases, amounting to 8, in which there was previous valvular disease, in three of which the aortic valves were also incompetent. The heart affection was severe in the whole of these cases save one, and the joint affection was so in five of them. The all but universal presence of inflammation within the heart in patients of this class supports the inference that in acute rheumatism old standing valvular disease, by throwing additional labour on the organ, tends to produce endocarditis and pericarditis, and to increase the severity of the inflammation of the heart, both within and without.

II. *Cases in which Endocarditis was absent or doubtful.*—The signs of endocarditis were absent or uncertain in only 9 of the 63 cases of pericarditis. In five of these patients no murmur was audible; in one there is no note that a murmur could be heard, and in the remaining three the existence of a murmur was doubtful. One of these cases proved fatal, and the affection of the heart was severe in two and of moderate severity or slight in the remaining six patients. The joint affection was severe in six of these cases.

Classification of the cases of Pericarditis.—I have classified the cases according to the presence or absence of endocarditis,

PERICARDITIS WITH AND WITHOUT ENDOCARDITIS.

Relation of the Degree of the Heart Affection and of the Joint Affection to the Occurrence and Degree of Endocarditis.

		Fatal.	Very severe + +	Severe +	Rather severe — +	Not severe ○ +	Slight —	Doubtful.	Total.
With Endocarditis.									
Tricuspid murmur . . . . ← ←	2 Heart affection ♡	...	...	1 +	1 — +	...	...	...	2
permanently established . . . . . ←	Joint affection	...	...	...	2 — +	...	...	...	2
Tricuspid murmur . . . . ←	1 Heart affection ♡	...	...	...	...	1 ○ +	...	...	1
disappearing on recovery . . . . . ←o	Joint affection	...	...	1 +	...	...	...	...	1
Tricuspid murmur . . . . ←	3 Heart affection ♡	...	...	1 +	1 — +	1 ○ +	...	...	3
Total number	Joint affection	...	...	1 +	2 — +	...	...	...	3
Mitral regurgitation, ending . . . . →	11 Heart affection ♡	1	5 + +	1 +	2 — +	...	2 —	...	11
in mitral valve disease . . . . . . →	Joint affection	...	4 + +	4 +	3 — +	...	...	...	1
Aortic and Mitral regurgitation, ending . → ↓	5 Heart affection ♡	1	1 + +	3 +	...	...	...	...	5
in established disease of both valves . → ↓	Joint affection	...	1 + +	3 +	1 — +	...	...	...	5
Mitral and Mitral-aortic regurgitation . → →	16 Heart affection ♡	2	6 + +	4 +	2 — +	...	2 —	...	16
ending in established valve disease . . → ↓ → ↓	Joint affection	...	5 + +	7 +	4 — +	...	...	...	16
Mitral regurgitation . . . . →	8 Heart affection ♡	...	1 + +	3 +	2 — +	1 ○ +	1 —	...	8
lessening on recovery . . . . o→	Joint affection	...	...	3 +	2 — +	2 ○ +	1 —	...	8
Mitral regurgitation . . . . →	17 Heart affection ♡	...	4 + +	8 +	4 — +	1 ○ +	...	...	17
disappearing on recovery . . . . . →	Joint affection	...	2 + +	7 +	6 — +	2 ○ +	...	...	17
Aortic regurgitation . . . . ↓	1 Heart affection ♡	...	...	1 +	...	...	...	...	1
disappearing on recovery . . . . . ↓	Joint affection	...	1 + +	...	...	...	...	...	1
Mitral-aortic regurgitation . . . . . →↓	1 Heart affection ♡	...	...	...	1 — +	...	...	...	1
disappearing on recovery . . . . . o→↓	Joint affection	...	...	...	1 — +	...	...	...	1

Mitral, Aortic, and Mitral-aortic regurgitation . . . . } 19	Heart affection	...	4 + +	9 +	5 — +	1 O +	...	...	19
disappearing on recovery	Joint affection	...	3 + +	7 +	7 — +	2 O +	...	...	19
Mitral valve-disease of old standing . } 5	Heart affection	1	1 + +	2 +	1 — +	...	...	...	5
	Joint affection	...	1 + +	2 +	1 — +	1 O +	...	...	5
Mitral-aortic valve-disease of old standing (1 recent) . . . . } 3	Heart affection	...	3 + +	...	...	...	...	...	3
	Joint affection	...	1 + +	1 +	1 — +	...	...	...	3
Mitral and Mitral-aortic valve-disease of old standing . . . . } 8	Heart affection	1	4 + +	2 +	1 — +	...	...	...	8
	Joint affection	...	2 + +	3 +	2 — +	1 O +	...	...	8
Total Number of cases of Pericarditis accompanied by Endocarditis . . . } 54	Heart affection	3	15 + +	19 +	11 — +	3 O +	3 —	...	54
	Joint affection	...	10 + +	21 +	17 — +	5 O +	1 —	...	54
Endocarditis absent or doubtful.									
Cases without sign of Endocarditis	Heart affection	1	...	2 +	1 — +	1 O +	1 —	...	6
	Joint affection	...	1 + +	3 +	...	1 O +	...	...	5
Cases in which the signs of Endocarditis were doubtful	Heart affection	...	...	...	3 — +	...	...	...	3
	Joint affection	...	1 + +	1 +	1 — +	...	...	...	3
Total Number of cases in which Endocarditis was absent or doubtful . . .	Heart affection	1	...	2 +	4 — +	1. O +	1 —	...	9
	Joint affection	...	2 + +	4 +	1 — +	1 O +	...	1 ?	9
Grand Total of cases of Pericarditis .	Heart affection	4	15 + +	21 +	15 — +	4 O +	4 —	...	63
	Joint affection	...	12 + +	25 +	18 — +	6 O +	1 —	1 ?	63

and subdivided those with endocarditis into the groups which have just been described, and which are specified in the following scheme :

I. Cases of pericarditis in which endocarditis was present . . . 54

A.—Cases with endocarditis attacking the healthy heart 46

1.—Cases with tricuspid regurgitation ← 3

a.—Cases in which the regurgitation became permanent after recovery from acute rheumatism . . . . ← ← 2

c.—Cases in which the regurgitation disappeared on recovery . . . . . . ← ←∘ 1

2.—Cases with mitral (36 →), aortic (1 ↓), and mitral-aortic 1 (↓→) regurgitation 43

a.—Cases in which the regurgitation became permanent after recovery from acute rheumatism (mitral, $11\overset{\rightarrow}{\rightarrow}$, mitral-aortic ↓→↓→). . 16

b.—Cases in which the regurgitation lessened after recovery (mitral $8\overset{\rightarrow}{\rightarrow}$) 8

c.—Cases in which the regurgitation disappeared after recovery (mitral $17_{\circ\rightarrow}^{\rightarrow}$, aortic 1 ↓ $\overset{\circ}{\downarrow}$, mitral-aortic 1 $\overset{\circ}{\downarrow}$∘→) 10

B.—Cases with endocarditis attacking a heart already affected with mitral (5 ⇒), or mitral aortic (3 ⇓ ⇒), valve-disease 8

II.—Cases of pericarditis in which endocarditis was absent (6) or doubtful (3) 9

TOTAL number of cases of Pericarditis . . . 63

VIII.—SKETCH OF THE PROGRESSIVE CHANGES THAT TAKE PLACE IN THE HEART AND PERICARDIUM DURING THE PROGRESS OF PERICARDITIS.

We cannot rightly understand the symptoms and signs of pericarditis unless we keep in the mind's eye the changes that are going on in the heart and pericardium and the surrounding organs during the periods of the beginning, increase, and *acme*, the decline and ending of the disease. I shall, therefore, before discussing the symptoms and signs of the disease that were present in my cases, give here a slight sketch of the more important morbid changes, in so far as they make themselves appreciated during life, and shall afterwards describe some of those changes more fully when the consideration of the symptoms and signs of the affection seems to call for it.

When the surface of the heart becomes inflamed, a blush of fine vessels, consisting of a velvety network, appears on the surface of the organ, and especially over the larger coronary vessels at the base and septum of the ventricles. The inner surface of the pericardial sac, wherever it rests upon the inflamed heart, kindles also into a blush of fine vessels. The inflammation caught from the heart on the inner lining of the sac spreads rapidly to the fibrous structure of the pericardium, and through it may even often extend to the surface of the pleura covering the sac. The inflammation of those parts tells upon the nerves distributed to them. The surfaces of the heart and sac, instead of being smooth and glistening, become dull and velvety ; and fluid is poured out and lymph exudes from the inflamed surfaces.

The liquid in the pericardium increases rapidly. At first it falls into the back part of the sac, but as it increases in quantity, it makes a space for itself between the floor of the pericardium, which it depresses, and the lower surface of the heart, which it elevates, and it gradually distends the pouch in every direction, displacing the lungs to each side in front, pushing the central tendon of the diaphragm, the stomach, and the liver downwards, and pressing backwards, when the distension from the fluid becomes great, upon the bifurcation of the trachea, the left bronchus, the œsophagus, and the aorta. The fluid at the same time re-acts upon the heart so as to compress the auricles, the venæ cavæ, the pulmonary veins, and the ascending aorta ; and to displace the apex and body of the organ and its great arteries upwards and forwards, owing to the extensive interposition of the fluid between the lower surface of the heart and the floor of the pericardium.

The lymph is poured out upon the surfaces of the heart and the sac. Where those two surfaces touch each other, the soft lymph is drawn into threads and little pointed ridges and prominences, and wrought into a network, so that when ridges or prominences are present on the heart, ridges or prominences are present on the inner surface of the pouch lying upon it, and when a network of lymph covers the heart, a network of lymph lines the corresponding sac. The constant play of expansion and contraction of the heart alternately stretches and relaxes its coating of lymph, so that its surface represents a honeycomb in structure.

The heart, elevated by the fluid between the under surface of the ventricles and the base of the pericardium to a degree proportioned to the amount of the fluid, leaves the broader part of the chest below, and ascends into the narrower part of the chest above. The lungs, and especially the left lung, are consequently displaced from before the swollen sac and the heart, and the front of the right and left ventricles, including the apex and the great arteries, beat with some force against the higher costal cartilages and intercostal spaces, and the adjoining portion of the sternum, with which they come into close contact. Owing to the narrowing compass of the portion of the chest in which the heart is then situated, and the withdrawal of the lung from before the organ, its impulse is both elevated and widened outwards, so that it is felt beating strongly in the second and third, or third and fourth left spaces, according to the amount of the effusion, the apex-beat being felt above and beyond the nipple ; instead of the impulse, as in health, being felt gently in the fourth and fifth spaces, the apex-beat being within the nipple-line. When the pericardium is distended to the utmost, its sac becomes pyramidal or pear-shaped, the apex or narrowest part of the pyramid pointing upwards, behind the lower portion of the manubrium and to the left of it, the base of the pyramid bearing downwards and extending across the ensiform cartilage from the sixth right costal cartilage to the lower border of the sixth left cartilage at its attachment to the rib. The fluid rapidly fills the sac, and often reaches its acme in two, three, or four days ; but it soon begins to lessen, and in from four to six additional days it usually returns to its healthy amount. At the same time the heart descends and comes again in contact with the lower end of the sternum and the top of the ensiform cartilage, the fifth space, the sixth costal cartilage, and the diaphragm. In most instances slight threads of adhesion form between the sac and portions of the right auricle, and often also between the sac and the apex and interventricular septum, that being the portion of the front of the heart that presents the least movement during the action of the ventricles. These soft threads of adhesion are generally drawn out, by the oscillating movements of the heart, until they at length yield, and break away, but sometimes permanent adhesions form, which may be partial or universal.

IX.—Over-Action of the Heart in Acute Rheumatism as a Cause of Endocarditis and Pericarditis; and (in illustration), Over-Action of the Limbs, Local Injury and other Influences, as Causes of Acute Rheumatism with Affection of the Heart.

In a small number of my cases of rheumatic pericarditis the inflammation of the heart commenced soon after laborious, or violent, action of the organ.

A woman (12), aged 26, a servant, was attacked, seven days before admission, with great pain in the soles of her feet. On the following day the pain continued, and proceeded up the legs to the knees and hips, so as to confine her to bed. On the third day she was seized with violent palpitation of the heart, and pain below the lower part of the sternum. On admission her countenance was flushed and anxious, the pulse was 160, and there was pain on pressure over the region of the heart, which was beating with great force. A friction sound was perceptible at the apex with each beat, but indistinctly, owing to the violent action of the organ. The breathing was hurried. Eight leeches were applied over the region of pain, and next day her aspect was better, the action of the heart was natural, the area of dulness on percussion over the region of the pericardium was greatly enlarged, reaching as high as the second cartilage, and friction sound was audible over the whole front of the heart, where the pain was only slight. After this the heart's action became feeble, irregular, and intermittent, but it regained its regularity in eighteen days. The friction sound lasted for about three weeks, and a mitral murmur became permanently established.

Another patient (24), already referred to, a labourer, aged 27, came in with acute rheumatism and endocarditis, presenting first mitral and then aortic regurgitation, both of which became established. He was allowed to get up on the 36th day. On the 48th he looked well, but pain in the hip, a trouble of old standing, had increased in severity. On the 50th the right side of his face was swollen and flushed, and he complained much of stiffness in the muscles of the neck, and next day of great præcordial pain and palpitation, the heart acting strongly and rapidly. On the 52nd he was seized with terrible pain in the neck and head, and the heart's action was so loud that the endocardial murmurs were rendered inaudible, and on the 53rd he suffered from acute pain about the præcordia, the left cartilages were arched, præcordial dulness extended up to the third space, and a loud and harsh double-friction sound was heard over the front of the heart. His attack was of unusual severity, but the rubbing sound had disappeared on the 68th day after his admission, and on the 83rd he was walking about.

A third case (17), a servant girl, aged 20, who was affected with permanent mitral disease owing to a previous attack, was admitted on the fifth day of her illness with severe joint affection, the heart being rapid and its sounds loud. Next day its action was very tumultuous, its impulse was strong, and its sounds were ill-defined, loud, and harsh. Leeches were applied to the chest, and the bleeding from one of the bites could not be restrained. On the 3rd the sounds of the heart were softer; on the 13th the first sound was more rough, on the 16th the impulse was very much diffused, and a murmur was audible over the front of the heart, and next day friction sound was heard over that region, and pericarditis in a severe form was fully established. After this the heart's action became irregular and intermittent, and she looked and felt anxious and depressed. A long, severe, and varying illness followed. On the 55th day she seemed to be sinking, though she thought herself better. On the 58th day she kept nothing on her stomach, but on the 59th she felt better and looked much brighter. Small-pox, however, then in the wards, declared itself on the 62nd day, and on the 63rd she died.

In the first and second of these cases the heart continued to act with increased force during the period of the onset of the pericarditis ; but in the first of them this condition gave way, after the application of leeches, to irregular action of the heart, which lasted for eighteen days. In seven or eight other cases the impulse of the heart was strong during the early period of the inflammation of the exterior of the heart. As a rule, however, the impulse of the heart was feeble when first observed during the attack of pericarditis. The condition of the impulse of the heart during pericarditis will, however, be considered under its proper heading.

If we look at these cases, and especially the first and second of them ; combine with them the six others already given in which pericarditis followed closely upon a relapse in the joint affection, brought on often by getting up too soon ; and add to these the relation that existed in my cases of acute rheumatism, between the severity of the joint affection and the presence, character, and severity of the heart affection, the joint affection being slight in the majority of cases without signs of endocarditis, severe in the majority of cases with simple endocarditis ; and still more severe in the great majority of cases with pericarditis and endocarditis ; the severity of the heart affection corresponding, as a rule, with the severity of the joint affection ; we must, I consider, conclude that we have here not a mere lifeless chain of passive links, but a living succession of active events, one giving birth to the other. Exposure to cold and wet, combined with undue labour or exertion, give the first impulse,—the start, to the affection of the joints. When the joint affection is severe it may call forth excessive labour or even tumultuous action of the heart. In acute rheumatism, inflammation attacks the fibrous structures, especially if those structures are unduly strained, and the increased action of the heart may therefore, I consider, induce inflammation of the fibrous tissues of that organ, such inflammation being proportioned in severity to the augmented action of the heart.

This interesting subject derives larger illustration from the influence, already considered, of *sex, age, and occupation*, in the production of acute rheumatism, accompanied, in proportion to the severity of the affection of the joints, by inflammation of the heart within and without. I need only here again refer to the large number of young female servants, in whom the ends and shafts of the bone are as yet only united by cartilage, who are attacked by acute rheumatism in a severe form ; and the very large proportion in which those cases have endocarditis or pericarditis, or both, the heart being subject in those overworked young women, to undue action and palpitation.

In illustration of the influence of over-action of the heart in producing inflammation of the interior and the exterior of that organ, I shall give here a brief summary of the influence of local injury, scarlet fever, chorea, abscess, and general illness in the production of acute rheumatism with endocarditis and pericarditis, including those cases of acute rheumatism in which a relapse of the joint affection, followed by pericarditis, was induced by the too early use of the limbs, when the recovery was almost but not quite perfect.

Two influences usually combine to produce acute rheumatism ; one, exposure to wet and cold ; the other, the *over-use* of certain limbs and joints. The part immediately in use is usually the part first attacked, while the joints that take the greatest share in the permanent labour of the patient are generally those visited by the disease with the greatest severity and duration. Thus, among the coachmen admitted under my care, one was first attacked in the right thumb, the knees being afterwards affected ; another was seized badly in the right arm, and then in the left ; a third in the wrist and hands ; and a fourth in the hands, and especially the middle finger, the arms, and then the knees, the affection of the fingers being obstinate ; in a fifth the back and hips were the seat of pain ; and in the sixth the ankles, knees, hands, and hips were all involved. If we take the carpenters, we find that one of them was attacked in the arms, wrists, and elbows ; another, who was in search of work, in the arms, back, ankles, and knees ; and a third was seized, when walking, with pain in the knees, the ankles, shoulders and arms being afterwards affected. Young female servants, for to them I must here again refer, who usually work too hard, whose joints are not yet perfect, being still in a state of active growth, are for the most part first attacked in the feet and ankles, that is to say, the parts that more immediately tread the ground. The knees usually then suffer, or perhaps earlier, at the same time as the feet and ankles ; and afterwards the wrists, hands, arms, and shoulders, in succession, share in the affection. The knees, which generally bear not only the internal pressure of standing, but also the external pressure of kneeling when at work, are, as a rule, more constantly and deeply affected, and for a longer period, than any other joint. The effect of past labour is, so to speak, stored up in the knees, which are therefore in these cases more affected in acute rheumatism than any other joint.

Under the combined influence, then, of exposure and overwork, rheumatic inflammation is set up in the joints, and under the combined influence of the disease thus established, and overwork of the heart, rheumatic inflammation is established in that organ.

In a small but important group of my cases, acute rheumatism followed *local injury.* The first of these, a stonemason, fell from a scaffold on his back. He had pain in his back and legs, and could not stand. On the 5th day he had a profuse sour perspiration, and his finger and elbow-joints were red, swollen, and painful. The hips, knees, and shoulders were afterwards attacked, and he probably had endocarditis, the first sound being prolonged, while the second was followed by a soft murmur. The second patient was admitted under Mr. Lane's care for a slight injury, and was attacked on the fourth day with pain in the chest and inflammation of the wrist and ankles. On the 7th he was transferred to my charge with acute rheumatism, mitral murmur, and pericarditis. A third patient, a dustman, hurt his back by carrying a sack of flour. The pain in the back was increased by his getting wet; and this was followed by acute rheumatism. A fourth patient was attacked with the disease in the wrists 32 days after breaking his leg. A fifth came in with acute rheumatism five days after leaving the surgical ward; and a sixth, who was admitted with endocarditis and transient pericarditis, had received a kick in the groin five weeks previously, and since then had been subject to pain in the loins. In some of these cases the disease appeared to be directly, and in others to be indirectly, caused by local injury.

These cases and others given below are allied to those previously given, in which the *too early use of a limb*, during the period of convalescence from acute rheumatism, produced inflammation in the used joint, a *relapse* of the affection in the other joints, endocarditis and pericarditis, ending in permanent crippling of the valves of the heart. The whole of these results, the latter of them so permanently injurious, started from the renewed focus of the disease in the single joint thus affected for the second time.

Through what means is this diffusion and transmission of the disease effected? Is it by a blood poison? Is it by a change in the fibrous structures of the limbs and the heart? Or is it by reflex influences, transmitted through the afferent nerves, locally acted upon in the inflamed joint or injured part, and sent back through the vaso-motor or other nerves distributed to the fibrous structures of the joints and the heart? The local character of the injury inducing this general effect, and the quickness with which the effect is induced, would appear to forbid the material agency of either blood poison or change in the tissues; and would tend to throw us upon the transmission of influences through the nerves for an explanation of these remarkable effects,—effects not less remarkable, but rather more so, that they are open to daily observation; or must we look for some other explanation than any of those here suggested?

We cannot, however, limit ourselves to the points of view just sketched in our inquiry into that many-sided disease, acute rheumatism, with its attendant inflammation of the heart; and I would here briefly state the other influences that have been apparently at work in the origin of the disease, besides overwork and exposure on the one hand, and local injury on the other.

In three of my patients the disease was associated with *scarlet fever*, one of whom had pericarditis in the hospital, one out of it. The latter was the son of a medical friend, who detected symptoms of acute rheumatism just as the scarlet fever was declaring itself, and by which the acute rheumatism was suspended. When, however, the eruption had ceased and desquamation was going on, endocarditis and pericarditis, the offspring of the original rheumatism, declared themselves. This case did well, and though a mitral murmur existed for some time, it at length disappeared. In the two other cases acute rheumatism followed a chill caught by too early exposure after the scarlet fever had disappeared.

In several of my cases, *chorea* has given place to acute rheumatism, or the reverse. In one patient, a girl, acute rheumatism passed into chorea, for which she was admitted. After a time the choreal movements were for a period suspended by the renewal of acute rheumatism. I do not here speak of that terrible complication, the occurrence of serious local choreal and tetaniform symptoms in connection with rheumatic endocarditis and pericarditis, complications to which I shall soon refer.

In three patients the acute rheumatism was preceded by recent *abscess*, in one of them in the axilla, in another in the perineum, and in a third in the tonsil; and in a fourth case abscess in the neck existed some time before the supervention of the rheumatism.

Sore throat appeared for from one day to three weeks before the occurrence of acute rheumatism in thirteen cases, including the case of abscess in the tonsil just quoted. Two of these patients had pericarditis; three had simple endocarditis; in three endocarditis was threatened; and five gave no sign of heart affection.

In eleven patients, *pain in the chest*, sometimes accompanied by cough, existed for from one day to two or even three weeks before the development of acute rheumatism.

I refrain from pursuing this important collateral subject farther in this place.

X.—Pain.

1.—*Pain over the Region of the Heart and Pericardium.*

Pain over the region of the heart and pericardium showed itself in six different ways: 1, Over the front of the organ; 2, On pressure at the same place; 3, In the epigastrium, chiefly on pressure; 4, Over the back of the heart, when it was excited by swallowing and by eructation; 5, After eating ; and, 6, Pain shooting through the heart, evidently anginal in character.

1. The pain over the front of the heart extended usually from the right of the sternum at its lower two-thirds to the left nipple ; it was more or less continuous, and was complained of in three-fourths of the cases (48 in 63). This pain came on in one-fourth of the patients affected with it (9) before the friction-sound was heard, and in a greater number (16, including 5 in which the pain and the friction-sound were both present on the day of admission) at the time that the sound was first audible. In a few instances (7) it was felt soon after the appearance of the rubbing sound. It was either relieved, suspended, or removed by the application of leeches. It was complained of in about one-fourth of the cases (8) at the time the effusion was at its height, but usually relief, which was permanent, came at that time. In two instances (15, 51) of relapse, the second, and in one (44*a*) even a third, wave of increase of pericardial effusion was preceded by a second, and in one even a third attack of pain over the heart ; but in three cases the pain came late in the period of the relapse, and when the effusion was declining. In scarcely any instance did the pain over the heart continue during the whole period of the duration of the friction-sound, and in only two or three of the cases did it last over the first half of that period. When the pain comes on with the first blush of the inflammation on the surface of the heart, before it has spread to the inner surface of the pericardial sac, and before friction-sound is audible, it may be inferred that it is seated in the sentient nerves distributed to the surface of the heart. When, however, the pain strikes over the heart at the same time as the appearance of the friction-sound, and still more when it comes on at a later period, it is generally, I believe, seated in the pericardial sac, and especially in the pleura covering the sac.

The accompanying table gives a *résumé* of the period of the occurrence of pain over the region of the heart in relation to the time of the appearance of friction-sound in the cases of Pericarditis (see page 296.)

2. If the pain over the heart is increased or excited by pressure over the region of the organ, it may, with an approach to certainty, be attributed to inflammation of the pleura, especially if the pain on pressure is complained of, not before, but at the time of or after the first presence of friction-sound.

Pain on pressure over the heart occurred in one-fourth (14 in 63) of the whole number of cases affected with acute rheumatism, and in one-third of those who suffered from continuous pain in the region of the heart (11 in 38). In two only of these cases was the pain excited by pressure before the friction-sound was audible, and in these the pain was probably excited over the surface of the inflamed heart. In one-half of the patients the pain on pressure and the rubbing sound appeared on the same day, and in the rest the pain was preceded by the friction-sound. In most or all of these cases, the pleura covering the pericardial sac, or the fibrous structure of the sac itself, was the probable seat of the suffering (see Tables, pages 296, 297.)

In one-half of those patients (7 in 14) the skin over the region of the pericardium was tender and sensitive, so much so indeed, in some instances, as to forbid the slightest manipulation over the chest, and to make a proper examination of the heart impossible until this exquisite sensibility was subdued by the application of leeches or of belladonna liniment with chloroform.

In the majority of the cases the pain was deeper than the skin, and was not excited unless actual pressure was made. In three of the patients the pain was only felt when pressure was made over the region of the heart; but in all the others continuous pain already existed over that region, and was intensified by the pressure. In one or two instances the suffering and distress over the heart were so great as to drown all other complaints; but in three others, as I have just said, the pain was only brought into play when pressure was exerted. Between these two opposite extremes there was every shade in the extent, variety, and constancy of the pain.

Period of the occurrence of Pain over the region of the Heart and Pericardium in relation to the time of the appearance of Friction Sound in cases of Rheumatic Pericarditis.

Pain over the region of the heart and pericardium, including pain over the epigastrium.	Cases.	
Pain over heart ♡ and friction sound on day of admission	5	
Pain over epigastrium and friction sound on day of (in one day after) admission, included above		4
Pain over heart ♡ before admission, friction sound on admission	4	
Pain over heart ♡ before appearance of friction sound.	9	
Pain over epigastrium before appearance of friction sound, included above		2
Pain over heart ♡ and friction sound occurring on same day	11	
Pain over epigastrium, and friction sound occurring on same day, *not* included above		3
Pain over heart ♡ coming on after friction sound had been observed . .	7	
Pain over epigastrium coming on after friction sound had been observed, *not* included above	2	
Ditto, included above		8
Pain over heart ♡ appearing shortly before relapse (renewed increase of fluid in the pericardium) *not* included above	1	
Ditto, included above		1
Pain over epigastrium before relapse .		1
Pain over heart ♡ late in period of relapse, *not* included above	1	
Ditto, included above		2
Pain over heart ♡ at the time of acme of Pericarditis		8
Pain over heart ♡ shortly before time of acme of Pericarditis		2
Pain of epigastrium at time of acme of Pericarditis		6
Ditto, before acme of Pericarditis . .		4
Ditto, after acme of Pericarditis . . .		4

Pain on pressure over the region of the heart ♡	⇉	o⇉	⇒ or ⇓	No Endo-carditis.	Total.
Appearing before friction sound .	1	...	1	...	2
Appearing same time as friction sound	4	2	...	1	7
Appearing after first indication of friction sound	2	1	1	...	4
Appearing after friction sound had ceased . .	1	...	...	...	1
	8	3	2	1	14

Explanation of Symbols.

← tricuspid regurgitation.

→ mitral regurgitation.

↓ aortic regurgitation.

→↓ mitral-aortic regurgitation.

Table showing the proportion in which Pain was present over the region of the Heart ♡, in the Side, and in the Chest, in 326 *cases of Acute Rheumatism.*

(This table is continued on the following two pages.)

CASES WITH PERICARDITIS.

Explanation of Symbols.

- ← tricuspid regurgitation.
- → mitral regurgitation.
- ↓ aortic regurgitation.
- →↓ mitral-aortic regurgitation.
- ⇒ mitral valve-disease.
- ⇒ ⇓ mitral-aortic valve-disease.

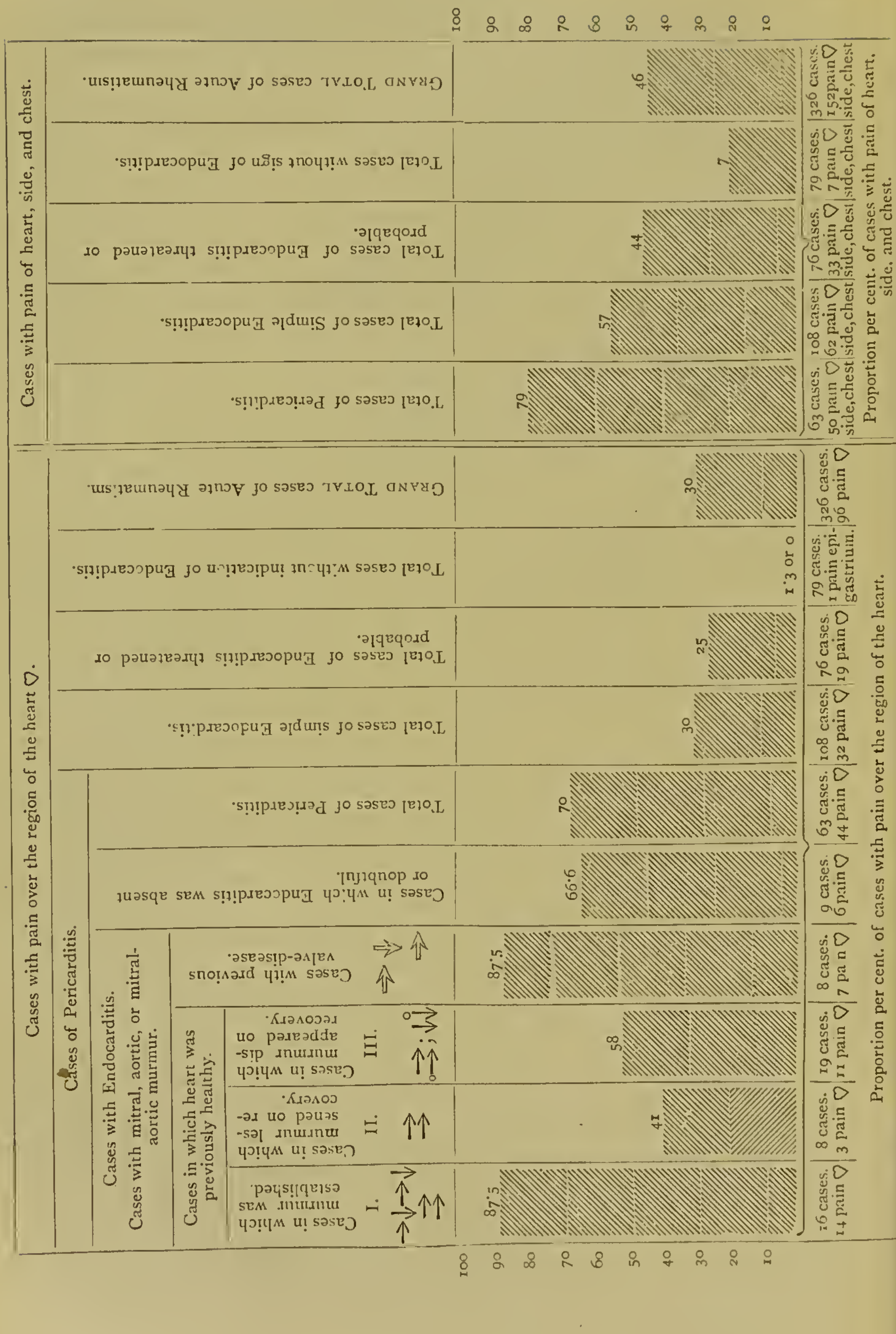
	Cases with Endocarditis. Cases with tricuspid murmur, valves previously healthy.	Cases with mitral, aortic, and mitral-aortic murmur. Cases in which the valves were previously healthy. I. Murmur established on recovery from acute rheumatism. →↓→↓		II. Murmur lessening on recovery.		III. Murmur disappearing on recovery. →↓→↓		Cases with previous valve disease. ⇒ ⇒ ⇓		Cases in which Endocarditis was absent or doubtful.		TOTAL cases of Pericarditis.		TOTAL CASES WITH SPECIAL CONDITIONS.
Total of each class of cases	3	16	...	8	...	19	...	8	...	9	...	63	...	...
Cases with pain over the region of the heart ♡	2	12	...	3	...	11	...	5	...	5	...	38	...	38
Pain on pressure over the heart, included above	...	...	5	...	1	...	3	...	1	...	1	...	11	14
Pain on pressure over the heart, *not* included above	1	1	...	...	...	...	...	1	...	...	...	3	...	
Pain shooting through the heart, included above	...	...	2	...	...	...	1	...	3	...	...	...	6	6
Pain in the epigastric space (Pain seated in pericardium), included above	...	...	9	...	...	...	4	...	1	...	...	...	14	16
Pain in the epigastric space (Pain seated in pericardium), *not* included above	...	1	...	...	...	...	...	...	...	1	...	2	...	
Pain in the abdomen. Pain not noted in epigastrium, included above	...	...	1	...	...	...	1	...	2	...	1	...	5	5
Pain at back of pericardium, from swallowing, included above	...	...	2	...	1	...	3	...	1	...	...	...	7	
Difficulty in swallowing, without note of pain, included above	...	...	3	...	1	...	2 *or* 1	...	...	...	1	...	7 *or* 6	14 or 13
Pain in back of pericardium, from retching, included above	...	...	1	...	...	...	...	...	...	...	...	...	1	1
Pain in back of pericardium, from eructation, *not* included above	...	...	...	...	...	...	...	1	...	...	...	1	...	1
TOTAL cases with pain in the region of the heart ♡ and pericardium, including the epigastrium	3	14	...	3	...	11	...	7	...	6	...	44	...	
Pain of side, included above	...	...	10	...	1	...	8	...	7	...	1	...	27	31
Pain of side, *not* included above	...	1	...	1	...	1	...	...	...	1	...	4	..	
Of these the pain was in the left side in	...	7	...	2	..	4	...	4	...	2	...	19	...	31
,, ,, right side in	...	1	...	...	...	3	...	1	...	..	...	5	...	
,, ,, both in right and left sides in	...	3	...	..	...	2	...	1	...	...	...	6	...	
,, ,, of uncertain situation in	...	...	...	...	...	...	...	1	...	..	...	1	.	
Pain of chest, included above	...	...	9	...	1	...	9	...	5	...	4	...	28	30
Pain of chest, *not* included above	...	...	...	...	...	1	...	1	...	...	...	2	...	
Leeches to region of heart, without note of pain, included above	...	...	1	...	...	...	...	...	1	...	...	...	2	6
Leeches to region of heart, without note of pain, *not* included above	...	...	...	1	...	2	...	...	...	1	...	4	...	
Tightness of chest, without note of pain over the heart, included above	...	...	...	...	...	...	1	...	...	...	...	...	1	2
Tightness of chest, without note of pain over the heart, *not* included above	...	...	...	...	...	1	...	...	...	...	..	1	...	
TOTAL of the above	...	15	...	5	...	16	...	8	...	8	...	55	...	
No note of pain over heart, side, or chest, *not* included above	...	1	...	3	...	3	...	...	...	1	...	8	...	
GRAND TOTAL	3	16	...	8	...	19	...	8	...	9	...	63	...	

Table (*continued from p.* 297) *showing the proportion in which Pain was present over the*

	Cases with Endocarditis.								
			Cases with mitral, aortic, and mitral-aortic murmurs.						
			Cases in which the valves were previously healthy.						
			Cases with mitral murmur.			Cases with aortic murmur.		Cases with mitral-aortic murmur.	
	Cases with prolonged first sound.	Cases with tricuspid murmur.	I. Murmur established on recovery from acute rheumatism.	II. Murmur lessening on recovery.	III. Murmur disappearing on recovery.	I. Murmur established on recovery.	III. Murmur disappearing on recovery.	I. Murmur established on recovery.	III. Murmur disappearing on recovery.
Total of each class of cases . . .	2	13	18	11	24	5	5	5	2
Pain over the region of the heart . .	1	4	7	2	4	...	2	1	1
Pain on pressure over the heart — included above . .	...	...	...	1	...	...	...	...	...
— *not* included above .	...	...	...	1	...	...	...	...	...
Pain shooting through heart . — included above . .	...	...	...	...	1	...	...	...	...
Pain in epigastrium . . . . — included above . .	...	...	1	...	...	...	...	...	...
— *not* included above .	...	...	...	...	1	...	...	...	...
Pain in abdomen not noted in epigastrium. . — included above . .	...	...	...	...	...	...	...	...	...
— *not* included above .	...	...	...	1	...	...	...	...	...
Pain in pericardium from swallowing . — included above .	...	...	...	...	...	...	...	...	...
Swallowing difficult, no note of pain . . — included above .	...	...	...	...	...	...	...	...	...
Pain in pericardium from retching . . — included above .	...	...	...	...	...	...	...	...	...
Pain in pericardium from eructation . . . — *not* included above .	...	...	...	...	...	...	...	...	...
TOTAL cases with pain over heart and pericardium	1	4	7	3	5	...	2	1	1
Pain of side . . — included above . .	...	2	1	3	3	...	...	...	...
— *not* included above .	...	2	1	...	2	1	2	2	...
Of these, pain in left side in	...	3	2	1	4	1	1	1	...
,, ,, right side in . . .	...	1	...	1	1	...	...	1	...
,, ,, right and left sides in	...	...	...	...	...	...	...	...	...
,, ,, of uncertain situation in	...	...	...	1	...	...	1	...	...
Pain of chest . . — included above . .	...	1	5	...	2	...	...	...	...
— *not* included above .	1	1	2	2	3	1	...	...	...
Leeches over heart no note of pain — included above . .	...	...	1	2	...	...	...	...	...
— *not* included above.	...	...	1	...	1	...	...	...	...
Tightness of chest, included above . .	...	...	...	...	...	...	...	...	...
No note of pain over heart . . — *not* included above .	...	...	...	...	...	...	...	...	...
Total of the above	2	7	11	5	11	2	4	3	1
No note of pain over heart . . — *not* included above .	0	6	7	6	13	3	1	2	1
GRAND TOTAL	2	13	18	11	24	5	5	5	2

region of the Heart ♡, in the Side, and in the Chest, in 326 cases of Acute Rheumatism.

Cases with Endocarditis.											
Cases with mitral, aortic, and mitral-aortic murmurs.											
Cases in which the valves were previously healthy.				Cases with previous valve disease.							
Combined cases with mitral, aortic, and mitral-aortic murmurs.				Cases with							
I. Murmur established on recovery. →→; ↓↓ →↓→↓	II. Murmur lessening on recovery →→; ↓↓ →↓→↓	III. Murmur disappearing on recovery. o→→; ↓o↓ →↓o→o↓	Total cases with valves previously healthy.	Mitral valve-disease. ⇒	Aortic valve-disease. ⇓	Mitral-aortic valve-disease. ⇒ ⇓	Total with previous valve-disease. ⇒; ⇓ ⇒ ⇓	Total cases of Endocarditis.	Cases with Endocarditis threatened or probable.	Cases with no indication of Endocarditis.	Grand Total of cases of Acute Rheumatism. (For cases of Pericarditis (see p. 297.)
28	11	31	70	9	3	11	23	108	76	79	326
8	2	7	17	3	2	3	8	30	14	...	82
1	1	...	2	...	...	...	...	2	...	...	13} 18
...	1	...	1	...	...	...	...	1	1	...	5
...	...	...	...	...	...	...	...	1	...	...	7
1	...	...	1	...	...	1	...	2	3} 7	...	19} 27
...	...	1	1	...	...	...	...	1	4	1	8
...	...	...	...	...	...	...	...	...	3	...	8} 11
...	...	...	...	...	...	...	...	...	...	2	3
...	...	...	...	...	...	...	...	...	...	...	7 } 14
...	...	...	...	...	...	...	...	...	...	...	7 or 6 } or 13
...	...	...	...	...	...	...	...	..	...	...	1 1
...	...	...	...	...	...	...	...	...	...	...	1
8	3	8	19	3	2	3	8	32	19	1 *or* 0	96
1	3	3	7	2	1	2	5	14} 26	5} 17	1} 3	47} 77
4	...	4	8	1	...	1	2	12	12	2	30
4	1	5	10	...	...	1	1	14	6	1	40
1	1	1	3	...	...	2	2	6	7	...	18
...	...	...	...	2	...	1	3	3	2	...	11
...	1	1	2	...	1	...	1	3	2	2	8
5	...	2	7	4	1	2	7}	15} 33	2} 4	...	52} 76
3	2	3	8	2	1	5	8	18	2	2	24
1	2	...	3	...	...	...	...	3} 5	...	...	5} 11
1	...	1	2	...	...	...	...	2	...	...	6
...	...	...	...	...	...	...	...	...	...	...	1
...	...	...	...	...	...	...	...	...	...	...	1} 2
16	5	16	37	6	3	9	18	64	33	5	157
12	6	15	33	3	0	2	5	44	43	74	169
28	11	31	70	9	3	11	23	108	76	79	326


Cases with pain over the region of the heart ♡.
Cases of Pericarditis.
Cases with Endocarditis.
Cases with mitral, aortic, or mitral-aortic murmur.
Cases in which heart was previously healthy.
I. Cases in which murmur was established.
II. Cases in which murmur lessened on recovery.
III. Cases in which murmur disappeared on recovery.
Cases with previous valve-disease.
Cases in which Endocarditis was absent or doubtful.
Total cases of Pericarditis.
Total cases of simple Endocarditis.
Total cases of Endocarditis threatened or probable.
Total cases without indication of Endocarditis.
Grand Total cases of Acute Rheumatism.
87·5
41
58
87·5
66·6
70
30
25
1·3 or 0
30
16 cases. 14 pain ♡
8 cases. 3 pain ♡
19 cases. 11 pain ♡
8 cases. 7 pain ♡
9 cases. 6 pain ♡
63 cases. 44 pain ♡
108 cases. 32 pain ♡
76 cases. 19 pain ♡
79 cases. 1 pain epigastrium.
326 cases. 96 pain ♡
Proportion per cent. of cases with pain over the region of the heart.
Cases with pain of heart, side, and chest.
Total cases of Pericarditis.
Total cases of Simple Endocarditis.
Total cases of Endocarditis threatened or probable.
Total cases without sign of Endocarditis.
Grand Total cases of Acute Rheumatism.
79
57
44
7
46
63 cases. 50 pain ♡ side, chest
108 cases. 62 pain ♡ side, chest
76 cases. 33 pain ♡ side, chest
79 cases. 7 pain ♡ side, chest
326 cases. 152 pain ♡ side, chest
Proportion per cent. of cases with pain of heart, side, and chest.
100
90
80
70
60
50
40
30
20
10

3. Pain was present over the epigastric region, frequently increased and sometimes induced by pressure, in one-fourth of the patients with rheumatic pericarditis (16 in 63), and in nearly two-fifths of those who suffered from pain over the region of the heart (14 in 38). It would appear curious, at first sight, that pain over the pit of the stomach should be a marked feature in so many cases of pericarditis. When, however, we consider that in health the lower boundary of the heart is situated behind the upper third of the ensiform cartilage, and that the pericardial sac, when distended with fluid in pericarditis, dips downwards so that its lower boundary may be on a level with the point of that cartilage, or perhaps even below it, we see how natural it is that pain should be excited by pressure over the epigastric region (see Tables, pages 297-300).

This epigastric pain appeared in only two cases before the supervention of friction sound. Those two patients, however, suffered from a renewal of the pain after the commencement of the rubbing sound, consequently in every case the suffering over the pit of the stomach was complained of either at the time of the first observation of the friction-sound (7 in 16, including 4 in which the pain and the friction-sound were both present on the day of admission), or from one to several days later (9 in 16).

In one-third of the cases (6) the epigastric pain appeared at the time when the effusion into the pericardium was at its height, and when the sac bulged downwards into the epigastric space; and in four of them it was complained of before, and in four of them after, the effusion had reached its acme.

In all these cases the disease had reached a stage in which the heart was separated by the intervention of fluid from the floor of the pericardial sac, which is formed by the central tendon of the diaphragm. The pain in the epigastric region in these cases, especially when it is increased or excited by pressure, is therefore seated not in the surface of the heart, but in the lower portion of the pericardial sac. It is natural to suppose that the branches of the phrenic nerve must be the immediate seat of the pain, but the exact anatomical distribution of the phrenic nerve has not yet been ascertained. These questions suggest themselves: is the pain seated in the fibrous tissue, the pericardial surface, or the peritoneal surface of the affected diaphragmatic portion of the sac?

Peritonitis affecting the central tendon of the diaphragm has been noticed in few or no fatal cases of pericarditis, but indirect evidence of its existence has been supplied in rare instances by the discovery of partial adhesions of the spleen and liver to the diaphragm in cases with adherent pericardium. We may however, I think, fairly infer that the pain on pressure below or at the side of the ensiform cartilage is in these cases due, not to peritonitis, but to inflammation of the fibrous structure and pericardial or inner surface of the central tendon of the diaphragm, where it forms the floor of the pericardial sac, and the lower and anterior portion of that sac.

The distribution of the nerves to the pericardium, like that of the phrenic nerve, has not yet been ascertained, and this interesting clinical question therefore invites the attention of the physiologist.

4. In three of the patients affected with rheumatic pericarditis deep pain was felt between the shoulder-blades, and in one of them this pain was increased by the act of swallowing. Pain in the chest was excited in three cases by swallowing, and in two others it was complained of there after eating. Another patient complained that the ascent of wind from the stomach gave much pain over the posterior region of the heart. In all these instances, amounting to nine, the suffering must have been seated in the back of the inflamed pericardium,

being either constant or induced by local pressure, due to swallowing or eructation. In several other cases it is stated that pain was seated in the back, but it is impossible to say, from this description, whether the pain was situated in or near the pericardium or lower down.

5. Pain and fulness after eating was complained of by one patient, and I think it likely that the suffering in this instance was excited by the pressure made by the distended stomach over the lower and back part of the pericardium.

We thus see that in a large proportion of my cases affected with rheumatic pericarditis, pain was felt over the heart, frequently in front of the pericardial sac, and occasionally behind and below it, the pain being usually fixed, sometimes increased by pressure, and less often excited by it.

6. The heart itself was attacked with a shooting pain, more or less violent, associated either with faintness or failure in the action of the organ, and evidently anginal in character, in four of my patients affected with rheumatic pericarditis.

In two of these cases the heart, already crippled by valvular disease, was attacked with inflammation within and without, but in the others the pericarditis and endocarditis seized upon the virgin heart, the valves being previously healthy; one of these two cases proved fatal, and in the other valvular disease became established.

In the fatal case (4), a man, aged 27, a carpenter, a darting pain passed now and then from the heart to the right side on the day of his admission. This pain was relieved by leeches, the application of which was followed by faintness. On the 3rd his limbs started when he fell asleep; on the 6th he was seized with delirium and trembling; and on the 7th, the day of his death, he was noisy and restless, and was continually moving his lower jaw.

Another patient (15), a servant girl, suddenly became very faint on the evening of the 10th day, when she was suffering from a relapse of pericarditis, and was attacked with great pain over the heart. This pain returned on the evening of the 12th, when it was also felt between the shoulders.

One (3) of the two remaining patients had old standing aortic and mitral disease, and suffered from pain over the region of the heart on the 10th day, when friction-sound appeared. On the 16th day, when the pericarditis was at its height, when I was examining him, he cried out as if from pain, beginning over the stomach, and begged to be raised up, the dyspnœa becoming extreme, the face being flushed, the perspiration pouring off it, the lips somewhat livid, and his countenance being expressive of extreme anxiety. He was immediately raised up, and, having a towel placed behind him, was as it were slung in it, when he took a little port wine and fell asleep.

The other patient (17), a young woman, affected with old mitral disease, was attacked on the 17th day, when the pericarditis was at its acme, with great pain over the sternum and the whole front of the chest, the pain passing through to the back. She ultimately died on the 63rd day, with small-pox, which attacked her when in a state of extreme exhaustion.

If we add to the cases in which there was continuous pain over the region of the heart (38), those others not so affected in which *a*, there was pain on pressure over the heart (3); *b*, pain over the epigastric region (2); and *c*, pain at the back of the pericardium on eructation (1); we find that in 44 of the 63 cases of pericarditis, or in 70 per cent., there was pain over the heart or pericardium.

2.—*Pleuritic Pain in the Side.*

Pain in the side was complained of in one-half of the cases of rheumatic Pericarditis (31 in 63). Pain was present over the region of the heart and pericardium also in all but 4 of these patients. The pain was limited to the left side in 19 cases, and to the right in only 5, while it attacked both sides in 6 instances. There were, besides the pain, other symptoms or physical signs of pleurisy in all but 7 of the patients thus affected.

Pleuritic friction-sound was heard in nearly one-half of those cases (15 in 31), and in five others there was tenderness on percussion over the seat of pain. In a large proportion of the cases the pain was increased or excited by a deep breath (18 in 31), and in four of these it was catching. The pain was induced by coughing or laughing, stooping or moving, in fourteen instances, and in three it was "pleuritic" or cutting.

The first complaint of pain in the side was made after the appearance of the friction-sound in 19 of the 31 cases that suffered in this manner; the pain and the friction-sound appeared together in seven patients; and the pain occurred before the friction-sound in five. In one of the five, and three of the seven patients just spoken of, the pain affected both sides, having appeared at a late period in one side, and at a period actually or comparatively early in the other.

The pleurisy that induced the pain in the side which came into play either with or after the friction-sound was due to two causes: one, the extension of the inflammation through the fibrous structure of the pericardium to the pleura covering it; the other, the occurrence of pulmonary apoplexy with its attendant pleurisy.

The more frequent appearance of the pain, and the greater spread of the pleurisy on the left side of the chest than the right is, I conceive, due in many instances to the greater extent to which the inflamed pericardium occupies the left side of the chest than the right, and the great displacement backward of the left lung, and especially its lower lobe, by the distension of the pericardial sac. Perhaps the pressure of the distended pericardium on the left bronchus increases the tendency of the left lung to inflammation.

In one of the five patients that were seized with pain in the side before the supervention of the friction-sound, the pain came on at the first onset of the disease, and at the same time as the affection of the joints, three days before admission. I think it likely that this case was attacked with pleurisy and acute rheumatism affecting the joints at the same time, the pleurisy being, however, rheumatic in its nature, like the joint affection in this instance, and like the pericarditis in the other cases. We may have, in short, in these cases, rheumatic pleurisy, just as we may have rheumatic pericarditis.

In another of these cases (20), the patient, a married woman, aged 24, was attacked with pain in the joints the day after being wet through, and a week before admission. She came in with very severe pain in the left side, which had existed for some days, and which was somewhat reduced by leeching. On the 6th day after admission she suffered much in the left side, and a pleuritic friction-sound was audible just below the seat of pain. Friction-sound from pericarditis was heard over the region of the heart for the first time on the same day. In this case the pleurisy preceded the pericarditis by ten days.

Pain in the side was, in proportion, twice as frequent in pericarditis usually accompanied with endocarditis as in simple endocarditis ; one-fourth of the latter (26 in 108), and as we have just seen, one-half of the former (31 in 63) being thus affected. A similar proportion of such cases existed among the patients who were threatened with endocarditis, of whom rather more than one-fourth were affected with pain in the side (17 in 63). None of the thirteen cases classed under the heading of "probable endocarditis" suffered from pain in the side, and only three of those who were attacked with acute rheumatism and had no endocarditis complained of pain in that region (3 in 71). The pain more frequently attacked the left side than the right in the cases of endocarditis in the proportion of 14 to 6; but among those threatened with endocarditis, the two sides were affected in nearly equal numbers, the right side being rather more often attacked than the left in the proportion of 7 to 6.

3.—"*Pain in the Chest.*"

"Pain in the chest" was present in 30 of the 63 cases of rheumatic pericarditis. The pain thus described is so indefinite in situation, that it may be seated either at the centre of the chest or at its sides, either over the pericardium or the pleura. Fortunately, to guide us to the actual seat of suffering, the "pain in the chest" was attended in all but two instances with other pain, either over the heart, or in the side, or in both regions. Thus in all but four of the thirty cases pain was present over the region of the heart or the epigastrium; in all but nine, in the side; and in one-half of them (16 in 30) it was situated both over the heart and in the side.

In fully one-half of the cases (17 in 30) the pain in the chest was itself associated with symptoms of pleurisy, in the way of being increased or caused by deep breathing, or coughing, or moving, or it was a cutting pain, or it was accompanied, in two instances only, by pleuritic friction-sound. There were symptoms of pleurisy in eight of the nine cases in which pain of the chest was not associated with pain of the side, and I think those eight cases may be added to the 31 in which pain in the side was actually present, thus bringing their number up to 39 in 63 cases of rheumatic pericarditis. On the other hand, there were four cases with pain in the chest in which there was no notice of pain in the heart, and I think that these four cases may probably be added to those in which the presence of cardiac pain is stated ; thus bringing the total number so affected up from 44 to 48 in 63.

Eleven patients suffered from pain in the chest, either previously to admission or before friction-sound was audible. In the greater number of these I think that the pain was seated over the region of the heart, and was not due to pleurisy. And I find, giving strength to this view, that in all of these but two pain was described as being present over the heart.

It would be futile to compare the relative frequency of pain in the chest in pericarditis, and in the other various groups of cases in acute rheumatism, since to do so would be to compare unlike conditions under the same name. But it will be instructive to compare the proportion of cases attacked with pain over the heart, in the side and in the chest, combined together, with those in which there was no such pain, in cases of acute rheumatism with pericarditis and endocarditis, and with and without simple endocarditis. The accompanying table, and graphic scheme, will show this comparison, the one by study, the other at a glance (see pages 296—300).

In those affected with pericarditis, most of whom had endocarditis also, four-fifths had pain in the heart, chest, or side, and one-fifth had no such pain; in those with endocarditis nearly six-tenths had such pain and over four-tenths had none; in those threatened with endocarditis, less than one-half had pain, and more than one-half had none; and in those who gave no sign of endocarditis only one-tenth suffered from this kind of pain, and nine-tenths had no internal pain, thus nearly reversing the proportion that we find in cases affected with pericarditis.

XI. Irregularity and Failure of the Action of the Heart. Faintness.

We have already seen that in two of the patients the action of the heart, which was powerful and tumultuous before the occurrence of pericarditis, became at a later period feeble, irregular, and intermittent, this state being accompanied by a look of great anxiety and depression. We have also seen that the four patients who were attacked with pain shooting through the heart experienced faintness or failure in the action of the organ (p. 302).

In the following case (13) death took place from syncope. A female servant, aged 25, came in on the 7th day of her illness, with difficult, hurried breathing, which was relieved when she was raised; great pain in her chest, cough, which had continued from the 2nd day of the attack; mucous rattle, slightly rusty phlegm, a sensation of choking, difficulty in swallowing, and great anxiety. The joint affection was slight, and apparently limited to the shoulder. Pericarditis, with friction sound and great effusion, was at its height. She was very ill throughout, perspiration being profuse, the voice husky, the face flushed and anxious, and breathing laborious. Her face was brighter, and she breathed with ease from the

7th day to the 13th, when her appetite was improving; but at two hours after midnight, in the early morning of the 14th, when attempting to turn on her side, she became quite pulseless, her face turned livid, and she frothed at the mouth. After taking some wine she gradually recovered. An hour later the sounds of the heart were muffled, and the rubbing noise, which had been harsh, loud and dry, on the previous day, could not be detected. In another hour she had a similar attack, in which she died. There were 18 ounces of fluid in the pericardium, the heart was covered with honey-comb lymph, and there were patches of pulmonary apoplexy in the left upper lobe.

Faintness occurred as a symptom in several of the cases, but in none, besides those alluded to and that just given, did it appear in a threatening form.

Although, as we have already seen, in a few cases the action of the heart was unusually strong during the early period of pericarditis, yet even then, or rather when the attack was first observed, the impulse of the heart was more frequently feeble than strong, and this was especially the case during the remaining course of the affection.

Feebleness, irregularity, and even failure of the heart's action may evidently be induced in these cases by several influences working separately or together, and by the exhaustion of the nervous and general forces induced by the accumulated effect of those influences, all tending to lower and exhaust the power of the heart, and even, as in the case just told, to arrest its action. Among such influences are, the pain and inflammation of the joints when severe, extensive, and prolonged; the pain in the heart and pericardium, the side, and the chest; the existence of endocarditis with its immediate and remote consequences; the presence of previous valvular disease; the grave influences exerted by great distension of the pericardium, which—by compressing the venæ cavæ, the pulmonary veins, both auricles, and the aorta, impedes the supply of blood through the venæ cavæ and pulmonary veins to both sides of the heart, and through the aorta to the system, and causes the accumulation of blood in the lungs,—by pressing upon the bifurcation of the trachea and the left bronchus, and by lessening the size of the lungs, seriously embarrasses respiration—and by compressing the œsophagus, renders deglutition difficult; and the existence of congestion of the lungs, of pulmonary apoplexy and pleurisy, due to one or more of the causes just named.

Besides these, there are two important influences that may induce feebleness, irregularity, and perhaps even failure of the action of the heart: one, the inflammation of the superficial muscular fibres of the heart: the other, the inflammation of the nerves situated at the surface of the heart and great vessels. Inflammation of the superficial muscular fibres of the heart, which sometimes occurs in pericarditis, paralyses the affected fibres. This paralysis of the inflamed fibres must in itself embarrass the action of the heart, especially when we consider that those superficial fibres turn inwards by a double entrance at the apex, to become the innermost fibres of the left ventricle, where they end in the papillary muscles of the mitral valve. But this influence cannot be limited to those fibres, but must extend in a varying degree to the other muscular structures of the organ so as to interfere with the exercise of their power; just as inflammation of certain limited fibres of a voluntary muscle, say the biceps, while it paralyses those fibres, interferes with the exercise of the whole muscle.

The many and important nerves situated at the surface of the heart and great vessels may be more or less involved in the inflammation affecting those parts in pericarditis. That accurate physiologist, Dr. Burdon Sanderson, remarks, "that nothing is known either as to the anatomical distribution of nervous elements in the hearts of mammalia, or as to the functions which they perform."[1] When, however, we consider that electrical or other excitation of the vagus retards the contractions of the heart, and, if it is strong enough, arrests the organ in diastole, and in the dog lessens arterial pressure, while division of the vagi produces acceleration of the contractions of the heart, and in the dog increased arterial pressure; that the lower cervical ganglion of the sympathetic exercises an accelerating influence, not always in action, on the contractions of the heart; and that in the frog, the ganglion cells contained in the heart are the springs of its automatic movement; and that the surface of the heart is rich in nerves connected with the vagi, the sympathetic and the intrinsic ganglia of the heart, and that those nerves are therefore locally affected by the inflammation in pericarditis; we must, I consider, conclude that this affection exercises in such cases an important influence, either to stimulate or to injure those nerves, and so to accelerate or retard the contractions of the heart, to excite or, more frequently, depress the powers of the organ, and to increase or diminish arterial pressure. It is for the physiologist to ascertain, by direct experiment, the effect of the inflammation or irritation of those nerves on the functions of the heart.

It is right that I should mention another depressing influence on the action of the heart in pericarditis, accidentally due, in the case about to be referred to, to treatment. In one case (17) already given at page 287, the loss of blood due to irrepressible hæmorrhage from a leech-bite seemed to produce serious irregularity of the action of the heart.

[1] *Handbook for the Physiological Laboratory*, p. 263.

XII. Difficult and Quickened Respiration.

Respiration was disturbed to a marked degree in 49 of the 63 patients affected with rheumatic pericarditis; it was slightly or not at all affected in 3, and in 11 its character was not recorded. The pericarditis was severe in 2 only of the 11 cases in which the state of the respiration was not noticed, and in none of the 3 in which the breathing was but slightly affected; but the attack was severe in 37 of the 49 patients in whom the respiration was markedly disturbed.

The respiration was rendered difficult and quick by three or four local causes: first, in order of time, the inflammation of the heart, without and within, and of the pericardial sac, including the central tendon of the diaphragm, and the accompanying pain in the heart, the sac, and the diaphragm, with the consequent restraint imposed upon the movements of the latter; after this, the distension of the pericardial sac with fluid, which greatly enhanced the severity of the symptoms; and, at a later period, the supervention of pleurisy with its attendant permanent pain and stitch in the side, or of pulmonary apoplexy, often accompanied by pleurisy. The breathing is hurried, and rendered laborious by distension of the pericardium, often so as to demand a raised posture owing to two causes, one, the encroachment of the swollen sac upon both lungs, and especially upon the lower lobe of the left one; the other, the direct pressure, backwards and upwards, exerted by the fluid in the tense pericardium on the trachea at its bifurcation, and on the left bronchus, a pressure that is materially relieved by the erect posture, and still more by the forward attitude which throws the volume of the liquid forwards and downwards towards the diaphragm and away from the trachea.

There was great distress, difficulty, and rapidity of respiration in 24 of the cases of rheumatic pericarditis, and in one-half of them it is recorded that the patient was raised or propped up. The attack was fatal in 4 of those patients, and severe in 18, being very severe in 11.

One of those cases (3), a sawyer, aged 26, who had aortic and mitral valve-disease of old standing, came in feeling low and anxious, and was delirious at night. On the 5th day he was better, the respirations being 20 in the minute ; but on the 10th he had pain and friction-sound over the heart, and the respirations rose to 30 in the minute. The dulness over the pericardium increased, and reached its acme on the 19th. On the 16th he was seized with extreme and urgent dyspnœa, which was relieved when he was raised. The respirations were 70 during the attack, and fell after it to 35 ; on the 18th they varied from 36 to 44, and on the 21st, when the pericardial dulness had greatly lessened, they had fallen to 28 in the minute.

A man (24), whose case I have already given, had pericarditis with rubbing sound on the 53rd day, the pericardial effusion being at its height on the 57th. On the 55th the respirations were 44 in the minute, and he had extreme difficulty in breathing, which was relieved by the upright posture. On the 58th the pericardial effusion had lessened, the respirations had fallen to 24, and he breathed easily in the recumbent posture.

Another patient (36), a servant girl, breathed 32 times in a minute on admission, as well as on the 7th day, when leeches were applied over the region of the heart. On the 8th friction sound appeared, and the effusion was at its height next day, when the respirations were 52, and on the 10th her head and shoulders were propped up. On the 11th the effusion had lessened, and her breathings numbered 40. On the 14th there was pleuritic pain, followed by friction sound, and the respirations rose to 48; but on the 20th, when there was no pain in the chest, they had fallen to 24.

In the following case (38), a female servant, the breathing rose in frequency a second time during a second wave of increased pericardial effusion. On the 6th the respirations were 28 in the minute; on the 7th they were 40; on the 9th friction sound was heard over the heart, and on the 10th the pericardial dulness was at its height. On the 12th the effusion had lessened; she was in a raised position breathing more freely, 40 times in a minute; but on the 17th the fluid in the pericardium had again attained to the full; she had pulmonary apoplexy and pleurisy, and the respirations mounted up to 66; but next day, with a renewed diminution of the fluid, there was a renewed lowering of the respirations to 44.

I would gladly illustrate this point by additional cases, but shall limit myself to one more instance (55) that shows the effect on the breathing of pulmonary apoplexy and pleurisy in cases of rheumatic pericarditis. A young man was admitted with pain in the chest and shortness of breath. On the 2nd day friction-sound was heard, and pericardial effusion had already reached its acme; leeches gave relief, and the breathing was more free; but on the 6th he had a stitch in the side, and the respirations numbered 60 in the minute; on the 8th, when he was easier, they were 46; but on the 13th pulmonary apoplexy was established, and they had risen to 72. On the 17th he had diphtheria, the respirations being 50; on the 28th this was nearly well, and he raised little phlegm, the respirations being 36, and on the 35th they were 28.

We thus see that with pain over the heart and pericardium, the breathing is hurried and distressed, while it is slackened and relieved with the relief of the suffering; that with the rise and fall of pericarditis, with the increase, the acme, and the decline of pericardial effusion, we have an increase, an acme, and a decline in the number of the respirations; that a second wave of increase in the amount of pericardial effusion leads to a second wave of increase in the number of the respirations; and that the respirations are also again accelerated, if, in the later progress of the case, pleurisy should spring up from the spreading of the pericardial inflammation; or if pulmonary apoplexy should declare itself, especially if combined, as it usually is, with notable pleurisy.

XIII. Difficulty in Swallowing.

There was difficulty or pain in swallowing in 13 of my cases of rheumatic pericarditis.

I have already spoken of cases in which the act of deglutition caused pain over the back of the inflamed pericardium, generally complained of, however, in the chest, by the pressure of the morsel of food upon the inflamed structures during its descent along the œsophagus, where it passes behind the affected region.

The difficulty in swallowing, of which I now speak, occurs when the pericardial sac is distended to the full with fluid, and is caused by the compression of the œsophagus between the swollen sac and the spinal column. When the effused fluid lessens, the pressure diminishes, and swallowing becomes easy; but it becomes again difficult when a relapse takes place and the effusion again increases.

When the patient lies flat, the weight of the fluid in the pericardium falls backward with full pressure upon the œsophagus, and deglutition becomes more difficult; when, however, he is raised into the sitting posture, and especially if he leans forwards, the volume of the liquid tends forwards and downwards, and swallowing is more easy.

A servant girl (15), aged 16, who had been ill about three weeks, came in suffering much both in the joints and the chest. Her breathing was laborious and very rapid; she looked anxious; dulness was increased over the pericardial region, and a soft friction sound was audible over the heart on pressure. On the 3rd day the amount of effusion in the pericardium had reached to its acme; swallowing was difficult, breathing was accelerated, her face was livid and anxious, she had pain in the epigastrium, increased by pressure, and the veins of the neck were full. On the 5th she still had much difficulty in deglutition, but on the 8th the pericardial dulness had lessened all round, and she swallowed much more easily. On the 9th she was more bright and lively, the pericardial dulness had lessened much, but pain came in catches over the heart. On the evening of the 10th she had a relapse, she became suddenly faint, her lips turned blue and dusky, and she had great pain over the heart, which was soon relieved, but difficulty in swallowing returned. Next day the dulness over the pericardium had again increased, and the difficulty in swallowing was very great. On the 12th she was still very ill, but she could swallow more easily, and on the 15th the effusion into the pericardium had again lessened, and she was better. The friction sound was audible until the 17th day. She improved daily and gained strength.

The poor female servant (13), who died from sudden failure in the action of the heart, whose case I have just related (p. 309), on the day of her admission, when the amount of effusion into the pericardium was great, swallowed more easily when the shoulders were raised than when she was lying flat.

One patient (44*a*), a female servant, had a fourfold attack of difficulty of swallowing—on the 2nd day after admission, from great distension of the pericardium, the effect being heightened by shortness of breath ; on the 4th by diphtheria ; on the 7th from a renewed increase in the effusion owing to a relapse, there being great distress in the chest ; and on the 11th to a slighter degree from a second relapse with increase of the pericardial effusion. This case recovered perfectly without valvular mischief, after passing through an attack of pneumonia, or rather pulmonary apoplexy and pleurisy.

Each patient presents some peculiarity in the way in which deglutition is affected ; but I shall only allude here specially to two more cases ; one of them (40), a youth, could not swallow solids readily, but could drink freely ; the other (50), a coachman, aged 22, sometimes when drinking had a spasm which stopped his breath before he could swallow.

The possibility that diphtheria may be the cause of the difficulty of swallowing must not be overlooked. It was, as we have seen, the intervening cause, in my case (44*a*), with double relapse, and it was the cause of dysphagia in another patient (55), a young man of 18, a commercial traveller, who had diphtheria on the 6th day after the cessation of friction-sound, and the 16th after admission.

XIV. Loss of Voice.

In the case fatal from syncope (13), a female servant, to whom I have several times alluded, on the 5th day after admission the voice was husky, and she spoke in a whisper, but she could, with a great effort, speak aloud. She was less husky on the 5th, and on the 8th her voice was more natural. This case tends to support the view that the left laryngeal recurrent nerve may become so affected by the contiguous inflammation as to paralyse the larynx.

XV. Effects on the Pulse of Rheumatic Pericarditis.

The pulse obeys the same law as the respiration under the influence of the disease; it rises in number, like the respirations, as the disease rises in intensity, is at its greatest rapidity when the disease is at its acme, and falls in number as the disease declines. The increase in the rate of the pulse is not as a rule in proportion to the increase in the number of the respirations. During the early stage of inflammation of the heart, when pain is generally felt and friction-sound is audible over the organ, the pulse usually mounts up to 90, 100, or even 120, while the respirations increase to from 30 to 40 in the minute, so that at this early period the ratio of the pulse to the breathing is in number as about three to one, instead of maintaining the healthy standard of about four to one.

When the amount of the effusion into the pericardium reaches its height, the pulse is usually quicker than it is during the early stages, and on rare occasions it becomes very much quickened, reaching even to 160. More often, however, the pulse is not more rapid at this, the stage of the acme of the disease, than it is during its early period. The breathing, as we have just seen, is almost always more quickened and laborious at the time the fluid in the pericardium has reached to its height than at any previous period, so that then the ratio in number of the pulse to the respiration is often two, or two and a half, to one, instead of maintaining the healthy ratio of four to one.

At a later period, when the effusion is lessening, and the inflammation of the pericardium is coming to an end, the pulse, like the respiration, falls in number. At this stage, however, in severe cases, one or other, or even both of the two secondary affections, pleurisy and pulmonary apoplexy, that quicken the respirations quicken also the pulse, when the numbers of both, and the proportion that they bear to each other, are as a rule nearly the same that they were during the early period of the attack, the ratio of pulse to respiration being usually three to one.

In considering the effects of rheumatic pericarditis on the pulse and respiration, I have separated from each other the advance, the acme, and the decline of the disease, and the two secondary influences, pleurisy and pulmonary apoplexy. In nature, however, those stages melt into each other, and those various causes combine and operate together to produce the hurry and distress of breathing and the quickening of the pulse of which I have just spoken.

XVI. Fulness of the Veins of the Neck from Distension of the Pericardial Sac.

In several of the cases of rheumatic pericarditis there was fulness of the veins of the neck, sometimes with pulsation, during the period that the effusion into the pericardium was at its height, and the sac was distended to the utmost.

The fulness of the veins of the neck present at this period must, I consider, be mainly due to the resistance offered to the return of the blood through the venæ cavæ into the right auricle, owing to the yielding inwards of the thin walls of that cavity before the pressure of the fluid contained in the swollen pericardium. The fluid exerts also direct pressure upon the thin walls of the descending vena cava, which carries on the latter part of its course for the extent of an inch within the pericardial sac. The ascending cava, on the other hand, sustains this pressure to a considerable extent by being short and very large, and by possessing walls thickened by fibrous structure derived from the central tendon of the diaphragm. We may, indeed, measure the degree of the distension of the pericardial sac by the degree of the distension of the veins of the neck. This compression inwards of the right auricle must be looked upon as one of the most serious consequences of pericardial distension, for it materially lessens, or in extreme cases may almost tend even to cut off the supply of blood to the right side of the heart, the lungs, the left side of the heart, and the system. The walls of the left auricle, being thicker, do not yield so readily as those of the right, but the compression of the left auricle and of the pulmonary veins by the fluid in the distended pericardium produces its own special mischief by impeding the flow of blood from the lung, thus often inducing pulmonary apoplexy. From this joint compression of the sister auricles flows a succession of consequences to which I need not here allude in detail, but which in their turn tend to produce weakening and intermission of the heart, a feeble irregular pulse, and even death from syncope. I shall have occasion by and by to speak of the support that the thin walls of the auricles and veins derive from the coating of lymph with which they are covered, and which enables them to bear much of the pressure to which they are then subjected.

One patient (16), a servant girl, after being ill for a week and affected severely in the joints for two days, came in breathing hurriedly, suffering from pain over the region of the heart, and in great distress. There was dulness over the pericardium from the second space to the sixth, and a loud, harsh friction-sound was heard over all that region. The left jugular vein was distended and did not empty during inspiration; next day the amount of effusion had lessened, she improved rapidly, and the friction-sound ceased on the ninth day, when a mitral murmur declared itself.

In another servant (13), whose case, already referred to, proved fatal, the veins on the right side of the neck pulsated strongly, while those on its left side did so to a less extent, as they did not fill or empty themselves so completely. She died in a fit of syncope on the 14th day. Eighteen ounces of fluid were found in the pericardium, and several patches of pulmonary apoplexy were diffused through the upper lobe of the left lung.

Another fatal case (4), a carpenter, who died delirious on the eighth day, presented pulsation in the neck on the second day after admission, when the pericardial effusion had reached its acme. This pulsation was partly in the carotids, but was chiefly venous, and was more marked on the right side of the neck, the veins on that side being fuller than those on the left. On the third day the upper boundary of the region of pericardial dulness was lower, having descended from the third to the fourth costal cartilage, and the venous pulsation was not so perceptible. I will name two other cases of this class: one (29), a man who came in with an anxious expression of face: on the fifth day friction-sound was heard over the heart, and on the seventh he presented extensive double venous pulsation in the neck: the other (15), already related, a girl who came in with rheumatic pericarditis, and in whom the veins of the neck were full during expiration on the third day, when the pericardial effusion was at its height and deglutition was difficult.

There was visible pulsation of the jugular veins in three of the patients who had been affected with valvular disease of some standing before being attacked with rheumatic pericarditis. In these cases the venous pulsation was evidently due to the valvular affection.

XVII. Appearance and Expression of the Face during the course of Pericarditis.

The face was flushed, dusky or very pallid, or its expression was one of anxiety or depression, in 43 of the 63 patients affected with rheumatic pericarditis. In six other cases it is stated that the aspect had improved, although there is no previous description of the face. There was thus a marked change in the appearance of the patient in four-fifths of the cases (49 in 63). The face is not mentioned in the remaining thirteen cases, and in one only of these was the attack severe, while it was so in thirty-six of the patients in whom its appearance was notably altered. The face was similarly affected in three-fifths of the patients attacked by endocarditis (60 in 108), in less than one-half of those who were threatened with endocarditis (27 in 59), and in one-fourth only of those who presented no sign or symptom of endocarditis. The appearance of the face was less and less profoundly altered in these patients, as the class to which they belonged became less and less affected in the heart, and still less in the class made up of those who gave no evidence of affection of that organ.

The face was flushed in 19 of the 63 cases of rheumatic pericarditis. Perspiration was copious in all but three of these, the perspiration often standing in beads upon the face. The flush, instead of being limited to the cheeks, was diffused over those parts that are usually white even in persons of the most rosy hue, the forehead, namely, the eyelids, the nose, the white skin of both lips, and the chin. I never noticed the colour spread at the first blush from feature to feature, but it seemed to tint them all at once. Thus the face was pallid on the day of admission in a fatal case already quoted by me, and on the following day it was flushed all over. But the flush, which at first seemed to suffuse the whole face, usually vanished step by step; the pink skin of the upper and lower lips first becoming white, then the nostrils, and, in succession, the eyelids, the chin, the brow, and the cheeks in several of my cases.

The face was pale during the period of the friction-sounds in nine cases. One of these (13), a female servant, was very pallid and sallow, the features being pinched, when admitted with pericarditis; while on the following day the face was rather flushed, and the fever seemed to be greater. Another case (44*a*), a servant girl, aged 20, admitted with pericarditis, was flushed on the second day, but on the third, when the fluid in the pericardium had reached its acme, deglutition was difficult, and she was depressed, pallid, and weak. The face was twice as often flushed (19 times), as pale (9 times), during the attack of pericarditis. I have been unable to discover clinical reasons for the difference in these cases of the hue and colour of the face. The clinical history of the pallor of the face induced by rheumatic pericarditis is illustrated by a case, the physical features of which I published in 1844;[1] a youth, aged 16, was admitted into the General Hospital near Nottingham on the 17th of November, 1842, under the care of Dr. Williams, suffering from acute rheumatism, with pericarditis. His countenance was pale, and his surface generally was also pale. On the third day after admission the general symptoms were milder, although the extent of pericardial dulness had not lessened, and the face was less pallid, the lips being red. On the sixth, the following is my report: "The gums are slightly tender, his general appearance improves, the hue of the skin is clear, and rather red; the reflex influence of disease in contracting

[1] *Prov. Med. Trans.*, vol. xii., 1844, p. 532. Paper I. of this collection.

the capillaries being removed." He made a complete and rapid recovery. In this case, the general surface was pale as well as the face; but in the cases under analysis, my notes do not, as a rule, describe the hue of the body.

The aspect was dusky, muddy, or glazed in sixteen, and the expression of the face was anxious or depressed in thirty-five of the patients affected with pericarditis.

I would here briefly compare these numbers with the numbers of those thus affected in the other cases of acute rheumatism.

The face was notably flushed in one-fifth of the cases with simple endocarditis (19 in 108), one-eighth of those threatened with endocarditis (8 in 63), and in one-twentieth of those giving no sign of endocarditis (4 in 79). The aspect was dusky or muddy in one-tenth of those with simple endocarditis (10 in 108), in one of those threatened with endocarditis (1 in 63), and in one of those who gave no evidence of endocarditis (1 in 79). The expression was anxious or depressed in one-fourth of those with simple endocarditis (25 in 108), in one-sixth of those threatened with that affection (10 in 63), and in one-twelfth of those who presented no sign of inflammation of the heart (6 in 79).

I have drawn up these numbers from a careful examination of my case books, and they present an accurate return of the symptoms there recorded. These cases are however necessarily reported with varying degrees of minuteness, and the more severe cases, attracting the greatest interest, are naturally observed and related with greater care than those that present no unusual features. These must therefore be taken not as the actual, but the approximate numbers.

Keeping this in view, it must be felt, from what I have said, that rheumatic pericarditis with endocarditis, and to a less degree simple endocarditis, produce a remarkable change on the complexion, aspect, and expression of the face. The attention is at once drawn to the heart by the altered countenance. When the inflammation of the heart is established, the varying hue and expression of the face tell, with remarkable accuracy, the varying state of the powers of the heart, and of the double inflammation with which the organ is affected.

When the tide of the effusion into the pericardium has reached its height, as I shall illustrate in the next section, the hue of the face is usually more dusky and livid, and its expression more anxious than at any other time; but when the tide has fairly turned, and, the effusion having lessened, the inflammation ceases to be active, the face becomes often quite suddenly cheerful, while its hue becomes clear; the eye at the same time, instead of being heavy and charged with blood-vessels, becomes bright and clear. After this, if there is no relapse, the powers rally with remarkable quickness and freedom, and the appetite returns. This state is very different from the convalescence of fever, which passes through its period of improvement slowly, and with scarcely perceptible steps.

In a patient, to whom I have already alluded, whose heart acted strongly and rapidly at the time of the first onset of the inflammation, the right side of the face was swollen and flushed, evidently under the influence of the attack of pericarditis.

What are the causes of this remarkable influence of inflammation of the exterior and interior of the heart on the face?

There are probably more causes than one at work to produce the flushing or pallor present in pericarditis. The moderate elevation of temperature present in all cases of inflammation is probably connected with flushing of the face, either as a cause, or rather as a common effect. The question must here be put, what is the cause of the moderate elevation of temperature in cases of inflammation? Is it from general relaxation of the arteries, with elevation of temperature, owing to the influence of the inflammation on the afferent nerves of the part affected? such influence being conveyed to the vaso-motor centre in a manner analogous to that in which relaxation of arteries and elevation of temperature is produced on one side of the head and face by the division of the sympathetic on that side of the neck, or by the pressure of that nerve by an aneurism of the arch of the aorta? This influence would, of course, only account for the moderate rise of temperature in local inflammation, and does not touch the question of the cause of the increased heat in fevers or in cases of acute rheumatism with delirium.

Putting this cause aside, which applies to every case of inflammation, I would suggest that one great cause of the flushing or pallor of the face in pericarditis is the influence of the inflammation on the afferent nerves at the surface of the heart and great vessels, which, being depressed or stimulated, may induce reflex dilation of the arteries of the head, with flushing of the face, or reflex contraction of the arteries of the head with pallor of the face. I suggested this in principle as the cause of the pallor in the Nottingham case in my note-book in 1842, and am still disposed to do so. In aneurism of the arch of the aorta, pressure on the branches of the sympathetic of one side causes relaxation of the arteries and elevation of temperature on the corresponding side of the head and face. I consider that a parallel effect would result from the excitation or the injury of the sympathetic and sensory nerves, and perhaps of other nerves having, say, a vaso-inhibitory property distributed to the seat of the inflammation of the heart and great vessels in pericarditis ; contraction of the arteries of the head and face with pallor being produced on the one hand, and relaxation of those arteries with flushing and perspiration on the other. In one case only, just referred to, was there flushing and perspiration notably limited to one side of the face. It is natural, however, to expect that as the inflammation affects the nerves of both sides in pericarditis, both sides of the face should be equally affected, as it was indeed in all but one of my cases of pericarditis affected with pallor or flushing of the face.

I would here remark that as the reflex contraction or dilatation of the arteries with pallor or flushing, from excitation or injury of the sympathetic or sensory nerves, is *continuous*, it differs essentially from the reflex movements of the muscles caused by the excitation of an afferent nerve, such movements being necessarily short and *intermittent*, the withdrawal and renewal of the stimulus to the afferent nerve being needed for their reproduction. In short, the reflex vaso-motor current is continuous, while the reflex excito-motor current (of the muscle) is interrupted.

The increased contraction of the arteries caused by the excitation of a sensory or sympathetic nerve appears to be due to the increased discharge of nervous force directly from the vaso-motor centre when that centre is thus stimulated by the excitation of those nerves. That centre would indeed seem to require, for the exercise of its proper functions, to be reinforced and stimulated through the sympathetic nervous system, and probably by the blood circulating in the arteries, when we consider that the division of the left splanchnic in the rabbit may lower the arterial pressure from 90 millimetres to 41, that excitation of the divided nerve may raise the pressure to 115 millimetres, and that division of the other splanchnic may further lower it to 31 millimetres.[1]

I would here remark that similar effects are produced by analogous causes in pneumonia, and especially in pneumonia of the upper lobe, when the face, besides being congested, presents a dusky hue and a powerless expression that speak of the profound influence exercised upon it by the disease. In this disease also, as in pericarditis, with the turn of the tide of the inflammation and with the removal of its products, the veil is as it were lifted away from the countenance; and a patient, one day under the weight of the inflammation, with an aspect dark, depressed, and anxious, presents on the next day, with the removal of the exudation from the affected air cells and the renewal of their respiration, a face clear and clean, and an expression bright and cheerful.

The eye is every now and then reported to have been dull and heavy in appearance during the attack of pericarditis, its minute vessels being congested; but it is more frequently described as becoming bright and clear when the effusion into the pericardium was lessening, and the inflammation was becoming inactive and only present in the shape of its results. I had not, until quite recently, made any close observation of this organ, but in one of the last cases of acute rheumatism with endocarditis treated by me in St. Mary's Hospital I found that during the acme of the disease, when the face was flushed, dusky and anxious, the conjunctiva was crowded with small vessels which ended a very short distance from the cornea, so that round the clear of the eye there was a white zone or ring edged by fine converging vessels. When the inflammation ceased to be active, and the face, in keeping with this improvement, became clear and cheerful, the eye became

[1] Ludwig and Cyon, quoted by Dr. Burdon Sanderson: *Handbook for the Physiological Laboratory*, p. 249.

bright, and the vessels crowding the conjunctiva lessened in number, so that the ball of the eye became again white. This organ requires careful observation in cases of rheumatic pericarditis and endocarditis.

XVIII. Condition of the Face when the Pericardial Distension was at its Height.

When the pericardium is distended to the full with fluid, under the threefold influence of (1) what may be termed the "fluid" pressure, induced by the distension of the sac bearing with varying force outwards upon the œsophagus and trachea, the left bronchus, the lungs, especially the left, and the diaphragm; and inwards on the descending vena cava, the right and left auricles, and the pulmonary veins; (2) inflammation involving the nerves distributed to the surface of the heart and the great vessels; and (3) inflammation of the superficial muscular fibres of the heart itself; as we have seen, point by point, pain may be present around and within the heart, over the pericardial sac and the pleura; swallowing may be difficult; the voice may be hoarse or reduced to a whisper; the action of the heart, which at the beginning of the attack is often forcible, may become feeble and intermitting, or even altogether fail; the respirations may be hurried and laborious, often so as to compel the raised and forward posture; the pulse may be rendered weak and irregular, and be quickened, though not in the same proportion, as the breathing, the ratio of the pulse to respirations being two or three and a half to one, instead of, as in health, four to one; and the veins of the neck may be swollen and pulsating. The last effect of the over-distension of the pericardium that I shall illustrate is that upon the circulation of the head and face.

A female servant whose case (15) has already been alluded to was admitted with acute rheumatism and pericarditis of great severity. On the third day, I found that the pericardium was distended to the full, she complained of a sensation of choking, swallowing was difficult, the countenance was anxious, the face was livid and perspiring profusely, and the veins of the neck were full. On the sixth day the pericardial dulness had lessened all round, her face was less dusky, and her aspect had improved. On the tenth, in the evening, she suddenly came over faint, the lips being blue, and the face dusky; but in a few hours the face, though still anxious, lost its dark hue, and the lips became again red. Next day it was found that the pericardial effusion had again increased. The fluid, however, soon again diminished. On the twelfth her aspect had again improved, on the fifteenth her face was flushed, and on the sixteenth it was of good colour and its expression was no longer anxious. Here, twice over, the effusion in the pericardium reached its acme, and under the influence of its pressure and the inflammation of the organ, the heart faltered, the venous blood was delayed in its passage, the arterial blood was with difficulty supplied, the face and neck became charged with venous blood, and the lips became livid; and here, twice over, the pressure was removed by the lessening of the fluid, when the colour returned to the face and the expression of anxiety disappeared.

XIX. Affections of the Nervous System in Rheumatic Pericarditis.

Dr. Davis, of Bath, in the year 1808[1] published three cases of acute rheumatism, two of them being affected with pericarditis, and one with endocarditis. One of the cases of

[1] *An Inquiry into the Symptoms and Treatment of Carditis*, by John Ford Davis, M.D.

pericarditis, which was observed in 1785 by Dr. Haygarth—who curiously does not mention this important case in his *Clinical History of the Acute Rheumatism*, published in 1806—was affected with moaning, restlessness, and delirium ending in death. The other case of pericarditis, a young lady, who was under the care of Dr. Davis, had great heats, with perspiration, screaming, and the most violent jactitation of the body, "occasioned by the extreme anguish which she felt in the region of the heart." She was perfectly sensible throughout, and died after the disease had lasted twenty-six days. The patient with endocarditis was affected with want of sleep and violent delirium, for nine days, at the end of which time she died.

In a series of important clinical contributions Corvisart, Mr. Stanley, Dr. Abercrombie, Dr. Macleod, Andral, Dr. Latham, Dr. Bright, Dr. Mackintosh, M. Bouillaud, Sir Thomas Watson, Sir George Burrows, and Dr. Kirkes,[1] have described cases of pericarditis, some connected with acute rheumatism, but many not so, in which delirium, coma, convulsions, temporary insanity, chorea and choreiform movements, or tetaniform symptoms and rigidity, and even actual tetanus were present.

These observations suggested to several of those authors, including Andral and Dr. Bright, a close connection, amounting even to cause and effect, between pericarditis and the affections of the nervous system associated with it.

The affections of the nervous system in cases of rheumatic pericarditis and acute rheumatism are always serious, often fatal, and comparatively rare. Recent observations have

1 For references to these authors, see the note given in the Appendix to the table at pages 334—337, of cases of acute rheumatism with affection of the nervous system, in which the temperature of the body was not observed.

shown in many of those cases the presence of a very high temperature, delirium and coma, ending in death. I shall therefore, in inquiring into the clinical history of those associated affections, examine those cases admitted into St. Mary's Hospital under my care during the twenty years that I have held office, and all the published cases that I can find of this class.

I have brought together, from various sources, 180 cases of acute rheumatism with affections of the nervous system, more than one-half of which had pericarditis (92 in 180). The temperature of the body was recorded in one-third of the total number of cases (61 in 180); and although these cases were observed at a much more recent period than those in which the temperature was not recorded, I shall examine the more recent series of cases first, for they throw light upon the older series of cases. (See Tables on the following pages.)

Cases of Acute Rheumatism with Affections of the Nervous System, in which the Temperature of the Body was observed.

Dr. Sidney Ringer published in the year 1867 three cases of acute rheumatism with pericarditis, in which the temperature rose before death respectively to 109·2°, 110·8°, 110·0°.[1] These three patients had delirium, followed by coma and death, and one of them was under the care of Dr. Reynolds as early as May 1862.

Dr. Kreuser related in 1866[2] three fatal cases of acute rheumatism in which the temperature rose respectively to 109·4°, 110·2°, and 110·4°, and these three patients were affected with delirium, and one of them with coma also.

[1] *Medical Times and Gazette*, 1867, II. 378.

[2] *Medizinisches Correspondenz-Blatt des Württembergischen ärtzlichen Vereins*," Band xxxvi. p. 105.

CASES OF ACUTE RHEUMATISM WITH AFFECTION OF THE NERVOUS SYSTEM, IN WHICH THE TEMPERATURE WAS OBSERVED.

CASES WITH PERICARDITIS.

TOTAL PATIENTS OF BOTH SEXES, **27**.

SEX AND AGE . . .

MALE PATIENTS. Total **14**.—Below 21 years, 0; 21 to 25 years, 5 (3, 14, 20, 26, 27); above 25 years, 9 (6, 7, 9, 12, 13, 17, 21, 22, 23).

FEMALE PATIENTS. Total **13**.—Below 21 years, 5 (2, 4, 10, 24, 25); from 21 to 25 years, 1 (18); above 25 years, 7 (1, 5, 8, 11, 15, 16, 19).

OCCUPATION, HABITS, AND PREVIOUS CONDITION . .

MALE PATIENTS. Total **14**.—*Workers out of doors*, **6**—laborious, **4**; gardener, 1 (6, never ill); smiths, 2 (22, 26); bargeman, 1 (27): on foot, **1**; policeman 1 (unconscious after kick in mouth ten years before); among horses, **1**, coachman, 1 (7, lived well, not a drunkard) *Workers in-doors*, **6**—servants, 2 (17; 21, well-nourished, heavy drinker, much exposed); coachmaker, 1 (20, poorly nourished, anæmic); shoemaker, 1 (23, poorly nourished, pale); shopman, 1; in cigar shop, 1 (12); gentleman in business, 1 (13, muscular, intellectual, nervous, took beer, took chloral for sleep). *Occupation not stated*, **2** (3; 9, had epistaxis a month before admission).

FEMALE PATIENTS. Total **13**.—*Active in-door Workers*, **7**—servants, 2 (1, 18); married 5 (5, lived badly till year before attack; 8, had child three months old, badly off, no milk; 15, publican, stout; 16, in great trouble; 19, had child ten weeks old, subject to palpitation). *No occupation*, **1**, (24, a slim, passionate, nervous child). *Occupation not stated*, **5** (2, 4, 10, 11, 25).

CHARACTER OF AFFECTION OF THE NERVOUS SYSTEM .

A^1—Had *Coma* not preceded by delirium, **1** —5, coma at temp. of 108·4°–110°; bath, lowered to 63°, ice; at 106·2° some consciousness, at 100·6° could speak; *Recovery*. For cases of semi-consciousness and temporary coma see below.*

A^2 {Had *Delirium* followed by *Coma*} **11**—3 {del. first violent, then moaning / coma at temp. 109·4°–110·8°}; 4 {del. 104·2°, first out of bed, then muttering / coma at temp. 109·4°–110·8°}; 11 {del. temp. 104·4–96·6° / coma at temp. 108·4°–110·4°}; 6 {del., temp. (?) first excited, then incoherent / coma at temp. 106·2°–110°}; 9 {del., temp. 103°, out of bed / coma at temp. 109·5°}; 2 {del., temp. 104°–105°, first very delirious, then muttering / coma at temp. 109·2°}; 1 {del., temp. 104·8°–107·8° / coma at temp. 109°, bath}; 21 {del., hallucination, temp. 104·6°–105·2° (bath at temp. 90°–75°, ice), after it temp. 99·5°, still del., temp. rose to 107°, del., afterwards temp. 106·6°. Coma at temp. 107·6° (bath at 91°–74°), after it temp. 100·3°; finally *Recovered*}; 16 {very del., temp 103°–104·8° / coma at temp. 106·8°}; 8 {del. violent, temp. 104·5° / semi-coma, temp. 105·3°, coma, temp. (?)}; 17 {del. violent, temp. 104·6° / coma, temp. (?)}.

A^3—Had *Delirium*, followed by deep *Stupor*, **1**—15 {very delirious, temp. (?) / deep stupor, temp. 103·5°–106°}.

Had *Delirium* followed by *violent spasmodic movements of body*, **1**—12 {del., temp. 105·8°; then muttering del., temp. 107° / spasmodic movement, semi-stertor, temp. 110·2°}.

B^1—Had *Delirium*, without coma or other important complication, **9**.
25, sudden restlessness, lively del., strong desire to escape from bed, temp. 110·4°.
22, nervous manner, temp. 104°, del., temp. 108·2° (bath, temp. 100°–97°) after it temp. 103·8°, rational—*Recovered*.
10, del. severe, temp. 103°–107·4°, death sudden.
7, del., temp. 105·6°–107·3° (bath at temp. 89°–86°), temp. became 103·1°, conscious. temp. fell to 93°, rational—*Recovered*.
13, del., temp. 102·5°–105° (bath at temp. 71°), after it temp. 100°, rational, afterwards delirious at 104°, rational at 102°.
23, del., temp. 104·9°, muttering, temp. 103·6°, 104·3° (bath at temp. 90°–76°, ice) after it temp. 99·8°, temp. 105·5° (bath), after it temp. 96·8°, answers natural, later del. at 102·6°–100·5°—*Recovered*.
26, slight del. at first, temp. 104°, afterwards wasting, temp. 102·2°.
20, tremulous, temp. 103°, sometimes muttering, del., temp. 102·6° 103·8° (ice-bag to head)—*Recovered*.
14, del., temp. 102°–103°, hallucination—*Recovered*.

B^4—Had *Delirium* with *stiffness of jaws*, neck, spine, and limbs—27, temp. 103·2°–102·2°, *risus sardonicus*, speech difficult, can scarcely separate teeth, del. at night, general stiffness, improvement, relapse.

* *Temporary Unconsciousness*, **1**.—19, unconscious one night, no delirium, temp. 99·3°; Bright's disease.

* *Semi-consciousness*, **1**.—18, kind of fit, frothing at lips, semi-conscious for four hours at night, temp. 99·3°–100·8°, albumen in urine.

$C^{1\cdot 2}$—Had *Choreal Movements, and continuous muscular contraction*, **1**.—24, temp. 101·5°.

The Duration of Delirium and Coma, and their Relation to Pericarditis and Endocarditis . .	*Coma*, 5 {coma 2 hr., bath / peric., end *Rec.*}. *Delirium and Coma*, 3 {del. about ¾ hr., coma about ½ hr. / pericarditis and endocarditis. ( )}; 4 {del. 14 hrs., coma ½ hr. / pericard , no endocard. ( )}; 11 {del. 5 nights. coma 3 h. / pericard. and endocard. ( )}; 6 {del. 1 hr., coma 7 hr. / slight per., no end. ( )}; 9 {del. 3 nights, coma 8 hr. / pericard., endocard. (?) ( )}; 2 {del. 8 days, coma 2 hr. / pericard. and endoc. ( )}; 1 {del 5-6 hr., coma 24 hr. / pericard., no endocard. ( )}; 16 {del. 6 days, coma 6 h. / pericar. and endocar. ( )}; 21 {del. about 5 days and 7 nights, coma 4th day of del. (bath.) / pericarditis and endocarditis. *Recovered.*}; 8 {del. 2 nights, coma 3-4 hrs. / slight pericard., no endoc. ( )}; 17 {del. 1 night, violent del. 3 hr., coma 1 hr. / pericarditis, no endocarditis. ( )}; *Delirium Stupor*, 15 {delirium stupor 4 days / pericarditis, endocarditis (?) ( )}. *Delirium. Movements Convulsive*, 15 {delirium 2 days, convulsive movements, ½ hr. / slight pericarditis, no endocarditis. ( )}; *Delirium without Coma*, 25 {delirium 5 hrs. / per. and en. ( )}; 22 {del. 1 hr. (bath, relief), violent del. ¼ hr. (bath, relief)—*Recovered* / pericarditis, endocarditis not noted}; 10 {delirium 5 days. / peri., no endoc. ( )}; 7 {del. 6 hr. (bath)—*Recov.* / pericard. and endocard.}; 13 {del. 8 days (bath), rational. afterwards alternately del. and ratnl. / slight pericarditis, no endocarditis. ( )}; 23 {del. 5 nts. 2-3 days, after 2nd bath rational / pericarditis and endocarditis. *Recovered.*}; 26 {delirium at first / peric.. no endoc. (?)}; 20 {del. 2-3 nights, rational, del. 1-2 days—*Recovered* / pericarditis, no note of endocarditis.}; 14 {del. 7 nights, later incoherent, childish some days—*Recovered* / slight pericarditis and endocarditis.}; 27 {del. 8 or 10 nights. / pericarditis and endocarditis. *Temporary Coma*, 19 {1 night / per., no en. ( )}. *Semi-coma*, 18 {about 6 hrs. / per. and en. ( )}. *Choreal Movements*, 24 {4 weeks—*Recovered.* / pericard. and endocard.
Affection of Joints	{*Before Delirium or Coma* → / *During Delirium or Coma* →} *Coma*, 5 {severe +. / none O.} *Delirium and Coma*, 3 {moderately severe − +; / slight −;} 4 {+; / O or −;} 11 {+; / (?);} 6 {− +; / − (?);} 9 {+; / O;} 2 {+; / − or O;} 1 {not sevr. O +; / doubtful (?)} 21 {− +; / − (?);} 16 {+; / − or O;} 8 {+; / (?);} 17 {− +. / O.} *Delirium Stupor*, 15 {+ or − +. / −.} *Delirium Conv. Movnt.*, 12 {+; / O;} *Delirium*, 22 {− +; / − or O;} 10 {+; / (?);} 7 {− +; / O;} 13 {+; / O;} 23 {(?) +; / O;} 20 {+ or − +; / O + or − +;} 14 {+. / O.} *Transient Coma*, 19 {+. / (?).} *Semi-coma*, 18 {− +. / O +.} *Choreal Symptoms*, 4 {+; / O;} 25 {+; / O;} 26 {O +. / (?).} *Delirium, stiffness of jaws, spine, and limbs*, 27 {−. / O.}
Perspiration . . .	{*Before very high Temperature, Delirium, or Coma* → / *During very high Temperature, Delirium, or Coma* →} *Coma*, 5 {profuse +; / O, after bath persp. free ;} *Delirium and Coma*, 3 {very profuse + +; / less, but consid. − +;} 4 {doubtf.(?); / slight −;} 6 {+; / O;} 9 {(?); / +;} 2 {+ +; / −;} 1 {−; / O;} 21 {O +; / +;} 6 {− + or +; / O +;} 8 {−; / O;} 17 {+. / +.} *Del. and Conv. Movement*, 12 {+. / − + or O +.} *Delirium*, 22 {O; / (?);} 7 {+; / O;} 13 {+; / + +;} 20 {+; / and −;} 14 {+ or + +. / + +.} *Miliary Eruption Sudamina*, 3, 8, 9, 12, 13, 14, 16, 17, 19, 21, 22, 23. *Face.*—Flushed, usually dusky, glazed, or anxious, 22; (before delirium), 2, 7, 16, 17; purple dusky, 5; flushed at 110·8°, pale livid at 109·4°, 4; flushed, later death-like pallor, temp. 108·3-6°, very pale, livid, 3. *Diarrhœa* during delirium or coma, 1, 7, 14, 19, 21, 22, 23. *Urine very abundant* during delirium or coma, 7, 13, 21. Evacuations in bed, 1, 8, 9, 14, 21. *Restlessness*, before delirium or coma, 1, 4, 25; during delirium or coma, 2, 9, 20 *Want of Sleep*, 8, 12, 13, 14, 16, 20, 21. *Tremulousness*, 5, 12, 13, 14, 20, 21, 22.
Convulsive, Choreiform, or Tetaniform Symptoms .	Violent spasmodic movements of the whole body, 12; convulsive movements of limbs and jaw, 1; twitchings of hands, arms, or legs, 1, 4, 6, 9; jactitation, 14, 20; distortion of face, 4, 14; rolled violently about bed, 3; rolled head from side to side, 4, 14; spasms of rigidity of muscles of lips, 5; lips pouting and rubbing teeth, 6; *risus sardonicus*, 22, 23, 27; trismus, 1, 27 (could not separate teeth); spasms of rigidity of muscles of neck, 3; fore-finger flexed, 14.

Explanation.—The numbers (1-27) refer to the different cases analysed in this table. Throughout the table each number refers to the same case. Reference to the sources from which the cases have been obtained will be found in the Appendix.

CASES WITH SIMPLE ENDOCARDITIS.

TOTAL PATIENTS OF BOTH SEXES, **13**.

SEX AND AGE.
- MALE PATIENTS. Total **7**.—Below 21 years, 3 (3, 5, 12); 21 to 25 years, 1 (7); above 25 years, 3 (2, 4, 10).
- FEMALE PATIENTS. Total **6**.—21 to 25 years, 1 (1); above 25 years, 5 (6, 8, 9, 11, 13).

OCCUPATION, HABITS, PREV. CONDITION.
- MALE PATIENTS. Total **7**.—*Worker out of doors*, **1**; on foot, **1**; porter, 1 (4). *Worker in-doors*, **1**; laundryman, 1 (12). *Occupation not stated*, **5** (2, drank beer freely; 3, 5, 7, 10).
- FEMALE PATIENTS. Total **6**.—Servants, 3 (1, 6, 11); cook, 1 (9); married, 2 (8, always ailing; 13, sixth attack).

CHARACTER OF AFFECTION OF THE NERVOUS SYSTEM.

A^3—Had *Delirium* followed by *Coma*, **4**.—10 {violent delirium, temp. 109°; coma, temp. 110·2°}; 7 {delirium violent, temp. 106°, then muttering delirium; coma, temperature 10 minutes after death, 107·8° axilla, 106·8 rectum};
8 {delirium slight, temp. 102°; coma, temp. 109·5°-109·8° (bath 80°-62° 45 minutes), end of bath, 100·3°, one hour later 96·5°, maniacal (2nd bath), tetaniform symptoms.};
2 {delirium slight 1 night, temp. 104·4° morning, then muttering delirium; coma, temp. (?)}

Had *Delirium*, followed by *Convulsive* movements, **1**.—4 {delirium, temp. 102°-106·2°; face convulsed, threw arms about; died, temp. 111·6°}.

B^1—Had *Delirium*, without coma or other important modification, **5**.—
5, del. violent, temp. 107·6°-108·8°, general collapse, temp. 111·4°. 11, uninterrupted del., temp. 104°-109·4°.
1, del. (sensorium much disordered), 108·5° (cold applied inside and out), after it temp. 98·6°, no del.—*Recovered.*
3, del. one night, temp. 103·9°, later 102°, no del.—*Recovered.* 6, del. 1 night, temp. 99·6°-102·2°.

B^2—Had *Delirium* with cerebral *Embolism* and *Hemiplegia*, **1**.—13, after acute rheumatism, del., left hemiplegia, imperfect speech, temp. 103°, cessation of del.. Old mitral-aortic valve disease, endocarditis.

B^3—Had *Delirium* and *Chorea*, and minute cerebral embolism, **1**.—12, del., speech indistinct, twitching, especially of right side, screamed, left bed, temp. 103°-102·3.

Had *High Temperature*, without note of delirium, **1**.—9, head heavy, giddiness, great heat, temp. 105·8° (ice-bag to head and præcordia), in half an hour temp. 103·2°.—*Recovered.*

Delirium and *Coma*.—8, del. about 3 days and 3 nights, coma short time—duration (?), (2 baths); 7, del. 3 hours, coma short; 2, slight del. first night; no del. 2nd night, violent del. ¼ hour, coma 1¼ hour.

DURATION OF DELIRIUM AND COMA.
- *Delirium, Convulsive Movements.*—4, del. about 3 nights.
- *Delirium.*—5, del. 1 hour, exhaustion one hour; 1, del. duration (?) shortened by bath—*Recovered*; 3, del. 2 nights—*Recovered*; 6, del. 1 night.
- *Delirium Embolism.*—13, del. 3-4 days.
- *Delirium Chorea.*—12, del. 8-9 days.

AFFECTION OF JOINTS. {*Before Delirium or Coma*; *During Delirium or Coma*}. 8 {severe +; none ○}; 7 {+; (?)}; 3 {+; (?)}; 4 {+; ○ none, and − slight}; 1 {+; = or − + ○ +}; 3 {− + rather severe; (?)}; 9 {+ or − +; ○ +}; 10 {+; (?)}; 13 {+; ○ +}.

PERSPIRATION. {*Before Delirium or Coma*; *During Delirium or Coma*}.—8 {very profuse + +; (?) +}; 7 {+; −}; 2 {+; (?)}; 4 {+; ○ or −}; 1 {+; ○, after bath, +}; 3 {+; (?)}; 6, del. on admission +.

Miliary Eruption or Sudamina, 4, 7, 9

Diarrhœa during delirium or coma, 5, 5, 7, 8. *Urine very abundant* during delirium or coma, 4, 5, 7. *Evacuations involuntary*, 4, 8; probably, 5, 7. *Restlessness* usually before delirium, 4, 8, 11, 7 (during delirium).

CONV. CHOREIFM. OR TETANIFM. SYMP. Twitchings of legs and arms, 2; of right side, 12; threw arms about, 1; convulsions of face just before death, 4; much convulsed, tonic spasms, teeth closing firmly on lower lip—drawing blood, *risus sardonicus*, opisthotonos, 8.

CASES IN WHICH THERE WAS NO PERICARDITIS, ENDOCARDITIS BEING ABSENT OR DOUBTFUL.

TOTAL PATIENTS OF BOTH SEXES, **21**.

SEX AND AGE.
- MALE PATIENTS. Total **12**.—Below 21 years, 3 (3, 17 beer drinker, 18); 21 to 25 years, 1 (21); above 25 years, 8 (5, 6, 7, 12, 13, 16, 19, 20).
- FEMALE PATIENTS. Total **9**.—Below 21 years, 1 (10); 21 to 25 years, 2 (1, 2); above 25 years, 5 4, 8, 11, 4, 15); sex and age not stated, 1 (9).

OCCUPATION, HABITS, PREV. CONDITION.
- MALE PATIENTS. Total **12**.—*Workers out of doors*, **6**; laborious, **6**—labourers, 2 (5, 6, nervous); smith, **1** (7, had itch); carpenters, 3 (16 free liver, 19, 21). *Workers in-doors*, **1**—carver, 1 (20); *no occupation*, **1** (18); *occupation not stated*, **4** (3, 12 nervous, 13 nervous, 17 had ague twice, 19).
- FEMALE PATIENTS. Total **9**.—Servant, 1 (14); married, 1 (8); *no occupation*, **1** (15); *occupation not stated*, **5** (1, 2, 4 had neuralgia, 10, 11).

CHARACTER OF AFFECTION OF THE NERVOUS SYSTEM.

Had *Delirium*, followed by *Coma*, **6**—5 {wandering, later muttering delirium at temp. 108·4°; coma at temp. 109·2°-111·1°}; 14 {delirium, would leave bed, at temp. 103·4°; coma at temp. 110·1°}; 4 {slight delirium (?); coma at temp. 109·4°-110·2°}; 6 {violent delirium, out of bed, like del. trem. at temp. 107°; coma at temp. 110°}; 13 {delirium violent, would leave bed, temp. (?); coma at temp. 103°-109·5°}; 7 {1st, slight delirium. 2nd, coma, 3 violent delirium at temp. 105·8°.}

Had *Delirium*, followed by *Somnolence*, **2**—11 {muttering del. at temp. 104·5°-105·3°; coma at 106°, in bath at temp. 90°-81° for 20 minutes, then temp. 102°, comfortable—*Recovered*}; 8 {noisy delirium at temp. 102·5°; drowsy at temp. 106°-101°}.

Had *Delirium* without coma or other important complication, **10**—

1, noisy del., sank rapidly, temp. 110°.

3, muttering del., temp. 107·8°-108·2° (bath at 71°-82° for ½ hour), when removed from bath temp. 101·8°, 35 minutes later, temp. 98·8°, asleep, temp. 105·8°, slight del. (second bath)—*Recovered.*

15, del., temp. 107° (bath 90°-42°), after bath, temp. 97°, mind clear—*Recovered.*

16, slight del. at 104·2°, noisy del. 104·6°-106·5° (ice-bag to head, bath at 80°-96°), after it temp. 101·4°, wandering (highest temp. 106°, had 20 baths, bath lowered temp. restored reason for a time).

18, del. at temp. 102·6°-104·5°.

17, noisy del. at temp. 103·4, followed by paraplegia—*Recovered.*

20, del. sometimes muttering, temp. 100·4°-101·2°—*Recovered.*

10, del. temp. 101·1°—*Recovered.*

9, del. somewhat violent, temp. 101·10° (albumen in urine)—*Recovered.*

21, slight and violent del., hallucination, sprang through open window, killed, Bright's disease, temp. 100·4°.

Had *very High Temperature*, without delirium, **2**—12, very restless, talked in sleep, deaf, temp. 102·8°-106·3° (bath 90°-83° for 33 minutes), after bath temp. 101°, later 99·8°, deafness left him—*Recovered*; 2, vomiting, dyspnœa, no note of delirium, temp. 110·8°.

Twitching of limbs, **1**—19, no sleep, general muscular twitchings at temp. 101°-102°, later repetition of twitching at 98·4°, albumen in urine—*Recovered.*

DURATION OF DEL. AND COMA. . . .

Delirium and Coma, **6**—5, wandering, one day, then better, muttering del. ½ hour, coma 1 hour; 4, del. 1½ hour, coma about 1 hour; 14, del. and coma combined, 1½ hour; 6, del. 6 days, coma 1½ hour; 13, del. 4 hours, coma 4 hours; 7, del. about 2 days, del. and coma alternately 2 days.

Delirium and Somnolence, **2**—11, del. about 1 day (bath)—*Recovered*; 8, del. about 10 days, drowsy about 1 day.

Delirium, without coma or other important complication, **10**—1, del. 2½ hrs.; 3, del. ¾ hr., bath, sleep, slight del. second bath—*Recovered*; 16, del. about 16 days (?), 20 baths; 18, del. 3 nights; 17, del. 13 nights, several days—*Recovered*; 20, del. 3 nights, muttering 1 morning—*Recovered*; 10, del. if diarrhœa checked, duration (?)—*Recovered*; 9, del. especially during nights—*Recovered*; 21, del. about 2 days.

AFFECTION OF JOINTS

Before delirium → / *During delirium or Coma* → *Delirium and Coma*, 5 {mod. severe − +; (?)}; 4 {− +; ○}; 14 {− +; (?)}; 6 {+; +, later − +}; 18 {+ +; (?)}; 7 {+; +}. *Del. and Somnolence*, 11 {− +; (?)}; 8 {− + or +; ○ + or much better}. *Delirium*, 3 {− +; −}; 16 {+; − ○}; 18 {+ +; (?)}; 20 {− +; − +}. *Very High Temp., no Del.* 12 {+; −}. *Twitchings*, 19 {+ or − +; ○ + and − +}. 21 {+; ○}.

PERSPIRATION . . .

Before very High Temperature or Delirium → / *During very High Temperature or Delirium* → *Delirium and Coma*, 5 {+; ○}; 4 {+; ○}; 14 {+; (?)}; 6 {+; ○}; 13 {+; perspiring}; 7 {+; (?)}. *Delirium*, 3 {+; −}; 16 {○ then +; +}; 20 {+; ○ +}. *Very High Temperature*, no delirium, 12 {+; (?)}.

Had *Miliary Eruption or Sudamina*, 3, 5, 6, 7, 12, 13, 14, 16.

Face during period of excessive heat, delirium, or coma—red, 7; red and then livid, 13; flushed during delirium, pallid, cadaverous during coma, 6; pale, 4, 5; livid, 3; cyanosed, 14.

Diarrhœa during delirium or coma, 3, 13, 16, 18, 19. *Urine abundant* during delirium or coma, 3, 13. Evacuations involuntary, 3, 16, 17, 18. Vomiting, 13. *Restless*, 3, 7, 11, 12, 13, 14, moved his arms about, 16, 17, 20, 21. Tremulousness, 16, 17.

CONVULSIVE CHOREIFORM AND TETANIFORM SYMPTOMS.—Twitchings of limbs and body, 19; of limbs and features, 5; of face, 6 (sardonic grin), 16, especially of lips.

EXPLANATION.—The numbers 1-13 and 1-21 refer to the different cases analysed in these tables. Throughout each table, each number refers to the same case. Reference to the sources from which the cases have been obtained will be found in the Appendix.

More recently an important series of cases of this class have been communicated by Dr. Hermann Weber in an important paper, Dr. Murchison, Dr. Burdon Sanderson, Dr. Greenhow, Dr. Southey, Dr. Henry Thompson, Dr. Meding, Mr. Anderson, Dr. Wilson Fox, whose work on the treatment of hyperpyrexia is of great value, and Dr. Andrews.[1]

I have brought together from these and other sources, sixty-one cases of acute rheumatism, affected with coma, delirium, chorea, or convulsive choreiform, or tetaniform symptoms, in which the temperature was observed during the progress of the illness. See table, pp. 334—337.

Of the sixty one cases in which the nervous system was affected, and the temperature was ascertained—I. Twenty-seven had pericarditis ; II. Thirteen had simple endocarditis ; and III. Twenty-one were free from pericarditis, endocarditis being absent or doubtful.

I.—Cases with Pericarditis in which the Nervous System was affected, and the Temperature, generally very high, was observed.

SUMMARY.

A^1 Had *coma* without *delirium*, maximum temp. 110°	1
A^3 Had *delirium* followed by *coma*, temp. 110.8°—104·6° . . .	11
A^4 Had *delirium* followed by *stupor*, temp. 106°—103°	1
Had *delirium* and *convulsive movements*, temp. 107°—110·2°	1
B^1 Had uncomplicated *delirium*, temp. 110·4°—103°	9
Had *delirium* with general stiffness, temp. 103·2°—102·2° . .	1
Had *temporary* or *partial coma*, temp. 101·8°—99·3°	2
C^1 Had *chorea*, temp. 101·5°	1
Total	27

1 For references to these authors, see the note given in the Appendix to the Table, at pages 334—337, of cases of acute rheumatism with affection of the nervous system, in which the temperature of the body was observed.

The temperature of the body was observed in twenty-seven cases of rheumatic pericarditis with affection of the nervous system, and was very high in three-fifths of them (15 in 27), their highest temperature varying respectively from 106·8° to 115·8°. Five of these cases were placed in a cooling bath, when their temperature, then at the highest, was ascending rapidly, with the effect of arresting its rise, cooling the body, and, in four instances, leading to the recovery of the patient. The bath was employed also in two cases in which the temperature was 105° and 105·5° respectively, with the effect of cooling the body; but as the ascent of the thermometer was neither rapid nor very high, those cases can scarcely be included with those of hyperpyrexia. The temperature was 104·6° and 105·3° respectively in two cases during the period of delirium, but was not observed during that of coma, and I therefore think that both those cases may be included with those of hyperpyrexia—which bring their number up to seventeen, or two-thirds of the total number of cases with pericarditis.

Seven of the remaining ten cases, or one-fourth of the total number, had a high, but not very high, temperature, varying from 103° to 106°, so that these cases would rank, as regards the heat of the body, with fever or pyrexia. The temperature was only moderately high in the three remaining cases, or one-eighth of the total number, varying from 99·3° to 101·8°.

A [1] Profound coma, without delirium, was present in one case; *A* [3, 4], delirium that passed into coma in eleven cases, into stupor in one case, and into convulsive movements in one case; *B*, uncomplicated delirium was present in nine cases, one of which had Bright's disease; and delirium with stiffness of jaws, neck, and limbs occurred in one case. Temporary coma occurred in one case, and semi-consciousness in another, both with albumen in the urine; and C^1 chorea and slight continuous contraction of certain muscles existed in one case.

A^1 The case of coma without delirium, a woman, was under the care of Dr. Wilson Fox,[1] with acute rheumatism and pericarditis. The temperature was about 102° on the morning of the fourteenth day of illness, and had risen to 108·4° at 9.15 P.M., when she became entirely unconscious, and to 109·1° at 9.50 P.M., when she was put into a bath at 96°, and ice was applied to her body. She was unconscious, pulseless, and cyanotic, her respirations were irregular, gasping, and stertorous, and she appeared to be dying. In half an hour her temperature had fallen to 106·2°, when the pulse became perceptible, and she showed signs of consciousness. In ten more minutes, the temperature was 103·6°, and she was taken out of the bath, and twenty minutes later it had fallen to 100·1°, when she could speak, and had imperfect consciousness. After various oscillations, this patient recovered. I relate this case here briefly not to illustrate the treatment, but to show that profound coma became established when the temperature was excessively high, and that consciousness was restored when the body was cooled.

A^3 Ten cases, in which delirium was followed by coma, and in which the bath was not used, proved fatal, but one such case recovered after the employment of the bath.

Delirium appeared at a temperature of from 103° to 104·8° in eight of the eleven cases in which coma was preceded by delirium, the temperature in six of these being at or above 104° when the disturbed state of mind was first noticed. In three of these cases delirium was still present when the thermometer was as high as from 107° to 108°, and in one of them when it was as low as 99·6°.

[1] *Treatment of Hyperpyrexia*, by Dr. Wilson Fox, p. 2.

Profound coma declared itself when the temperature had risen from 109° to 109·4° in five of the eleven cases in which complete unconsciousness followed delirium, when the thermometer stood at 108·4° in one of them, at 106·8° in another, and at 106·6° to 107·6° in another, in which the coma, not profound, was transient.

In several of these cases it was noticed that the temperature rose between the supervention of coma and death.

The delirium was violent in five of those eleven patients who passed from delirium into coma, two of whom got out of bed; was active in three of them; and resembled delirium tremens in two, while in another the manner was strange and excited, and the sentences were disconnected and incoherent.

The transition from a state of violent or active delirium to coma was usually gradual. Muttering replaced active delirium in three instances, the muttering delirium being accompanied by restlessness in two of them. A state of semi-consciousness, accompanied by moaning in one and by restlessness in the other, intervened in two cases between the period of delirium and that of coma; and two other cases passed from delirium to a state almost of unconsciousness, and from that to coma. Violent delirium ceased abruptly after venesection in one patient, who was quiet for a short time, but soon passed into a state of perfect unconsciousness.

The duration of the delirium was very various in the different cases, lasting in one case about three-quarters of an hour, and in another, eight days. The delirium was more frequent by night than by day, and lasted from one to four nights in four cases in which it was scarcely observed during the day.

The period of coma varied much less than that of the delirium, lasting from a quarter of an hour to seven hours in nine of the eleven cases with delirium and coma. In one of the remaining cases, the duration of the coma was prolonged, death being delayed, and in another of them consciousness was restored, and recovery was established by the use of the bath.

The two cases were fatal in which delirium preceded semi-stertorous breathing, with violent spasmodic movements of the whole body in one instance, and profound stupor in the other. The temperature in the former case rose to 110·2° before death, but in the latter it was never higher than 106°. Dr. Murchison favoured me with the leading features of that case.

B[1] Delirium without coma or other important modifications affected nine cases of acute rheumatism with pericarditis. These cases divide themselves naturally into two groups; in the first group, consisting of four, the delirium was of the usual character, and the temperature was very high, varying from 107·3° to 110·5°, and was kept in check in two of them by the cooling bath; while in the second group, containing four cases, the temperature was not so very high, varying from 103·3° to 105·3°. The delirium was accompanied by tremor, and usually by hallucinations, and a general condition resembling delirium tremens. The remaining case of delirium belongs to neither of these groups, since the delirium was slight, and gave way to general emaciation, ending in death.

Delirium was present throughout in one of the four cases with very high temperature, and in that patient it ranged from 103° to 105·6°, and ascended to 107·4° during the last ten hours. Death was sudden. The second case, a coachman who had lived well, was under the care of Dr. Wilson Fox.[1] His temperature was 107°, his pulse 100—108,

[1] *Treatment of Hyperpyrexia*, p. 10.

respiration 44—45. At 2 A.M. he was put for 25 minutes into a bath at 89° to 86°, when his temperature fell from 107° to 103·1°, and he became perfectly conscious. Fifteen minutes after the bath his temperature had fallen to 98°, when his pulse was 84, respiration 20, and he was perfectly rational and conscious. The pericarditis in this case was of unusual duration and severity. The bath, the wet-pack, or the ice-bag was employed during the next six days to keep down the temperature, which had a strong tendency to rise. This patient recovered. In another case, a man, the temperature was lowered by the bath from 108·2°, when he was delirious, to 103·8°, when he could answer questions rationally. A second bath lowered his temperature from 105° to 102°, and thirty-five minutes after his removal from it, to 98·7°, when he was quiet. He recovered slowly.[1]

One of the four patients with tremor, hallucinations, a state resembling delirium tremens, and a temperature not excessively high, who was under the care of Dr. Southey, was an intellectual, nervous man, and a drinker of beer. His tongue and hands were at a temperature of 105°; he was placed in a bath at 71° for ten minutes, when he felt cold, talked rationally, and thought it the queerest treatment for rheumatism. He was wet-sheeted whenever his temperature rose to 104°, when he was always delirious. He died with bronchial symptoms. Sir William Gull saw the case, and suggested that it indicated the association of acute rheumatism with delirium tremens.[2]

The next case resembling delirium tremens was a poorly nourished, pale man. The bath lowered his temperature on the first occasion from 104·3° to 99·8°, and on the second from 105·3° to 101·6°, when he was rational, and after the

[1] Dr. Andrews, *St. Bartholomew's Hospital Reports*, x. 338.

[2] *Lancet*, 1872, ii. 562.

second bath he had *risus sardonicus*, his limbs were tremulous, and he remained delirious until the fourteenth day (temp. 103·4° to 100·2°). After this he steadily improved.[1] Dr. Southey favoured me with the notes of another case of this class, a poorly nourished, anæmic man, a coachmaker, who had been ill ten days. When admitted (temp. 103°), his tongue was tremulous, and he perspired profusely. On the fifth day he had pericarditis; on the seventh night, constant muttering delirium; and next day an abrupt manner. On the ninth, after a delirious night, his hands were tremulous. On the seventeenth day his skin was hot and dry, temp. 103·8°; and the activity of his mind resembled what is observed in delirium tremens, but he had no horrors. The ice-bag was applied to his head on the eighteenth, and as he was sleepless, he had 30 grains of chloral, after which he slept for four hours. On the following day he was conscious, had pain in the knees and shoulders, perspired less, and looked better, but still had some tremulousness and jactitation. His respiration and temperature steadily fell, and he gradually recovered.

The fourth case was a constable, who ten years before had been unconscious after a kick. His highest temperature was 103·3°, but it rarely exceeded 102°. In the course of his illness he had delirious nights, choreal movements of the left hand, on one occasion tremor of the right hand, hallucinations, and frequent rolling of his head from side to side. He improved slowly, but remained for some days incoherent, and childish in manner.[2]

B[4] Delirium with stiffness of jaws, neck, back and limbs, occurred in a patient of Dr. Bristowe's, a bargeman, aged

[1] Dr. Andrews, *St. Bartholomew's Hospital Reports*, x. 350.
[2] Dr. Greenhow, *Clin. Soc. Trans.* vii. 172.

21, with slight acute rheumatism, pericarditis, and endocarditis.[1]

Two cases, one affected with temporary unconsciousness, the other with stridor and semi-consciousness, were under my care in St. Mary's Hospital. They had albumen in the urine, and were both fatal. The first case had previous aortic and mitral valvular disease. The second had a presystolic murmur, and mitral and tricuspid systolic murmurs, and the inspection after death showed pericarditis, button-hole contraction of the mitral valve, and acute Bright's disease of the kidneys.

C[1] Choreal and continuous contraction of some muscles occurred in the following case, a delicate, excitable girl, aged eleven, for observing which I am indebted to Mr. Saunders. When I first saw her, about the tenth day of her illness, a loud pericardial friction-sound prevailed over the whole front of the chest, extinguishing all other heart-sounds. Ten days later, temp. 101·5°, she took little notice, bent and extended her right arm and hand irregularly, but bent the hand backwards on the fore-arm, flexed the fingers, and pointed the right great toe downwards, by the continuous, but not constant, contraction respectively of the flexors and extensors of the fore-arm and muscles of the calf. The face was still, the tongue protruded itself steadily and for long; her body was quiet, and speech was limited. During the night she alarmed her mother by screaming violently, throwing herself about the bed, and tossing her head from side to side. After about twenty minutes she became quiet and fell asleep. Four days later she had a return of pain and swelling in the right knee, friction-sound was barely audible over the heart, and the movements of the right arm had lessened, and were more simply those of ordinary chorea.

[1] *Path. Trans.* xxiv. p. 75.

The *affection of the joints* during the early period of the attack of acute rheumatism was severe in three-fifths (15 in 27), and of moderate severity in one-third of the patients (8 in 27), not severe in two instances, and in one the condition of the joints was not described. The affection of the joints disappeared, or was much lessened in severity at the time of the delirium, coma, or chorea, in all those cases (20 in 27) in which the condition of the joints is described. In thirteen cases the affection of the joints was well at the period in question; in four it was slight, and in three it was not severe.

The invariable subsidence of the inflammation of the joints in these cases, when affection of the nervous system takes place, shows that there is some connection between the appearance of the one affection and the disappearance of the other. The improvement of the inflammation of the joints generally coincides with improvement of the general symptoms, unless the heart is inflamed. We may therefore, I think, infer that the presence of trouble in the nervous system, whether accompanied or not by a very excessive rise in temperature, has a distinct association with the lessening of the affection of the joints.

The *perspiration*, before the nervous system was affected, in these cases was noted in ten of the fourteen cases with coma, stupor or convulsions preceded in all but one instance by delirium, and during that early period it was profuse in seven, and moderate or slight in three of those ten cases. The perspiration was observed in eleven of the fourteen cases just noticed during the period of delirium or coma, when it was absent in three, slight in four, moderate or considerable in two, and profuse in two of these eleven cases.

The perspiration was noted both before and during the period of the delirium or coma in nine of those fourteen cases. In eight of those nine patients, the temperature was excessively high at the time of the delirium or coma, and perspiration was then absent or lessened. In one case with delirium, the highest temperature observed was only 103·8°, and perspiration, previously moderate, was then profuse.

The perspiration was observed during both periods in four of the nine cases in which delirium was present without coma or stupor, and was profuse in those four cases during the early period of the disease. One of those patients had on previous days perspired freely, but the skin became dry when the temperature rose to 107·3°. In another of them, the skin, previously perspiring, felt hot and dry when delirium appeared at a temperature of 103·8°. The perspiration remained profuse in two cases during the period of delirium with hallucinations and tremor, the temperature being then respectively 105° and 102°. Both of those patients were predisposed to affections of the nervous system. Dr. Wilson Fox justly regards the cessation of perspiration while the temperature is still high as a symptom of very great gravity. It would appear from what I have just stated, that the cooling influence of the perspiration may have kept down the temperature in the three latter cases, while in the ten former cases the want of that cooling influence may have allowed the temperature to rise unchecked when heat was supplied from within by the rapid combustion of the tissues of the body during the disease.

The presence of a *miliary eruption* or sudamina was noticed in nearly one-half of the cases (12 in 26).

The *pericarditis* was of average intensity or severe in eleven and slight in three of the fourteen cases with coma, stupor, or convulsions, in all of which but one the more grave affection of the nervous system was preceded by delirium. In seven of the nine cases with uncomplicated delirium, the pericarditis was of average severity, and in two of them it was slight. The pericarditis was of average severity in the remaining three patients, in none of whom was the temperature above 101·5°, one of them having transient coma, one of them coma, and the other choreal symptoms.

We shall be better able to consider whether the presence of pericarditis had any influence in producing the excessive rise of temperature in cases with "hyperpyrexia" when we have inquired into the whole chain of cases, those namely without as well as those with that affection.

Endocarditis was present in nearly one-half of these cases, with pericarditis and affection of the nervous system (11 in 26), was absent in almost as many (9 in 26), and was doubtful or not noted in the few remaining cases (5 in 26).

Convulsive, Choreiform, and Tetaniform Movements.—Movements of a convulsive, choreiform, or tetaniform kind affected nine of the twenty-four patients with acute rheumatism and pericarditis in whom the temperature was observed, including the case just related, in which choreal symptoms were present without delirium. Besides these, two patients affected with delirium had distinct *risus sardonicus.*

One of these patients, a shopman in a cigar shop, aged 28, had in the morning muttering delirium, and a temperature of 107°. In the afternoon he had violent spasmodic movements of the whole body, his respirations were semi-stertorous, his temperature was 110·2°, and an hour later he died.[1] Another of them, a female servant, being violently delirious, temp. 107·8° F., was bled, and became, as I have already stated, abruptly unconscious. Then succeeded a peculiar series of irregular muscular movements of the hands and arms, with chattering and grinding of the teeth, and convulsive

[1] Dr. Murchison, *Clin. Soc. Trans.* i. 32.

movements of the jaw, or trismus. Fully two hours later, after being in the bath, when she had cooled down to 104°, she had an attack of clonic spasms of the muscles of the arms, lasting some minutes.[1] There were muscular twitchings of the limbs in three patients when in a state of unconsciousness.

One patient, a police-constable, aged 23, who, ten years previously, had been unconscious from a kick in the mouth, after little sleep, had wandering, much jactitation, constant movement of the fingers of the left hand, tremors of the right hand, and subsultus. Two days later there was also frequent rolling of the head from side to side. His temperature was not above 102°.[2] Another patient, a woman aged 29, also rolled her head from side to side, contracted her brows, and distorted her face into various grimaces. Her temperature was 107·8°.[3] One patient, a man aged 23, on the evening before he died, temp. 105·4°, was very delirious, and rolled violently about the bed, so that he required to be held down. This violence quickly passed away, and he then lay half unconscious and moaning loudly.

Symptoms of a more or less tetaniform character, that is to say, with continuous rigidity or contraction of muscles, appeared in five of the cases.

Dr. Wilson Fox's patient, already sketched at page 342, after the bath, temp. 100·6°, had at times spasms of rigidity of the muscles of the lips and neck, but not of the limbs. Another patient, a gardener, seven hours before death, became incoherent, and, within ten minutes, unconscious; his lips pouted and rubbed incessantly over the teeth, and his whole voluntary muscles twitched constantly.[4] The third is that

[1] Dr. Fox, *Treatment of Hyperpyrexia*, 44.
[2] Dr. Greenhow, *Clin. Soc. Trans.* vii. 175.
[3] Dr. Sydney Ringer, *Medical Times and Gazette*, 1867, ii. 380.
[4] Mr. Anderson, *British Medical Journal*, 1871, i. 529.

of Dr. Wilson Fox just referred to, with chattering and grinding of the teeth, and convulsive movements of the jaw, or "trismus."[1] The fourth case is Dr. Greenhow's, already noticed, with choreal movements of the left hand. When that hand was turned on to its back,[2] there were constant twitching movements of the hand and fingers, and the fore-finger became flexed, towards the palm. The fifth case is my own, already related at page 345, with choreiform movements of the right arm. Her right hand was bent backwards, her right fingers were flexed, and her right toe pointed downwards, owing to the continuance contraction of the corresponding sets of muscles, which offered steady resistance when put on the stretch. These five cases seem to suggest a combination of convulsive, choreiform, and tetaniform movements.

The question naturally arises, were the cases presenting choreiform movements associated with endocarditis? The answer to that is, however, as regards these cases, definitely in the negative, for endocarditis was absent, or not observed, in those cases, excepting to a slight and doubtful degree in one of those with muscular twitching. Endocarditis was, however, present in Dr. Wilson Fox's case with spasms of rigidity of the muscles of the lips and neck. I shall again briefly consider these cases when I return to the important question of the association of pericarditis with tetaniform and choreiform movements.

Tremor was present in seven of the cases, all of which have been already alluded to.

[1] *Loc. cit.* p. 48.
[2] *Loc. cit.* p. 174.

II.—Cases with Simple Endocarditis in which the Nervous System was affected and the Temperature, generally very high, was observed.

SUMMARY.

A^3 Had *delirium* followed by *coma*, temp. 104·4°—110·2° . . .	4
A^2 Had *delirium* and *convulsive movements*, temp. 111·6° . . .	1
B^1 Had uncomplicated *delirium* in three, temp. 108·5°—111·4°; in two, temp. 102·8°—103·9°	5
B^2 Had *delirium*, cerebral embolism, and hemiplegia, temp. 103°.	1
B^3 Had *delirium* and *chorea* (minute cerebral embolism), temp. 103°—102·3°	1
Had high temperature without notice of delirium, temp. 105·8° (ice-bag)	1
Total	13

The nervous system was affected in thirteen cases of simple endocarditis in which the temperature was observed. The majority of these cases, like that of those affected with pericarditis, presented an excessively high temperature; and in three of the whole number the temperature, when undergoing a rapid ascent, was arrested in its rise, lowered, and kept down by the use of the cooling bath or the external application of the wet sheet and ice. The temperature was as high as from 108·5° to 111·6° in three-fifths of the cases (7 in 13); and in the one of those cases in which the temperature was the lowest, 108·5°, the vigorous use of ice-cold water within and without arrested the rise of temperature and induced its permanent lowering, followed by the recovery of the patient. In one patient the temperature was checked at 105·8°, and brought down by the bath; and in another the thermometer was at 104·4° during the period of delirium, but was not employed during that of coma. In four of the cases the temperature was only of a moderate height, being from 103·9° to 102·3°; and we may therefore infer that fully two-thirds of the cases with simple endocarditis (9 in 13) in which the nervous system was affected had "hyperpyrexia."

A[2,3] Twelve of the thirteen cases had delirium, which passed into coma in four instances, ended in convulsive movements in one; *B*[1] was without complication in five, was associated with *B*[2] cerebral embolism and hemiplegia in one patient, and with *B*[3] minute cerebral embolism and chorea in another. In one instance, in which the temperature was high (105·8°), there was no note of delirium.

A[3] One of the four cases in which delirium passed into coma was a delicate, ailing woman. On the seventh day her temperature in the morning was 102°, but it rose in the evening to 109·5°, when she was comatose. For want of a bath, she was taken downstairs, placed, doubled up, in a washing-tub containing water at 80° cooled to 62°, and cold water was ladled over her body. Spasms soon came on, which were more and more continuous until she was taken out of the bath in one of them, after being there for forty-five minutes, while her temperature had fallen to 100·3°. Towards midnight she was much convulsed, the teeth closing firmly on the lower lip and drawing blood. On the tenth day the temperature rose to 105·1°, she was again put into the tub for fifty-eight minutes, and at the end of that time was taken out in a state of well-marked opisthotonos, which passed off gradually in about two hours. She died on the twelfth day.[1]

B[1] Three of the four cases with delirium without coma had high temperatures, 111·4°—108·5°; while in two the temperature was comparatively low, 103·9°—102·8°. One of the patients with delirium and high temperature was a female servant, aged 22. On the eighth day of treatment, temp. 108·5°, her sensorium was much disturbed, and her skin,

[1] Dr. Andrews, *Bartholomew's Hospital Reports*, x. 346.

which hitherto had been moist and sometimes covered with sweat, was dry. Cold was used energetically. Ice-cold water and cloths were applied freely to the body, and ice-water enemata were given every half-hour. In an hour's time she breathed more freely, her head was relieved, and the pulse fell. At half-past six in the evening her temperature was 98·6°, skin perspiring, mind clear, and she felt like a new-born person. Two days later she sat up in bed, and took food with appetite.[1]

In the two cases with comparatively low temperature the delirium was only present during the night. The temperature was 103·9° in the daytime in one of these patients, and 100·4° in the other. Convulsive movements affected four of the thirteen patients belonging to this group with endocarditis.

The *affection of the joints* was severe in eight, and was rather severe in one of the thirteen cases with simple endocarditis before the period of delirium or coma; while it was absent in two and not severe in three; and its condition was doubtful in four of those cases during that period.

Perspiration was profuse in five and absent in one of the cases of simple endocarditis before delirium set in; and it was absent in two, slight in one, probably profuse in one, and doubtful in two of those cases after the appearance of delirium, while it was profuse in another patient who was delirious when admitted, and whose temperature never rose above 102·8°.

[1] Dr. Meding, *Archiv der Heilkunde*, xi. 467.

III.—Cases in which there was no Pericarditis, Endocarditis being absent or doubtful, in which the Nervous System was affected, and the Temperature, generally very high, was observed.

SUMMARY.

A[3] Had *delirium* followed by *coma*, temp. 111·1°—105·8° . . .	6
A[4] Had *delirium* followed by *somnolence*, temp. 106°	2
B[1] Had *delirium* uncomplicated, temp. 110° to 100·4°	10
Very high temperature without *delirium*, temp. 110·8°—106·3° .	2
Twitching of limbs, temp. 102°	1
Total	21

Twenty-one cases had no pericarditis, endocarditis being absent or doubtful; and the majority of these cases, like that of those with pericarditis and with simple endocarditis, presented an excessively high temperature; and in five of the whole number the temperature, when undergoing a rapid ascent, was arrested in its rise, lowered, and kept down by the use of the cooling bath, the wet sheet, or ice. The temperature was as high as from 106° to 111·2° in three-fifths of the cases (12 in 21), being kept down in the one of those in which it was the least high by the use of the cooling bath. In one-fifth of the cases (4 in 21), the highest ascertained temperature varied from 106° to 103·4°, and in these the cooling bath was not employed. In one-fourth of the cases (5 in 21), the highest temperature varied from 102° to 100·4°. From this summary it would appear that three-fifths of these cases of acute rheumatism without pericarditis, endocarditis being absent or doubtful, in which the nervous system was seriously affected, had hyperpyrexia.

Pericarditis was absent and endocarditis was absent or doubtful, as we have just seen, in twenty-one cases of acute rheumatism in which there was affection of the nervous system and the temperature was ascertained. *A* 3 In six of those cases delirium gave place to coma, and in one of these the delirium reappeared. *A* 4 In two delirium passed into somnolence. *B* 1 Delirium without coma was present in ten cases. Two patients had very high temperature without delirium, one of whom was restless and talked when asleep, and the other had vomiting and dyspnœa ; and in one there was twitching of the limbs and body without delirium, the temperature not rising above 102°.

A 3 The whole of the six cases in which delirium passed into coma were fatal. The delirium was present in these patients when the temperature varied from 102·2° to 108·4°, and coma replaced the delirium in five of them at a temperature ranging respectively from 108° to 110°. The highest temperatures observed in these cases towards or at the time of death was from 109·5° to 111·1°. In a case in which delirium gave place to coma and that again to delirium, the temperature about the period of coma was 104°, but eight hours before death it was 105·8°.[1]

The delirium was violent or active in four of these six patients, three of whom got out of bed or tried to do so; and in two of them it was muttering or quiet.

The duration of the delirium varied much in these cases. In one patient the delirium continued for four days, in another two; in one it lasted four hours, and in another, the most interesting of the series, after it was slight for one day, it became muttering for half an hour. The duration of the coma was more constant. It lasted for from an hour to an hour and a half in four cases, and in one for four hours,

[1] Lebert, *Klinik des acuten Gelenkrheumatismus*, p. 55.

while in one there was alternate delirium and coma for two days.

A[4] In two cases delirium passed into drowsiness. One of these, a dull, corpulent woman, aged 32, was strange in manner (temp. 103·4°) on the eighth day after admission, and had low muttering delirium. At 2 A.M. on the following night (temp. 105·3°) she awoke restless; and at 5 A.M. (temp. 106°) she was dull and somnolent. She was put for twenty minutes into a bath at 90° to 81°. When in the bath she felt comfortable, but at length she complained of cold (temp. 102°). After this her temperature never rose above 104·7°, she had bronchitis and pneumonia for some days, and finally recovered.

I was favoured by Dr. Murchison with notes of the other case of this class. A lady, aged 35, stout, was attacked with acute rheumatism. At the end of ten days her joints were better, but she became sleepless and delirious. Opium, chloral, and bromide of potassium only made her worse. Her pulse was 108, weak; temp. 102·5°. She gave no signs of peri- or endo-carditis, and had headache. The following is the report of her case ten days later:—"The temperature has been as high as 106°, but is now only 101°. She is heavy and drowsy, but has been very noisy and delirious. Respiration is quick and irregular—cerebral. She swallows well. Pulse 64. Heart seems still sound. Urine is made in bed. There are bedsores, and she has some pains in the joints." She died next day.

B[1] There was delirium without coma in ten cases. In three of these the temperature was very high, being 110° in a fatal case; and 108·2° and 107° respectively in two that recovered after the use of the cooling bath; in one of these the temperature, rarely above 104·6°, once rose to 105°, and this case died in spite of the repeated use of the bath; while the remaining six cases had the comparatively low maximum temperatures respectively of 104·5°, 103·4°, 101·2°, 101·1°, 101·1°, and 100·4°; and of these the first case (temp. 104·5°) and that in which the temperature was the lowest (100·4°), a case with Bright's disease, died, while the four others recovered.

The duration of the delirium was very various in different cases, having ended in death in one instance in two hours and a half, and being prolonged with interruptions in another for twenty-nine days, the high temperature being kept down and lowered and the delirium from time to time suspended by the cooling effects of a succession of twenty baths.

As I have just said, in two of the three cases with delirium and very high temperature, the temperature was kept in check by the cooling bath. One of these cases, a youth, on the morning of the fourth day of treatment, muttered to himself, but could be roused, temp. 107·8°, and at 7.45 temp. 108·2°. After being half an hour in a bath at 76°, his temperature was 101°, and half an hour later 98·8°, when he fell asleep, and awoke in a perfectly conscious state. In the evening, a second bath again lowered the temperature from 105·8° to 98°, when he perspired freely and slept. After this the temperature never rose above 99·8°, and he recovered.[1] The second case, a woman, with a temperature of 107°, was put into a bath at 90° cooled to 42°. Her temperature was lowered to 97·5°, and her mind became clear.[2]

One patient, a man, who had been a free liver, presented throughout from time to time profuse sweating, variable delirium, tremor of hands, subsultus, and twitchings of the face, and a temperature varying from 104·4° to 106·4°. The use of the cooling bath invariably lowered the temperature,

[1] Dr. Weber, *Clin. Soc. Trans.* v. 186.
[2] Sir William Gull, *Lancet*, 1872, ii. 562.

restored the patient from a state of delirium to one of consciousness, and caused a subsidence of the other nerve-symptoms, tremor, subsultus, and facial spasms. This condition lasted for twenty-nine days, during which time twenty baths were employed, five of them in one day for a combined period of over five hours, and the patient finally died, the temperature at the instant of death being 104·2°.[1]

Among the six cases with delirium in which the temperature was not very high, varying from 104·5° to 100·4°, two died and four recovered.

One of these cases, with a temperature of 103·5°, was a great beer-drinker. His hands were tremulous, he wandered during the day, was very noisy towards the evening, when he screamed out much, continued in a state of variable delirium for fourteen days, and finally recovered.[2]

The highest temperature observed in the four remaining cases with delirium was 101·4° and 100·4° respectively. Two of them had albumen in the urine, and the other one had obstinate diarrhœa, and was delirious when the diarrhœa was checked.

There were three cases of hyperpyrexia in which there was no delirium. One of these was a man whose temperature rose to 106·3°. He had previously been deaf and very restless. Under the influence of a cooling bath his temperature fell to 101·8°, and later to 99·8°. After the bath his deafness left him, and he did well.[3] Another case, a woman aged 24, was suddenly seized with dyspnœa and vomiting, which continued until death ; a short time before which event her temperature was 110·8°.[4]

[1] Dr. Greenhow, *Clin. Soc. Trans.* vi. 7.
[2] Dr. Johnson, *Lancet*, 1867, i.
[3] Dr. H. Thompson, *Medical Times and Gazette*, 1873, i. 269.
[4] Dr. Ogle, *Lancet*, 1870, ii. 154.

Convulsive, Choreiform, and Tetaniform Movements.—Twitchings were present in four of the twenty-one cases that form this group, in which there was no pericarditis and endocarditis was absent or doubtful. The twitchings affected the body in one instance, the limbs and features in another, the muscles of the face for a long period in another, whenever the temperature rose; and in a fourth, the features occasionally twitched with a sardonic grin. In one case the patient was restless, and moved his arms about; but, perhaps with this exception, there were no notable choreiform or tetaniform movements in any of the cases. In two cases there was tremor—in one, of the trunk and limbs; in the other, of the hands.

Twitching movements were present in four of the twenty-six cases with pericarditis, in one of the eleven cases with simple endocarditis, and, as we have just seen, in four of the twenty-one cases in which there was no pericarditis and endocarditis was absent or doubtful. Twitching movements were therefore distributed in nearly equal proportion in those three groups of cases, and were therefore not due to pericarditis. Twitchings were present in eight cases with hyperpyrexia, and it is therefore probable that they were associated with the very high temperature. This is borne out by a case of Dr. Greenhow's, in which twitchings came on, and were again and again renewed when the temperature became very high, and were again and again almost or quite suspended by the cooling bath.

In the remaining case with twitchings, a man who was under my care, the temperature was never above 102°. On the fifth day, temp. 100·2°, he had muscular twitchings all over the body, which continued for several days, and reappeared on the twenty-eighth day. There was albumen in the urine on both occasions when the twitchings were present. His recovery was slow.

There were choreiform or tetaniform symptoms—or both—in seven of the twenty-four cases with pericarditis, but in only one of the eleven cases with simple endocarditis, and in none of the twenty cases in which there was no pericarditis, endocarditis being absent or doubtful. The question how far the choreiform and tetaniform movements observed in these cases were connected with pericarditis will be considered when we review the larger series of cases of acute rheumatism with and without pericarditis in which the temperature was not observed.

The *affection of the joints* during the early period of the disease was severe in ten, and moderately so in five of the twenty-one cases in which there was no pericarditis and endocarditis was absent or doubtful. The affection of the joints was more severe before than during the delirium or other affection of the nervous system, in all but three cases, in which the joint-affection was equally severe during the two periods. In two of these three exceptional cases the temperature never rose above 102°, in one of these the delirium was only present during the night, and in the other there was no delirium, but twitchings were present for a short time during the early days of the illness.

Perspiration.—The state of the skin is described in one-half of the cases belonging to this group (10 in 21), and all of these had profuse perspiration before the nervous system became affected. In seven of those cases there was either no perspiration or it was much lessened during the period of delirium. In that case, perspiration was equally copious during the two periods. In three of these cases the skin, which had been perspiring profusely before the excessive rise of temperature, and the occurrence of delirium, was hot and dry when the temperature was 110° to 111·1°; coma was present, and death approached. These clinical facts correspond with those which, as we have already seen, occurred in the analogous cases affected with pericarditis. One of the cases in which there was no affection of the heart was observed by Mr. Anderson night and day. This patient, of a nervous, excitable temperament, a labourer, aged 29, had a hot, dry skin, and rambled during the night for four succeeding nights; but during the three intervening days his skin was covered with a profuse acid perspiration, and his mind was unaffected. On the morning of the fourth day his manner was wild and excitable, not unlike that of a patient in the early stage of delirium tremens, and his skin was hot and dry, and covered with a miliary eruption. After a bath, he sprang out of bed, ran into the grounds, and struggled violently. His temperature at that time was 107°, and later in the evening, ten minutes before his death, it was 110·3°.

Dr. Greenhow's case, already referred to at page 350, offers a contrast in some respects, but not in others, to Mr. Anderson's case. In this man, perspiration was absent with delirium at a temperature of 104·8°, and was absent without delirium after the bath at 100·2°, and was present afterwards with obscured intellect and intermediate temperatures.

Perspiration, which is not present at ordinary temperatures, is indeed an index of the internal production of great heat, and a safety-valve for carrying away a large portion of that heat. When perspiration takes place from an exposed skin in a dry air—in motion—its evaporation tends to keep down the heat. In these patients, however, lying, as they do, in their own perspiration, covered by bedclothes, in a still air saturated with moisture, evaporation can do comparatively little towards cooling the body.

We must look, then, to some other influence than evaporation to account for the cooling effect of perspiration in acute rheumatism. Such an influence we find in the welling out of hot liquid from every part of the body—a liquid charged with a portion of the surplus heat generated by the rapid combustion or disintegration of the internal structures in that disease. It is self-evident, that if the temperature of the body be 103° or 104°, the fluid poured out from the body must likewise have a temperature of 103° or 104°, and that this fluid during its steady universal expulsion must carry away with it a corresponding proportion of the heat generated within, and so tend to keep down the temperature of the whole of the structures that compose the body.

If, on the other hand, the skin is dry, the chemical heat generated in the rapidly changing tissues tends not to escape, and may be stored up in accumulating quantities in the blood and the tissues, with the effect of producing an excessively high temperature, or "hyperpyrexia."

Respiration.—I have not made an analysis of the rate of respiration in cases of acute rheumatism with affection of the nervous system, with and without high temperature. One well-observed and well-treated case of hyperpyrexia is sufficient for our present purpose, which is to illustrate the influence of an excessively high temperature of the body on the one hand, and of the cooling of that body on the other, on the frequency of respiration. In Dr. Wilson Fox's case, already related at page 342, when the temperature of the body was 107°, the patient was delirious, and the respiration was 45 in the minute, but when the patient's body had been cooled down by the bath to 98°, the mind was clear, and the respiration was 20 in the minute.

It is evident, therefore, that during hyperpyrexia, the cooling effect of respiration is stimulated to its highest degree by the excessive heat of the body, but that this cooling effect is quite inadequate to keep down the temperature of the body below that of hyperpyrexia.

There were some conditions common to the three sets of cases—those namely with: 1, pericarditis; 2, simple endocarditis; 3, without pericarditis, endocarditis being absent or doubtful—and I shall now briefly notice those conditions.

Restlessness affected a considerable proportion of the patients before the occurrence of delirium.. Six of the twenty-seven case with pericarditis; three of the thirteen cases with simple endocarditis; and ten of the twenty-one cases that had no pericarditis, endocarditis being absent or doubtful, were thus affected with restlessness.

A *miliary eruption* or *sudamina* appeared in a considerable number of the cases, being noticed in twelve of the twenty-seven cases with pericarditis; in three of the thirteen cases with simple endocarditis; and in eight of the twenty-one cases in which there was no pericarditis and endocarditis was either absent or doubtful.

An *abundant secretion of urine* took place in a few of the cases, at the time of the great rise in temperature. The urine was very abundant under those circumstances in three of the twenty-seven cases with pericarditis; in three of the thirteen cases with simple endocarditis; and in two of the twenty-one cases in which there was no pericarditis, endocarditis being either absent or doubtful.

Diarrhœa, sometimes profuse and offensive, was present when the temperature was very high in seven of the twenty-seven cases with pericarditis; in four of the thirteen cases with simple endocarditis; and in five of the twenty-one cases in which there was no pericarditis, and endocarditis was either absent or doubtful.

Excessively high temperature or "hyperpyrexia" in acute rheumatism with and without pericarditis. We have just seen that in sixty-one cases of acute rheumatism in which the temperature of the patient was observed, the nervous system was affected, and we shall now inquire how many of them presented an excessively high temperature, and what was the influence of pericarditis in those cases of hyperpyrexia. The temperature was excessively high, ranging from 106·8° to 111·1° in thirty-one of those sixty-one cases, and was arrested during its rise when it was at from 105° to 106·3° by the use of the cooling bath, or cold externally, in six cases. In three of those six cases, the tendency of the temperature to rise was great, but in three of them it was not so. The temperature was not observed during the period of coma or the last hours of life in three fatal cases in which the temperature was 104·6°, 104·8°, and 105·8° respectively at the time of the last observation, and I consider that these three cases, and three of the six in which the high temperature was kept in check by the bath, ought to be added to the thirty-one cases in which the temperature was very high, thus bringing up the number of those with "hyperpyrexia" to thirty-seven of the total number of sixty-one cases. Thus estimated, we find that seventeen of the twenty-seven cases with pericarditis, nine of the thirteen with simple endocarditis, and eleven of the twenty-one without pericaditis, endocarditis being absent or doubtful, either had or were threatened with "hyperpyrexia." Among these thirty-seven cases of hyperpyrexia, one had coma without delirium, twenty-one, delirium followed by coma, or, in one instance, stupor, two, delirium with convulsive movements, ten, uncomplicated delirium, and three had neither coma nor delirium.

The case of simple coma, and all but one of the twenty-one cases in which delirium passed into coma, were affected with actual (18) or threatened (3) hyperpyrexia. The temperature observed soon rose above 106° in three cases with delirium and stupor, but in one of these it was kept down and lowered by the cooling bath, while in both the cases which ended fatally with convulsive movements the temperature was very high. Of the twenty-four cases with uncomplicated delirium, only two-fifths had hyperpyrexia (10 in 26).

Coma preceded by delirium is, as we have just seen, the typical effect of rheumatic hyperpyrexia, and one-half of those with hyperpyrexia and coma preceded by delirium had pericarditis (10 in 20). From these clinical facts it would appear that hyperpyrexia attacked cases of acute rheumatism almost as frequently when they had pericarditis as when they were not so affected (17 in 27 with pericarditis, 20 in 37 without pericarditis). When we consider that pericarditis usually attacks only one in every five or six cases of acute rheumatism, we must multiply the cases of pericarditis with hyperpyrexia by five or six if we would make a parallel comparison between those cases with pericarditis and those without it. It would appear from this that the presence of pericarditis in a case of acute rheumatism increases the chance of the occurrence of hyperpyrexia with delirium and coma, in the proportion of four or five to one. An important case successfully treated by Dr. Wilson Fox by the cold bath had pericarditis in its worst form. The dulness or percussion over the region of the pericardium filled the whole left front of the chest from apex to base. In that case the tendency to the renewed excessive rise of temperature after it had been brought down again and again by the cold bath, the ice-bag, or the wet-pack, continued until the seventh day; when the pericardial dulness fell to the first rib mid-sternum, and the tendency to the increase of temperature lessened. It is a clinical fact that here the renewed rise of temperature continued so long as the pericarditis was severe, and gave way when the pericarditis gave way, and it is probable that the continued severity of the pericarditis had an influence in keeping up the tendency to the rise of temperature. It must however not be lost sight of that, as a rule, cases of acute rheumatism with pericarditis are in all respects worse than those without it, and that, not only at the time of the pericardial inflammation, but usually also before it. It becomes therefore a question whether or not the same severity of the acute rheumatism itself that brought the pericarditis into existence brought also the excessively high temperature, with its attendant delirium and coma, into existence, the two affections being affiliated, and due to a common cause.

The occurrence of a high temperature of the body in cases of acute rheumatism corresponds in essential features with the high temperature observed in sun-stroke, in certain exceptional cases of tetanus, and in injuries to the cervical portion of the spinal marrow. In sun-stroke the temperature varies from 112° to 105·5°, the skin is hot and dry, coma supervenes, preceded occasionally by delirium, and death tends to ensue unless the temperature of the body is lowered by cold.[1]

The temperature in tetanus, though variable, does not, as a rule, rise to a very great height. Wünderlich, however, gives a case in which it attained to 44·75° C. (112·55° F.) before death.[2] This instance resembled in all its main features the cases of hyperpyrexia in acute rheumatism. The patient, before the time of the fatal rise of heat, was very restless; had profuse perspiration and an abundant miliary rash; then came on delirium, night trembling, contracted pupils, and death. Wünderlich, without giving any reason for it, gives

[1] Dr. Levick, *Pennsylvania Hospital Reports*, 1868, p. 371; Dr. Gee, "Gulstonian Lectures on Pyrexia," *Brit. Med. Journal*, 1871, i. 302; Dr. Maclean on Sunstroke, Reynolds's *System of Medicine*, ii. 128.

[2] Wünderlieh, *Archiv der Heilkunde*, ii.

the name of rheumatic tetanus to another but less extreme case of the same kind.

Injury of the spinal cord from the fourth to the sixth cervical vertebra from fracture or caries of the spinal column has induced an excessively high temperature in several cases published since the first observation to that effect by Sir Benjamin Brodie.[1] The symptoms in these cases closely resemble those of hyperpyrexia in acute rheumatism, but in only one of them was it stated that the final and fatal coma was preceded by delirium. One of Dr. Hermann Weber's two cases was a youth, who could walk supported, but like a drunken man, and could move his arms twenty minutes after the accident, which caused fracture and incomplete dislocation of the third, fourth, and fifth cervical vertebræ. He voided urine frequently and in great quantities. An hour after admission his temperature was 100·4°. Two hours and a half after the accident he passed liquid motions unconsciously, had occasional convulsive twitches in the arms and legs, his skin was slightly moist and hot, and his temperature was 109·58°. Four and a half hours after the accident there was complete coma, and his temperature was 111°, and it was 111·2° at the time of death, eight hours after the accident.[2]

Dr. Burdon Sanderson, who has favoured me with the use of the manuscript notes of his lectures delivered at Manchester, gives an account of experiments made by him in which the cervical portion of the spinal cord was injured. He found that there was no increase of temperature for two hours after the injury to the cord, but that at the end of that time it began to rise and to rise rapidly, attaining a very

[1] Sir Benjamin Brodie, *Med. Chir. Trans.* xx. 118; Reineke, *Berliner Klinisches Wörterbuch*, 1869, 113, 301; Billroth, *Archiv für klinische Chirurgie*, Langenbeck, ii. 482.

[2] Dr. Hermann Weber, *Clin. Soc. Trans.* i. 163.

great elevation, 42° C. or 107·6° F., or higher than that of fever. Dr. Burdon Sanderson considers that this experiment shows conclusively that the process of which the higher temperature is the outcome must consist in a gradual modification of those processes on which heat production depends, must have as wide a localisation as they, and cannot therefore be attributed to any sudden interruption of the relation between the centre and the periphery of the nervous system. These experiments correspond remarkably with Dr. Hermann Weber's case just reported.

Cases in which the temperature of the body was below that of hyperpyrexia.—We have just seen that of the sixty-one cases of acute rheumatism associated with affection of the nervous system in which the temperature was observed, in thirty-seven there was actual (31) or threatened (6) "hyperpyrexia." In the remaining twenty-four cases, the maximum temperature of the body observed in the different instances varied from 99·3° to 106·3° temp. Ten of the twenty-seven cases with pericarditis, four of the thirteen with simple endocarditis, and ten of the twenty-one without pericarditis, and in which endocarditis was absent or doubtful, belong to this group in which the temperature was not excessively high. In twelve of these twenty-one cases, the maximum temperature varied in the different cases from 103° to 106°, and in nine of them from 99·3° to 102·8°.

A considerable proportion of those who were attacked with delirium at comparatively low temperatures were either habitual drinkers, or of a nervous temperament, or had been subject to anxieties and privation, or to lowering diseases, or had received injuries affecting the nervous system, and in several of those cases the affection was closely allied to delirium tremens; several such cases occurred among those affected with pericarditis. This was so in Dr. Southey's two cases with pericarditis, referred to at pages 343, 344, in Dr. Greenhow's case, given at page 349, in Dr. Murchison's two patients, quoted at page 348, and in a patient of my own.

To these must be added the case with which Dr. Southey favoured me since the above was written, given at page 344, and two of Dr. Andrew's cases.

Most of these cases had pericarditis.

Cases of Acute Rheumatism with Affections of the Nervous System in which the Temperature of the Body was *not* observed.

There were 119 cases of acute rheumatism with affections of the nervous system in which the temperature was not observed. Of these 65 had pericarditis; 16 had simple endocarditis; and 38 were free from pericarditis, endocarditis being absent or doubtful.

CASES OF ACUTE RHEUMATISM, WITH AFFECTIONS OF THE NERVOUS SYSTEM IN WHICH THE TEMPERATURE WAS *NOT* OBSERVED.

I.—CASES WITH PERICARDITIS.

Total Patients of both Sexes, **65**.

Sex and Age.

Male Patients. Total **37**.—Below 21 years, 15 (1, 2, 3, 20, 23, 24, 25, 32, 42, 43, 49, 50, 55, 60, 65); 21 to 25 years, 10 (9, 12, 13, 31, 48, 52, 56, 61, 63 ?), 64; above 25 years, 12 (5, 6, 10, 11, 14, 15, 16, 40, 47, 54, 58, 62).

Female Patients. Total **27**.—Below 21 years, 19 (17, 19, 21, 22, 26, 27, 28, 29, 30, 33, 34, 36, 37, 38, 41, 45, 46, 51, 57); 21 to 25 years, 1 (4); above 25 years, 7 (7, 18, 35, 39, 44, 53, 59). Sex and age not stated, **1** (8).

Occupation, Habits, and Previous Condition.

Male Patients, **37**.—*Workers out of doors*, **12**; laborious, **11**; labourers, 5 (6, 10, 40, 43, 54); gardener, 1 (32, excitable, not under control); sawyer, 1 (62); carpenters, 3 (16 drinker, 58, 61); butcher-boy, 1 (55); painter, 1 (5). *Workers in-doors*, **3**: greengrocer, 1 (60); sealmaker, 1 (11); copper-worker, 1 (13). Schoolboy, 1 (3). Potman, &c., **2**; potman, 1 (56); brewer's worker, 1 (64). *No occupation*, **5** (1, 2, 23 chorea four years before, (42, 49). *Occupation not stated*, **14** (9, 12, 14 strong, 15 rather intemperate, 20, 24, 25, 31, 47, 48, 50, 52, 63, 65).

Female Patients, **27**.—*Active in-door Workers*, **8**: Servants, 6 (7, 19, 41, 44, 46, 57); cook, 1 (59); married, 1 (39); *Sedentary in-door Workers*, **2**, sempstress, &c., 2 (4, 21). *No occupation*, **4** (22 chorea two years before, 30, 45, 51). *Occupation not stated*, **13** (17, 18, 26, 27, 28, 29 often had rheumatism, 33, 34, 35, 36, 37, 38, 53, 66 anæmic.)

Character of Affection of the Nervous System.

*A*¹—Had *Coma* not preceded by delirium, **3**—12, died ⊂⊃. 44, consciousness restored after bath, ⊂⊃ exudation on pia mater. 47, became unconscious in vapour bath, died in twenty minutes ⊂⊃.

*A*²—Had *Coma* ending in convulsions and death, **2**—10, ⊂⊃. 11, ⊂⊃.

*A*³—Had *Delirium* followed by *Coma*, **5**—3, ⊂⊃. 5, ⊂⊃. 6, ⊂⊃. 31, del., convulsions, tetaniform spasms, coma, ⊂⊃. 33, del. choreiform and tetaniform movements, coma, ⊂⊃. Had *semi-consciousness* for some days, **1** 57—*Recovered.*

*B*¹—Had *Delirium* without coma or other important complication, **21**.—1, del. during nights, ⊂⊃. 2, del., incoherent, ⊂⊃. 4, would get out of bed, maniacal—*Recovered.* 7, sudden loud del., wet packing, better—*Recovered.* 9, strong del. ⊂⊃. 13, del. nights—*Recovered.* 14, violent del., convulsive movements, ⊂⊃ 15, violent del.—*Recovered.* 16, trembling, agitation, fastened down, confused—*Recovered.* 17, violent del., out of bed, jactitation, ⊂⊃. 18, del., jactitation—*Recovered.* 49, occasional del, ⊂⊃. 50, severe del. ⊂⊃. 52, tremor, furious del. ⊂⊃. 55, transient del.—*Recovered.* 59, occasional del., albumen in urine—*Recovered.* 62, transient del.—*Recovered.* 63, furious del. ⊂⊃. 64, swear, tremor, violent del., hallucination as in del. trem.—*Recovered.* 53, del., agitation, pyæmia, injected arachnoid, ⊂⊃. "*Symptoms of inflammation of brain*," probably delirium, 1 8 ⊂⊃.

*B*²—Had *Delirium* passing into *temporary insanity*, taciturn melancholy, lasting three weeks to three months, **11**.—19, despondent, speech confused continued twelve days, improved by wet sheet—*Recovered.* 35, del., vacant, taciturn, ill two months—*Recovered.* 36, dejected, hallucination, taciturn, ill fully six weeks—*Recovered.* 37, del., taciturn and rational by turns, ill two months, ⊂⊃. 38, reason gave way—*Recovered.* 39, del., confused, hallucinations, speech obscure, ill three months, ⊂⊃. 40, silent, melancholy, hallucinations, ill about a month (?)—*Recovered.* 41, mind confused, duration doubtful—*Recovered.* 46, melancholy, taciturn, cried out (wet sheet), silent, ill about one month—*Recovered.* 54, embolism, aphasia, taciturn, ill about three weeks—*Recovered.* 56, depressed, taciturn, refused food, evacuations in bed, ill about two months—*Recovered.*

*B*²,3—Had *Delirium* passing into *temporary insanity* with *Chorea*, *choreiform* or *tetaniform movements*, **5**—29, choreic movements of right arm and leg, childish answers—sometimes irrelevant, sometimes rational, 7th day, less chorea, better, 10th day more rational, 35th day well—*Recovered.* 20, violent chorea, incoherent, utterance difficult, died 16th day, ⊂⊃. 21, taciturn, violent chorea, noisy del., died 8th day, ⊂⊃. 43, del, better, relapse, stubborn, hallucinations, choreiform movements, speech varied, convulsed, 23rd day, ⊂⊃. 34, eyes rolled, excited, tetanic spasms, del., idiotic and violent by turns till 28th day—*Recovered.*

*B*3—Had *Delirium* and *Chorea* (excluding 3 20. 21. 29 that are included among those with temporary insanity). **3.**—24 chorea, del., convulsions.
45, foolish manner, twitchings of face and arm—*Recovered.* 51, occasional del., choreiform twitching three days.
Had *Delirium* and *jactitation* with *choreiform movements*, (excluding 1 (43) that is included among those with temporary insanity), **1.**—61 muttered. needless movements with hands—*Recovered.*

*B*4—Had *Delirium* with *tetaniform movements* (excluding **1** (34) that is included among those with temporary insanity, **2.**—58, trembles, not quite rational, continual movement of lower jaw and biting of lip, knocks about. 65, occasional del., slight opisthotonos.

*C*1—Had *Chorea* without delirium, **7.**—22, first chorea, then pericarditis, then acute rheumatism (usual order reversed)—*Recovered*.
23, chorea and pericarditis on admission. 25, endocarditis, pericarditis, and chorea apparently commenced at same time—*Recovered.*
26, chorea came on in course of acute rheumatism and pericarditis. 27, involuntary movement of limbs, violent chorea.
28, involuntary movement of left arm, pursing of mouth. chorea ceased in six days, apparently came and went with pericarditis—*Recovered.*
42, violent chorea. symptoms of pericarditis improved—*Recovered.*

*C*2—Had *Jactitation* in course of pericarditis, **1**.—30, screaming and most violent jactitation of body for short time in course of illness.

*C*3—Had *Choreiform* and *tetaniform movements*, **2**.—32, twitchings of face, movement of head from side to side, convulsions like tetanus and opisthotonos, rolled eyes, smacked lips. 60, choreiform movements. later rigid bending of left hand on forearm, and forearm on arm.

D—Had *slight Fit*, with ptosis of one eye, few hours before death, **1.**—48.

The Duration of Delirium and Coma, and their Relation to Pericarditis and Endocarditis.

*A*1—*Coma*, 12 {sudden short coma / peric. and endoc.}; 4 {sudden coma, restored by bath / pericarditis and endocarditis}; 47 {coma twenty minutes / slight pericard., no endocard.}.

*A*2—*Coma, Convulsions*, 10 {coma 1 hour / per., no end.}; 11 {convulsions, speedy death / pericard., endocard. (?)}. *A*3—*Delirium and Coma*, 3 {del. 1 night, coma short / peric., no endoc.};
5 {del. 1 night. coma (?) / pericarditis, no endocarditis}; 6 {del. 1 night, coma short / pericarditis, no endocarditis}; 31 {del. 7-8 nights, occ. days / pericarditis and endocarditis}; 33 {del. 9 days, coma short (?) / peric. and endoc.—*Recovered.*}.

Semi-conscious, 57 {almost unconscious 2-3 days / pericard. (?), endocard.—*Rec.*}. *B*1—*Delirium*, 1 {del. 1 or 2 nights, later 2 or 3 days / pericarditis, no endocarditis (?)}; 2 {del. 2 nights and 1 day / peric., no endoc. (?)};
4 {del. several nights and 2 days / peric. and endoc.—*Recovered.*}; 7 {del. 1 night and day (wet pack) / pericarditis, endocarditis (?)—*Recovered*}; 9 {del. 12 hours in night / peric., no endoc.}; 14 {del. 5 nights, remission / slight peric. and endoc.};
15 {violent, del. 2 hours, del. about 4-5 days / pericarditis (?) endocarditis—*Recovered*}; 16 {del. 3 or 4 days / peric., no endoc.—*Recovered*}; 17 {del. 1 day, remission, coma 4 hours / pericarditis, no endocarditis (?)}; 18 {del. 2 or 3 days / per., no end. (?)};
49 {del. occasionally / per. and end.}; 50 {slight del. before death / peric and endoc.}; 52 {del. 3 days / slight per., no end.}; 55 {del. about 1 night / per. and end.—*Recovery*}; 59 {del. 1 or 2 nights / slight peric., endoc. (?)};
62 {del. 2 or 3 nights / per. and end.}; 63 {del. a few hours / per , no end. (?)}; 64 {del. trem. 2-3 days / per., no end.—*Recovered*}; 53 {del 1 day. / per. and end.

*B*2—*Delirium* passing into *temporary insanity.* (For duration see above.) Presence of pericarditis and endocarditis—19, per. and end.; 35, per., no end. (?); 36 per. and end.; 37, per. and end.; 38, per. and end.; 39, per. and end.; 40, per. and end.; 41, per. and end.; 46, per. and end.; 54, per. and end.; 56, per. and end, *Delirium* passing into *temporary insanity*, with *chorea.*—29, per. and end.—*Recovered;* 20, per. and end.; 21, per. and end.; 43, per. and end; 34, per. and end.—*Recovered.*

*B*3—*Delirium, Chorea*, and *choreiform movements*, 24 {del. chorea, 7 days / per. and end.}; 45 {childish, chorea, after peric., 3 weeks / pericard. and endocard.—*Recovered.*}; 51 {occ. del., chorea 3 days / pericard. and endoc.};
Jactitation, 61 {muttering, movement of hand 3-4 days / pericard. and endocard.—*Recovered*}. *Choreiform and Tetaniform Movements*, 58 {conv. movt. 4 days / peric. and endoc.}; 65 {opisth. 2 days / peric. and end.};

*C*1—*Chorea, choreiform movements*, no delirium, 22, peric. and endoc.—*Recovered*; 23 {chorea 3 weeks / per. and end.}; 25 {chorea and pericarditis simultaneous / peric. and endoc.—*Recovered*};
26 {chorea in course of pericarditis / pericard., endocard. not named}; 27 {chorea 5 days / per. and end.}; 28 {chorea 6 days / per. and end.—*Recovered*} 42, per., end. (?). ; *C*2 *Jactitation*, 30 {jactitn. a few days / peric., endoc. (?)};

*C*3—*Choreiform and tetaniform movements*, 32 {choreif. movement 19 days, tet. movement, 7 days / pericarditis and endocarditis}; 60 {chorea 1 day, choreif. and tet. movement / 30 days pericarditis and endocarditis}.

CASES OF ACUTE RHEUMATISM, WITH AFFECTIONS OF THE NERVOUS SYSTEM, IN WHICH THE TEMPERATURE WAS *NOT* OBSERVED—*Continued.*

I.—CASES WITH PERICARDITIS—*Continued.*

AFFECTION OF JOINTS	*A¹—Coma.* Convulsion $\left\{\begin{matrix}\text{before coma or delirium}\\ \text{during coma or delirium}\end{matrix}\right\}$ 10 $\left\{\begin{matrix}- \; +;\\ - \; + \; (?)\end{matrix}\right.$ 11 $\left\{\begin{matrix}+ \; +.\\ -.\end{matrix}\right.$ *A²—Delirium Coma,* 5 $\left\{\begin{matrix}+;\\ \text{prob. } \bigcirc \; (?);\end{matrix}\right.$ 6 $\left\{\begin{matrix}+;\\ -;\end{matrix}\right.$ 33 $\left\{\begin{matrix}+.\\ (?).\end{matrix}\right.$ *B¹*—Delirium, 13 $\left\{\begin{matrix}+ \; +;\\ - \; +;\end{matrix}\right.$ 14 $\left\{\begin{matrix}+;\\ (?);\end{matrix}\right.$ 15 $\left\{\begin{matrix}+;\\ \bigcirc;\end{matrix}\right.$ 16 $\left\{\begin{matrix}+;\\ (?);\end{matrix}\right.$ 17 $\left\{\begin{matrix}- \; +;\\ - \text{ or } \bigcirc;\end{matrix}\right.$ 49 $\left\{\begin{matrix}+;\\ (?);\end{matrix}\right.$ 55 $\left\{\begin{matrix}+;\\ (?);\end{matrix}\right.$ 59 $\left\{\begin{matrix}+\\ \text{occ. } +;\end{matrix}\right.$ 62 $\left\{\begin{matrix}+;\\ (?);\end{matrix}\right.$ 64 $\left\{\begin{matrix}+.\\ \bigcirc.\end{matrix}\right.$ *B²*—Temporary insanity, 35 $\left\{\begin{matrix}+ \; +;\\ -;\end{matrix}\right.$ 39 $\left\{\begin{matrix}(?);\\ +;\end{matrix}\right.$ 40 $\left\{\begin{matrix}+;\\ (?);\end{matrix}\right.$ 54 $\left\{\begin{matrix}+ \; +;\\ +;\end{matrix}\right.$ 56 $\left\{\begin{matrix}+ \; +.\\ - \; + \text{ or } \bigcirc \; +.\end{matrix}\right.$ *B3—Delirium Chorea* $\left\{\begin{matrix}\text{before chorea}\\ \text{during chorea}\end{matrix}\right.$ 21 $\begin{matrix}+;\\ (?);\end{matrix}$ 43 $\left\{\begin{matrix}+;\\ - \; +;\end{matrix}\right.$ 6, − +. *B4—Choreiform* and *tetaniform movements,* 34 $\left\{\begin{matrix}+;\\ (?);\end{matrix}\right.$ 58 $\left\{\begin{matrix}+.\\ -.\end{matrix}\right.$ *C¹—Chorea,* no *Delirium,* 28 $\left\{\begin{matrix}+;\\ (?);\end{matrix}\right.$ 60 $\left\{\begin{matrix}- \; +.\\ - \; +.\end{matrix}\right.$
PERSPIRATION . . .	$\left\{\begin{matrix}\text{Before affection of nervous system}\\ \text{After affection of nervous systen}\end{matrix}\right\}$ *A²—Coma, Convulsion,* 11 $\left\{\begin{matrix}+.\\ (?).\end{matrix}\right.$ *A3—Delirium Coma,* 5 $\left\{\begin{matrix}+.\\ -.\end{matrix}\right.$ *B—Delirium,* 2 $\left\{\begin{matrix}(?);\\ \bigcirc;\end{matrix}\right.$ 9 $\left\{\begin{matrix}+;\\ +;\end{matrix}\right.$ 14 $\left\{\begin{matrix}+;\\ (?);\end{matrix}\right.$ 16 $\left\{\begin{matrix}+;\\ (?);\end{matrix}\right.$ 49 $\left\{\begin{matrix}+;\\ - \; (?);\end{matrix}\right.$ 55 $\left\{\begin{matrix}+;\\ (?);\end{matrix}\right.$ 59 $\left\{\begin{matrix}+;\\ \text{oce. } +;\end{matrix}\right.$ 62 $\left\{\begin{matrix}\bigcirc \text{ 1st day;}\\ + \text{ 2nd day;}\end{matrix}\right.$ 64 $\left\{\begin{matrix}+.\\ +.\end{matrix}\right.$ *B²—Temporary insanity,* 54 $\left\{\begin{matrix}+;\\ (?);\end{matrix}\right.$ 56 $\left\{\begin{matrix}- \; +.\\ +.\end{matrix}\right.$ *Chorea,* 21 $\left\{\begin{matrix}+;\\ (?);\end{matrix}\right.$ 60 $\left\{\begin{matrix}+.\\ \text{cold sweat.}\end{matrix}\right.$
	Miliary Eruption, Sudamina, 5, 6, 9, 16, 44, 53, 58.
	Face.—Flushed, 6, 34, 53; pale, 1, 7, 27 (before del.), 31 (before del), 35, 40; flushed, then pale (when worse), and again flushed (when better), 58; clouded, 5; dusky, 6; anxious, 2, 14, 31, 34, 54, 58, 60, 61, 64.
AFFECTIONS OF NERVOUS SYSTEM . .	*Restlessness,* 1, 2, 3, 4, 6, 16, 17, 18, 21, 31, 33, 34, 43, 45, 46, 54, 58, 60, 61, 62, 64. *Trembling.* 16, 52, 58, 64. *Moaned,* 2, 35. *Noisy,* 21. *Shrieked, screamed,* or *cried out loud,* 6, 7, 21, 30, 31, 43, 46. *Agitation,* 14, 16, 32, 53, 55.
	Diarrhœa, 5, 16, 44, 56, 58, 61, 62. *Motions involuntary,* 7, 16, 44, 56.
CONVULSIVE CHOREIFORM OR TETANIFORM SYMPTOMS .	Convulsive movements. 3. Subsultus. 64. Twitching of muscles of mouth, 32; of face, 64; of voluntary muscles, 51. Jactitation of joint and movement of body, 30; of limbs, 5, 16; of face, 18; of left arm, 30; of right arm and leg, 33. 17, Involuntary movements of limbs, 27. Objectless movement with fingers, 61. Head thrown from side to side, 20, 21, 32.
AFFECTIONS OF INTELLECT	Would get out of bed, 4, 17, 21, 33, 35, 43. Hallucinations, 19, 36, 39, 40, 43, 35 (?).

II.—CASES WITH SIMPLE ENDOCARDITIS.

Sex and Age . . .

Total Patients, **16**.

Male Patients. Total **8**.—Below 21 years. 3 (3, 6, 12); 21 to 25 years, 2 (4, 14); above 25 years, 3 (2, 5, 9).

Female Patients. Total **8**.—Below 21 years, 2 (1, 8); 21 to 25 years, 3 (14, 15, 16); above 25 years, 3 (7, 10, 13).

Occupation, Habits, and Previous Condition . .

Male Patients. Total **8**.—*Workers out of doors.* **3**; laborious, **1**; labourer, 1 (2); among horses, 1; post-boy, 1 (5). Plumber's labourer, 1 (11). *Workers in-doors,* **3**; servant, 1 (14, nervous, not robust); shoemaker, 1 (10); upholsterer, 1 (3). *Occupation not stated,* **2** (6, 9).

Female Patients. Total **8**.—*Active in-door Workers,* **4**; Servants, 4 (4, 7, 13, 15). *No occupation,* **3** (1, 8, 12). *Occupation not stated,* **1** (66).

Character of Affection of the Nervous System.

*A*²—Had *Convulsions and Coma,* **1**.—15, 43rd day—rigors, restless, convulsions, impaired consciousness; 44th day—violent convulsions, coma. urine bloody .

*A*3—Had *Delirium* followed by *Coma,* **1**.—16, muttering delirium, depressed, drowsy, active delirium, coma, death. Had embolism of minute cerebral arteries .

*B*¹—Had *Delirium* uncomplicated, a., **7**.—1, sleepless, continuous agitation, del. often loud (9 days) ; 2, violent del. (about 1 day,) agitation ; 14, del. (2 nights and 1 day) (?). somnambulism, much agitated—*Recovered;* 10, restless, quite del. (1 night) ; 11, violent del. (4 days)—*Recovered;* 12, del., left bed 1st night, 3rd night lay muttering—*Recovered;* 13, wandering del. (1 day and several nights)—*Recovered.*

*B*²—Had *Delirium* passing into *temporary insanity,* taciturn, melancholy, **5**.—5., del., left bed, dogged silence (3 weeks) ; 4. restless, hallucinations, apathetic, slowly *recovered;* 3, melancholy, spoke low. hallucinations, ill about 2 months—*Recovered;* 6, taciturn, hallucinations, imbecility, ill 2 months ; 7, violent del., taciturn, hallucinations, melancholy, pendulum movement of head, ill about 3 months—*Recovered.*

C—Had *Choreal* movements, **1**.—8, apparently no del., choreal movements, violent restlessness .

E—Had *Embolism and Hemiplegia,* **1**.—2, headache, agitation, right hemiplegia, apoplectic symptoms, clot in basilar artery .

Affection of Joints

*A*²—*Convulsions, Coma* $\begin{cases}\text{before coma}\\ \text{during coma}\end{cases}$ 15 $\begin{cases}-\ +.\\ \bigcirc.\end{cases}$ *B*1—Uncomplicated *delirium* $\begin{cases}\text{before delirium}\rightarrow\\ \text{during delirium}\rightarrow\end{cases}$ 1 $\begin{cases}\bigcirc\ +\ \text{(not severe)};\\ \bigcirc\ \text{or}\ -\ \text{(none or slight)};\end{cases}$ 2 $\begin{cases}++\ \text{(very severe)};\\ -;\end{cases}$

14 $\begin{cases}+\ +.\\ -.\end{cases}$ 10 $\begin{cases}+;\\ (?);\end{cases}$ 11 $\begin{cases}+;\\ -\ +\ \text{or}\ +\ (?);\end{cases}$ 12 $\{\ -$ (del. on admission). *B*²—*Delirium and Temporary Insanity,* 5 $\begin{cases}+;\\ (?);\end{cases}$ 4 $\begin{cases}+;\\ -;\end{cases}$ 3 $\begin{cases}-\ +;\\ (?);\end{cases}$

7 $\begin{cases}\bigcirc\ +\ \text{or}\ -+.\\ \bigcirc\end{cases}$ *C*—*Embolism, delirium* – 16 $\{$ during del. –. *Choreal Movements,* 8 $\begin{cases}-\ +.\\ (?).\end{cases}$ *Embolism, hemiplegia,* 14 $\begin{cases}+\ +.\\ \bigcirc\ \text{or}\ -.\end{cases}$

Perspiration . .

*B*¹—*Delirium* (*a*) with *agitation,* 2 $\begin{cases}+;\\ +.\end{cases}$ (*b*) Uncomplicated delirium, 10 $\begin{cases}+;\\ (?);\end{cases}$ 11 $\begin{cases}+;\\ +;\end{cases}$ 12 $\{\ \bigcirc\ +$ (del. on admission).

Sudamina, 11.

Face.—Red, 2 (before del.); pale, 3, 6, 12; dusky, 12, 13.

Diarrhœa, 3, 5, 11 (?). Involuntary evacuations, 16.

Affections of Nervous System . .

Restless, 3, 4, 5, 8, 10, 15, 16. Agitation, 1, 2, 2, 14. Pendulum movement of head, from side to side, backwards and forwards, 7.

CASES OF ACUTE RHEUMATISM, WITH AFFECTIONS OF THE NERVOUS SYSTEM, IN WHICH THE TEMPERATURE WAS *NOT* OBSERVED—*Continued.*

III.—CASES WITHOUT PERICARDITIS, ENDOCARDITIS BEING ABSENT OR DOUBTFUL.

SEX AND AGE.

TOTAL PATIENTS, **38**.

MALE PATIENTS. Total **25**.—Below 21 years, 2 (15, 37); from 21 to 25 years, 6 (3, 7, 17, 22, 28, 38); above 25 years, 12 (5, 6, 8, 9, 14, 18, 20, 21, 27, 30, 35, 36). Age not specified, **5** (10, 11, 16, 23, 26).

FEMALE PATIENTS. Total **12**.—Below 21 years, 2 (24, 25); 21 to 25 years, 5 (1, 2, 13, 19, 33); above 25 years, 3 (4, 29, 34). Age not specified, 2 (31, 32). SEX *and age doubtful*, **1** (12).

OCCUPATION, HABITS, AND PREVIOUS CONDITION.

MALE PATIENTS. Total **25**.—*Workers out of doors*, **3**; laborious, **2**; labourers, 2 (5, 20 drunkard); among horses, **1**; groom, 1 (17). Gentleman, **1** (26). *Workers in-doors*, **12**; servants, 4 (7, 15, 21, 23, robust); clerk, 1 (18); baker, 1 (14); tailor, 1 (28); shoemaker, 1 (6); typographic worker, 1 (16); barmen, brewer's servant, **3** (36, 38, 3). *No occupation*, **1** (37). *Occupation not stated*, **8** (8, 9, 10, 11, 22, 27 formerly drunkard, 30, 35).

FEMALE PATIENTS. Total **12**.—*Active in-door Workers*, **8**; servants, 4 (2, 13, 19, 29); nurse, 1 (31); married, 3 (32, 34, 4 widow of landlord). *No occupation*, **2** (24, 25). *Occupation not stated*, **2** (1, 33). SEX *and occupation not stated*, **1** (12).

CHARACTER OF AFFECTION OF THE NERVOUS SYSTEM.

*A*¹—Had *Coma* not preceded by delirium, **2**.—14, suddenly lost consciousness, soon dead ⚰; 34, agitation, coma about 2 hours ⚰.

*A*²—*Convulsions and Coma*, without delirium, **2**.—28, sudden convulsions, coma, speedy death ⚰; 29, sudden convulsions, coma 12 hours ⚰.

*A*³—Had *Delirium* followed by *Coma*, **8**.—3, sudden violent del. (about 12 hours (?), sopor, coma (2-3 hours) ⚰; 1, wandering (2 nights), tremor violent del. (few hours ?), quiet coma, death ⚰; 19, restless, del. (1-2 nights), tremor, violent del. (few hours ?), coma (few hours) ⚰; 16, violent del., agitation, depression, coma (nervous system affected 4-5 days) ⚰; 2, del., coma (few days) ⚰; 37, wandering, trembled (albuminuria), heavy, coma (3 nights) ⚰; 17, del., coma (strangulated intestine 6th day) ⚰; 8, del. ($1\frac{1}{2}$ day), coma (pyæmia ?) ⚰.

*A*⁴—*Delirium* followed by *Stupor*, **2**.—15, inarticulate cries, accompanied by imperfect consciousness (27 hours, including del.); 5, del. (1 night and day), left bed, stupor, del. (about 24 hours)—*Recovered.*

*B*¹—Had uncomplicated *Delirium*, **14**.—6, restless, very del. (3 nights) ⚰; 7, restless, left bed, del. (1 night) ⚰; 13, restless, del. (1 day) ⚰; 18, del., restless, violent del., out of bed (7 nights, 1 day) ⚰; 23, sudden struggling del. ($\frac{1}{4}$ hour) ⚰; 33, violent del. (3 days and nights) ⚰; 4, del., quiet, return of recollection, restless, collapse (1 day and night) ⚰; 38, restless, hurried in speech (1 night) ⚰; 9, excessive agitation, del. (2 days), sleep, rational—*Recovered*; 36, violent del. (about 4 days ?), out of bed, quiet, slept, rational—*Recovered*; 12, cerebral symptoms, del., extravasation pia mater ⚰; 30, del. (4 days), trembling, agitation, purt. effusion pia mater ⚰; 10 and 11, "brain symptoms"—both *recovered.*

*B*²—Had *Delirium* passing into *temporary insanity*, taciturn, melancholy, 1 or 2 months, **3**.—20, during mornings, morose, taciturn; during nights, lively, del., hard to keep in bed, ill about 1 month (?)—*Recovered*; 21, hallucinations, despondent, trembled, stammered, ill 1-2 months—*Recovered*; 27, sullen night and day, violent fits of noisy del., taciturn, sulky, ill about 1 month—*Recovered.* Had *Delirium, temporary insanity, choreiform movements*, **2**.—22, speech slow, hallucinations, del. in paroxysms, choreic and convulsive movements, [del. continuous, ill about 2 months—*Recovered*; 25, very restless, moved arm but not in jerks, did not answer questions, movements more violent, constant del.—*Recovered.*

*B*³—Had *Delirium* and *choreiform* movements, **1**.—24, speech very indistinct, choreiform movements in arm and face, noisy screaming del. at night, incoherent, well in 8 or 9 days—*Recovered.*

*B*³—Had *Delirium* and *tetaniform* movements, **1**.—26, tetanic spasms, opisthotonos, violent del.—*Recovered*

F—Had paraplegia, **2**.—31, pain in back, lower limbs paralysed (some time)—*Recovered*; 32, stupor 2 days ill, then paraplegia, case incomplete (ill some time).

G—Had agitation and prostration, **1**.—35, agitation, prostration, death rapid.

Affection of Joints

Before delirium / During delirium or coma } A^1—*Coma*, 14 $\left\{\begin{matrix}+;\\(?);\end{matrix}\right.$ 34 $\left\{\begin{matrix}++.\\ \end{matrix}\right.$ A^2—*Convulsions, coma*, 28 $\left\{\begin{matrix}+;\\(?);\end{matrix}\right.$ 29 $\left\{\begin{matrix}+.\\(?).\end{matrix}\right.$ A^3—*Delirium, coma*, 3 $\left\{\begin{matrix}+ \text{ or } - +;\\-;\end{matrix}\right.$ 1 $\left\{\begin{matrix}+;\\-;\end{matrix}\right.$ 19 $\left\{\begin{matrix}+;\\(?);\end{matrix}\right.$

2 $\left\{\begin{matrix}+ +;\\-;\end{matrix}\right.$ 8 $\left\{\begin{matrix}+.\\(?).\end{matrix}\right.$ A^4—*Delirium, stupor*, 15 $\left\{\begin{matrix}+ +;\\+ (?);\end{matrix}\right.$ 5 $\left\{\begin{matrix}+ \text{ or } - +.\\+ (?)\end{matrix}\right.$ B^1—*Delirium*, 6 $\left\{\begin{matrix}- +;\\;\end{matrix}\right.$ 7 $\left\{\begin{matrix}+;\\+ (?);\end{matrix}\right.$ 18 $\left\{\begin{matrix}+;\\- +;\end{matrix}\right.$ 38 $\left\{\begin{matrix}+;\\- + \text{ or } +;\end{matrix}\right.$ 9 $\left\{\begin{matrix}+ +;\\;\end{matrix}\right.$

36 $\left\{\begin{matrix}+;\\-;\end{matrix}\right.$ 30 $\left\{\begin{matrix}+.\\O + (?).\end{matrix}\right.$ B^2—*Delirium, temporary insanity*, 20 $\left\{\begin{matrix}+ \text{ or } - +;\\-;\end{matrix}\right.$ 21 $\left\{\begin{matrix}- +;\\O;\end{matrix}\right.$ 27 $\left\{\begin{matrix}- +.\\O + (?).\end{matrix}\right.$ *Delirium, temp. insanity, choreiform movements* } 22 $\left\{\begin{matrix}- + (?);\\O;\end{matrix}\right.$ 25 $\left\{\begin{matrix}- +.\\O + (?).\end{matrix}\right.$

C^1—*Delirium, choreiform movements*, 24 $\left\{\begin{matrix}- +.\\- +.\end{matrix}\right.$ *Agitation, prostration*, 35 $\left\{\begin{matrix}- +.\\(?).\end{matrix}\right.$

Perspiration . . .

Before delirium or coma / During delirium or coma } A^1—*Coma*, 14 $\left\{\begin{matrix}+;\\(?);\end{matrix}\right.$ 34 $\left\{\begin{matrix}+.\\+.\end{matrix}\right.$ A^2—*Convulsions, coma*, 28 $\left\{\begin{matrix}+;\\(?);\end{matrix}\right.$ 29 $\left\{\begin{matrix}+.\\(?).\end{matrix}\right.$ A^3—*Delirium, coma*, 3 $\left\{\begin{matrix}+;\\-;\end{matrix}\right.$ 1 $\left\{\begin{matrix}+;\\(?);\end{matrix}\right.$ 19 $\left\{\begin{matrix}+\\(?).\end{matrix}\right.$

A^4—*Delirium, stupor*, 15 $\left\{\begin{matrix}O +.\\+,\end{matrix}\right.$ 5 $\left\{\begin{matrix}+.\\.\end{matrix}\right.$ B^1—*Delirium*, 18 $\left\{\begin{matrix}+;\\+;\end{matrix}\right.$ 23 $\left\{\begin{matrix}+;\\(?);\end{matrix}\right.$ 4 $\left\{\begin{matrix}+;\\O;\end{matrix}\right.$ 30 $\left\{\begin{matrix}(?).\\+.\end{matrix}\right.$ B^2—*Delirium, temporary insanity*, 20 $\left\{\begin{matrix}+;\\(?);\end{matrix}\right.$ 21 $\left\{\begin{matrix}+ -.\\+ +.\end{matrix}\right.$

Miliary Eruption, Sudamina, 5, 9, 19, 29, 34.

Face.—Flushed, 1, 8, 19 (before delirium); pale, 4, 9, 15; dusky, 1, 37; livid, congested, heavy, anxious, 37. Pain of neck, 21. Stiffness of neck early in illness, 24.

Diarrhœa, 4, 6, 6, 9, 15, 37. Motions involuntary, 4, 9, 15, 37. Urine abundant, 9.

Affections of Nervous System . . . Restlessness, movement of various muscles of hands and feet during sleep, 5, 4, 6, 7, 13, 18, 19, 25, 38. Sleepless, 24, 27. Trembling, 1, 19, 30, 37. Inarticulate cries, 15. Screaming, 24. Agitation, 9, 16, 30, 34, 35.

Convulsive, Choreiform or Tetaniform Symptoms . Startings on falling asleep or during sleep, 36, 37. Very violent movements of arms and legs, 25. Rolling of head from side to side, 24. Constantly flexed and extended fingers, 22.

Affections of Intellect . . . . Would get out of bed, 5, 7, 18, 20, 21, 23, 36. Had hallucinations, 21, 22, 23.

CASES OF PERICARDITIS, NEITHER RHEUMATIC NOR FROM BRIGHT'S DISEASE, ACCOMPANIED BY AFFECTIONS OF THE NERVOUS SYSTEM.

	TOTAL PATIENTS, **26**.
SEX AND AGE . . .	MALE PATIENTS, **19**.—Below 21 years, 7 (2, 6, 7, 10, 20, 22, 26); 21 to 25 years, 2 (4, 13); above 25 years, 10 (3, 11, 14, 15, 16, 17, 21, 23, 24, 25). FEMALE PATIENTS. Total **7**.—Below 21 years, 3 (8, 9, 19); 21 to 25 years, 1 (18); above 25 years, 2 (5, 12). Age not stated, 1 (1).
OCCUPATION, HABITS, AND PREVIOUS CONDITION . .	MALE PATIENTS. Total **19**.—*Workers out of doors*, **3**; coachman, 1 (24 drunkard); shoe-black, 1 (14). Painter, 1 (13). *Workers in-doors*, **3**; paper-stainer, 1 (22); printer, 1 (4); schoolboy, 1 (6). *No occupation*, **3** (2, 7, 20). *Occupation not stated*, **10** (3, 10, 15, 16 creole, 17, 19, 21, 23, 25 gin drinker, 26). FEMALE PATIENTS. Total **7**.—*Active in-door Worker*, **1**; married, 1, (12). *No occupation*, **1** (8). *Occupation not stated*, **5** (1, 5, 9, 11, 12, 18 creole).
DISEASES (IF ANY) WITH WHICH PERICARDITIS WAS ASSOCIATED . .	Uncomplicated pericarditis, 9.—(1, 3, 4, 5, 7 granulations on surface of heart, 9, 10, 11, 12 after miscarriage). Pericarditis with chorea, 2 (8, 19). Pericarditis with pyæmia, 5 (2, 6, 17, 20, 21). Pericarditis probably with Bright's disease, 1 (13). Percarditis with pleurisy, 3 (14 left, 15 left, 16 right). Empyema, 2 (22, 26 both left). Pericarditis with pleuro-pneumonia, 3 (4, 18, 24 left). Phthisis, 1 (25 vast cavity right lung).
CHARACTER OF AFFECTION OF THE NERVOUS SYSTEM .	*A*[1]—Had *Coma* not preceded by Delirium, **1**.—1, 2nd day, coma, 4th day. *A*3—Had *Delirium* followed by *Coma*, **2**.—2, 2nd day del., watchful; 3rd day, convulsive fit; 4th day, coma; 12, on admission, obstinate taciturnity, lips trembled convulsively; 3rd day, convulsive movement of body, incoherent; 4th day, no delirium, convulsive agitation of face, tetaniform stiffness of arms from time to time; 5th day, delirium, coma. Had *Coma* followed by *Delirium*, **2**.—3, 11th day, coma; 12th day, loquacious del.; 13th day; 13 (painter, probably Bright's disease), 12th day, confused, coma; 13th day, eyes turned up, foaming, limbs relaxed; 17th day, slight del.; 19th day stertor. Had *Delirium* and *Convulsions*, **1**.—6, great heat, del., convulsions, pain forehead. *B*[1]—Had *Delirium* uncomplicated, **11**.—23, 22nd day, del.; 25th day, never quiet, maniacal; 5, 1st day, slight del.; 7th day; 21, 14th day, 10 P.M., del., shouted, tried to get out of bed; 16th day; 22, 10th day, wandered much; 12th day; 24, 3rd day of illness, del.; 5th day, admitted, had little sleep, hands tremulous, rambled; 20, 2nd day (7th of illness), del. previous night, wished to get out of bed; 3rd day; 14, 6th day of illness, headache; 7th day, loquacious del., left bed, went twice to window, lay down; 17, 25th day, del.; 26th day; 25, 3rd day, 10 P.M., del., bathed in sweat; 26, 3rd day, restless; 4th day, wandered; 4, 5th day, slight del.—*Recovered.* *B*3—Had *Delirium* and *Choreiform Movements*, **1**.—9, first 2 weeks very restless, scarcely slept, del.; 3rd week, convulsive agitation of limbs, constant motion of head, wild rolling of eyes, del., cold to head—*Recovered.* (Second illness fatal.) Had *Delirium* and *Jactitation*, **1**.—16, head affected, extreme agitation of body, jactitation, head more and more affected. *C*[1]—Had *Chorea* without delirium, **2**.—8, had chorea 6 weeks before admission; on 27th day, slight convulsion, soon; 19, 3rd day, choreic symptoms; 5th day, chorea established; 7th day, less chorea; 9th day. *C*[2]—Had *Choreiform movements* without delirium, **2**.—18, extreme jactitation; 15, 3rd day, convulsive movements of face; nights of 13th and 13th, agitation, del. *C*3—Had modified *Tetanus* without delirium, **2**.—10, relapse; 1st day, fingers bent convulsively, later and successively paroxysms of suffocation, cramps in legs, fingers, forearm, and arm; feet and legs strongly bent, muscles of limbs, abdomen, and jaws as hard as a stone, skin hot, sweating, cold affusion, great relief; 3rd day, return of cramps; 4th day, no rigidity, joints slightly closed, suffocation on drinking: accidental cold bath, relapse; 5th day, intense spasmodic contraction, death in paroxysm of choking; 11, 1st day, violent spasmodic contractions of limbs; 5th day, occasional spasmodic rigidity of whole body, opisthotonos during night, spasms so severe could scarcely be kept in bed; 6th day. *D*—Had slight *Convulsions* without delirium, **1**.—7, 20th day, slight convulsions, exhausted, died in half an hour.

SUMMARY OF CASES OF ACUTE RHEUMATISM, WITH AFFECTIONS OF THE NERVOUS SYSTEM, IN WHICH THE TEMPERATURE WAS NOT OBSERVED.

	With Pericarditis.	Simple Endocarditis.	No Peric., Endocard. absent or doubtful.	TOTAL.
A^1—Coma without delirium or convulsions	3	0	2	5
A^2— „ with convulsions	2	1	2	5
A^3— „ preceded by delirium	5	0	8	13
A^4—Stupor preceded by delirium	0	0	2	2
A—Had coma or stupor. TOTAL	**10**	**1**	**14**	**25**
Had Semi-consciousness	1	—	—	1
B^1—Delirium, uncomplicated	21	8	14	42
B^2— „ passing into temporary insanity	11	5	3	20
„ with chorea or choreiform or tetaniform symptoms	5	0	2	7
„ TOTAL	16	5	5	27
B^3—Delirium, with chorea and choreiform movements, not including those with temporary insanity	4	0	1	5
B^4—Delirium, with tetaniform movements, not including those with temporary insanity	2	0	1	3
B—Delirium without coma. TOTAL	**43**	**13**	**21**	**77**
Delirium. TOTALS (including those with coma)	**48**	**13**	**31**	**92**
C^1—Chorea without delirium	7	—	—	7
C^2—Choreiform movements (jactitation), without delirium	1	1	—	2
C^3—Tetaniform symptoms, without delirium	2	—	—	2
D—Had slight fit	1	—	—	1
E—Had embolism, hemiplegia	—	1	—	1
F—Had paraplegia	—	—	2	2
G—Had agitation and prostration	—	—	1	1
TOTAL	**65**	**16**	**38**	**119**

I.—CASES AFFECTED WITH PERICARDITIS.

There were sixty-five cases of acute rheumatism with pericarditis, in which the nervous system was affected. (*A*.) Ten of these had coma, of which (A^1,) three had uncomplicated coma; (A^2,) two had coma with convulsions; and (A^3,) in five the coma was preceded by delirium. (*B*.) Forty-three cases had delirium without coma; of these (B^1,) twenty-one had uncomplicated delirium, one of which had "symptoms of inflammation of the brain," and one apparently had pyæmia; (B^2,) sixteen, of which five had choreal or tetaniform symptoms, had temporary insanity, lasting from two weeks to three months, or, in three instances, insanity was cut short by death; (B^3,) four had chorea or choreiform movements, and (B^4,) two had tetaniform symptoms without temporary insanity. (C^1.) Eight of the cases had chorea or choreiform movements, and (C^2,) two had tetaniform symptoms without delirium. (*D.*) One of them had a slight fit with ptosis.

II.—Cases affected with Simple Endocarditis.

There were sixteen cases of acute rheumatism with simple endocarditis, in which the nervous system was affected, excluding cases of ordinary chorea, but including cases of chorea rapidly fatal, or with delirium.

(A^2.) One of these cases had coma with convulsions, associated with acute Bright's disease from embolism. (A^3.) One had delirium ending in coma, with embolism of the minute cerebral arteries. (B.) Twelve of them had delirium without coma, of these (B^1,) seven had uncomplicated delirium; and (B^2,) five passed into a state of temporary insanity, lasting from three weeks to four months. (C^1.) One had chorea ending rapidly in death. (E.) One had embolism with hemiplegia.

III.—Cases in which there was no Pericarditis and Endocarditis was absent or doubtful.

There were thirty-eight cases of acute rheumatism without pericarditis, endocarditis being absent or doubtful, in which the nervous system was affected, exclusive of cases of ordinary chorea. (A.) Twelve of these had coma or stupor, of which, (A^1,) two had uncomplicated coma, (A^2,) two had coma with convulsions, (A^3,) in eight the coma was preceded by delirium; and there were also (A^4,) two cases in which delirium passed into stupor. (B.) Twenty of the cases had delirium including two with "cerebral rheumatism," and one that had pus in the pia mater; of these (B^1,) fourteen had uncomplicated delirium; (B^2,) five passed into temporary insanity, two of which had chorea also; (B^3,) one had chorea; and (B^4,) one had tetanic spasms. (F.) Two of the cases had paraplegia. (G.) One of the cases had agitation and prostration ending in rapid death.

A.—Coma.

I.—*Cases with Pericarditis.* A^1.—*Uncomplicated Coma.*—Three cases with Pericarditis had coma without convulsions or delirium, all of which proved fatal.

A^2.—*Coma with Convulsions.*—In the two cases of coma with convulsions, death was speedy.

A^3.—*Coma preceded by Delirium.*—Four of the five cases in which delirium passed into coma, died; and one recovered. One of the cases passed rather into stupor than coma. The duration of the coma in these cases was variable and uncertain, and that of the delirium lasted for from one or two nights to nine or ten days.

II.—*Cases with Simple Endocarditis.* A^2.—*Coma with Convulsions.*—One fatal case of coma preceded by convulsions had simple endocarditis with embolism of the spleen and kidneys, the coma and convulsions being evidently associated with acute Bright's disease.[1]

III.—*Cases without Pericarditis, Endocarditis being absent or doubtful.* $A^{1,2}$.—*Coma without and with Convulsions.*—There were four fatal cases of coma without delirium among

[1] Frerichs, *On the Diseases of the Liver*, New Sydenham Soc. Edition vol. i. p. 164.

the cases without pericarditis, endocarditis being absent or doubtful, two of them having convulsions. In three of them death was very rapid, and in one coma, coming on after convulsions, lasted for twelve hours before death.

These cases did not differ materially in character and history from those with coma and pericarditis.

A³.—*Coma and Delirium.*—Coma was preceded by delirium in eight fatal cases that presented no sign of affection of the heart.

The delirium was more frequent by night than by day, being present in three of the cases from two to five or six nights, while it was absent in the day-time, and it lasted in the other five cases from two to four or five days.

The coma, as a rule, soon ended in death. In one-half of the cases, or four, the delirium became violent, and in the other half, its character was not described.

These cases do not differ materially in essential character from those with pericarditis that were affected with delirium and coma. There were, however, nervous symptoms in the form of agitation, twitchings, and choreiform and tetaniform movements in a much greater proportion of those with pericarditis than of those not so affected.

A⁴.—*Delirium and Stupor.*—One of the two cases in which delirium preceded stupor recovered after the employment of the wet sheet, and the other died.

B.—Delirium.

B¹.—*Uncomplicated Delirium.*—1. *Cases with Pericarditis.*—Twenty-one of the sixty-five cases with rheumatic pericarditis had uncomplicated delirium, including one with " symptoms of inflammation of the brain," and one with probable pyæmia. Eleven of these cases died and ten recovered.

The duration of the delirium varied much. The delirium was more active by night than by day, and in five cases was present from one to three or four nights, but was absent during the day. In the rest of the cases it lasted for from a few hours to four or five days. The delirium was noisy or violent in eleven instances, moderate in four, and slight in five cases.

One case, a female servant, felt much better at the evening visit, but a quarter of an hour later became delirious, with loud continuous cries. A varied treatment, including wet packing, was employed, and she recovered.

Another case, a workman in Messrs. Guinness's Brewery, drank largely of their XX porter besides whisky. He had pericarditis and "delirium tremens," and recovered after taking opium.[1]

2. *Cases with Simple Endocarditis.*—Seven of the sixteen cases with simple rheumatic endocarditis had uncomplicated delirium. Three of these cases died and four recovered.

The duration of the delirium varied from, for a single night in one patient, to at least nine days in another. It was present more often, and, as a rule, with greater violence by night than by day. In four of the cases the delirium was active or violent, in one the delirium was wandering, and in another it was accompanied by somnambulism.

One of these cases was observed by Dr. Boisragon and Mr. Tudor, and reported by Dr. Davis, and is, so far as I have discovered, the first case in which endocarditis was well described.

Three of the cases of endocarditis with delirium were under my own care, and of these, one died and two recovered.

[1] Dr. Graves, *Clinical Lectures on the Practice of Medicine*, vol. i. p. 531.

3. *Cases without Pericarditis, Endocarditis being absent or doubtful.*—Fourteen of the thirty-eight cases without pericarditis, endocarditis being absent or doubtful, had uncomplicated delirium. Ten of the fourteen cases died, and four recovered.

The duration of the delirium varied much in the different cases. It prevailed more during the night than the day. In three instances it was only present during the night for from one to three nights. In one case the delirium was only present for a quarter of an hour before death, in four cases it existed for one day, and in four others from two to five or six days. The delirium was violent or lively in five of the cases, and five were simply "delirious."

These cases corresponded in essential features with those that had delirium with pericarditis.

"*Hyperpyrexia*" *in cases of acute Rheumatism, without and with Pericarditis, in which the temperature was not observed.*—The ten fatal cases belonging to the last group of fourteen with delirium, the twelve with coma and the two with stupor, all of which had neither pericarditis nor endocarditis, evidently belong to the important group of cases of acute rheumatism with hyperpyrexia. All of those twenty-four cases except one with stupor, died, and that patient recovered after the external use of the wet sheet. The ten cases with coma, and the eleven fatal cases and one case that recovered under the use of wet packing that had uncomplicated delirium among the patients with pericarditis, and three fatal cases of delirium with simple endocarditis, may also be ranked among the cases of hyperpyrexia. According to this estimate, twenty-two of the sixty-five cases with pericarditis, three of the sixteen with simple endocarditis, and twenty-four of the thirty-eight without pericarditis or notable endocarditis, in which the temperature was not observed, were affected with "hyperpyrexia."

These forty-nine cases corresponded in their broad features as regards coma, delirium, and death with those cases of "hyperpyrexia" in which the temperature was observed. As in those also so in these, in the few cases where these conditions were observed, the affection of the joints ceased when the delirium appeared, and the perspiration, copious during the earlier stages, was absent or much lessened during the stage of delirium or coma, when the skin was usually dry and hot.

Convulsive, choreiform, and tetaniform movements in the cases with Hyperpyrexia.—There was an important difference in the two sets of cases with and without pericarditis, as regards the presence of convulsive, choreiform, and tetaniform symptoms in combination with the far more important symptoms of "hyperpyrexia."

Convulsive movements, jactitation, agitation, choreiform movements without actual chorea, and tetaniform symptoms, appeared more frequently in the cases of coma or delirium with pericarditis, than in those without pericarditis. Involuntary movements of the muscles occurred in one, and general agitation in three of the twenty-five cases of hyperpyrexia that had neither pericarditis nor notable endocarditis. A convulsive fit occurred in one, jactitation of the limbs or body in two, tetaniform symptoms in two, and great general agitation in three, of the twenty-two cases with hyperpyrexia that had pericarditis. Besides these eight instances of convulsive, choreiform, or tetaniform affections among the fatal cases of coma and delirium with pericarditis, there were two with jactitation, and one with twitchings of the muscles of the face, among the cases of delirium with pericarditis that were not fatal. Four of the eleven cases with pericarditis thus affected with convulsive, choreiform, or tetaniform movements had endocarditis, three had no endocarditis, and in four the presence of endocarditis was doubtful.

We have already seen that among the cases of "hyperpyrexia," in which the temperature was observed, choreal and tetaniform symptoms occurred much more frequently among those with, than among those without, pericarditis; while on the other hand twitching movements were as frequent among those without, as among those with, pericarditis.

Delirium resembling Delirium Tremens.—Among the cases of delirium in acute rheumatism without pericarditis or evident endocarditis as among those previously analysed with pericarditis, there are several that present symptoms partly allying them to delirium tremens—partly to the delirium of rheumatic hyperpyrexia, and that are associated with previous habits of drinking, or with some affection of the nervous system. One of these patients, a hard drinker, complained of being unable to see, called out "thief," rushed out of bed and fell down. After this he struggled with two attendants, and then dropping back, died. All this took place in less than a quarter of an hour.[1]

Two of my own patients belong to this class, one of whom recovered, the other died. One was a stout florid waiter, aged 40, who perspired profusely, slept but little, and became very violent. On the seventh night he slept with an opiate. He recovered rapidly.

The patient who died was a barman, aged 23, who was rather restless, and hurried in speech on the day after admission, became more restless on the third day, and died suddenly.

[1] Trousseau, *Lectures on Clinical Medicine*" (New Sydenham Soc. vol. i. p. 513.)

B 2.—Temporary Insanity with Taciturn Melancholy and Hallucinations.

B 2. I.—*Cases with Pericarditis.*—The series of cases that I have now to consider present a remarkable succession of symptoms. In eleven cases of acute rheumatism with pericarditis, delirium, usually desponding and taciturn, often with hallucinations, came on when the heart was inflamed; but instead of passing away quickly, this sombre delirium lasted for from two or three weeks to three months. Of these eleven cases of temporary insanity, ten recovered, and one died; eight of those cases were females, six being below the age of twenty, and three were males. All but one of these patients were affected with endocarditis as well as pericarditis.

The duration of the insanity varied considerably, and the return to a healthy state of mind was gradual, and never sharp. The temporary insanity lasted for above a fortnight in three cases; for about a month in three; for two months in one; for ten weeks in one patient, whose mind was not yet clear at the end of that time; and one died with her intellect still confused at the end of two months.

The prevailing feature of the delirium was a state of taciturn melancholy. Only one patient, a young woman, the fatal case, was at times in wild delirium, at times taciturn and almost idiotic, and at times quiet and rational.[1] Eight of the patients were taciturn, and two others were confused in mind or speech. Four of them had hallucinations; one saw her mother at her side; one a knife and poison; one was followed and insulted, and then reached out his hand as to an old

[1] Sir Thomas Watson, *loc. cit.* ii. 307.

friend; and one complained of vermin. Another patient had delusions.

Two of my patients belong to this series of cases. One of these, a potman, aged 21, on the seventeenth night after his admission was in a state of partial stupor and delirium. On the following day he answered no questions, and as he would not take food, stimulants were given by enema. On the twenty-sixth day he again took food, but he continued to be taciturn. On the thirty-ninth day he recovered the powers of nature, was up on the forty-seventh, and left on the seventy-fifth day, his heart-sounds being healthy.

The other case, a labourer, with endo-pericarditis, had a vacant, torpid, and wandering mind for three weeks, which followed an attack of hemiplegia from embolism affecting the right side, with loss of speech, which was apparently a mixture of aphasia and a taciturn character of mind. On the tenth day his face was paralysed on the right side, and the pupils were irregular. On the thirteenth he would not or could not speak, but muttered slightly, and tried to get out of bed. He improved daily and his speech returned, but his expressions were incoherent. On the thirty-eighth day he had more command over his articulation, and on the forty-second had almost regained the use of his right side. He improved steadily, and on the seventy-second day he went out well, the heart-sounds being healthy.

Besides the eleven cases just spoken of with temporary insanity of a taciturn melancholic type, there were five others in which a similar condition was associated with chorea or choreiform movements (in 4) or with tetaniform symptoms (in 1). Three of these cases were fatal, and two of them recovered. The whole of the five cases were below the age of twenty-one, and two of them were male and three were female patients. All of them had endocarditis as well as pericarditis. The affection lasted in one of the two that recovered about a month, and in the other for a shorter period. The three fatal cases died respectively in about twenty-three, sixteen, and nine days after the beginning of the mental trouble. One of those patients was taciturn, then delirious, and finally had the most violent choreiform movements, ending in death. Another fatal case had difficult utterance, incoherence, tossing of the head from side to side, and choreiform spasms which put on the character of the most violent convulsions. A third case spoke loud and low, after, in succession, being excited and stubborn, weeping, seeing a dead man, and grimacing as in chorea: death took place an hour after an attack of universal convulsions. One of the two cases that recovered had a rather childish appearance; her answers were sometimes irrelevant, sometimes rational, and she had choreal movements of the right arm and leg.

The last case had delirium with tetanic spasms; at first he had an excited manner, with wild rolling of his eyes, then furious delirium, followed by firm clenching of the hands, sleep, and a more tranquil state. After this he was idiotic and violent by turns, until the twenty-eighth day after the first disturbance of the mind, when he became tranquil.

These sixteen cases with taciturn melancholy, often with hallucinations, lasting for from three weeks to three months, and then usually getting well, present a group of conditions that seems to separate them from the twenty-one cases of delirium that were not followed by coma, and the five that were so. In those cases the delirium was often violent, generally active, sometimes muttering; in these it was melancholic and taciturn. In those cases the delirium was often exclusive by night, and was then almost always most noisy; in these it was present day and night, though it was usually more active by night. In those cases the delirium lasted for from one or more hours to five or six nights and five days; in these it lasted for from three weeks to three months. In those cases perspiration was generally profuse before the appearance of the delirium, the skin usually becoming hot and dry as the temperature rose to the fatal height; in these perspiration was only noted as being profuse in two cases, and slight in one. In those cases death was the natural result; in these, all but one of the eleven without chorea recovered, while three of the five with chorea died. In those endocarditis was absent in three-fifths of the cases (11 in 32) with coma and delirium, but three more of those cases probably had endocarditis; in these endocarditis was present in all but one.

We saw that in the two sets of cases, in one of which the temperature was, and in the other was not observed, delirium presented itself in two forms: (1) one, and the leading form, of delirium with hyperpyrexia, ending in death; (2) the other, the secondary form, with a less high temperature in which a condition resembling delirium tremens associated itself with and modified the delirium of hyperpyrexia, often occurring in persons who had been intemperate, anxious, nervous, or in want, and ending generally in recovery.

In these cases of temporary insanity with taciturn melancholy we have clinical evidence of a third kind of delirium, differing from the two other kinds of which we have just spoken.

These cases resemble in some of their symptoms, cases of insanity with settled taciturn melancholy; but from those they differ in this essential point, that while in those the insanity is obstinate, often indeed for life; in these the insanity comes definitely to an end in from two or three weeks to three or even four months.

The features, then, that characterize these cases of temporary insanity are youth and previous good health ; or in a few cases intemperate habits ; the absence of hyperpyrexia ; the existence of endocarditis ; the settled though varying and even intermittent character of the taciturn delirium, which is present, though modified, by day as well as by night ; and the dying out of the affection in a limited period. These conditions point, not to a rapidly progressive and varying cause, which marks hyperpyrexia, which is kept in check or suspended by a perspiring skin, or the external use of cold, and is promoted by a hot dry skin ; but to a continuous cause, that is excited during the height of the disease, but that varies in operation for from two weeks to three months after the acute rheumatism and the acute stage of the endocarditis have passed away. In one of my own cases there was embolism, evidenced by the loss of power in the right side, and taciturn aphasia, in combination with endocarditis ; and it appears to me that in embolism of the minute cerebral arteries of the convolutions, we have a series of conditions that correspond with those occurring in the whole of these remarkable cases. Embolism of the cerebral arteries comes on with endocarditis, and arrests for a time the circulation of the blood through the parts of the brain supplied by the affected vessels ; its effects remain after the acute stage of the originating endocarditis has passed away ; and, if death does not cut short the clinical history of the case, those effects usually gradually lessen and disappear in from two or three weeks to several months, unless the extent of the plugging of the vessels be such as to cause extensive softening of the part of the brain supplied by those vessels. I therefore consider that to embolism we may have to look for the explanation of these cases. We shall find other instances of a like nature among the cases without pericarditis, in which endocarditis was present, and in those also in which it was doubtful or absent.

B^2. II.—*Cases with Simple Endocarditis.*—Five of the sixteen cases that had endocarditis without pericarditis were affected with delirium of a desponding type with taciturn melancholy. Two of these died and three recovered. In addition to these five cases with taciturn melancholy, there was another analogous case of embolism of the basilar artery, with headache and agitation, and in the evening apoplectic symptoms, right hemiplegia, and difficulty of speech.[1] As this case did not survive the first great attack, I shall not add it to the rest. The length of time that the mind was disturbed varied in the different cases from three weeks to four months ; one of the fatal cases lasted twenty-three days, and another two months ; while those that recovered were affected for one, two, and four months respectively. Four of them were restless ; three were taciturn, especially during the night ; another answered slowly ; and the fifth case in a low voice ; three had hallucinations, including one of those that were also taciturn, and two would get out of bed. Three of them were desponding or melancholy ; one was apathetic ; and the remaining one, a fatal case, was for ten days in a state of quiet delirium, and afterwards preserved a dogged silence. Two of them were confused ; and one of them was violent. If we compare these five cases of temporary insanity with simple endocarditis, with the sixteen cases of the same class with pericarditis and endocarditis, we find that the two sets of cases correspond in their main features. Both had disorder of mind, by day as well as by night, though with greater accentuation at night in those with simple endocarditis ; in both early restlessness, obstinate silence, melancholy, apathy, and hallucinations prevailed ; and in both the affection of the

[1] Bouillaud, *Maladies du cœur*, vol. i. p. 405.

intellect commenced during the attack of acute rheumatism and of the accompanying endocarditis, and lasted for a variable period after the acute affections had ceased.

As we have just seen, five out of the sixteen cases, or one-third, with simple endocarditis, not including the fatal case of embolism, difficult speech, and right hemiplegia, and another case with embolism of the minute cerebral arteries and delirium that died on the eleventh day, and sixteen of the sixty-five with pericarditis, all but one of them having endocarditis also, or one-sixth, were thus affected with taciturn melancholy lasting for a limited period after the cessation of the acute affection. We may, I think, consider that the existence of endocarditis in so large a proportion of such cases adds to the probability of embolism being the cause of the temporary insanity.

Since the above was written Dr. Broadbent has favoured me with his notes of an important case of acute rheumatism and endocarditis, with chorea and delirium, in which there was capillary cerebral embolism. I have also met with a case observed by Dr. Dickinson of acute rheumatism and endocarditis with delirium and minute cerebral embolism, and red softening of some of the convolutions; and with another case of chorea and endocarditis with delirium and minute cerebral embolism. These three cases afford direct evidence of the association of embolism of the minute arteries of the convolutions of the brain with delirium.

Dr. Broadbent's patient, a laundryman, aged 17, when attacked, had severe affection of the joints, and was light-headed; two days later his right limbs twitched and jumped, and he was delirious. On admission, after being ill a week, he seemed stupid, had to be spoken to loudly; his answers were confused, his articulation was indistinct, and his limbs still twitched, but especially on the right side. T. 103°.

During the two following nights he had no sleep, was very delirious, talked, screamed, and jumped out of bed. He slept after a dose of chloral, but was soon pale and prostrate, and died on the fourth day after his admission. Recent loose clots were found in the minutest arteries and capillaries of the *corpora striata* and of some of the convolutions.

B^2. III.—*Cases without Pericarditis, Endocarditis being absent or doubtful.*—Five of the thirty-eight cases in which there was no pericarditis, and endocarditis was absent or doubtful, or one in eight of the whole number, became delirious during the acute stage of the disease, and remained of unsound mind for two months and a half in one, and for about a month in four instances. Two of these patients were also affected with choreiform movements. Four of these were men, and one was a girl, aged 16. Two of the men had been at one time drunkards, one of them had suffered in health from losses and excesses, and the other man was a servant, and probably lived generously. The speech was affected in all of them. One stammered, one answered slowly, one was taciturn, one refused to answer, and the girl did not reply to the question put to her, but spoke of something else. Two of them had hallucinations; one was despondent; another, after being noisy, became sulky; one was morose by day, and had lively delirium. One, with choreal movements, after being confused and delirious in paroxysms, became so continuously; and the fifth, also having chorea, was strange in manner.

In none of these five cases was there any notable sign of endocarditis, and the disturbed state of mind and speech could not therefore be attributed to embolism.

B^2. *Temporary Insanity—General Summary.*—There were altogether twenty-one cases of acute rheumatism with temporary insanity; and six of delirium, usually of the low melancholy type, in which the insanity was cut short by death. Of these twenty-seven cases, sixteen had pericarditis, six simple endocarditis, and five had apparently neither pericarditis nor endocarditis.

Four-fifths of the cases had endocarditis (21 in 27), and one-fifth of them gave no evidence of endocarditis (6 in 27).

I have already given clinical reasons for thinking that the temporary insanity may have been due to embolism of the minute cerebral arteries in those cases with endocarditis, and direct evidence that in two cases that condition coincided with delirium.

In six of those cases with endocarditis the temporary insanity, delirium, or melancholy was associated with chorea, and their clinical history would seem to suggest that in those cases the temporary insanity and the chorea were due to a common cause acting perhaps on different parts of the nervous centre. This view is strengthed by Dr. Tuckwell's important remarks on Muscular Chorea and its probable connection with Embolism. This memoir is illustrated by a case [1] in which there were two large patches of red softening affecting the cortex, and in one of them the white substance also, of the right hemisphere of the brain. The arterial branches leading to one if not both of these softened patches were occluded by coagula, and very fine granular particles were dotted along the small blood-vessels in the softened cerebral grey matter. This patient, a boy, was attacked with chorea nine days before admission, and became delirious during the first night after it. On the third day he had wild maniacal delirium, and furious choreic movements. This wild state soon quieted itself, but was renewed on the eighth night, and on the ninth day he became comatose and died.

More than one-half of the cases were below the age of

[1] *British and Foreign Medico-Chirurgical Review*, xl. p. 506.

twenty-one (14 in 27) and of these all but one had endocarditis, while one-third of them were above the age of twenty-five (9 in 27) and of these nearly one-half (4 in 9) presented no sign of endocarditis.

Although the majority of these cases, and especially those with endocarditis, were young people of previously good health, yet a small but definite group of the cases form an important exception to this typical series. Six of the cases, all men, were either known to be of habits of intemperance, or were of occupations in which such habits are possible. Three of those male patients were drunkards or given to excess, and of the rest, one was a policeman, one a man-servant, and the sixth was a post-boy. Four of these patients, all of whom recovered, presented no sign of endocarditis, and the two others had endocarditis.

The question arises here, whether the temporary insanity in these four men who had not endocarditis, one of whom had chorea also, may have been due to thrombosis or the spontaneous collection of fibrine in the minute arteries of the convolutions? I simply put this as a question, but in support of the possibility of this condition I find an important case that was closely observed by Dr. Charlton Bastian during life and after death. The patient was a strong man, a gate porter, who had been accustomed to drink a great deal of late, and was attacked with erysipelas of the head and face following a fall, when he cut his head on the kerb-stone. He became violently delirious, was then quieter, became comatose at night, and died early on the following morning. The heart was healthy; the pia mata and brain were abnormally vascular; the consistence of the brain was good. Minute embolic masses were present in the small arteries and capillaries of the brain in every specimen looked at.[1]

[1] *Path. Trans.* xx. 8.

B^3 & $C^{1,2,3}$.—Chorea and Choreiform and Tetaniform Movements, with and without Delirium, in Cases of Acute Rheumatism, with especial reference to Pericarditis.

The occurrence of chorea without delirium in cases of acute rheumatism when connected with endocarditis will be considered when we inquire into that affection. The present inquiry will be limited to (1) cases of chorea and of choreiform movements with delirium, or ending in sudden death, occurring in acute rheumatism with or without pericarditis; and (2) cases of chorea and choreiform movements without delirium, occurring in acute rheumatism with pericarditis; and in inquiring into these cases, I shall briefly include the cases of combined chorea and temporary insanity that have already been considered.

B^2 & $C^{1,2}$,—I.—*Cases with Pericarditis.*—Chorea occurred as a definite accompanying affection in six instances with delirium, and in seven without delirium; and choreiform movements not amounting to definite chorea occurred in two instances with delirium and in one instance without delirium among the sixty-five cases of acute rheumatism affected with pericarditis now under examination. In addition to these cases so affected, there were six patients with pericarditis who had delirium, or coma, or both, as the principal affections, and who had choreiform movements as a subsidiary affection. There were thus twenty-two cases of rheumatic pericarditis with chorea or choreiform movements, not including several who had also tetaniform symptoms.

The thirteen cases with chorea, and two of the three with limited choreiform movements, were below the age of twenty-one, nine of these being girls and six youths. The remaining case with limited choreiform movements was a man aged 22. Nine of these sixteen choreal cases died and seven recovered.

Thirteen of these cases, including the whole of those with delirium, had endocarditis as well as pericarditis; in two cases endocarditis was probable, and in one it was absent or doubtful.

In eight of the cases the chorea appeared after the commencement of the pericarditis; in seven of them the two affections probably came into existence about the same time; and in one exceptional case, recorded by Dr. Ormerod, the chorea appeared first, then the pericarditis, and finally the affection of the joints, thus reversing the usual order of succession of those affections.

The chorea appears to have continued up to the time of death in most of the fatal cases when the pericarditis was active; but the reports of several of them are, in this respect, imperfect.

The relation of the termination of the chorea to that of the pericarditis varied much in the cases that recovered. In one case the choreic movements were violent on the day that the frottement diminished, and were absent four days later. In another case the chorea improved with the improvement of the state of the heart.[1] A patient of my own made objectless movements with his hands when the pericarditis was at its acme; and two days later those movements ceased. In a boy with pericarditis, violent chorea appeared when the rheumatic and cardiac affections rather suddenly disappeared. Six days later with return of pain in the joints the chorea ceased.[2] In another patient, a girl, chorea appeared four days after the disappearance of friction-sound.[3]

[1] *Guy's Hospital Reports*, vi. 1841, pp. 420, 421.

[2] Mr. Land, *Lancet*, 1873, i. 38.

[3] Dr. Kirkes, *Trans. of the Abernethian Society*, 1850, p. 57.

Partial choreiform movements, usually of short duration, appeared in six of the cases that were affected with delirium with and without coma, and in all of them the movements appeared when pericarditis was present.

The character of the choreiform movements was peculiar in some of the cases. Two of the patients rolled the head from side to side; one smacked his lips, another pursed his mouth, a third snapped, grimaced, and cried out; two moved the left hand and arm constantly; and in five the spasmodic movements of the body were very violent, so that in three of them personal restraint was demanded. In one of those five patients, on the second and third days, the spasms put on the character of the most violent convulsions. The cases of chorea with delirium presented considerable variety; and several of them, as we have already seen, had temporary insanity.

Five of the eight cases with delirium were fatal, and three recovered. The duration of the cases varied considerably. The five fatal cases died at various periods from the fourth to the sixteenth day of the delirium. Of the three that recovered, one had delirium for a month, one had chorea for three weeks, and in one, a man under my care, quick and needless movements of the hands, and occasional muttering, lasted two or three days.

B^3. II.—*Cases with Simple Endocarditis.*—No case of chorea with delirium, and only one with rapid death, occurred among the cases of acute rheumatism with endocarditis.

B^3. III.—*Cases without Pericarditis, Endocarditis being absent or doubtful.*—I have already given two cases of this class with chorea and delirium that were affected with taciturn melancholy of limited duration. The third case, a girl, aged 14, also had chorea and delirium.[1]

[1] Tüngel, *loc. cit.* 1860, p. 125.

B³.—*Cases with Choreiform Movements* in which those movements were partial and of secondary importance, and occurred in patients already included among those with delirium or coma. B³. I.—*Cases with Pericarditis.*—Six cases with delirium, one of which had coma also, among the sixty-five cases of rheumatic pericarditis had movements of a choreiform character for a single day in the course of the disease. Three of these patients died and three recovered. Four of them were male and two were female patients, and of these, five were above the age of twenty-five, and only one below that of twenty-one.

B⁴, C³.—*Cases with Tetaniform Movements sometimes associated with Choreiform Movements.*—I. *Cases with Pericarditis.*—In a small but important group of cases tetaniform symptoms occurred in connection with rheumatic pericarditis. Seven of the sixty-five cases of pericarditis had tetaniform movements, or continuous contraction or rigidity of muscles, of greater or less intensity. Some of these affections approached in their severity and characteristic form to tetanus, others could only be indistinctly associated with that disease.

The first case was an excitable man, aged 19, a gardener, who had, when first seen, twitching of the muscles, and of the right side of the face, increased by speaking. He had increasing agitation, indistinct articulation, and a difficulty in opening his mouth, which he closed with a snap. After this he threw his head from one side of the bed to the other, his convulsions resembled tetanus and opisthotonos, and his distress in swallowing was like that in hydrophobia. Four days later he rolled his eyes, ground his teeth, and smacked his lips; and he died exhausted by laborious spasm and probably by want of sustenance. His brain was vascular, and there was questionable softening around a vascular spot in the spinal cord opposite the first dorsal vertebra. There was pericarditis and endocarditis.[1] The next case, an overworked girl, aged 19, at a late period of its history, seemed to plunge almost at once into the tetaniform condition. She rolled her eyes wildly, had furious delirium, and violent tetanic spasms with firm clenching of the fingers. After a week the delirium subsided, but she talked incessantly and incoherently, and was half maniacal, half idiotic, up to the forty-sixth day, but from that time her progress to recovery was steady.[2] The third case, a youth, had pericarditis, but no endocarditis, inflammation of the kidney, occasional delirium, and slight opisthotonos; and on the eleventh day he died.[3]

The two following cases, both of which were fatal, were under my own care. The more important case was a youth aged 17. On the eighteenth day, the left side and the tongue were affected with choreiform movements, which extended, with stiffness, to both arms. On the thirty-eighth the left arm, which still jerked and shook about, was rigid, the fore-arm being bent on the arm, the hand on the fore-arm. On the forty-seventh day, stiffness of the neck appeared, and he moved his arm with difficulty; and on the following day he died. He had both pericarditis and endocarditis. In this case the rigidity of the limb points to an affection of the nervous centre, probably due to embolism.

The other case, a man aged 27, a carpenter, came in with pericarditis at its acme, and endocarditis. On the third day he frequently slumbered and, as the eyes were half-closing, the arms and legs started. On the evening of the seventh day he was restless, and not quite rational, trembled, and kept moving his lower jaw and biting his lips. Half an hour

[1] Dr. Yonge; Dr. Bright, *Guy's Hospital Reports*, v. (1840), p. 276.
[2] Dr. Fuller, *loc. cit.* 201. [3] Dr. Fuller, *loc. cit.* 289.

later he was more noisy, and knocked about, still shaking his jaw. His pupils were dilated and very sluggish, and at eleven o'clock he died. I can find no notes of his post-mortem examination.

The two remaining cases with tetaniform symptoms belong to the group of cases of endo-pericarditis with delirium and coma. One of these, a young man, had pain in his right temple, followed by wild delirium. During the night general convulsions came on in occasional spasms of a tetanic character, and in the intervals he lay in a state of coma. He remained in this condition for three more days, when he died.[1] The remaining case, a young woman, became restless and flighty on the sixth day of her illness, and next day pericarditis and endocarditis declared themselves. She then became very violent. The right arm and leg were never still; at times, however, this state became aggravated into one of general convulsions of a tetanic character. She continued thus for nine days, the convulsions being incessant. On the twelfth day she became comatose, after jumping up and falling out of bed with her forehead on the floor. She finally recovered.

Pericarditis—neither Rheumatic nor from Bright's Disease — accompanied by Affections of the Nervous System.

An important series of cases of pericarditis in which there was neither acute rheumatism nor, so far as was directly ascertained, Bright's disease, have been published from time to time by Rostan, Dr. Abercrombie, Dr. Bright, Bouillaud, Andral, and Sir George Burrows.

The cases of this class that I have gathered together from

[1] Sir Thomas Watson, *loc. cit.* ii. 306.

the records of various observers, and from the note-books of St. Mary's Hospital, amount to twenty-six. (See Analytical Table at page 376.)

These cases present examples of the whole series of affections of the nervous system that have been observed in cases of rheumatic pericarditis, with the exception of those with temporary insanity, and these were possibly represented by one fatal case that had obstinate taciturnity.

Among these twenty-six cases, (A^1) one had coma without delirium ; (A^3) four had delirium and coma, the delirium in two of them preceding, and in two of them following the coma ; one had delirium and convulsions ; (B^1) eleven had uncomplicated delirium, which was slight and of short duration in seven of them ; and of those without delirum ($C^{1,2}$,) three had chorea or choreiform movements ; (C^3) two had tetanus, and (D) one had slight convulsions. The affections of the nervous system in these cases of pericarditis, instead of being similar in character were thus very various.

A^1. *Coma.*—The patient with coma was a woman who was suddenly seized with complete loss of consciousness, remained in this state four days, and died. Pericarditis was the only appreciable lesion.

A^3. *Coma with Delirium.*—Among the four cases with coma associated with delirium, in two instances the delirium, as usual, preceded the coma, while in two the delirium followed the coma. One of the former class, a boy, aged 12, affected with pyæmia, was delirious, and after a night without sleep, became unconscious and died in the afternoon. Pericarditis was associated with small deposits of pus in the walls of the heart, the fibres of which were soft and almost black.[1] The other case in which delirium was followed by coma presented tetaniform symptoms. A woman aged 26, was admitted soon

[1] Mr. Stanley, *Med. Chir. Trans.* vii. 322.

after a false conception in a state of delirium and obstinate taciturnity. After this she frequently reversed her head backwards, had convulsive movements of the face, and the arms presented from time to time a rigidity almost tetanic. On the fifth day the arms when raised fell as if paralysed, she became comatose, and died in the evening. Pericarditis was the only morbid state discovered after death.[1]

Three of these cases may have been affected with "hyperpyrexia." There is, however, no indication that their temperature was raised.

In the other patient, a house-painter, in whom the coma preceded the delirium, I think that Bright's disease, not noticed after death, when the kidneys were not examined, was the probable cause of the fatal conditions spoken of.[2]

The patient with delirium and convulsions was a schoolboy with evident pyæmia, who had, in the opinion of all who saw him, severe inflammation of the brain. His brain was healthy, but his pericardium was inflamed, and innumerable small patches of pus oozed from among the muscular fibres of the heart.[3] The case with convulsions without delirium was also a boy, aged 7, who had pain in the left side and the epigastrium, and on awaking next morning was seized with slight convulsions, sank into a low exhausted state, and died in half an hour. There was universal pericarditis, and when the heart was cleared from its soft gelatinous envelope, it was covered with small irregular granulations.[4]

B[1]. *Delirium* without coma or other complications was present in eleven cases of pericarditis not occurring in acute rheumatism or Bright's disease.

[1] Andral, *Clinique Medical*, i. 25.
[2] Bouillaud, *loc. cit.* i. 319.
[3] Dr. Latham, *London Medical Gazette*, iii. 1829, p. 209.
[4] Dr. Abercrombie, *Trans. Edin. Med. Chir. Soc.* i. 1821-4.

The most important of these cases was a man aged 36, under the care of Sir James Alderson. Three and a quarter pounds of dark amber-coloured fluid were found in his pericardium, the heart being covered and the sac lined with a thick honey-combed layer of new membrane. The supra-renal capsules, especially the right one, were enlarged with tubercular deposit. He had excessive distress and pain over the heart, the whole front of the chest was dull on percussion, and the impulse and sounds of the heart were absent. From the presence of these signs Sir James Alderson concluded that his patient was affected with pericarditis. On the twenty-second day after admission he became delirious, and on the twenty-fifth he was maniacal, and died.

Another case of this class was a shoeblack, aged 67, who had delirium with great loquacity. He raised himself suddenly, went to the window to breathe, returned to bed, lay down and soon died. There was extensive pleurisy on the left side, spreading to the pericardium, which contained a pound of purulent liquid; the walls of the heart being soft, and its fleshy substance yellow.[1] A third case, a man, had pericarditis associated with pyæmia, following an operation for stricture.

Seven of the remaining cases of this series presented only slight delirium and may be conveniently grouped together. One, who had pleuro-pneumonia and pericarditis, recovered.[2] Another had slight delirium and fever, and pericarditis. One had empyema and pericarditis. Two cases under my care were delirious the day before death. One had pyæmia, and purulent dots were scattered through the fleshy substance of the heart; the other had empyema of the left side, and pericarditis. In the two remaining cases the delirium appeared a short time before death; one had extensive phthisis of the

[1] Corvisart, *loc. cit.* p. 239.

[2] Bouillaud, *loc. cit.* i. 367.

right lung and a vast cavity, the other had empyema of the left side, the pericardium being inflamed and thickened. In all these cases the delirium appeared to be quite as much connected with the disease upon which the pericarditis had grafted itself as upon the pericarditis itself, and in most of them it was little more than the wandering of mind incident to illness of so lowering and fatal a character.

The remaining patient of this group, a coachman, aged 51, and a drunkard, who was under the care of Dr. Chambers, presented a condition resembling delirium tremens. He had extensive pleuro-pneumonia of the left lung, and pericarditis. Two of these cases with brief delirium were under the care of Sir James Alderson, and two under that of Dr. Chambers.

C^1, ^{2}. *Chorea and Choreiform Movements.*—Two cases of non-rheumatic pericarditis had chorea, and four presented movements of a choreiform character.

C^1. *Chorea.*—One of the cases, a well-grown girl of 15, had chorea for six weeks before admission, and on the twenty-seventh day after it was suddenly seized with obstructed respiration followed by a convulsive fit, and died. There was pericarditis, and the mitral valve was somewhat thickened, but the presence of endocarditis was not noted. The other case, a little girl, was under my own care. She was brought to the hospital in her mother's arms, in great distress. She presented prominence over the region of the pericardium, dulness on percussion extending up to the clavicle, and a pericardial friction-sound. There was evidence also of pleurisy of the left side. Choreal symptoms appeared in the face, beginning in the corrugator supercilii, on the third day after admission, and chorea was established on the fifth day. On the ninth day she was much quieter ; her face was pale, her lips were blue, and the veins of the neck pulsated, being full during expiration and during the ventricular systole; and a loud mitral murmur was audible at the apex. She died on that day, but I have found no notes of the examination after death.

C[2]. *Choreiform Movements.*—Four cases of non-rheumatic pericarditis presented in the course of their illness movements of a choreiform character. These cases hold an intermediate place between those with well-developed chorea, and those with regularly repeated local convulsive movements. The most important case ought perhaps to be included among those with chorea, but it developed certain characteristic symptoms of the choreiform type that are rarely or never present in uncomplicated chorea. This patient, a young lady, after a fortnight of extreme restlessness, and a good deal of delirium, fell into a state resembling chorea with convulsive agitation of the limbs, constant motion of the head, and wild rolling of the eyes. Cold was applied to the head, her symptoms subsided in a few days, and she gradually recovered. Three months and a half after the commencement of her illness she took cold, became suddenly worse, and died on the seventh day. The pericardium was universally adherent to the heart by lymph, and a deposit of lymph covered its outer surface.[1]

The other three cases, all fatal, of non-rheumatic pericarditis were reported by Corvisart, and the most remarkable symptom was a state of extreme agitation amounting to jactitation. They all had pleurisy as well as pericarditis, and one had pneumonia also. One of them had delirium, in another the mind was affected, and in the third disturbance of the intellect was not noted.

C[3]. *Tetaniform Symptoms and Tetanus.*—Two of the cases of non-rheumatic pericarditis were affected with tetaniform

[1] Dr. Abercrombie, *Trans. of Med. Chir. Soc. of Edin.* i. 1.

movements, or rather with actual tetanus, some of the symptoms of which were unusual. One of these cases was a boy who when admitted had cramps and a threat of suffocation. His fingers, arms, and forearms, his legs and feet, were strongly bent, and the muscles of his limbs and abdomen and his masseters were so hard that they felt like touching a stone, especially during the paroxysms. A warm bath and cold affusion gave great relief, and the paroxysms of suffocation ceased half an hour later. After this the jaws were slightly closed, he had a return of the suffocation, especially when he drank, and occasional cramps. On the fifth day he had a cold bath by accident, and was seized with cramp when in the bath. He had spasmodic contractions of great intensity on the following day, and died in a paroxysm of suffocation. There were two ounces of pus in the pericardium, the surface of which was injected.[1]

The other patient with tetanus was a gentleman of middle age who, when first seen, was suffering from a violent spasmodic contraction of his limbs. On the fifth day he had cramps of his extremities and occasional spasmodic rigidity of the whole body, which was sometimes bent backwards, being supported by the occiput and the heels in a state of complete opisthotonos. During the night his spasms were so severe that he could scarcely be kept in bed, and he died suddenly on the following day. He had pericarditis, and the brain and spinal cord were healthy.[2]

I have ranked these cases with those of tetanus because they presented universal rigidity of the limbs and body; which, in the first case, extended to the masseters; and in the second, caused, during the paroxysms, complete opisthotonos. There were, however, certain conditions in which

[1] Bouillaud, *loc. cit.* i. 333.

[2] Dr. Mackintosh, *Practice of Physic*, ii. 25.

they both differed from ordinary tetanus. In neither of them did the affection commence with trismus, and in the second case its presence is not mentioned. In both of them at the outset of the attack the muscles of the extremities were involved ; and in the first of them, besides cramps of the legs, the fingers, arms and forearms were strongly bent. In tetanus I need scarcely say that the reverse conditions prevail, for trismus is usually the earliest symptom, and the affection of the limbs is comparatively late, while that of the hands and arms is usually slight, the extensor muscles being more affected than the flexors. In tetanus the advance of the disease is steadily progressive, but there was a suspension of the spasmodic contraction of the limbs in both of these cases.

Dr. Bright describes a case of tetanus occurring in a man affected with inflammation of the pleural surface of the right side of the pericardium, involving the phrenic nerve, in which there was no pericarditis. In this instance the tetanus advanced rapidly through its usual progressive course. On the first evening he complained of difficulty in opening his mouth, and swallowed with a convulsive catch. During that night his teeth were completely closed, and next morning he could get nothing into his mouth, and could not even swallow his saliva. There were slight indications of opisthotonos, and spasmodic action of the muscles of the back. In the afternoon there was no relaxation of the spasm ; he had several epileptiform seizures, during which his face was purple, his eyes stared, and his whole body was convulsed. He rambled occasionally, and died twenty-four hours after the first seizure of dysphagia. Dr. Bright suggests that in this case tetanus may have been caused by the phrenic nerve being involved in the seat of the inflammation.[1]

[1] *Med. Chir. Trans.* xxi. 4.

Convulsive Movements, Chorea, and Choreiform and Tetaniform Symptoms in cases of Acute Rheumatism with and without Pericarditis, and in cases of Non-Rheumatic Pericarditis, in which Bright's Disease was Absent. Summary.

Convulsive Movements.—I do not consider here cases of coma with convulsions, of which there were five, three with and two without pericarditis, one with and three without endocarditis, which was probably present in the remaining instance; nor those with convulsions associated with albuminous urine, of which there was but one patient, affected with both pericarditis and endocarditis.

There were altogether nineteen patients with convulsive movements among the whole series of 180 cases of acute rheumatism with affection of the nervous system; twelve of whom had pericarditis and seven had no pericarditis, while eight or perhaps nine of them had endocarditis. Fourteen of these cases had twitchings of the limbs or face; and of these, eight had pericarditis, and five endocarditis.

From this *résumé* it is evident that although these convulsive movements are probably influenced, and may in some instances have been caused by the co-existence of pericarditis or endocarditis, yet they may, and often do occur quite independently of either of those affections, and in the absence of both of them.

Hyperpyrexia (actual in seven cases, inferred in four,) was present in eleven of the nineteen cases with convulsive movements or twitchings. In Dr. Greenhow's important case, given at page 349, twitchings of the face were generally present when the temperature ranged from 102·1° to 106·2°, but they were suspended by the cooling bath, and returned after removal from the bath.

The general affection of the nervous system varied in the different cases with convulsive movements and twitchings. In one patient a convulsive fit preceded coma without delirium. In seven cases there was delirium followed by coma. In four of these, twitchings occurred during the delirium; while in two of them, twitchings, and in one, convulsive movements, accompanied the coma. Convulsive movements of the whole body in one instance, and of the face in another, followed delirium and preceded death. There were general convulsive movements in one, and twitchings of the face in two cases of uncomplicated delirium.

There were twitching movements in four cases with chorea and delirium, in one of which there was also a state resembling tetanus and opisthotonos. In these four cases the twitchings were probably choreiform in character.

In one of the two remaining cases, a slight fit with ptosis preceded death by a few hours; and in the other twitching was present with albuminuria.

Convulsions were present in three, and convulsive agitation of the limbs in one, and of the lips or face in two of the twenty-six cases of non-rheumatic pericarditis in which there was no Bright's disease.

Chorea, and Choreiform, and Tetaniform Symptoms. Chorea. —Twenty-one of the 180 cases of acute rheumatism with affections of the nervous system had chorea. Fifteen of those patients with chorea had pericarditis, six had no pericarditis; while fourteen of them had endocarditis; three had no endocarditis; and in three of them, endocarditis was probable or doubtful. Pericarditis and endocarditis attacked three-fifths of these patients conjointly (13 in 21). It would appear from this, at first sight, as if pericarditis favoured or influenced the production of chorea, thus apparently supporting the view of Dr. Bright that the more frequent cause of chorea in conjunction with rheumatism is inflammation of the pericardium, the irritation being probably communicated thence to the spine through the phrenic nerve.[1] This view is apparently strengthened by the history of several of the cases in which the chorea and the pericarditis appeared, improved, and disappeared simultaneously. On the other hand, in one case, chorea preceded pericarditis, and in at least two others it came into play when the pericarditis was vanishing. The united presence of inflammation without and within the heart in so many of these cases, complicates the question as to the influence of pericarditis on the production of chorea ; and these clinical statistics favour the view that endocarditis may be the cause of the chorea, quite as much as that pericarditis may be its cause. I will not pursue this question in this place farther, excepting to repeat that in Dr. Broadbent's and Dr. Tuckwell's important cases of chorea and delirium, there was embolism of the most minute cerebral arteries, associated with endocarditis. These two cases seem to show that it is possible that in some of the above cases also, chorea may have been associated with minute cerebral embolism due to endocarditis. I have already illustrated the possible or probable connection of temporary insanity in cases of acute rheumatism with endocarditis and minute cerebral embolism, or with minute cerebral thrombosis, the convolutions being affected ; and five of these cases of chorea had also temporary insanity, in three of which there was endocarditis, while in two there was no endocarditis.

Chorea was present in two cases of non-rheumatic pericarditis without Bright's disease. In one of these the onset

[1] *Med. Chir. Trans.* xxii. 15.

of the chorea preceded, and in the other followed, that of the pericarditis. In one of those cases endocarditis was also present, and in the other it was doubtful.

Choreiform Movements. Jactitation.—Chorea, as we have just seen, affected twenty-one of the 180 cases of acute rheumatism with affection of the nervous system. Besides these there were fourteen cases that had choreiform movements without definite chorea. One patient moved automatically, as in chorea, and another made objectless movements with his hands. Both of these cases had endo-pericarditis. Eight patients were affected with jactitation, which was general in six instances, and limited to the right or left side in two. The whole of these patients had pericarditis, while endocarditis was present in three of them, was absent in one, and probably absent in four.

There was extreme jactitation of the whole body in three cases of non-rheumatic pericarditis, probably without endocarditis, observed by Corvisart; two of these had pleurisy, and the other one pleuro-pneumonia; those affections in two of the cases being the probable cause of the pericarditis.

The invariable presence of pericarditis and the frequent apparent absence of endocarditis in these cases of general jactitation, would appear to point to pericarditis as a possible cause of that condition, and perhaps by inducing reflex movements.

Agitation.—Fourteen of the cases with affection of the nervous system in which the temperature was not observed had agitation, which is a condition allied to general jactitation, which was also present in two of them. I find no express mention of agitation in the sixty-one cases in which the temperature was observed. Five of the fourteen cases with agitation had pericarditis; eight of them had endocarditis; while five of those cases had neither endocarditis nor pericarditis.

Ten of the cases with agitation died and four recovered.

Rolling of the Head from side to side.—A peculiar, regularly repeated rolling of the head from side to side occurred in eight of the 180 cases of acute rheumatism with affection of the nervous system. Five of these cases had well-developed chorea, and two others had limited choreiform movements. Six of these cases had pericarditis, while five of them had endocarditis, and in one its presence was doubtful. All of them had either endocarditis or pericarditis. This peculiar oscillating movement of the head, though generally connected in these cases with chorea or choreiform movements, is not, so far as I know, ever present in ordinary chorea, and it forms, therefore, a feature of difference between those cases and these. One patient, who had endo-pericarditis, delirium, and coma rolled violently about the bed so that he required to be held down.

Choreiform movements were present in four cases of non-rheumatic pericarditis without Bright's disease. In one of these the state resembled chorea, there being convulsive agitation of the limbs and constant motion of the head with delirium; in another patient there was slight convulsive agitation of the face; and in two other cases there was violent general jactitation.

Tetaniform Symptoms and Tetanus.—Thirteen, or if the presence of "risus sardonicus" alone be included, fifteen cases presented symptoms of a tetaniform nature.

In eight of those cases the tetaniform symptoms were general. Some of these had also chorea, or choreiform movements. In one such case the choreal convulsions put on a character resembling tetanus and opisthotonos, and the distress in swallowing was not unlike that in hydrophobia. Another case had opisthotonos and tetanic spasms; and a third had slight opisthotonos. Three other cases had spasms or convulsions of a tetanic character, which were accompanied in one instance by firm clenching of the hands. One patient under my care had stiffness of the neck; and rigid jerking and shaking about of the left arm; the fore-arm, at a later period, being bent on the arm, the hand on the fore-arm. The eighth case, a woman, had a temperature of 109·5°, and after being put into a tub of cold water was attacked with tonic spasms. Two cases had spasms of rigidity of the muscles of the neck, in one after being cooled in the bath from 109° to 103·6°, and two had stiffness of the neck, one of which has been already alluded to.

One patient who was violently delirious at a temperature of 107·8° to 109°, after being bled, immediately passed into a state of unconsciousness, and was attacked with trismus, and convulsive movements of the jaws, hands, and arms. Two cases were affected with stiffness of the jaw; which was accompanied in one of them by swelling of the temporo-maxillary articulation; this being the patient just spoken of who was seized with tonic spasms after the bath; and who closed her teeth firmly over her lips, drawing blood. Another patient, a man, was continually moving his lower jaw and biting his lip; and another, also a man, kept incessantly pouting his lips and rubbing them over his teeth. One patient, spoken of above, with spasms of rigidity of the neck after the bath, and also spasms of rigidity of the lips. Another case with opisthotonos and tetanic convulsions, closed the lips in snaps before, and smacked the lips after having convulsions.

"Risus sardonicus" was observed in five cases, in three of which there were, and in two there were not, other tetaniform symptoms.

Of the above thirteen cases with tetaniform symptoms, not including the two with simple "risus sardonicus," ten had endo-pericarditis, one had pericarditis, endocarditis being absent, in one both of those affections were doubtful, and in one they were both absent. These clinical facts make it probable that pericarditis or endocarditis, or both, may sometimes be concerned in the production of tetaniform symptoms. Other influences were, however, at work connected with hyperpyrexia in some of the cases. Thus trismus appeared in one patient just alluded to who became unconscious after being bled, the temperature rising from 107·8° to 109°; and in three cases the tetaniform symptoms came into play after the excessive temperature had been cooled down by the bath.

We have already seen that in one case of non-rheumatic pericarditis ending in coma, the arms presented occasionally a rigidity as of tetanus; and that in two other cases of the same kind, there was actual tetanus of a peculiar type. These three fatal cases had no endocarditis.

Andral, in commenting on the first of these cases, or that with occasional rigidity of the arm, and delirium ending in coma, asks whether the cause of the affection of the nervous system in these cases is not in the inflammation of the pericardium itself? We have already seen that Dr. Bright looks to the communication of an influence from the inflamed pericardium, through the phrenic nerve to the spine, as a cause of choreal and tetaniform affections. I would here remark that tetanus may be caused by a wound and by exposure to cold, and there is nothing therefore inconsistent, so far as I can see, in the idea that it may be caused also by an internal inflammation affecting local nerves, and through their channel acting on the spinal marrow.

Tetanus is not, so to speak, an intermittent contraction of the muscles of the reflex type, but a continuous contraction of the muscles, due to the direct continuous action of the spinal cord. In tetanus, as Dr. Lockhart Clarke has shown, there are areas of disintegration in the spinal cord. In traumatic tetanus, the cause of the affection is the injury to the nerve, and in these cases the nerve must carry from its periphery to its centre an influence that sets into action the disintegration of the cord. If the inflammation of the peripheral ends of the nerves of the pericardium excites tetanus, it would perhaps do so in some such manner as that just suggested. The cases of tetanus and tetaniform affection associated with pericarditis, though striking are very rare, and we may fairly ask whether in those cases in which the two affections coincided, some other cause may not have been at work to induce the tetanus. I know of no instance in which tetanus was induced by any other internal inflammation, and if this be so, it is not easy to see why pericarditis or pleurisy affecting the phrenic nerve should be the only internal inflammations capable of inducing that affection in its typical or modified form.

END OF VOL. III.

LONDON:
R. CLAY, SONS, AND TAYLOR,
BREAD STREET HILL.