Paracentesis thoracis as a therapeutic agent : introduction to a discussion in the Section of Pharmacology and Therapeutics at the Fifty-second Annual Meeting of the British Medical Association / by W. Henry White.

With the Author's Compts.

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at the Fifty-second Annual Meeting of the British
Medical Association.

BY

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PARACENTESIS THORACIS AS A THERAPEUTIC AGENT.

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From the earliest period, no subject has excited more discussion, or has evoked greater divergence of opinion, than the treatment of effusion into the thorax. This divergence, however, whilst of late years much lessened, yet continues; and the profession is still far from unanimous as to the best methods of dealing with such cases of thoracic effusion as are found to resist routine treatment. Ever since Hippocrates advocated tapping the chest, a constant ebb and flow of opinion, for or against its use, has been observed. This is well shown by the oblivion into which this therapeutic agent had fallen at the time when Trousseau, Hamilton Roe, and others, directed their attention to the subject, and reinstated the operation.

We owe much to Trousseau in this matter, for his vigorous advocacy drew attention to the successful treatment of pleurisy by operation; and his influence still dominates our efforts. The rules drawn up by him for our guidance as to when, how, and where it may be necessary to interfere were invaluable, and the stress laid by him relative to the exclusion of air from the pleura, was shown by his use of Reybard's cannula, with a valve of goldbeater's skin, which, whilst permitting free exit of fluid, prevented the entrance of air. His reintroduction of this operation heralded a distinct advance in the treatment of thoracic effusion, and his results demonstrate its success as a means of saving life.

By the introduction of his aspirator, with its admirably adapted appliances and readily induced vacuum, Dr. Dieulafoy has furnished us with an instrument which has considerably diminished the difficulties of the operation, not only in respect of those connected with the operation itself, but those which arise from the objections of the patient. Many other aspirators have since been invented, but those which came into use almost simultaneously, or soon after, Dr. Dieulafoy's, were Potain's and Rasmussen's.

Pleuritic Effusion.—Before proceeding to consider effusion into the pleura and its treatment, it is important to bear in mind the normal relations and condition of the parts involved. The pleura, which is a serous membrane, not only lines the lung, but also the parietes of the chest on each side. The cavities formed by the pleuræ correspond pretty accurately to the shape of the lungs. The visceral and parietal layers are in close apposition, and continue so during the to-and-fro movements of respiration, being lubricated by the serous fluid secreted by the pleura. This apposition of the two layers is due, in the normal state of distension of the lung, to the atmospheric pressure within the lung and upon the walls of the thorax.

In dealing with this subject, it is well to remember the mechanism of respiration, which is as follows, in ordinary and quiet breathing. Inspiration is accomplished by the action of the ordinary muscles of inspiration and the diaphragm. These, by dilating the thoracic walls, overcome the resistance of the elasticity of the lung, and cause an influx of air through the bronchi, or inspiration. Upon the relaxation of these muscles, the elasticity of the lung again comes into play, and, assisted by the resilience of the chest-walls, produces an expulsion of air, or, in other words, expiration. On the other hand, in extraordinary efforts of inspiration, the action of the ordinary muscles is reinforced by the extraordinary. Expiration of an extraordinary character is performed by its ordinary method, *plus* the greater amount of lung-elasticity with extreme resilience; between inspiration and expiration, a slight pause occurs, which has been termed "the position of equilibrium." During this pause, certain forces are at work, namely, (*a*) a traction upon the chest-walls and diaphragm by the continual tendency of the lungs to contract and diminish the capacity of the thorax; for the lungs are distended, in order to fill a cavity much larger than themselves, and have their outer surface in close apposition to the walls of this cavity. This constitutes the contracting force; (*b*) the elasticity of the ribs, cartilages, and diaphragm, which dilate the cavity of the chest. These two forces, the one of contraction, and the other of expansion, are in direct opposition the one to the other, and in this period of equilibrium accurately balance one another.

The part played by the mediastinum must not be forgotten; for, dividing, as it does, the thoracic cavity into two halves, it presents a surface to each, and includes between these two the heart and great vessels in connection therewith and the main bronchi. Within certain limits, it is movable from side to side. Now, just as the elastic tension of the lung draws upon the thoracic wall, and has its counterpoise in the resistance of the ribs and cartilages, so in the median line the elastic tension of the lung on the one side draws upon the mediastinum, and has it balanced by the equal tension of the opposing lung. In health, this double traction upon the mediastinum is constant, existing not only in expiration, but to a greater degree in inspiration. Its tendency is to draw apart the two layers of the mediastinum, if we may so think of them, and to exercise a suction-power upon the organs which they include.

It is evident, therefore, that when effusion of fluid takes place into the pleural cavity, it will interfere with the mechanism of respiration on the side affected, in direct proportion to its amount, by impeding the expansion of the lung during inspiration; and, during expiration, by preventing the contraction of the thorax, and the elevation of the diaphragm; whilst it also interferes with the mechanism of respiration on the sound side by the diminution of the pleural cavity consequent upon the distension of the affected side, and to the traction of the mediastinum towards the sound side, due to the unbalanced lung-tension of that side, which tension also leads to an alteration of the level of the diaphragm. And further, in addition to the above interference with respiration, we must not forget the ill effects produced by a large effusion upon the mechanism of the heart. For, remembering the assistance rendered by respiration to the circulation of the blood in its passage from the right to the left ventricle, it is easily seen how this assistance is diminished by the useless and compressed condition of the lung on the affected side, by the lessened tension upon that of the sound side, and by the altered position of the mediastinum.

But, beyond this, the dislocation of the heart, resulting from effusion, places the circulation under considerable disadvantage; for, being compressed, and that too in an abnormal position, and having its large vessels contorted, the entrance and exit of blood is rendered

less easy. This cardiac difficulty occurs more readily in left-sided effusion; seeing that, as pointed out by Bartels, there is imperfect filling of the heart, owing to the rectangular twist given to the inferior vena cava by the displacement to the right.

Pleuritic effusion, so far as the character of the effused fluid is concerned, may be classified as follows: 1, serous or sero-fibrinous; 2, sero-purulent or purulent; 3, sanguineous. As the treatment adopted will largely depend, *inter alia*, upon the nature of the fluid poured out, it is necessary to consider its properties.

1. *Serous Effusion.*—Serous effusion is usually a clear fluid, of a yellow, amber, or greenish hue, of alkaline reaction, and having a specific gravity varying from 1005 to 1030. The proportion of fibrine to the serous fluid which it contains varies considerably, and to this are due the differences observed in the amount of its coagulability when withdrawn from the chest. Should the proportion be large, it is soon converted into a jelly-like mass. As a rule, the fluid is clear; but, on standing, the lower strata become cloudy, and deposit a fine sediment; and this latter may be sufficient to give an opalescent appearance, or even to approach so nearly to pus that, anatomically, it cannot be decided to which class the case belongs. The sediment is composed chiefly of flakes of fibrine, of lymph-corpuscles, and a few epithelial cells in process of disintegration, with a small number of red blood-corpuscles.

The fibrine is deposited soon after exudation, as flakes of various sizes, upon the inflamed pleura, from the fluid in which it floats about in the form of numerous particles. This coagulated fibrine forms bands, layers, and divisions of false membrane between the two layers of the pleura; and, occasionally becoming saturated with the effusion, it is converted into a gelatinous-looking substance.

Sometimes more layers than one of false membrane are deposited; and these vary in colour from white to grey, red, or brownish red. Occasionally, it is soft and easily torn; while, on the other hand, it may be elastic, tough, and cannot easily be lacerated. This is due to the different degrees of coagulability of the fibrine.

Frequently the pleura itself participates in the changes going on, and not only its epithelial surface is affected, but also its deeper layers.

On section, numerous small cells are seen dotted about the connective tissue; and near the surface they are grouped into masses surrounded by a homogeneous matrix, forming a distinct layer. This becomes organised, being rapidly converted by the formation of granulation-tissue and the development of capillary vessels. A layer of fibrine is now deposited over this, and is separable at first from the pleura, but usually they unite later on. When the two layers of the pleura come into apposition, if the fluid be withdrawn, or it become absorbed, the newly developed vessels of the visceral and parietal layers approximate, and become fused together, leading to the obliteration of that cavity. But not unfrequently the pulmonary surface is covered over by a thick tough layer of fibrinous exudation, which forms a complete cover to the lung, and may be more than one inch in thickness. The unfavourable results of treatment in cases which have existed for long periods, with considerable effusion, are frequently due to this condition, preventing the expansion of the lung.

It is now necessary to say a few words about hydrothorax, or the effusion of serous fluid into the pleura, which generally occurs on both sides equally, without any inflammatory process, and is a complication of general dropsy from cardiac or renal disease. In addition to those mentioned above, it is met with in chronic respiratory maladies, interfering with the passage of blood through the right heart, and consequently leading to increased pressure in the general venous system. Under these circumstances, the serum of the blood transudes the walls of the veins, and collects in the subcutaneous cellular tissue, as well

as in the serous cavities. This also occurs in cachectic conditions, and in anæmia.

The fluid in the pleuræ consists of serum, of a bright yellow or greenish colour, but quite transparent. It is free from flakes of fibrine, as well as from the presence of blood-corpuscles or turbidity. The lung is generally at the same time found to be œdematous.

2. *Purulent Effusion.*—Effusion of pus into the pleura is a condition of much more serious import than that of simple serum, and its presence should be detected early if the function of the lung is to be preserved. The character of the pus varies considerably, oftentimes consisting only of serum, rendered opalescent by a small proportion of pus-corpuscles; at other times, it presents all the appearance of true laudable pus. Between these two extremes, various gradations in the amount of pus-cells present may be met with; but, as a rule, it presents a moderately thick, viscid, yellow, or green aspect, and yields an acid reaction.

By some it is supposed that, in a considerable number, if not in the majority, of these cases, pus is present from the commencement; whilst, on the other hand, many maintain that these effusions are primarily sero-fibrinous, and become subsequently transformed into empyemata. This is Moutard Martin's opinion, and he affirms that he has always found pus-corpuscles in sero-fibrinous fluids withdrawn which have been changed later on into empyema, leading him to the conclusion that the effusion would have been converted into pus, even though an operation had not taken place.

The same injurious consequences which follow serous effusion take place in purulent exudation, but in a worse degree. Adhesions of various extent—false membranes and lymph-productions—are rapidly formed, and, in proportion to the duration of the disease and to the extent of the surface affected, interfere with the lung and its surroundings. They vary in thickness, in vitality, and in resistance, and, adhering firmly to the layers of the pleura, prove effectual barriers to the restoration of the parts.

An empyema may be general or circumscribed; and the inflammation of the pleura may be limited in extent, or may spread over wide areas. The former is more likely to occur in the neighbourhood of the fissures of the lung. The consequent adhesions will much depend upon this; in fact, the adhesions set up may localise the inflammation, and prevent its spread; or the cavity of the pleura may be, and often is, subdivided by these bands into compartments, which, whether they communicate with each other or not, lead to increased difficulties in treatment.

The pressure-effects which result from purulent effusion and its products are highly injurious, and their baneful influence is brought to bear upon the pulmonary and costal pleuræ. In many cases, ulceration is set up, which plays an important part in the formation of pulmonary or thoracic fistulæ.

Formerly it was thought that, in every case of pulmonary fistula, pneumothorax occurred; this idea is now exploded. For the pus forced under pressure, during paroxysms of cough, through the yielding and softened lung-structure, reaches the bronchi; whilst the expansion of the lung being diminished, if not entirely absent, the entrance of air is correspondingly decreased, reducing the risk of its finding its way to the pleural cavity. The false membranes may also, by acting the part of a valve, whilst favouring the exit of pus, prevent the entrance of air.

The most favourable site for the occurrence of thoracic fistula is the neighbourhood of the sternum. This is owing to the thinning of the muscular coverings of the thorax at or about the fifth interspace, close to the nipple. Mr. Marshall has lately drawn attention to this fact, and suggests that this position be therefore selected for operation;

but pus may force its way in almost any direction. Caries of the ribs is not unfrequently a disastrous consequence of thoracic fistula, and pyo-pneumothorax is more likely to be found associated with this condition than with pulmonary fistula. In some rare cases, empyema is result of the pus reaching the pleura from abscesses in the thoracic walls, from the liver, or from the suppuration of an hydatid cyst.

3. *Sanguineous Effusion* is rarely met with, but, when found, is significant, seeing that such is usually associated with malignant disease or aneurysm, or with tubercular disease of the pleura. It is alkaline in reaction, and varies in colour from a pale pink to a brownish red. Under the microscope it is found to contain abundant red blood-corpuscles. It is important to search well for cancer-cells, whose presence is of considerable diagnostic value.

It is hardly within the scope of this paper to deal at any length with the physical signs of pleuritic effusion, but perhaps I may be allowed to call your attention to one or two of the more valuable signs, and to certain equivocal conditions which are not unfrequently found to mislead. And first, it seems to me that sufficient importance has not been given to a sign pointed out by Skoda, and with which his name is associated, namely, Skodaic resonance, which may be regarded as a definite indication of the amount of direct pressure upon the lung. This has been ably demonstrated by Dr. Douglas Powell in his ingenious experiments. Skodaic resonance is readily detected when, in cases of moderate effusion, the space extending from the line of absolute dulness to the supraclavicular region is percussed. A loud tympanitic note is then heard, whose pitch varies as the effusion increases, becoming higher and higher, until absolute dulness occurs, *pari passu* with complete compression of the subjacent lung. So long as this apical space is uninvaded by effusion, the lung remains uncompressed, and maintains the relaxed condition of physiological rest. This state readily permits such vibrations and oscillations of the column of air therein contained as are necessary for the production of the peculiar Skodaic note; hence its value as an index of lung-compression.

An additional indication of the amount of pressure upon the lung, in left-sided effusions, is furnished by the sign known as Traube's "semilunar space." In the normal state, an area of resonance on percussion is found to extend from the junction of the fifth or sixth rib with the corresponding cartilages, backwards and downwards, to the ninth or tenth rib. Its concavity looks downwards; and, seeing that its resonance is due to the underlying stomach and intestines, its upper line may be regarded as defining the position of the diaphragm. When effusion of large amount occurs on the left side, this space becomes gradually encroached upon by the fluid, and its resonance gives place to dulness, which, by revealing the position of the diaphragm, may indicate the amount of fluid.

Another sign of value as an index of the amount of fluid present is to be found in the displacement of the heart, seeing that its dislocation proceeds *pari passu* with the exudation; unless, indeed, as in rare cases, an adherent pericardium interferes. It is well to remember that, in children and young adults, this displacement takes place more easily than in older people.

Notwithstanding the definite diagnostic lines laid down in text-books for the recognition of pleuritic effusion, a practical acquaintance with the difficulties which are daily encountered in practice readily shows that the diagnosis of fluid is not always easy. These difficulties as a rule arise, so far at least as my experience has shown me, from questions connected with the presence or absence of bulging of the affected side, the line and position of the dulness, vocal fremitus, and bronchial or tubular breathing.

With regard to the first of these, it is a mistake to look for bulging of the affected side, in any but cases of large accumulation of fluid. On the contrary, ordinarily it is not only not present, but in cases where effusion has existed for some time, retraction of the side is observable, especially in children.

Chest-measurements, for purposes of comparison of the one side with the other, may be regarded as futile. Comparison, to be of value, must be revealed by the cystometer. By it alone, can the alterations of contour be demonstrated, for such is of more importance than differences of mere measurement.

Again, it is expected that the line of dulness should alter according to the position of the patient, but this depends upon the quantity and quality of the effusion. In some cases, such alteration is rendered impossible, owing to adhesions ; in others, the amount of fluid gives no opportunity for such alteration ; while some think that, whilst thin effusion readily follows change of posture, pus, on the other hand, less readily accommodates itself. Now and then diagnosis is complicated by the unusual position of the lung, which, instead of being forced backwards and upwards against the vertebræ by the fluid, is compressed against the front of the chest, there to mislead by the rough bronchial and tubular breath-sounds.

In the recumbent position, the area of dulness does not present a horizontal line at its upper margin, but extends outwards towards the axilla in an ascending curve, which faces the sternum ; highest in the axillary region, it runs downwards and backwards. Dr. Broadbent explains this by supposing that the lung, sinking in the effusion, permits the fluid to rise between it and the axillary walls. In the erect posture, this line of dulness tends to rise somewhat towards the sternum, whilst it falls proportionally towards the axilla. In pneumothorax, on the contrary, seeing that the lung is completely compressed, the line of dulness assumes a horizontal position.

Not the least important sign of effusion is the absence of tactile vocal fremitus ; but even this does not always obtain, for it occasionally happens that vocal fremitus is but slightly, if at all, diminished, and yet fluid undoubtedly exists. This may be accounted for by the presence of but a thin layer of fluid, separating the chest-wall from an engorged sound-conducting lung. At other times, the vibrations are conveyed from the sound side by the thorax ; this must be the explanation of an instance recently under my care, where vocal vibration was distinctly felt, notwithstanding the presence of bulging of the left side, displacement of the heart, and depression of the diaphragm.

On the other hand, it must not be forgotten that vocal fremitus is occasionally absent in cases where no fluid exists, and errors of diagnosis have thereby resulted. This condition may be accounted for by the plugging of the bronchi arresting the sound-waves in their conduction from the larynx to the corresponding portion of lung.

Not unfrequently, in children, diagnosis may be obscured by the presence of bronchial breath-sounds over the area of dulness. This is what we might expect, when we remember that in them bronchial breathing normally predominates over vesicular murmur.

It is not uncommon to find that, although the other signs of effusion are present, yet tubular breath-sounds are heard over a large portion, if not the whole, of the affected side ; so much so, that one hesitates definitely to diagnose effusion, especially as there may be but little bulging or displacement of parts. In fact, we often find this condition on the one side ; while, upon the other, are heard the same tubular breathing, only more marked, *plus* the other signs of a pneumonic consolidation. Amongst other signs, the marked broncophony on the pneumonic side, as compared with its absence, or with ægophony, on the other side, leads at once to the suspicion that we have to deal with a double pneumonia, *plus* effusion into one pleural cavity. In such

circumstances, it is well to recognise the explanation of the occurrence of tubular breath-sounds in effusion—namely, a lung whose consolidated condition prevents its contraction, and which, whilst conveying vibrations from the larynx and the bronchus of the opposite side, through its uncompressed bronchial tubes, largely occupies the thorax, and refuses either to float upon, or to shrink under the pressure of, the surrounding and thin layer of fluid. A knowledge of this condition is of importance, seeing that, under such circumstances, the quantity of fluid cannot be great, and that its removal cannot be necessary, and may be harmful.

On the other hand, if in pleuritic effusion with consolidation of the lung, accompanied by blocking of the bronchial tubes, thus preventing the production of tubular breathing, a diagnosis of the true state of affairs must then depend upon the absence of marked organic displacement.

Finally, pleuritic effusion may be erroneously diagnosed in cases of large pericardial effusion, especially when this is associated with collapse of the lower lobe of the left lung; but careful consideration of the conditions present should certainly prevent this.

In all cases of pleuritic effusion, whether in those in whom the physical signs are such as to place the diagnosis beyond question, or in those where equivocal signs lead to hesitation as to the existence of fluid, it is advisable to insert a small needle for diagnostic purposes; for the value of this procedure is that, in the former class of case, it demonstrates the character of the fluid, while, in the latter, it, generally speaking, settles the question of the existence or non-existence of fluid. This puncture is as harmless in my experience as it is valuable; but care should, of course, be taken that the needle should be suitable in calibre and thoroughly clean.

As a practical point of considerable importance in the matter, it is always well carefully to percuss and auscultate the spot intended to be punctured prior to its insertion. In a large number of cases in which serous effusion occurs, absorption follows without the necessity for the employment of paracentesis; and a too ready operative interference cannot be too strongly condemned when the effusion is of recent occurrence. Where there is but little displacement of the adjacent organs, especially of the heart, where the lung is only partially compressed, and where respiration is carried on with but little discomfort, an operation is not only unnecessary, but is contra-indicated. This is more especially so in the case of children, in whom the recuperative power is markedly demonstrated by this class of disease.

Operation is not needed in simple cases of serous effusion in otherwise healthy individuals, where the accumulation is well tolerated; nor in cases where, although the dulness be extensive, the tubular breathing and other signs, as mentioned previously, are due to engorgement of the lung surrounded by a thin layer of fluid only. Practically, I have found it well to delay operative interference until sufficient time has been allowed for absorption to take place. This having been done, and no decrease in the amount of fluid taking place, it is best not to further delay, and more especially so if there be signs of increasing effusion.

Should the heart be dislocated, the lung compressed, the diaphragm depressed, dyspnœa urgent, and syncope threatened, there is no alternative but to operate, and that without further delay.

Occasionally, the rapidity with which effusion takes place, rather than its amount, is a source of danger which will necessitate immediate operation. This is more likely to occur in persons of vigorous constitution, with strongly acting hearts and high tension, in whom, owing to the sudden cutting off of the lung upon the affected side from the circulation, engorgement of the other lung results. The

more rapid the effusion, the more acute the congestion, and the less time for the system to accommodate itself to the abnormal condition. Altered breath-sounds, moist crepitations, audible over the sound side, tenacious blood-stained sputum, with urgent dyspnœa, and, it may be, a systolic murmur over the pulmonary area, are the signs of this condition, and, when present, should not be disregarded.

Again, although the above conditions do not obtain, and the effusion be moderate in amount, yet, if the duration of the disease lead one to suspect that the lung may suffer from the consequent adhesions, the fluid should be evacuated. It is always well to operate early in old people with rigid chests and defective vital powers; in very young children, or in infants, seeing that, in them, the effusion is more generally purulent; in those patients whose health is undermined by excess, or by intemperance, or by disease, or whose family history is bad, and who have a pronounced tendency to phthisis, or who are actually phthisical, early interference is called for; occasionally, where pleuritic effusion follows a phthisis upon the same side, especially if the latter be rapid, it is well to withhold from operating, for the pressure of the fluid may be nature's method of reducing inflammation, and of providing physiological rest for the part affected. Again, patients sometimes present themselves suffering from dyspnœa, from large effusions which have not been ushered in by the usual symptoms of effusion. In cases of latent pleurisy, as it has been called, and in which absorption rarely takes place, the operation is indicated. Finally, where the disease has resisted other therapeutic measures, and where loss of flesh, feeble circulation, debility and dyspeptic troubles manifest themselves, operation is called for.

Paracentesis Thoracis.—The treatment by operative measures of pleuritic effusion will largely depend upon the nature of the effusion, seeing that the difficulties which are met with in dealing with cases of serous effusion are but slight as compared with those encountered in the treatment of a purulent collection; we may, therefore, regard these from a separate point of view. But, before doing so, it is well to consider the site to be chosen for operation. Now and then cases of empyema more especially arise, which give but little choice to the operator as to the site to be selected. If the purulent collection be localised, or if, on the other hand, the contained matter be about to choose its own outlet, then we have no option, but must act accordingly. However, in the large majority of cases, whether of serum or of pus, we are free to choose a site for operation. Amongst numerous positions which have been from time to time recommended for selection as the best sites for paracentesis, the following seem to me to be the most suitable.

1. Laennec and Fräntzel chose the fourth or fifth interspace between the mammary and axillary lines, while Mr. Erichsen and others prefer the fifth interspace at the line of insertion of the serratus magnus.

2. The most numerous class consists of authorities who prefer to puncture in the sixth or seventh interspace in the axillary region, according as the effusion occurs upon the right or left side. A few of these may be mentioned, namely, Drs. Cheadle, Douglas Powell, Trousseau, Mr. Marshall, Mr. Berkeley Hill, and many others.

3. The lower and posterior region of the chest is preferred by others. Bowditch selects his position in a line with the angle of the scapula, about one and a half inches above a horizontal line drawn through the lowest point at which the respiratory sounds can be heard upon the opposite side. Dr. Broadbent recommends the site to be chosen below the angle of the scapula, or in the eighth interspace.

Mr. Norman Porritt, in his prize essay, has ably advocated puncture in the seventh or eighth interspace, about the junction of the anterior

two-thirds with the posterior third of the chest-wall. In order to find the eighth intercostal space, he directs that the chest be marked where the angle of the scapula is ordinarily situated when the arm is by the side, and again when the arm has been raised above the head. If a line be drawn between these two points, the desired site corresponds to a place one inch below the middle of this line.

Due regard being had to the position of the various organs, and to the conditions peculiar to the individual case, which may require special consideration, I prefer to operate in the sixth interspace upon the right side, and in the seventh on the left side, in the axillary region. There is less danger of failure to enter the chest from the thickened pleuræ, or of interference with the cannula by fibrinous deposit here, than in the site at the angle of the scapula. In this position there is less likelihood of detaching the inflamed and thickened pleura, and of pushing it before the instrument without penetration, and consequent failure to obtain fluid from a full pleural cavity, as not seldom happens; and, besides, there is no difficulty in evacuating the exudation, seeing that this position is sufficiently low for the purposes of withdrawal of the fluid, without being so low as to become interfered with by the elevation of the diaphragm when the pressure is reduced. Moreover, the risk of striking the lung is not so great in the axilla as in the subscapular region.

Empyema, or pus in the pleural cavity, is a much more serious condition than serum, and requires different treatment, seeing that it is necessary to remove all the purulent fluid ; whereas in serous effusion the complete evacuation of the cavity is to be deprecated. Although sero-fibrinous exudations do, no doubt, undergo spontaneous decomposition, accompanied by all the usual septic symptoms, yet, on the other hand, we may regard it as certain that the operation of paracentesis thoracis not unfrequently changes a serous effusion into an empyema. In many such cases it may be argued that it would have become thus converted in any case. It is comparatively rare for a serous effusion to be transformed into pus by its non-removal. The explanation of the gravity of purulent effusion is that, if it be allowed to remain in the chest, disastrous consequences happen. Either the patient will die of exhaustion, or of syncope ; or, if he should escape the more immediate consequences, he will still have to run the risk of as great, if not greater dangers in the future. These are due, in a large measure, to the adhesions formed, binding down the lung and preventing expansion, when it is no longer compressed. Again, pulmonary and thoracic fistulæ may form, and the chest, greatly distorted, still contains a pus-secreting cavity which cannot be completely obliterated as the ribs have probably fallen in, the lung has expanded and the diaphragm has risen towards the chest as much as is possible, but not sufficiently to allow adhesions to form all over the surface of the pleuræ. Therefore, the patient with a discharging fistula is liable, after some time, to succumb to albuminoid degeneration of the organs essential to life. Although it is admitted that pus in the pleura has been in rare cases absorbed, yet the dangers incidental to the condition, even where this has taken place, are so great that we must not count upon such an occurrence. For the caseous residue left behind, after absorption, is liable to give rise to tuberculosis at any time.

As soon as we know that pus is contained in the pleura, arrangements should be made for its evacuation ; for the longer pus remains in the chest, the less the likelihood of a satisfactory issue. Pus may make its way either through the soddened lung or through the parietes of the chest, but although cases recover after the occurrence of such, the patient is exposed to grave risks, which should, if possible, be averted by early treatment, and especially as these spontaneous openings do not rescue the patient from subsequent operative interference.

Timely operation shortens the course of the disease, saves suffering, preserves strength, and places life in greater security.

Although some consider it an easy matter theoretically to diagnose the presence of pus in the pleura, yet, in practice, it is frequently difficult. Often the clubbed appearance of the fingers, the presence of aphonic pectoriloquy, the history and symptoms, come to our aid and render diagnosis easy; but the use of a small needle for diagnostic purposes usually settles the matter by practical demonstration.

There are two different kinds of operation for pleuritic effusions—namely, the close and the open method. In the former, the entry of air is prevented, whilst in the latter it is permitted, with antiseptic precautions.

Close Method.—Occasionally, the ordinary hydrocele-trocar has been used, with or without arrangements to prevent air from entering; but this accident is almost certain to occur after a certain quantity of fluid has been withdrawn, when the patient coughs and then takes a deep inspiration. The result of the entrance of air is disastrous, and it should not be allowed to occur. Reybard's cannula was the outcome of an effort to overcome this difficulty. The other forms of the close operation consist in withdrawing the fluid by the siphon or by the aspirator. The use of the latter ordinarily in effusion should be discarded, as it is a dangerous instrument in inexperienced hands, notwithstanding the brilliant results obtained with it by Bowditch, Dieulafoy, and others. For the instrument can be made to exert so great, so unnecessary, and so injurious a pressure within the chest, that more fluid is evacuated than is prudent, and consequently its reaccumulation, if not transformation into empyema, is encouraged, whilst cough and other disagreeable and urgent symptoms may be induced. If this instrument be used, it should have a manometer attached, in order to be able to estimate the tension within the chest. The most efficacious and simple method of evacuating the fluid is by the siphon. This is merely an India-rubber tube, which has been previously filled with water or some antiseptic solution before being connected with the trocar, and whose free extremity is brought to a vessel on the floor containing fluid, after the chest has been punctured. The fluid in the chest is then withdrawn by the suction caused by the weight of the column of fluid from the man's chest to the floor. As much fluid is drawn off ordinarily as will flow; and, should the cannula become plugged, we may raise the receiving vessel, and thus reverse the current, in the hope of clearing away the obstruction.

If we discover that the effusion is purulent, steps must be immediately taken to evacuate it, and all operative treatment in empyema must aim at the complete removal of the contained pus from the chest; and, as this cannot be accomplished in a closed cavity like the thorax, without the substitution of fluid or air, it appears better to remove as much of the accumulation as will flow by the siphon, and, when this ceases, to allow an antiseptic solution gradually to flow in. In this manner, two-thirds of the quantity of fluid evacuated may be safely replaced by the antiseptic solution. The alternate emptying and filling the chest is to be continued until the fluid returning from the pleura is free from pus. A small quantity of the solution is therefore left in the chest, replacing the pus, with the idea that it is less injurious and may be more readily absorbed.

This operation and irrigation may require to be performed several times in cases of large empyemata of some standing; but it is even then preferable to incision, which is rather a severe measure. This operation is of use also in cases which will eventually require incision, owing to the long continued compression of the lung leading to adhesions, or from the rigidity of the chest-walls, by reducing the intra-

thoracic tension, and preparing the patient for the sudden removal of the remainder of the effusion.

Many unpleasant symptoms may arise either during or after the removal of the fluid, and the chief of these is syncope, but embolism has also occurred; this is due to the compression of the veins giving rise to thrombosis, which, on the removal of the pressure and return of free circulation being set free, produces this complication.

Syncope may be fatal, and some cases of this sort have been recorded; but this is generally obviated by the gradual withdrawal of the effusion during the operation, and the avoidance of exertion, with the maintenance of the recumbent position afterwards. There is also little danger from irrigation of the pleural cavity if judiciously performed, with the avoidance of over distension of the thorax by arresting the flow at once, if discomfort should arise, and not introducing more than two-thirds of the quantity of pus withdrawn.

This mode of washing out the pleural cavity can be best performed by using Dr. Hensley's instrument, which is not only simple, but excludes the danger of the entry of air. In addition, it is made in such a manner as to be separable, and can be thoroughly cleansed. Attention to cleanliness, and to the various details of the operation, are essential to its success.

The instrument consists of a glass cylinder, with a piston made of steel, upon which two pieces of leather are attached. At the end of this steel rod there is a female screw, which receives the end of the trocar, which then becomes continuous with it, and can be removed together at pleasure.

When you are about to use the instrument, which can be utilised also as an exploring syringe, you slip a piece of India-rubber tubing, two inches in length, over the end of the cannula, and connect it in an air-tight manner with the glass syringe. Having introduced the trocar into the chest, the piston with the trocar is withdrawn sufficiently to allow the effusion to appear in the syringe, when you see at once the nature of the fluid. You are then in a position to deal with it; if serous, you attach a simple India-rubber tube, forming a siphon; or if it be purulent, by inserting a T-piece with an additional India-rubber tube, you are prepared to irrigate the chest.

The fluid being seen in the glass cylinder, the latter is carefully drawn nearly out of this short piece of India-rubber tubing, leaving a sufficient length free to be compressed between the finger and thumb, or by a clip. The glass tube is then removed, whilst the compression prevents the entry of air. The next step is to insert into the extremity of this piece of India-rubber tubing, one end of a piece of glass tube, which is previously fixed into a flexible tube about three feet long, in order to reach the floor, taking care that the whole tube is filled with water or some antiseptic fluid. This tube is then conducted through a cork into a large test-tube, which has another short piece of tubing emerging from the cork. These are all quite full of fluid, and, being held ready for use, with the open ends of the two tubes retained at the same level, it is easy to insert the end of the glass tubing attached to the India-rubber tubing into the short piece fixed to the cannula, without permitting the entrance of air. There is a complete continuity of fluid from the chest to the test-tube, and when this is lowered the flow commences.

The advantages of this method are these.

1. Air is excluded, and a gentle continuous flow takes place.

2. You can always see whether the flow continues, and more especially so at the end of the operation, thus avoiding the danger of the entry of air during inspiration from the tendency to raise the end of the tube above the surface.

3. Should obstruction occur, by raising the end of the tube above the level of the chest, it can be cleared and washed back.

In empyema, it is only necessary to attach a branch leading to a reservoir above the level of the chest, and, by means of taps or clips, to interrupt the flow from the reservoir above or with the vessel below, as may be required.

Dr. Fred. Hicks has invented an instrument combining the siphon principle with the aspirator if necessary, which is beautifully controlled by a three-way stopcock, and to which a manometer can be attached in order to estimate the pressure within the chest at any stage of the operation. In addition, he can attach a bottle-aspirator to this siphon, which is exhausted by a syringe when necessary. With another bottle containing an antiseptic solution, by compressing the contained air he can, by turning the tap, allow the fluid to enter the chest, which can thus be washed out by alternately exhausting and compressing the air in the bottles.

If obstruction occur when the siphon is being used, the current is reversed by raising the lower end of the tube ; and, if this fail to get rid of the difficulty, resort may he had to the aspirator.

The needles supplied by Mr. Matthews with this instrument are admirable. They are hollow, with a stilet which works in an artificial collar, and can be withdrawn to allow the fluid to pass out of the lateral branch, which is connected with the siphon or aspirator. The points are ground quite flat, instead of the ordinary curve, and penetrate better, consequently. There is a shield supplied with each needle, which is of use when the instrument is in the chest ; for the point is then retracted within it, so that there is no fear of the organs, in returning to their normal positions after withdrawal of the fluid, being wounded. The whole instrument is admirably under control with one hand, owing to its being regulated by the three-way stopcock, which leaves the other hand free to deal with the needle in the chest.

The Open Method of Operation.—This mode of operating can be practised in various ways. First, it can be performed with a large trocar and cannula, with antiseptic precautions ; or, secondly, by a free incision into the intercostal space selected, with the insertion of a drainage-tube ; or, occasionally, counter-openings may be thought necessary, and a Chassaignac's drainage-tube may be passed through the chest-walls. Paracentesis with the large trocar and cannula is a less severe measure than incision ; but, when irrigation fails, I should prefer a free incision.

All these measures require strict Listerian precautions, with the use of the spray. Incision of the chest is performed in the following manner. The patient, in the recumbent position, is examined, and the place for puncture selected and marked. If the patient be nervous, and in children who struggle, an anæsthetic is permissible ; but frequently it is sufficient to freeze the part with the ether-spray. A scalpel is then plunged into the interspace, and a director introduced, which allows the complete division of the chest-wall by a probe-pointed bistoury for about one inch in length. The pus now runs away, and a drainage-tube is fixed in. The dressings require frequent changing at first ; but later on the intervals are increased, so that every other day is sufficient. As the discharge diminishes, the drainage-tube must be shortened until it is completely removed. There is danger of hæmorrhage after the operation ; but this should be avoided if the intercostal artery be not wounded—an accident which ought not to occur if the knife do not approach the lower border of the upper rib. The knife should be quickly withdrawn, in order to avoid wounding the expanding lung. Low incisions into the chest are to be avoided ; for the diaphragm may be wounded, and there may be difficulty in retaining the drainage-tube, from the pressure of the rising diaphragm against the ribs. The incision should not be lower than the seventh interspace beneath the angle of the scapula. Besides, there is the dif-

ficulty encountered in introducing a drainage-tube or probe, which is at once directed upwards by the diaphragm along a narrow sinus, slipping in easily after it has overcome this obstacle, into a wide cavity. The irritation of this tube prevents adhesion between the two layers of the pleura, and keeps up the purulent discharge. A greater danger of syncope exists in this operation, induced by the sudden removal of tension, and is a strong argument in favour of previous paracentesis to prepare the patient.

The difficulties in the way of treatment are much intensified when we have to deal with purulent effusion subdivided by bands and adhesions, or the condition which has been named loculated empyema. These cases may require the use of bent probes, the catheter, or perhaps the introduction of the finger, to break down the connecting bands, if injections have failed.

The after-treatment of empyema will consist in complete rest in bed for some days, with plenty of light nutritious food, and stimulants, if necessary; the administration of tonics, and more especially quinine and cod-liver oil, or the ferruginous preparations, and hypophosphites. But fresh air without fatigue, and, if possible, an early change to the seaside, will probably work wonders.

A time arises, sooner or later, in the treatment of old-standing cases of empyema, when improvement ceases; the flattening and deformity of the side is complete; the expansion of the lung, and the elevation of the diaphragm, are exhausted, and incapable of obliterating the pus-secreting cavity, the drain from which will exhaust the patient, or kill him by producing albuminoid degeneration of his organs. We have then to deal with a cavity which can only be closed by one method; I refer to resection of several ribs. This ancient operation, which has been recently revived, and is advocated by Thomas, Kœnig, Howse, and others, may be performed with a twofold object: *(a)* to allow the ribs already approximated to fall in more completely, in order to obliterate the cavity remaining between the diaphragm and the lung; *(b)* in order to permit more room for the drainage-tube; but Mr. Marshall has recommended the removal of the upper portion of the rib as sufficient for this purpose.

The operation consists in the removal of portions of several ribs, about one inch and a half in length, in adults. This is done through a T-shaped incision, in the axillary line, over the ribs that have been chosen, the periosteum having been stripped off before the bone-forceps completes the division. A drainage-tube is then inserted, and the wound dressed antiseptically. Portions of four ribs at least should be removed, including the fifth and sixth, which are essential to its success.

The operation of paracentesis may be called for occasionally in pneumothorax, or, more correctly speaking, in pyo-pneumothorax, whether this condition has arisen as a complication of empyema, pulmonary phthisis, or of gangrene of the lung. In the two latter, it is frequently undertaken, in order to ward off suffocation; and is, therefore, merely palliative, although cases have sometimes been benefited. In phthisis, the fluid frequently appears to exert a beneficial influence, and may arrest the course of the disease.

Attention has, of late years, been paid to the drainage of lung-cavities, and with occasional success. The operation has been undertaken in various conditions of the lungs, and we may mention the following examples: *(a)* in the cavities existing in bronchiectasis; *(b)* in the cavities which concur with pulmonary phthisis; *(c)* in those resulting from abscess or gangrene of the lungs.

The difficulties in the precise diagnosis of cavities are so great, that their treatment by drainage is sometimes well-nigh impossible, and this is more especially the case as we approach the apices of the lungs. Whether it is justifiable to tap all the various cavities to be met with,

remains to be seen; but I fear that little benefit will result from operation upon those occurring in bronchiectasis, where the bronchial tubes are irregularly dilated in many places. It may also be argued that it is useless to operate in those occurring in phthisis, upon the plea that it will not arrest the disease; but I maintain that it is only necessary to look at the temperature-chart of a patient, with a large cavity in the lung, in order to see that, if we could remove the pus contained, we might free our patient from many of his septicæmic symptoms, and probably enable him to live a little longer in comparative comfort.

I have lately seen two cases under my colleague, Dr. Gilbart Smith, in which extensive excavation existed, with an up-and-down temperature-chart. In both these cases, at the *post mortem* examination, the cavities were found to be immense, being bounded only by the thickened and adherent pleuræ, whilst they contained much fœtid pus. In both, during life, bulging of the intercostal spaces occurred in expiration. These cases could not have been injured by operation, whilst their condition might have been temporarily ameliorated.

Dr. Cayley and Mr. Pearce Gould have lately reported a successful case of drainage in gangrene of the lung, in a child, which is a good example of what may be done by a timely operative interference in suitable cases.

In conclusion, I am desirous of recapitulating the points which are of importance in the treatment.

1. In pleuritic effusion, early evacuation of the fluid is advocated by the siphon principle, discarding the aspirator.
2. In empyema, pus should be withdrawn at once, by the siphon or by the aspirator, with the use of the manometer, and the pleural cavity irrigated.
3. Incision is called for where large empyemata have existed for some time in old or rigid chests, or where irrigation, having been practised several times, has failed.
4. Where incision fails to effect a cure, resort must be had to resection of ribs.
5. Paracentesis, with drainage, should be employed in the treatment of lung-cavities.

Dr. FINNY (Dublin) confined his remarks to the treatment of purulent or seropurulent effusions in the thorax. In his experience, the best method was to give free vent, under due antiseptic precautions, by incision, to the fluid, which, so long as it remained, was a source of danger to the patient. Never having employed Dr. White's instrument, he had no intention to criticise adversely Dr. White's method of tapping the empyema, and by the siphon method draining it off before he resorted to incision. He protested, however, against the indiscriminate employment of washing out the pleural cavity with antiseptic fluid; as, unless the fluid were of a dangerous strength, it could do little or nothing as an antiseptic, and cases were on record of patients having evidenced toxic symptoms, due to the carbolic acid, the antiseptic employed.

Dr. GRAY (Castlewellan) agreed in the main with the remarks of Dr. Finny, that there was very little danger, with proper precautions, in opening the chest at once when it was ascertained that the effused fluid was pus, introducing a drainage-tube, and washing out the cavity. As an easy mode of introducing the tube, he recommended a common uterine sound to be introduced through the enlarged needle-hole, and pushed on until its point projected between two of the ribs, where it could be cut down upon, and pushed through. Upon this point, the

drainage-tube could be drawn and tied; then, by withdrawing the sound, the tube could be brought out through the needle-hole, and the two ends could be tied together. Through this tube the pus drained, and through it the antiseptic fluid could be injected.

Dr. CULLIMORE (London) said that, owing to the limited time at his disposal, he would direct his observations to the treatment by aspiration of hepatic abscess. At the present time, and also during his service in India, he had considerable experience in the use of aspiration. Soon after its introduction, it was largely used; but he thought that its early gained success was not attended with the good results anticipated. When the abscess was deep in the substance of the liver, and the diagnosis was doubtful, then, after the lapse of some time to clear up the case, the aspirator might be used, sometimes with success, both as a method of cure, and as a means of diagnosis. When the diagnosis was certain, and the abscess pointed towards the surface, after a certain time being allowed for formation of adhesions, the best method was either to use a trocar and cannula, or even incision, with anæsthetic precautions. The objections to the use of the aspirator were that, from its great suction-power, it was liable to break down the walls of the abscess, and so increase the danger of the spread of the disease. As a means of diagnosis, in obscure cases, exploratory puncture should always be made. It could be done with safety, and contributed greatly, by clearing up the diagnosis, to the peace of mind of the patient.

Dr. WHITE, in reply, stated that several of the speakers had misunderstood him, owing to his having been unable to go thoroughly into the subject from lack of time. He was anxious to correct the misapprehension into which Dr. Finny and Dr. Gray had fallen, as to the statement that air, entering the pleura after antiseptic precautions, was injurious. This was not only not the case, but, as was well known, the introduction of air, rendered aseptic, had frequently been used, and without bad results. Again, Dr. Finny thought that pus was left in the pleuræ. On the contrary, irrigation was to be performed by alternate injection and removal of the antiseptic solution, until what returned was quite free from pus; therefore, what was left behind was merely an antiseptic solution. Carbolic acid either should not be used, or, if employed, it should only be in the strength of 2 or 3 per cent. Numerous other solutions were to be preferred.