

E M P Y E M A
AND ITS
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During the time I was House Surgeon at the Isle of Man Hospital, a period of nearly three years, I was fortunate enough to see a number of cases of Empyema. I found the study of the subject a most interesting one and I devoted some considerable time to it.

Since leaving the Hospital I have met with other cases in private practice and I was accordingly led to make Empyema the subject of my Thesis for the Degree of Doctor of Medicine.

When I first began the study, reference to the leading text books showed a great difference of opinion as to the treatment recommended. Thus, some maintained that Aspiration should always be tried repeatedly, while others said that the only treatment was Excision of a Portion of a Rib. From my own observations I arrived at certain conclusions with regard to the treatment. My first intention on commencing this Paper was to limit myself to this alone. I found however, that there was really no thorough systematic description of the various causes, symptoms and effects of Empyema as considered apart from serous effusions. I thus decided to also include the discussion of the whole subject. Through the kindness of Dr James, I have been

been enabled to collect all the Cases of Empyema occurring in his Ward for the last four years: these along with my own I have drawn up in tabular form, and I have inserted notes of them wherever I thought they had a practical bearing upon my Thesis. The general plan I have followed is that I have first entered into a short Historical Account of the subject: I have then gone on to describe the various forms of the disease met with, referring particularly to the organisms which act as a cause. Next, I have discussed the effects produced by the presence of pus in the pleural cavity, and the various physical signs met with, and tried to explain why these occur. In the treatment I have endeavoured to the best of my ability to prove that Aspiration should always be tried as a curative means in the first instance, except in certain specified cases. Should this not be successful, I have tried to prove that mere incision of an intercostal space with drainage is generally all that is required.

The term Empyema is derived from the Greek ^{ἐμπίπυον} ~~ἐμπίπυον~~ pus, meaning therefore a collection of pus in a cavity. Such collections are not limited to the pleural cavity, as there are other localities where they may manifest themselves e.g., in the Antrum of Highmore. In the ordinary acceptance of the word however, and when it is used singly, "a collection of pus in the pleural cavity" is signified.

That this condition has been long recognised, there is undoubted evidence. In the Pre-Hippocratic Epoch Pleurisy and Empyema were discussed, while in the works of Hippocrates we find the term very frequently employed. Although apparently the term in several cases is made to include both pulmonary abscesses and true Empyema, yet in the main his description, with the treatment and other facts, is wonderfully lucid. A perusal of his work "On Diseases" Bk.I. gives us many interesting statements: "The necessity of carefully watching cases of Pleurisy and Pneumonia is emphasised, as they have a great tendency to pass into Empyema". Succussion is also mentioned and he remarks "Should the physician fail to recognise matter by this means, it is a most awkward mistake and one likely to cause him much trouble": (hence the

historical
account.

for he remarks "Of Empyema such as are spit by the origin of the term Hippocratic Succussion, a method now employed in the diagnosis of Hydro- and Pyo-Pneumothorax). Empyema is ascribed by him to three causes principally: I. - To the termination of Pleurisy and Pneumonia, II. - To a defluxion from the head: III. - To the consequences of a ruptured vessel (meaning probably by this, a case of cavity of the lungs produced by the ulceration of Tubercles). Its occurrence too, as a sequel to chronic Inflammation of the Lung, is mentioned. In the diagnosis, Succussion is considered the never-failing test. In the second book "On Diseases" the operation of Paracentesis Thoracis is recommended in order to evacuate the fluid. Another of his books, "The Book of Prognostics" furnishes us with an even more elaborate dissertation on the subject. He first of all describes the sputum in cases of pain about the lung, drawing close attention to the gravity of the case, when it is intensely yellow: he then goes on to say that "If the pain do not cease either by the discharge of the sputum or by the alvine discharges or by venesection, then it must be considered to be going on to Suppuration." That he seemed to appreciate the possibility of an Empyema bursting into the lung is evident, for

for he remarks "Of Empyemata such as are spit up while the sputum is still bilious are very fatal: it is to be expected that a person with such an expectoration shall die on the fourteenth day, unless something favourable supervene." The following he considers as being strongly indicative of Empyema: "In the first place the fever does not go off, but is slight during the day and increases at night and copious sweats supervene: there is a weight in the place where formerly he had pain: one side is hotter than the other, and when laid upon the sound side, enquiries are to be made as to whether he has a feeling of a weight hanging from above, for if so, the Empyema will be upon the opposite side to that on which the weight was felt."

Long after the time of Hippocrates, great confusion existed in the determination between Pleurisy and Empyema on the one hand, and Pneumonia and other pulmonary disorders on the other: The Pulmonary Pleura was considered a part of the structure of the lung, and therefore Empyema was often spoken of as a "Destruction of the Lung by Suppuration." Little advance was made in the subject until the discoveries of Laennec, when the proper consideration of pulmonary

pulmonary affections was put on a sound basis. On reading his book on Auscultation of the Chest, one cannot but marvel at the perfect description he gives. In his article on the "Signs and Symptoms of Acute Pleurisy with Effusion," he gives as being characteristic in this condition "Dulness on percussion, total loss of breath sounds except just under the clavicle and along the vertebral column, and the presence of Aegophony:" the last apparently being considered a very important sign. He also gives an elaborate description as to the differentiation between Pleurisy with Effusion and Pneumonia. In the Treatment, should operative measures be needed, he recommends the bistoury instead of the old method of burning or trepanning through a rib, and states his reasons for thinking that the proper seat of election for making the incision should be in the middle of the fifth interspace.

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It is only within the last few years that the true causes of Empyema have been discovered. For long it was not fully understood how it was that in one case as the result of a Pleuritis, a simple serous effusion occurred, while in another the effusion became purulent. It is true that, in many instances

instances, the presence of some morbid agent in the blood was recognised, as in Pyæmia, Scarlet and Puerperal Fevers etc., - in others again, the origin could be traced to the direct entrance of the pus-producing element, as in traumatism to a rib. But it was not understood why, after some cases of Pneumonia, a purulent effusion would supervene: again, no true explanation could be given, why, in some blood conditions (such as those consequent on the rheumatic diathesis or albuminuria) at one time a serous, at other times a purulent effusion occurred. The same difficulty was encountered in those cases of true Primary Empyemata which are so frequently met with in children. All that could be said then was "That the condition was the result of the state of the patient and through the severer influence of the exciting cause." In 1886 Weichselbaum demonstrated the existence of pyogenic organisms in Empyemata, and some little time after, the Pneumococcus was obtained from pus withdrawn from the pleural cavity. Since then, the presence of organisms in purulent effusions has been confirmed again and again. Many inoculation experiments have also been made, so that now we are enabled to say with certainty that "Every

"Every case of Empyema is the result of the invasion of the pleural cavity by microbes".

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The various microbes encountered in Empyemata have been isolated, and the following are the different kinds in their order of frequency:-

I. Streptococcus Pyogenes, II. Pneumococcus of Fraenkel, III. Bacillus Tuberculosis, IV. Staphylococcus Pyogenes, V. Saprogenic Microbes, VI. Bacillus of Typhoid Fever.

Streptococcus Pyogenes:- This is by far the most frequently met with. In adults, at least forty per cent of Empyemata are so produced, whereas, in children, the relative frequency is not so great, and in them it may be estimated at from fifteen to twenty per cent. Cases, the result of this organism, are always secondary, and usually it is an easy matter to trace their origin. Thus, among its sources may be mentioned Broncho-pneumonia, especially that form which is associated with Influenza: Influenza per se:
Bronchiectatic cavities: Gangrene, Tuberculosis and Cancer of the Lung: Pericarditis: Cancer and other diseases of the Oesophagus: and Retro-pharyngeal abscesses, especially those which have burrowed. Aspiration too, where a dirty instrument has been used must not be forgotten. This form of the disease

disease is also very common during the course of the Infective Diseases, more especially in Scarlet Fever, Erysipelas, Diphtheria and Puerperal Fever.

Pneumococcus of Fraenkel:- This has been found to be the most prevalent form met with in children, its occurrence in them being estimated to be three times more frequent than in adults. The first ten years of life are said to be the most favourable for its occurrence. It becomes after this time less common, and is extremely rare after fifty. Empyema associated with the Pneumococcus is usually secondary to Pneumonia, and hence the term Metapneumonic has been used. By many it is believed that the Pneumococcus may find its way to the pleural membrane without causing any pulmonary changes, and that then a Primary Empyema is set up.

Bacillus Tuberculosis:- One is apt to imagine that this would be a most frequent cause, but it is not so, as most Tubercular Cases prove to have a sero-fibrinous effusion. It is usual to find it associated with some other organisms, more particularly the Staphylococcus Pyogenes.

Staphylococcus Pyogenes:- It is rare for this organism to be found alone. In the majority of cases we

we find it along with other forms, and these forms then determine the character of the suppuration. Its source is either a foreign body or some other focus in the patient.

Saprogenic Organisms:- In a putrid Empyema they are always present. This condition is consequent on Gangrene of the Lung, especially of its surface:

Bronchiectasis: Phthisical cavities and Cancer etc., of the Lung: Cancer or Stricture of the Oesophagus: Retro-pharyngeal abscesses: Abscesses of the abdominal cavity or viscera: and Ulceration or Cancer of the Stomach.

Bacillus of Typhoid Fever or Eberth's Bacillus:-

Although it is usual for this organism to cause a sero-fibrinous effusion, yet there have occurred cases of Empyema where this bacillus alone could be demonstrated.

The subjoined Table by Whitney gives the comparative frequency of the occurrence of the different organisms as a cause of Empyema both in adults and children:-

ADULTS.

50% of all cases Streptococcal
25% - - - Pneumococcal
25% - - - divided among the other forms, of
which the Tubercular is relatively the most common.

CHILDREN.

60% (or 75%) of all cases Pneumococcal
40% - - - Streptococcal or
Staphylococcal, both Tubercular and Putrid Cases
being exceedingly rare.

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But although the evidence as to the causation of Empyema is indisputable, there still remains to be answered the important question:- How do these organisms get to the pleural cavity? As I have already shown, it is a matter of comparative ease to trace in some cases direct infection, e.g., in œsophageal cancer, gangrene of the lung, traumatism of a rib with breaking through of the skin, retro-pharyngeal abscesses which have burrowed along the mediastinum, etc., etc. But it is generally not such an easy matter. In some instances we must assume the blood to be the channel by which the organisms reach the pleural membrane, especially when the Empyema is the result of the Infective Diseases, as in Scarlet

Scarlet Fever and Puerperal Fever. In proof of this there is the evidence of the bacillus of Typhoid Fever having actually been found. There still remain however, many cases where we are driven to the conclusion that the microbe has in some way or other managed to work its way through the structure of the lung, on to the pleural surface. Let us take for the purpose of illustration, a purulent effusion due to the Pneumococcus. Very frequently this is secondary, being consequent on the occurrence of Pneumonia and here we have no difficulty in understanding how it arises. Yet I believe a very large number, especially in children, are primary. Numerous are the explanations which have been offered for this, some asserting that the Pneumococcus of Fraenkel has been carried by the blood, others again saying it has been introduced through the air-passages and has penetrated the alveolar structure of the lung. But another mode of entrance has occurred to my mind, which I do not see mentioned in any of the books. It is admitted that Acute Peritonitis can result from an Empyema, when a post-mortem examination reveals absolutely not the slightest trace of a perforation of the diaphragm, and this is believed to

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to occur through the lymph channels in the diaphragm. Now there is a very similar relationship between the lung and the pleura. In the cellular tissue subjacent to the pleura there is a layer of lymphatics which inosculate freely with the pulmonary lymphatics and communicate with the pleural sac by what are called Stomata. Are we not justified then in asserting that the Pneumococcus may by these channels get to the pleura, having reached the pulmonary lymphatics by the air-passages. Experiments which have been carried out are much in favour of the direct infection of the pleural cavity, in certain cases, by means of the air-passages. It has been shewn that the saliva from the mouth, if injected into the pleural cavity, say of a rabbit, will very often lead to the occurrence of a Putrid Empyema. The microbes present in Putrid Empyemata are constantly present in the buccal cavity even of a healthy individual: I think therefore, we are quite justified in assuming these organisms may find their way to the pulmonary tissues and thence to the pleura, when a Putrid Empyema will be set up, or an effusion already there, be made putrid.

There is still much divergence of opinion as

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as to whether the effusion in an Empyema is purulent from the beginning, or is at first sero-fibrinous, assuming later its final form. For instance, Powell in his book "On Diseases of the Lung and Pleura" asserts that in Acute Empyemata, the pus element is from the first, largely present and active. On the other hand, we have it stated "The Effusion is primarily sero-fibrinous and in the course of time it becomes purulent:" and that therefore in a Pneumonia with Empyema, there is at first a Pleuro-pneumonia, the pleuritic effusion changing into pus. In favour of the statement made by Powell is the condition of the fluid in some cases of Exudation apparently sero-fibrinous. Instead of being clear yellowish in colour, it is very often opalescent or greenish from the presence in it of corpuscular bodies derived from the pleura and from the leucocytes which have escaped from the blood-vessels. The tendency to become purulent may therefore be said to exist from the beginning. On the other hand, there is clinical evidence in favour of the argument that the effusion is primarily sero-fibrinous e.g., in a case of Pneumonia: there occurs the crisis, but instead of the lung clearing up, there is persistent

persistent dulness, which a physical examination shows to be fluid: for a varying period of time the temperature remains at normal or slightly above it, and then suddenly there supervene all the signs of septic absorption, pointing strongly to the supposition that the effusion has changed its character. Bacteriological research has however thrown some light upon this vexed question. It has been demonstrated by this means, again and again, that many cases of sero-fibrinous exudation contain the Pneumococcus. As I have already said, the Eberth Bacillus frequently causes this condition, so also in Scarlet Fever and Pyæmia, the Streptococcus has been shown to be present, while in serous effusion resulting from renal disease, the Staphylococcus has been obtained. In none of such cases did any further change take place. When leucocytes are present in at all large numbers in sero-fibrinous exudate, the appearance of opacity described by Powell, results. This is really the border line between this condition and Empyema, and it is indeed impossible to make a sharp anatomical line. Probably all we can say at present, resolves itself into this:- "Microorganisms have a great deal to do with the causation of sero-fibrinous

Sero-fibrinous Pleurisy: whether the condition remains so, or goes on to pus is determined either by the numbers of the microbe, or by the situation, in the immediate vicinity of the pleura, of some focus whose soil is peculiarly adapted to their multiplication" (Whitney).

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In Empyema and in ordinary Pleurisy with or without effusion, the primary changes which occur are practically the same, the only difference being one of degree. It has not been possible to show these altered conditions in the human body: it is from irritation of the pleural membrane of animals that we have derived our knowledge.

The first thing observed is an injection of the blood-vessels of the sub-serous tissue, due to their dilatation: minute extravasations take place resulting from the rupture of some of the dilated and engorged vessels. Next there occurs a proliferation of the cells on the surface of the membrane, along with the exudation of a fine fibrinous network, causing a dull opaque appearance, while the connective tissue corpuscles just beneath the endothelial layer multiply and leucocytes escape from the vessels. A microscopical examination of a pleural membrane where all

all these changes have occurred, shows us the presence of pus cells, with granular cells and red blood corpuscles and similar structures embedded in the fibrinous exudation. Friction sound is produced by the exudation although some maintain, that the mere prominence of the congested and dilated blood-vessels, is alone quite sufficient to cause it. The subserous tissue also becomes swollen and œdematous and infiltrated with pus cells. It is usual for the costal and pulmonary pleuræ to be affected at the same time, although either may suffer alone.

usion

The occurrence of effusion of fluid of some nature is a very common accompaniment of the inflammatory process. As a rule it progresses pari passu: it may however, go on with great rapidity, as there are cases given where dulness on percussion, absence of breath sounds and of vocal fremitus have been observed at the base of an affected lung, within an hour of the onset of symptoms. The leading forms of the effused fluid may be divided into three, viz., serous or ser-fibrinous, hæmorrhagic, and Purulent. With the first two of these, we are not here concerned and therefor there is no necessity for our discussing them further. The last, the Purulent form, may

may be classified as follows:- (a) Fibrino-purulent:
(b) Sero-purulent: (c) Wholly purulent. This
division, it is at once evident, is based upon the
degree to which the fibrinous or the serous elements
are present. When the Sero-purulent form occurs,
the prognosis is said to be graver than in the Wholly
Purulent: notwithstanding this, I think it is on
the whole perhaps better, to omit the first as simply
leading to confusion, and have only the two divisions
- Fibrino-purulent and Wholly purulent.

The Fibrino-purulent form is stated to be the result
of the Pneumococcus, Streptococcus Pyogenes, or the
Tubercle Bacillus, the Wholly purulent on the other
hand, being ascribed to the Staphylococcus Aureus
or Albus, especially in association with the Tubercle
Bacillus. That the former occurs very frequently
after a Pneumonia I can bear testimony from my own
experience.

The characters of the effusion vary with the
amount of the pus cells present: it may be thin and
watery or much inspissated and filled with masses of
fibrin which have more or less undergone fatty
degeneration: the effusion resulting from the
presence of the Pneumococcus is specially rich in

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in cellular elements and is usually very viscid. In colour the effusion may be yellow or whitish, or even red through being stained with blood: the most usual colour however, is green and this is typically seen in cases of Pneumococcal origin.

A microscopic examination reveals the presence of pus cells along with a varying number of red blood corpuscles: cast-off endothelial cells are often also to be seen, many of them showing signs of fatty degeneration. Crystals of cholesterin and free fatty globules are in evidence if the effusion be of any duration.

The pus is often thought to be a simple emigration of white blood corpuscles from the pleural capillaries, but it quite impossible to hold this idea, as there are far more pus cells, in a rapidly formed Empyema, than there are leucocytes in the whole body. Some assert therefore, that the pus partly results from a rapid cell division in the exudate itself. But very largely also the rapid proliferation and breaking down of the connective tissue corpuscles of the deeper pleural layers assists in the formation of the pus. It has seemed to me that there is still one other likely source for the

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the origin of the pus cells, viz., a proliferation and breaking down of the endothelial cells on the surface of the pleural membrane. Just as in a Bronchitis we have large quantities of pus produced, partly from the surface cells, partly from the connective tissue corpuscles and partly from the leucocytes, so also in Empyema it is probable the pus is derived from the same sources. In the majority of instances there is no odour with the exudate, but should it be foetid, the smell is usually so intense as to permeate in every direction. I shall give here, a short history of a case which I had the opportunity of seeing: it proves I think, what I have already stated viz., that many foetid-cases must arise from infection through the air passages.

Case I.- A young woman aged twenty-four was admitted into the Isle of Man Hospital in August 1896. The history obtained from her was that she had been in perfectly good health until four weeks previously, when a pain in her side came on. She was treated for Inflammation of the Lungs by her Medical Attendant, but as she did not consider that she was making much progress, she decided to come into Hospital. Her temperature for the few days she was under my

my care, varied between 99° in the mornings and 101.6° in the evenings: there was anorexia, with great wasting and dirty tongue, and sweating occurred whenever she slept. On examining the left side of the chest, I found there was marked dulness extending up to the sixth rib posteriorly, gradually shading off from this point upwards. From this dull area no vocal resonance nor vocal fremitus could be elicited and the stethoscope revealed practically no breath sounds. I came to the conclusion there was fluid present, and inserted the needle of a hypodermic syringe and managed to get away some thin, watery pus. What was my surprise however, on unscrewing the syringe, to find there was a most stinking odour. In this case there was no discoverable source for the fœtor unless it had been derived from saprogenic organisms reaching the effusion through the air passages. Unfortunately, I was unable to follow this case through to its termination, as the next day I relinquished my post as House Surgeon. I heard afterwards however, that about twenty-two ounces of pus had been removed by Aspiration. The subsequent history of this case I obtained from my successor, and I shall again have occasion to refer to it.

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In amount the effusion varies considerably: in many instances it is very large, and I have myself drawn off forty to fifty ounces. Sometimes however, it is but small in amount, due without doubt in some cases to adhesions having formed between the two layers of the pleura, preventing therefore any possible further accumulation. To such, when they occur, the term Encysted has been applied. An example of this is seen in Case VIII. of Dr James' Series.

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In the vast majority of cases the effusion takes place in the lower part of the pleural cavity, gradually filling it from below upwards. This of course, it is at once evident, results from the action of gravity. To this however, there are exceptions, because as I have already said the occurrence of adhesions may influence the position and it is possible to find the pus at any part of the cavity. Thus in Case VIII. of Dr James' Series, the Empyema was localised to the upper part of the chest, extending from the apex to the sixth dorsal vertebra. There is also at least one case on record where there were two such collections of fluid on the same side

side of the chest, one of which contained pus, the other merely serous fluid.

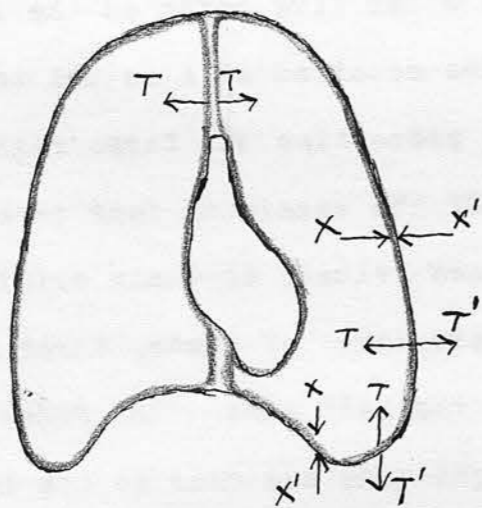
The side most commonly affected is a question which still awaits a definite answer. The majority of observers are however inclined to favour the left as being the one more frequently involved. Out of nine cases of Emyema which I have had the opportunity of observing in three years, four were on the right side, the other five being on the left. Five out of the nine occurred as a sequel to Pneumonia, and of these the proportion was three right-sided, two left-sided. Of the remaining four cases, three I considered were Primary in their origin, the fourth being Tubercular: of these, three manifested themselves on the left side. Dr James' Series show four on the right side and four on the left, and one where the effusion occurred on both sides.

There now comes to be discussed, the very important question of the Pressure Effects produced by the Effusion. These manifest themselves in all directions and cause displacement and other changes of the neighbouring organs. First and foremost, as being the structure first involved, we shall consider the action of the fluid upon the Lungs.

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side of the chest, one of which contained pus, the other merely serous fluid. The side most commonly affected is a question of observation, but is however inclined to favor the left as being the more frequently involved. Out of nine cases of Empyema which I have had the opportunity

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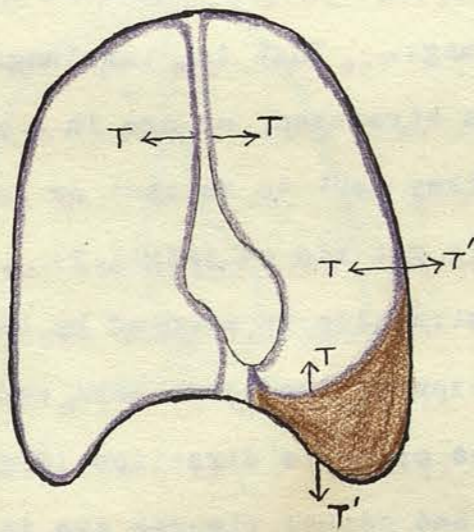
To understand this properly, it will be necessary to consider the forces which act in maintaining the state of equilibrium of the lungs, chest-wall, and diaphragm, in ordinary circumstances. The atmospheric pressure acts upon the inner surface of the lungs, the outer surface of the chest-wall and the lower surface of the diaphragm equally (See Fig. I. XX'-XX'). But there is the retractile power of the lungs. That is, the lungs are elastic and have been stretched, or are in a state of tension: so that they seek to retract or collapse until that tension is got rid of (Fig. I. T). This cannot occur as the retraction is opposed by the rigidity and muscular action of the chest wall and the diaphragm acting in the opposite direction (Fig. I. T'). The parietal and costal pleurae are in contact and they cannot separate as we cannot have a vacuum. Still T and T' act so that there is a tendency for a slightly negative pressure to be in the pleural cavity (if we may so term it). If we puncture the thoracic wall, the force T' is absent, and retraction or collapse of the lung occurs. It may be added that the tension (T) in each lung is exactly equal to that in the other

forces by which a state of equilibrium is maintained between chest-wall, diaphragm and Lungs

To understand this properly, it will be necessary to consider the forces which act in maintaining the state of equilibrium of the lungs, chest wall, and diaphragm, in ordinary circumstances. The atmospheric pressure acts upon the inner surface of the lung, the outer surface of the chest wall, and the inner surface of the diaphragm.

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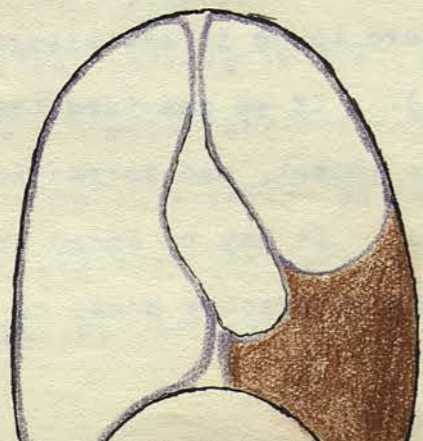


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other. If therefore the tension in one be diminished, that in the other being greater, matters tend to become equalised by the one with the greater tension dragging over to its side, the lung with the less tension. Of course, the attachments of the lungs at their roots, must modify any displacement from this cause.

Say now that a small amount of fluid is poured into the pleural cavity, (as in Fig. II.)- what is the result? The pressure relations between the lung, chest wall and diaphragm remain as before. The only result is that the lung is enabled to retract somewhat, there being now therefore less tension in the lung and consequently, correspondingly less force acting in an opposite direction on the chest wall ($T = T'$). No pressure is exerted upon the lung by the fluid, the lung simply makes way for the fluid. As a consequence, the state of equilibrium between the two lungs is lost, the opposite one being in a state of greater tension: hence the lung on the affected side (with the mediastinum) is dragged over to the opposite side.

Fig. III



Effusion increasing to such an extent that the tension of the lung disappears.

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Here the same holds, but to a greater and greater degree as the effusion increases Fig. III).

tends to become displaced to the sound side. There are two factors at play to account for this displacement, viz., the elastic traction of the sound lung and the mechanical pressure of the fluid. The former is a most important cause in explaining the displacement which occurs with small effusions, and it is one which is in most of the books overlooked. The latter comes on with larger effusions when there is positive pressure in the pleural cavity. According to the amount of effusion will depend the amount of displacement. It is more easily produced and to a greater extent in left-sided cases, than in those which are right-sided. It should be noted in this connection, that in left-sided cases should there be any displacement of the diaphragm, the heart tends, through its attachment to this muscle, to be dragged downwards. It formerly was asserted that there was always a change in the inclination of its axis. This idea arose from the fact of the cardiac impulse being observed at a point which seemed to indicate this : post-mortem evidence has however quite disproved this, and the explanation is that in all probability the impulse is given by some part of the right ventricle, at least in moderate effusions.

effusions. In cases of only moderate effusion, the apex beat may be absent, most likely through being concealed by the sternum. In large effusions there is usually great displacement. Should the exudation not have caused any descent of the diaphragm, when the effusion is large, the heart, being to a certain extent fixed at the base by the large blood vessels, is raised as well as pushed to the side and the apex beat may then be observed in the third right intercostal space. I have seen this myself on several occasions and I think this should aid us sometimes in deciding whether or not there is any depression of the diaphragm. It is stated that when the heart is pushed far over to the right, the mouth of the Inferior Vena Cava becomes bent almost at a right angle, just above the quadrilateral aperture in the diaphragm, the wall of the auricle forming a fold which covers a large part of the aperture. This is supposed to interfere with the due supply of blood to the heart, especially if at any moment the diaphragm is suddenly curved upwards in a fit of coughing, or if a sudden muscular effort is made, and for these reasons is considered to be often a cause of sudden death. If the case is left alone. Thus.

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Displacement
of the
diaphragm

This has been already explained. Depression of the diaphragm indicates large effusion and occurs earlier in purulent than in simply serous cases. This is to be explained, I believe, through the nutrition and elasticity of the lung being damaged by the fever of the suppuration and so bringing about earlier loss of tension of the lung: also to the same cause acting on the muscular substance of the diaphragm and so weakening its resistance: and in addition to the greater weight of the pus. The diaphragm is more easily displaced on the right than on the left side, for it is prevented to some degree on the latter side through the attachments of the pericardium. When it has manifested itself it usually appears as a fluctuating tumour in the hypochondrium.

Displacement
of the
liver

Of course, there follows as a result of the depression of the diaphragm, downward displacement of the liver, and like it this is usually more pronounced on the right side.

Effects
sequent
to the
effusion

But besides the changes upon the neighbouring structures, which follow as the result of the presence of pus in the pleural cavity, there are other results which may ensue if the case is left alone. Thus,

Thus, the pus may perforate the thoracic wall, or the lung or even the diaphragm, and there are many known cases where it has managed to make its way into the stomach, œsophagus and pericardium. When it opens through the diaphragm it will give rise to Peritonitis or a circumscribed abscess. Although peritonitis result from an Empyema it does not necessarily follow that there has been a perforation, as the pus seems to be able to make its way from the pleural to the peritoneal cavity, through the lymph channels in the muscle. But we have not by any means exhausted the various structures which may be penetrated. Rarely the effusion gradually works its way down the spine and simulates a peri-nephritic abscess, or it may go still further and appear as an Iliac abscess, or point below Poupart's ligament or as low as the knee, giving every indication of being a Psoas abscess. In Case I. which I have already mentioned, the matter must, I think, have found its way down the spine, because about two or three weeks after her side had been aspirated, a large œdematous swelling appeared over the region of the kidney, which with an exploring needle gave some fœtid pus. But the two favourite sites for the pus to choose

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choose for its exit, are either the thoracic wall, or the lung itself.

Empyema
Necessitatis

When the former occurs, the term Empyema Necessitatis is employed to designate it. It is in all probability due to necrosis of the Costal Pleura, with accompanying caries of a rib, although it is maintained by some, that it very frequently results from a peri-pleuritic abscess. This termination occurs most frequently in those cases which are of Pneumococcal origin, although it may result in any form of Empyema. The favourite site chosen is just under the border of the Pectoralis Major Muscle in front, in the fifth intercostal space immediately below the nipple. The reason for its so frequent occurrence here is that at this point there is a weak spot in the chest wall, which is covered only by the Internal intercostal muscle, and a thin layer belonging to the Pectoralis Major and external oblique muscles. The opening may however, occur at other situations, such as above or below the clavicle or at the back of the chest, or the pus may burrow and appear at places far distant. Although usually there is only one opening, there may be several. When about to occur, œdema usually precedes it: there is

is localised pain and then an elastic fluctuating tumour appears: the skin becomes red and ultimately acquires a violet tint. The tumour, it will be found, can be obliterated by pressure, and it becomes less tense on inspiration, but more tense on expiration or coughing. Although sometimes a cure may result, yet generally a fistula is established with long continued suppuration and all its attendant dangers.

Bronchial
Fistula

When the pus perforates the lung itself, a Bronchial Fistula is established. In all likelihood the same factor is at work in its causation, as in an Empyema Necessitatis, viz., a local necrosis of the pleura. Another explanation may however be given, and I think it is one which should not be lost sight of. Post-mortem the lymphatics of the pulmonary pleura are frequently found engorged with pus, and also these in the interlobular septa. The suppurative process may therefore affect the lung structure proper, and cause minute abscesses. One is apt to think that a Pyo-pneumothorax would result from a Bronchial Fistula but this is the exception and not the rule. In Case IV. of my own Series and in numbers VIII. and IX. of Dr James' Cases, a Bronchial Fistula had been

been established, and yet no air entered the pleural cavity. The explanation usually given is, that the opening in the lung is valvular, thus allowing pus into it, but not admitting any air from it to the pleural cavity. This, I think is rather a poor explanation. Probably the true one is, that after the opening has been made, the pus is forced by the expiratory pressure of coughing, through the minute opening or openings, and the pulmonary alveoli into the bronchial tubes, oozing into them as it were, while owing to the fact that the expiratory expansion is so slight, the air within the lung is unable to force its way against the pus and to gain entrance to the pleural cavity. This termination to an Empyema is said to be not infrequent in cases of Pneumococcal origin.

Thrombosis
of
pulmonary
artery

There is still one other condition which may result from the direct pressure of a purulent effusion and I think it is one which is apt to be lost sight of. I refer to the occasional occurrence of a Pulmonary Thrombosis from pressure on the artery, leading it may be to Gangrene of the Lung. The importance of bearing this in mind is, that I believe we can put on this the blame of some of the sudden deaths which

which occasionally occur in the course of the disease.

ptoms of
yema

The Symptoms of Empyema vary according to whether the condition is Primary or Secondary to other diseases, and on the whole I think it is best so to consider them, as frequently, for instance, when a purulent effusion occurs as a sequel to Pneumonia, many of the symptoms are obscured by the causal condition.

Primary
Form:

In the majority of instances in the Primary Form, the onset is sudden: occasionally however, there may have been some prodromata such as malaise, headache, pains in the limbs etc. The onset is marked very frequently by rigors, these occurring not only once but several times, differing therefore very much from Pneumonia, where usually there is but one, intense and prolonged. In children, the disease is not infrequently ushered in by nervous phenomena, the chief of which are headache, vomiting with great thirst, convulsions and even delirium. The temperature runs up to 100° -102°, often indeed much higher, and the pulse rate is increased in frequency. As a general rule the symptoms develop in one of the two following ways.

n Onset

I. Sudden onset with inflammatory and

and mechanical symptoms: there are present chills, fever, pain in the side, prostration and dyspnoea with all the physical signs of an effusion. The case really seems like one of Sero-fibrinous Pleurisy but on using an exploring needle pus is obtained.

II. The onset here is insidious. The inflammatory symptoms such as initial chill and fever, are not marked and mechanical and septic symptoms slowly develop. The patient is out of sorts, feels a vague dragging in the side and there is slight fever and dyspnoea: the fever then becomes higher and is remittent, while erratic chills with cold sweatings occur, and there is evident prostration.

The symptom which is most frequently met with in the early stage is pain: in its degree it varies very much, bearing a direct relation to the intensity of the mischief and to the nervous susceptibility of the patient. Most commonly it is very acute, and the patient describes it as being of a stabbing, screwing, tearing or dragging nature. It is felt usually over the seat of the Pleuritis if it be local if however, it is general, the pain occurs at these points where there is the greatest mobility of the lung, especially just under the nipple. The parts

dual
onset

is of
the pain

parts to which the patient refers the pain vary greatly however, and unless great care is exercised one is very apt to overlook the true cause of it. Thus, he may point to the sternum, the epigastrium or even to the loins. The explanation of this is not difficult to find; it depends upon the pain being referred by the patient to the nerve endings of the nerve or nerves involved in the Pleuritis. In illustration of this point I may mention what occurred in Case IV. When he was first seen, he complained of severe pain in the epigastrium: the question is, was this the result of diaphragmatic pleurisy or of mis-reference. The cause of the pain is not always the same. Sometimes it depends upon an extension of the inflammation from the parietal pleura to the neurilemma of the adjacent intercostal nerves. Bearing this out is the fact that pressure on the intercostal nerves often greatly increases the pain. An interesting case passed under my care, in which the opposite sequence of events occurred. The patient was suffering from Sub-acute Rheumatism: she also complained of great pain in the lower intercostal spaces of the left side, and this was rendered very acute on pressure. Great care was taken in the

use of
e Pain

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the examination of the side, but for three days not the slightest indication of friction could be obtained. On the fourth day however, on repeating the auscultation, fine friction was heard, and the patient said she could feel something rubbing inside her chest. I consider that here there was a rheumatic neuritis of the intercostal nerves (the patient had at the same time severe facial neuralgia) which extended so as to involve their ultimate divisions in the pleura, thus leading to Pleuritis. At other times the pain is due to the friction of the opposed inflamed surfaces upon one another, and this is present as a cause in the great majority of instances. In proof of this we have the fact, that as soon as fluid is poured out, so causing separation of the inflamed surfaces, the pain is lost, while as the fluid is got rid of, it frequently recurs. That there are nerve endings in the pleura is borne out by cough being produced by movements of a trocar in the pleural cavity, this resulting from the serous membrane, more especially the parietal layer, being irritated. Again, the fact that the pain is increased by respiration, coughing or speaking, is also I think, evidence in favour of its being so caused.

caused.

spnœa

Shortness of breath is a prominent symptom: to account for it we advance three reasons viz., the Pain: the Effusion: the Fever. Thus, on account of the pain the patient keeps his side as immovable as possible, and hence the breathing is rapid and shallow. Effusion acts mechanically by diminishing lung expansion: the quicker it is formed the greater will be the Dyspnœa. Should however, the fluid collect slowly, the breathlessness is often slight, unless on exertion, as the patient has had time to accommodate himself as it were, to the altered condition of things. The higher the fever runs, the more effect will it have upon the breathing, and a difference can thus be observed even between the morning and evening.

Position of Patient

The position assumed by the patient often affords us much assistance as to the course of the disease. Before effusion takes place and while the pain is still present, it is usual to find that he prefers to lie semi-supine across the bed, slightly bending towards the affected side. By this means, movement on that side is diminished, while free play to respiration is allowed to the sound side.

side. Sometimes however, a patient prefers to lie upon the sound side: why he should do so it is difficult to explain. I have myself observed where this position has been assumed, that it was in the majority of instances, the left side which was involved, and also that the pain in the side was increased by pressure. Thus, if he were to lie on the affected side, the pressure would increase the pain: I also think that as his breath is already short, if he were to lie upon the side where his heart is beating so rapidly, this would tend to increase the suffocative feeling. As soon as effusion has taken place, he changes his position, lying as a rule on the affected side, as by so doing the pressure of the fluid is prevented, to some degree, from acting by the force of gravity on the mediastinum, and at the same time the sound side is afforded fuller play. Should the amount of effusion, however, be only moderate in quantity, he very often lies upon his back.

It is very usual, especially in the early stage, for a cough to be present: it may be described as short and dry. It is produced in the same way as the pain, and as the pain is, so is the cough: they

expector-
ation

they bear a direct relation the one with the other. It is not usual for there to be any expectoration, unless some Bronchitis or Pneumonia be present. Occasionally there is a copious expectoration, due probably to hyperaemia of the sound lung, which is not only over-distended (as it were undergoing for the time being, what may be termed a Compensatory Hypertrophy) but also contains more blood as a certain amount is prevented from going to the affected lung. A profuse expectoration occurs when a Bronchial Fistula is established, either pure pus or pus mixed with bronchial secretion being brought up. It may begin gradually, but more frequently it is ushered in with a severe suffocative paroxysm. In Case IV. the patient had an attack of coughing and then suddenly he became almost suffocated and huge quantities of pure pus practically welled up into his mouth. In Cases VIII. and IX. of Dr James' Series the same occurred. In the former, some two or three weeks after the beginning of his illness, he had a severe attack of coughing, and then brought up sputum, yellow in colour and tinged with brown, with a very bad smell: the cough continued for five hours and he reckoned he must during this time have

have expectorated forty ounces of pus. In Case IX. some weeks after the original pain in the side, there came on a severe attack of coughing, and a large quantity of greenish-yellow bad smelling spit was brought up. In all these three cases there occurred on several occasions a phenomenon which is frequently seen in such cases of Bronchial Fistula. The expectoration copious at first, gradually ceases and after an interval returns, this taking place from time to time. The explanation usually offered for this is that the pus has sunk below the fistulous opening. This could hardly hold true in Case IV. and Case VIII. of Dr James' Series, because when the amount of pus in the pleural cavity was very small, there would be occasionally after varying intervals, some more brought up. The more likely cause is that some mass of fibrin blocks the opening.

ulse

As already stated the pulse rate is increased in frequency, running up to 120-130-150 and it remains rapid throughout the course of the disease. In a case of large effusion with much interference with the pulmonary circulation and with displacement of the heart, its character is greatly changed, becoming feeble and often dichrotic and lividity of

of the face then presents itself.

temperature

The Temperature Chart is of great value in Emyema as by it we are often aided in deciding between a Sero-fibrinous and a Purulent Effusion. At the onset it runs up to 100° - 102° or even higher and until pus has formed, it does not vary very much with the exception of its diurnal variations. As soon however, as pus has gathered it becomes characteristic. Instead of gradually becoming normal as in a simple plastic pleuritis, it remains persistently elevated week after week: it has often marked falls with corresponding marked rises, while rigors occur with great frequency, accompanied by profuse sweatings.

ne

As in all febrile conditions the urine is diminished in quantity, having a high specific gravity: it is high coloured and thick from the presence in it of urates and uric acid. The occurrence of Peptonuria is said to be frequent in Emyema.

eral
condition

A person suffering from a Purulent Pleuritis presents a typical general appearance. He looks anxious and his face is pale and drawn, quite different therefore from what it is in Pneumonia where the face is flushed. There follows rapid emaciation

emaciation with loss of appetite and the tongue gets furred, tending to become dry and cracked. Diarrhoea often manifests itself, and he sweats about the face. When septic absorption has begun, he has hectic sweats when he falls asleep.

ptoms of
secondary
pyema

There still remain to be considered those cases which I have designated by the term "Secondary Empyemata" i. e., those consequent upon some antecedent pulmonary or other trouble. I shall describe the condition following after Pneumonia, as it is the most important. Now some assert that this is rarely met with, and explain the occurrence of Pneumonic signs by the peculiar physical signs of Empyema so often met with in children. I do not think that one can say this is so. Undoubtedly many cases give all the signs of Pneumonia and then follows the Empyema after a varying time. There is really no typical course. It may begin during the height of the Pneumonia, or its development may be delayed for even two months. The usual time for it to appear is the beginning of the second month. Very commonly it comes on without any pain or local disturbance of any kind. We may take the following to represent the average type of this condition. We have a case

case of Pneumonia which runs its course, with an attempt at crisis: the temperature remains down but not quite normal for a varying period of time. Sooner or later it begins to rise gradually, and eventually becomes remittent. Dyspnoea develops and septic symptoms are manifest. Physical examination of the chest gives us all the signs of pleural effusion and the exploring needle draws off pus. I may remark in passing, that it is stated chills are not common in cases of Empyema resulting from infection of the pleura by the Pneumococcus alone.

The physical signs of Empyema must vary according to whether or not effusion has taken place. In the initial stages, before it has occurred, inspection shows a diminution in movement of the affected side, as it is kept steady on account of the pain: often too as already stated the side may be curved in through the position assumed by the patient to give him the greatest ease. Rarely it is quite possible, while inspecting the patient, to hear friction. A case occurred under my own care recently, where the sound was heard distinctly at a distance of two feet from the patient. Palpation usually demonstrates a diminished degree of expansion, and occasionally

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fusion

occasionally the friction fremitus can be felt, as happened in the case I have just mentioned.

On employing percussion we find there is practically no difference between the note of the two sides, although it is often stated that it may be dulled on the affected side through the lung not being allowed to expand as freely as its fellow: but to recognise this difference would require a very experienced ear. Auscultation usually makes manifest weakening to a slight degree of the respiratory murmur, and often a slight jerkiness in its character. It is worthy of note that bronchial breathing is very often heard from a very early period in children: and one is apt to come to the conclusion that there must be some Pneumonic Consolidation present. It is best heard, when it does occur, just about the angle of the scapula, and it is to be distinguished from consolidation by its being decidedly bronchial, not tubular. Case II. showed this peculiarity, as in her there was most distinct bronchial breathing just below the angle of the scapula. On the sound side the respiratory murmur is often exaggerated as the lung expands more than usual. Friction can nearly always be heard, but one must not forget that

that sometimes at first it cannot: this should be carefully borne in mind, otherwise we might say there is no pleuritis. This absence of the friction rub is very apt to be the case with children and some authorities even go so far as to affirm it is never present in those under six years of age. It is interesting to note that Hippocrates must have recognised the pleuritic rub, as he speaks of the pleura as "creaking like leather." Its characters vary very much, but usually it is jerky, i.e., made up of separate rubs giving the impression that one pleural surface moves over the other by a rapid succession of hitches. It is superficial and persistent and can be heard best at the end of inspiration and the beginning of expiration. In quality it may be creaking, like new leather, or it may resemble very closely the crumpling sound made in walking over newly fallen snow. It is to be distinguished from pericardial friction by its being evident only with respiration, and by its different character, the pericardial being usually a double shuffle. As effusion takes place it is lost altogether, although it is not necessarily so in children, as it is not uncommon in them to hear an unmistakeable friction sound at a spot where/

where immediately afterwards the aspirating needle draws off several ounces of pus. I have thought, could this not be explained as resulting from the contact of some mass of fibrin in the fluid, with the roughened pleural surface, and as fluid conducts well any sound produced in it, this is made evident to our ear.

ter
ffusion

When effusion has taken place, we get physical signs which vary according to the amount of pus present. Inspection shows, in a good sized effusion, great diminution or total loss of movement of the side. This is observed particularly on directing the patient to take a deep breath, when all that follows is a slow dragging upward movement, posterior in time to the expansion of the other side. There is no true expansion and the side often exhibits a marked change in the state of its intercostal spaces: these are widened, flattened or even bulging: why this occurs I have already endeavoured to show when speaking of the effects of the effusion upon the surrounding structures. The chest is enlarged and tends to become semicircular, owing to this distension of the intercostal spaces, the ribs at the same time becoming more horizontal in their direction. As a result of these changes the nipple and scapula are/

are both further removed from the middle line, and in very large accumulations the sternum may be deflected towards the affected side, simply through the pressure of the effusion acting on the ribs. This deflexion may be demonstrated by carrying a string from the sternal notch to the Symphysis Pubis. Oedema of the chest wall, especially in children and very chronic cases, may be apparent: to estimate the degree in which it is present, the best method is to pinch up a fold of skin and to compare its thickness with that of a similar fold on the opposite half of the body. There is no need for me to again repeat the displacements of the various organs which may sometimes be evident on inspection, further than to again remark that rarely it happens the heart may be prevented from being altered in position through old pericardial adhesions.

Pulsating
Empyema

Occasionally pulsation is observed in an Empyema when it is pointing. This pulsation is termed Extra-Pleural, in distinction to Intra-Pleural pulsation which is a shock communicated to a considerable area of the chest wall. This Extra-Pleural or Expansile Pulsation is nearly always found on the left side, synchronous with the heart, and nearly always systolic

systolic in time. For it to be manifest it is necessary that the fluid should be contained within more or less resistant walls and be under some tension. Thickening and rigidity of the lung and mediastinum is usually found post-mortem in such cases, and such being so, the pulsations of the heart, which must be transmitted to every large effusion on the left side, have not expended themselves on these structures, but upon the least resistant parts, viz., the intercostal spaces or the points where the Empyema is pointing. Case III. showed this pulsation very markedly, and so did Case V. of Dr James' Series, and here the heart was found to be bound down by adhesions.

No matter how copious the effusion in the pleura may be, the trachea, oesophagus and large veins nearly always escape, but to this there are exceptions, and husky voice and laryngeal cough or dysphagia may be very marked: while as a direct result of the pressure on the veins, there may be extensive oedema of the arm extending even to half the abdominal wall and leg of the same side.

Palpation

Palpation will reveal great diminution or total loss of the vocal fremitus over the effusion: this is easily explained as a bad conductor of vocal vibrations now intervenes between the lung and chest wall.

wall. Should adhesions be present, binding the lung to the chest wall at places, it is quite possible to get as a result vocal fremitus, but in such cases it is local not general. Light palpation should always be employed, using only the finger tips, or vibrations from the lung above, or even from the sound side in children, may be obtained. The loss of expansion is to be observed: while fluctuations may sometimes be obtained between the intercostal spaces, for the same reason that bulging occurs, viz., the muscles are stretched, their tonicity being destroyed by the fever and pus which are present.

Percussion

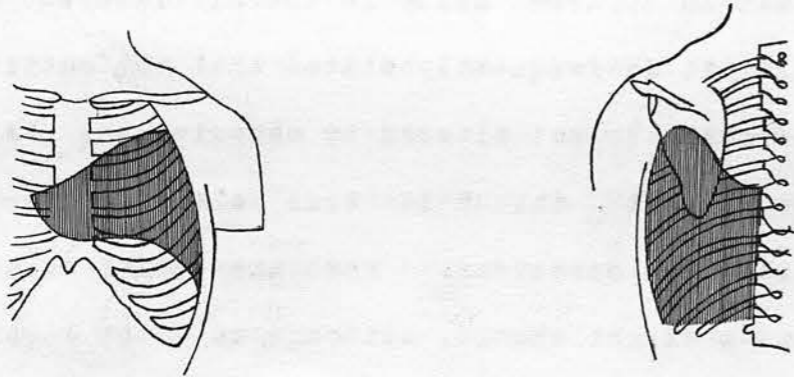
In adults the note obtained over the area where the effusion is situated, is absolute and toneless, accompanied by a feeling of greatly increased resistance, the character is well described in likening it to the percussion of a brick wall. It is stated that the quantity of fluid in the pleural cavity must be pretty considerable to have a marked effect upon the percussion note, at least ten to fifteen ounces being required. It is quite possible to believe this is so, as one can understand that the fluid at first will tend to spread itself out on the upper surface of the diaphragm. It is necessary to employ both heavy and

and light percussion, the latter being of special value as we approach the limits of the accumulation, where it shades off gradually to the pulmonary note. Should we proceed to the percussion of the heart, there is one very important thing to remember, and that is, that, as the base of the lung retracts, the right or left margin of the heart (according to the side affected) becomes uncovered, and hence this may make an apparent delay in the displacement of the organ. It is frequently stated that the outline of the effusion is not altered by changing the position of the patient: this holds true so far as very large effusions are concerned. Moderate effusions however, do show a slight change, although we often require to wait some minutes before it is appreciable. Why they change so slightly is said to be owing to a certain amount of cohesion which exists, even under normal conditions, between the costal and pulmonary pleurae, and also to the fact that a retracted lung assumes a definite shape which the weight of the fluid cannot easily alter.

Shape as -
sumed by
the
Effusion

We come now to a most important question, and that is the shape which the fluid assumes. This is best seen in those cases which are only serous or

and light percussion, the latter being of special value as we approach the limits of the accumulation, where it shades off gradually to the ordinary note.



Diagrams to show the characteristic curve which the upper limit of an effusion assumes (modified from Powell).

definite shape which the fluid cannot easily alter. We come now to a most important question, and that is the shape which the fluid assumes. This is best seen in those cases which are only serous or

shape as assumed by the effusion

or sero-fibrinous in their nature: it is perhaps not so marked in purulent cases for reasons I have already stated in considering the effects of the pus upon the surrounding tissues, but still to a greater or less degree it is quite appreciable. The pus does not acquire a uniform level, but assumes a curve, the highest point of the curve being in the axilla. This curve is sometimes known as Ellis's and sometimes as Garland's. It does not matter much whose it is, and we will designate it as the letter of S curve. Say we have a case of moderate effusion: on employing percussion the limit of dulness, beginning at the spine, passes outwards and then upwards by a gentle curve to the upper axilla or shoulder joint: from this point it drops in front to the sternum following approximately the course of the fifth or fourth rib. When the effusion is large, we cannot place the same reliance upon the curve in aiding us to a diagnosis. It cannot be so easily defined because the lung which is now beginning to be compressed will very likely give a dull note behind. Beginning at the junction of the second or third rib with the sternum, it will be found to pass outwards and upwards over the clavicle and shoulder, and then to go downwards and inwards to the



the fifth or sixth dorsal vertebra. How are we to explain this curved shape which the effusion assumes? It depends upon the fact that mainly the fluid adapts itself to the shape of the retracting lung, and not the lung to the fluid. The lung retracts in a definite manner towards its root, and hence the reason of the highest point of the curve being in the axilla. The fluid would be higher at the periphery than it really is, if it were not prevented from the same cause that operates in causing immobility of the effusion, i.e., a certain amount of cohesion existing between the costal and pulmonary pleurae.

Triangle of
Skodaic
Resonance

We have not as yet said anything as to the note obtained from the pulmonary organ. In a moderately large effusion, percussion in front reveals a triangular area which is resonant and this resonance tympanitic in quality. To this, the term Skodaic Resonance is applied. The statements given in explanation of this peculiar resonance are exceedingly many. Quoting from Powell we find he says "The lung is in contact with the parietes at the upper part of the chest, but it is slightly on the stretch, its periphery being adapted to the wider arc assumed by the ribs when released from the lung traction below". According

According to him, the loss of this triangle of Skodaic Resonance along with the dulness mounting up above the third costal cartilage, when the patient is sitting, is a sign that the thoracic pressure has changed from negative to positive, and that therefore after this, descent of the diaphragm may be expected. This he applies more particularly to serous effusions: it will probably occur sooner when the effusion is purulent.

Other explanations given to account for this Skodaic Resonance are the following:- "It is got from the smaller bronchi of the lung" "That it is probably due to diminished tension of the alveolar walls" and "That it results from the diminution of the vibrating area formed by the thoracic wall."

To my mind, the explanation of Powell seems the more plausible. The statement that it is got from the smaller bronchi of the lungs is possibly true, when the thoracic pressure is changing from negative to positive.

Posteriorly in the area corresponding to that in the front, which we have just spoken of, there is a triangle with a certain small amount of resonance, to which the name of Dull Triangle has been applied. It

Triangle
of Com-
parative
Resonance

It is sometimes very difficult to make this out, but we are often aided by instructing the patient to take several deep breaths, and we can frequently after this procedure, delineate the triangle. The possibility of clearing up this comparatively dull area, by repeated deep inspirations, has been made use of in deciding between effusion and Pneumonia.

Very Large
Effusions

When the collection in the pleural cavity is very large, the note from the lung may still be somewhat tympanitic at the apex in front, but it is now high-pitched: behind it is very dull, sometimes quite flat through the lung being wholly separated by fluid from the posterior chest wall. There is a special form of resonance sometimes obtained in a very large effusion, called Williams' Tracheal Note. It indicates that the lung is compressed, and originates in the larger bronchi or trachea, the vibrations of which are transmitted through the compressed lung. It is often very tympanitic and the pitch can be altered by the patient opening or closing his mouth. The best place to obtain it, is just below the inner end of the clavicle, and strong percussion must be employed.

Auscultation

In the early stages the breath sounds are

are usually simply weakened or there may perhaps be some prolongation of expiration. This feebleness of the breath sounds is due to the lessened expansion, and later on the pulmonary structure gets further removed from the ear through some fluid intervening. When pus is present to a considerable degree, the breath sounds become as a rule absolutely lost below its upper limit. This is easy to understand as now there is no working lung beneath it. Adhesions in adults may occasionally cause bronchial breathing to be heard, the sound being conducted from the larger bronchi, which of course must not be occluded. Very frequently in children and often in adults, bronchial breathing persists throughout the course of the disease. According to Powell, this bronchial breathing is not generated in the lungs or bronchi, but is really glottic, being conducted down the tubes and through the residual air. On the other hand, Garland asserts this persistent bronchial breathing only occurs in effusions of considerable size and that it is due to the bronchial murmur of the retracted lung above, being conducted by the ribs, this conduction being made more perfect from the tension of the chest wall being increased. Above the level of the pus, the

the breath sounds are usually faint bronchial, but they may be loud and often accompanied with crepitations. Friction may occasionally be heard just at the level of the fluid. Respiration over the sound lung is nearly always exaggerated with some prolongation of expiration.

Vocal
Resonance

The vocal resonance is suppressed below the level of the pus, becoming often near its upper limit ægophonic. This sign formerly had a great importance attached to it and Laennec in his Works puts it down as one of the greatest value. It is not to be relied upon too much, for it is sometimes present when there is no fluid whatever, being then produced by a consolidated lung. It sometimes happens that instead of the vocal resonance being lost, distant or rarely loud bronchophony can be heard, probably through conduction from above or through some of the larger bronchi still remaining uncollapsed or uncompressed. This bronchophony is nearly always obtained on auscultation over the collapsed or compressed lung near the spine.

Bacelli's
Sign

It was formerly thought that a distinctive sign, (called after its discoverer, Bacelli) had been obtained, which would enable us to decide between a serous and a purulent fluid. The manner employed to

to elicit it is as follows:- The unaided ear is applied to the affected side over the dull area, say below the angle of the scapula, and the patient is asked to say some rough word in a whispering voice. It was maintained that if the fluid were serous, the voice would be well conducted to the ear, but not so if it were purulent: that the fluid being homogenous and thin in the former, the vibrations were transmitted, while the thicker it became and the more it departed from the nature of serum, the less complete was the conduction of sound through it. It is now considered that this sign has no practical value, as the same result has been obtained in serous effusions.

The Heart Sounds

In the majority of cases, even although the heart may have undergone great displacement, there is no alteration in the character of the sounds. There are exceptions however, and occasionally in excessive displacement a systolic bruit may be developed over the base, probably the result of straightening or tension of the vessels from the pressure of the fluid.

Differential Diagnosis of Empyema.

It is not by any means always easy to definitely decide as to the presence of fluid in the pleural cavity. Probably about the greatest difficulty is met with in those cases which sometimes occur, of

of Pneumonia in which there is absence of respiratory murmurs and of vocal resonance and fremitus over the consolidated area: again, there are occasional cases of Empyema where these signs are found. Also, as I have already said, there are great varieties in the manner in which the physical signs on auscultation may manifest themselves. I was especially struck with this in going over Dr James' Cases: very few of them were really typical in their auscultatory signs.

Empyema and
Pneumonia

The following may be said to be the leading features which enable us to decide between Empyema and Pneumonia. In the former, the general absolute dulness with its feeling of greater resistance is present, and this dulness extends further forwards almost invariably. While the line of dulness in a Pneumonia is bounded by the interlobar fissure, in an Empyema it shows more or less of the letter of S curve which I have already described. There is also usually some displacement of the neighbouring organs to guide us. The character of the fever too, is often a very important aid to us, although we must not place too much reliance upon this, especially when children are concerned. There are other conditions which it is stated may lead to confusion in our diagnosis, such as Mediastinal

Mediastinal Tumour, Aneurysm, etc. I do not quite see how this can be, for the use of a hypodermic needle will always decide the matter. I have seen a pleural effusion credited with being an enlarged liver, but there should rarely be any difficulty in deciding between these two, if we only remember that an enlarged liver has absolute dulness highest in front and lowest behind. We can never finally determine as to whether a pleural effusion is serous or purulent, until we use an exploring needle and get away a sample, and this also is what we resort to in all obscure cases: what I always use is a hypodermic syringe with a needle not too fine. I am always careful not to enter at too high a level, but rather to go pretty low down: the solid constituents of a purulent effusion, especially in those cases due to the Streptococcus, may sink to the lower part of the thoracic cavity and were we to go too high up in our exploration, only a thick serum might be drawn off. When once we have drawn pus, we have next to decide as to the organism which has been the cause of the condition. This we do by aid of the microscope and by cultivations, and in rare cases by inoculation. Although much may be learned by simply putting a drop of the pus under the microscope, yet in

Use of
Exploring
Needle

in the majority of cases, staining requires to be resorted to. The Pneumococcus when stained with gentian violet, arranges itself in chains composed of elements which are distinctly lance-shaped or like the half of a grain of wheat, and are nearly always enclosed in a similarly stained capsule. The Streptococcus when treated in a like manner, is also found in chains, but each coccus is round and the chains are longer. In tubercular cases we may or we may not be able to demonstrate the Bacillus Tuberculosis. The absence of all germs on microscopical or culture examinations is strong evidence in favour of tubercle being the cause. A positive diagnosis can only be made by inoculation. In Case III. of Dr James' Series, Dr Noel Paton reported that no organisms were present in the pus, and Dr Muir failed to find any even after cultivation. Yet at the same time there was every indication of Phthisis at the apex of both lungs.

Prognosis

Before entering on the subject of Treatment, we must consider what is the Prognosis of Empyema if left alone. When we do not interfere in some way or other, the prognosis, with one exception, is most distinctly unfavourable. This one exception is where the condition results from the action of the tubercle

tubercle bacillus. I shall say nothing further about such cases at present, as they are fully discussed later on. Many of the results, which may follow on the presence of pus in the pleural cavity, have already been dilated upon, e.g., the manner in which it may burrow and appear at distant parts, simulating by this means other affections such as, Perinephritic abscess, Psoas abscess, etc. I have also mentioned how secondary Peritonitis may result (with or without perforation of the diaphragm): there is again the danger always imminent of Pericarditis supervening or Gangrene of the lung. Also very rarely the pus may perforate the Oesophagus, etc. Then there is the risk of a Bronchial or an External Fistula being established. In very rare cases it would seem that the pus loses its virulence, being contained within greatly thickened walls: we may liken such a condition to a cold abscess, neither increasing nor undergoing absorption.

Spontaneous
Cure of
Empyema

More frequently it is possible for a spontaneous cure to result. Some authorities deny this, but I think there can be no doubt that this may occur, and I shall give some cases in proof later on. I may in this connection refer particularly to Case VI of Dr James' Series. This spontaneous cure takes place

place in one of two ways: the pus cells may break down and a milky fluid be formed which is absorbed, or the fluid part of the pus may become absorbed and the pus cells etc., shrink and become degenerated into fatty acids and cholesterin, and a cheesy inert mass be formed which may go on to calcification.

Retraction
of the
Chest Wall

Very often during the cure of an Empyema, where nothing has been done or where operative measures have been resorted to, retraction of the chest wall takes place. This is brought about through the imperfect expansion of the lung aided by the contraction of the cicatricial tissue within the pleural cavity: occasionally too, the chest is fixed by adhesions in the attitude assumed through the pain in the earlier stages, while the thickening of the ribs which so frequently results from an Empyema, must materially assist. This retraction is most marked in children because in them the chest is so yielding. When it occurs, the shape of the thoracic wall becomes altered. The ribs get approximated to each other, and the shoulder falls to a lower level than it is on the sound side, so that a concavity is produced in the spine. The movement on the affected side being more or less abolished, that on the sound side becomes

becomes increased and aids therefore in the further retraction. The heart too, may be drawn to the affected side. Examination of a well marked case will show on percussion, absolute dulness over the unexpanded lung: should however, the bronchi be dilated, as they sometimes are, the note will be amphoric. The stomach note can often be obtained on the left side as high as the fifth or sixth rib, through the diaphragm having ascended. Should the lung be not totally collapsed, the percussion note will be defective, tympanitic or amphoric, while the respiratory murmur obtained on auscultation, will be weak, bronchial or tubular, especially if the bronchi are at the same time dilated.

Treatment of Empyema.

It is more particularly the Treatment which we should employ in Empyema, that I wish to discuss in this Paper. A reference to some of the leading books on the subject, shows at once what a vexed question this still remains. Of course, all are agreed that in every case, with the exception of a few, Tubercular in origin, interference in some way or other must be resorted to.

The following are the methods employed to get rid of the pus from the pleural cavity and to aid in recovery.

Various
Operative
Methods
employed.

- I. Aspiration (Tapping):
- II. Siphon method or some modification of it:
- III. Method of Perflation:
- IV. Opening an intercostal space and the insertion of a drainage tube:
- V. Excision of a portion of a rib and the insertion of a drainage tube:
- VI. Excising portions of several ribs, allowing the chest to fall in and so occlude the pleural cavity.

Paracentesis
Thoracis

Its
History

The operation of Tapping the Pleural cavity or Paracentesis Thoracis is one which has been employed from the very earliest times, mention of it being made by Hippocrates very frequently. He gives the symptoms which in his opinion, indicate the necessity

necessity for its performance, although these symptoms point to affections of very different kinds, comprising both hæmorrhagic and purulent effusions. One of his aphorisms is especially interesting "In cases of Empyema treated by the cautery or incision, when the matter is pure, white, and not fœtid, the patient recovers, but if it be of a bloody or dirty character he dies." In his day, the operation was done in one of two ways viz., opening an intercostal space either with the cautery or bistoury, or by means of perforation of a rib: for the latter the following was his method:- "To cut down on the third rib from the last and then make a perforation with a trocar (trepan) through the rib so as to give vent to a small portion of the fluid: the opening is then to be filled with a tent and the remainder evacuated after twelve days." The bistoury and cautery were the only means employed for opening the thorax, for many centuries. The operation then gradually became modified according to the idea as to whether or not, air should be admitted and about the middle of the 17th century, it was proposed to use a trocar instead of a bistoury. The next step in advance was to let the fluid out as completely as possible. In 1834 we

we find the following method recommended:- "Introduce an exploratory needle to get at the nature of the effusion: if pus be present, let out about fifteen to twenty ounces with a large trocar and then draw off some pus daily for two to three weeks through a gum-elastic catheter, leaving a fistulous opening for some time." To the admission of air no objection was made. At this time the operation was looked at with but little general favour, the majority saying it was very frequently fatal. Gradually however, better results were obtained as it was insisted upon that air should be prevented from entering, that the operation should be performed earlier and that all signs of inflammation should have ceased. The controversy however, went on for many years, but it got good supporters in 1870. It was then argued by one writer I. That the operation need hardly ever cause much danger or suffering: II. When the effusion is copious it is prudent to withdraw it, to relieve dyspnoea and to ward off sudden death: III. That it is best to tap when the condition of the patient is stationary and the pyrexia has abated, so as to enable the lung to expand before it has lost its power of so doing: IV. That after serous effusions the wound

wound should be closed at once and the admission of air scrupulously avoided: V. That in cases of purulent effusion the admission of air did not matter and that it was as well to secure free drainage for pus and occasionally to wash out the cavity with warm water." About this time too, it was recommended to tap frequently for chronic Empyema and to inject Iodine, while another writer summed up as follows:- "Tapping is urgently needed when the effusion is purulent: the difficult and frequent respiration by which the presence of pus is accompanied and not the quantity of the pus, is the best guide for tapping: there is strong evidence that the pleura may be tapped and air admitted without any ill effects following." After this it came to be recognised that the trocar should be small, so as to prevent too sudden an emptying of the pleural cavity, and at the same time many devices were tried to prevent the entrance of air, such as a piece of gold-beater's skin being put over the end of the trocar. Then there came the aspirating instrument of Dieulafoy and finally Potain's, and this has been so modified that now it is practically perfect and no air can possibly enter, and we are enabled by it to gauge, roughly perhaps, the degree of aspiration

aspiration power that is being exerted.

Treatment
by
Aspiration

Authorities
in favour

While there are supporters in favour of Aspiration being employed in Empyema in the hope that a cure may be effected, yet the majority seem to consider it as being wrong treatment in the great proportion of cases. Dr John Wyllie is a most decided advocate of its employment. He says "We may cure these cases by repeated tapplings: it is very good treatment in children, and even in adults it frequently does good, as each time the fluid is drawn off, it is often found to be less and less of the nature of pus. In all cases tapping should be performed several times, before laying the chest open, because by this means the formation of adhesions is aided, which are important in the ultimate healing up of the case." Dr James too, although he strongly advises a free incision with the introduction of a drainage tube, yet says repeated tapplings should first be tried in the majority of cases. Eustace Smith in his book on "Diseases in Children" also advocates aspiration. Garland, although he maintains that aspiration in Empyema of adults has proved a failure, yet strongly urges its employment in children.

children. Quoting from him, his advice is as follows:- "In children aspiration should first always be employed" and advances as an argument in its favour the statement made by Godlee viz., "that the tissues of children have apparently a greater faculty than those of an adult of absorbing both pus and serum: thus large intermuscular abscesses and acute suppuration of joints can be treated with smaller incisions in children than in adults: it follows therefore, from this greater absorptive power, that more is to be expected from aspiration of Empyema in children and statistics justify this expectation."

Authorities
against
Aspiration

On the other hand we must now consider what is said by those who condemn the method of aspiration. Thus, Dr Powell says "Tapping should only be done in those cases where there are urgent symptoms of dyspnoea, and it is not by any means to be looked upon as a curative means, but only as a prelude to the opening of the pleural cavity." Angel Money in his book on "Diseases in Children" expresses his opinion thus "Thin, laudable fluid, aspiration, if repeated twice or thrice at intervals of a week, may succeed in evacuating. A large Empyema wants immediate incision: pus is dead tissue and deadly, therefore

Capability
of Pus
Absorption

therefore away with it: there is nothing like a free opening." Whitney, in his article on Pleurisy in the 20th Century Practice of Medicine, is not quite so sweeping in his condemnation. He recommends its use in those cases of children which are known or appear to be of Pneumococcal origin, as such may be termed benign, and he also considers the same should be done in similar cases in adults. With the exception of these, he says, it is quite useless, that what we must obtain is free drainage. He brings forward as an argument against its performance, the results of Holt, who collected 121 cases, with the following results:-
21 cured: 6 died and 92 came up for further operation. He admits however, that we should seek a cause to explain why so many failed.

So far as my experience goes, I have been most favourably impressed with the utility of this procedure and I am now of opinion that in every case of Empyema, unless there be any distinct contra-indication, aspiration should be employed, not only once, but several times, before resorting to anything further. I shall endeavour to go shortly into the pros and cons of the question.

Capability
of Pus
Absorption

There is no doubt whatever, that pus is

is capable of being absorbed: this is brought about in one of two ways. The pus with its corpuscles at the time of absorption is still more or less intact: then the pus becomes thicker as the fluid portion disappears (Inspissation of Pus) and a thick inert mass results, containing shrivelled up pus cells: the fluid of the pus has here been absorbed and also a part of the fluid present in the cells. The second mode of absorption is the more favourable form, as the pus here disappears and no essential part of it remains behind. It undergoes fatty degeneration, every pus cell setting free fatty particles in its substance and then breaking up, and finally nothing remains further than fatty granules with some crystals of cholesterin and some little intervening fluid, the fluid part being almost entirely absorbed. Occasionally calcification takes place in such a mass, and frequently encapsuled caseous collections have been found at the base of the lung and in the interlobar fissures. This fatty degeneration is very often met with in an examination of pus obtained from an Empyema: Thus, in Case III. of Dr James' Series, the report given by Dr Noel Paton records that he found pus breaking down, oil globules and crystals of

of cholesterin: the solids formed a high proportion, being 14.1 per cent.

Arguments
in Favour
of
Aspiration

By the performance of Aspiration, I maintain that we assist in bringing about the retrogressive changes I have just described. When we aspirate, the pus left in the pleural cavity is much diminished in quantity and at the same time it is thicker, as the more solid constituents have, to a certain extent, fallen to the bottom and have not been removed. Thus, we have the pus becoming somewhat inspissated. At the same time too, by the removal of the pus, expansion of the lung is brought about and thus absorption of the fluid part of the inspissated pus is favoured, as the pulmonary lymphatics are now rendered capable of acting more perfectly. It therefore appears to me that, by Aspiration we bring about a state of the pus which is similar to what occurs in the first of the two methods of the spontaneous absorption of pus described. Not only so, but I think it is probable that we at the same time aid in favouring a fatty degeneration of the pus cells. It is true that after Aspiration pus may reaccumulate, but it does not necessarily follow that it will do so to such an extent as previously. Indeed no such gathering may take place,

place, for cases of cure after one tapping have often been recorded. Even with reaccumulation however, the pus as a whole will be more inspissated than it was originally, and on successive tapplings it will tend to become more and more so, and meantime the cavity will be closing by formation of adhesions. But is it not possible that, in other cases after aspiration, pus as such is not formed, but merely a serous exudate? for many of the causal organisms of Emyema are shortlived (e.g., the Pneumococcus) and the process of suppuration will not continue when these organisms die. Thus, on retapping, some of the purulent constituents will be again removed and further exudation of serum will not be so likely to occur as the lung still further expands and becomes adherent to the costal wall.

In this connection it seems to me quite probable that certain cases of Benign Emyema become absorbed spontaneously, without having been diagnosed as being otherwise than a sero-fibrinous effusion.

I shall now give some cases in support of what I have just asserted: the first of these does not indeed show that Aspiration did any good, but it demonstrates the possibility of a spontaneous cure.

cure. It is taken from Dr James' Cases(No.VI.)

M.B. aged 5 years was admitted into Ward XXX. R.I.E. with an Empyema situated on the left side. She had suffered for a long time from whooping-cough, and a fortnight before admission she was seized with shivering and pain in her side. The Doctor who attended her, on using an exploring needle, drew off pus. On examination of her side when admitted, there was found to be a dull area posteriorly extending up to about one inch below the scapula. She was given chloroform and when she was under its influence, a hypodermic needle was introduced into four different places in the dull area, without obtaining any pus. There was nothing further done, and a reference to the notes of her case shows continual improvement, and three weeks afterwards she was discharged. Her condition then was very good and no abnormal sign could be detected in the respiratory system, except a very slight impairment of the percussion note over the previously dull area. The diagnosis arrived at by Dr James was "A Case of Empyema, going on to a Natural Cure."

The other case I wish to give, occurred in my own practice: it is No.II. and is as follows. A

A little girl aged five years was first seen in August 24th, 1896. She was found to be delirious, with a temperature of 102° and every sign of embarrassed breathing. On examination of the left side behind, there was slight impairment of the percussion note and the side was less mobile than its fellow. Just below the angle of the scapula there was an area about the size of the palm of the hand, where bronchial breathing could be heard. She was seen daily and it was observed that the note on percussion became gradually duller, while all the signs of effusion manifested themselves: her temperature too, remained above 101° . The dullness extended posteriorly to above the inferior angle of the scapula. On September 3rd, on inserting an exploring needle into this dull area pus was obtained. Accordingly next day, aspiration was performed and six ounces of moderately thick pus removed with flocculi floating in it. Her temperature the same evening fell to 99° . The percussion note was now not so flat, but the limits remained much about the same, and the movement of the affected side was still impaired. As the temperature gradually rose to almost its former height, and the local condition did not improve, tapping was again resorted

resorted to, one week later. On this occasion, although the pleural cavity was emptied as thoroughly as possible, only two ounces of pus were obtained, of a greater consistence than on the previous occasion, with flocculi larger and more abundant. The condition of affairs now was much the same as after the first tapping and again the temperature rose to almost its original level. I would have waited longer to watch the progress of events, but being obliged to leave Edinburgh for a time, I determined to perform Thoracotomy. Accordingly one week after the second Aspiration, I entered the pleural cavity in the eighth interspace in the line of the posterior axillary fold. I was rather astonished to find no pus escaped. On introducing my little finger into the pleural cavity, I felt a mass, a small portion of which was withdrawn out of the wound and found to be organising lymph. This was replaced and the finger swept round as far as it could reach, but nothing further was found. A drainage tube was inserted and the wound dressed. The wound was dressed the next day, but there was practically no discharge. It was not again touched for five days: the highest temperature reached up to this time was 100°:

100°: absolutely no discharge was apparent. As the temperature continued between 99° and 100°, the tube was kept in for several weeks, although it was shortened every six or seven days. At the end of this time, the pleural cavity being closed and the tube no longer able to pass in, it was removed. The external wound gradually healed and the temperature by degrees became normal. During the whole course of the case there was no discharge from the pleural cavity: the tube was simply kept in as a precaution on account of the elevated temperature. It is worthy of note that the imperfect movement of the left side, the dull note and impaired respiratory murmur remained even until the wound was healed, although gradually returning to normal. In December when I again saw the little patient, I found there was no retraction. The side expanded almost equally with its fellow, and the percussion note and breath sounds were only slightly impaired. This case I think proves without doubt, that cure had resulted from the two aspirations. The dull note, the operation showed, was due to the large layer of lymph which was present. The temperature remaining up, is a very interesting feature: can it not be explained by the absorption of the

the inspissated Pus, which probably was lying at the bottom of the cavity between the lung and the diaphragm.

Besides the two cases which I have given, there are those given by Holt: he collected 121 cases from various sources, both English and American, and he found 23, or 19 per cent were cured: 6 died and the remainder came to some other method of treatment, usually incision. Of these 23 cases, 8 were cured by a single aspiration. Another observer, Branthon, who is quoted by Garland, gives even more favourable results, but his cases are derived from children. Of a total of 43 cases, all treated by aspiration, 18 were cured by a single operation, 11 cases by 2 tappings, 3 cases by 3 and 11 by a variable number varying from 6 to 122.

Powell
against
Aspiration

I must now give an argument which is advanced against aspiration. Its author is Powell, and it is this:- While he grants that an apparent cure may result from aspiration, yet he says Phthisis very frequently develops in the course it may be of months, or secondary pleuritic abscesses may occur at any time, consequent upon the breaking down of the caseous deposits that are so often left. With regard to the

the occurrence of secondary pleuritic abscesses, as far as I can make out, he gives no proofs in support of what he asserts, and there is no special reason to think that such should occur. With regard to the former part of his statement, I can hardly consider it a proper argument. He says nothing whatever as to what was the nature of the Empyema in those cases where Phthisis developed. It appears to me that when such a result took place, Tubercle was the real cause of the Empyema, and that Pulmonary Tuberculosis would have occurred sooner or later, even if these caseous deposits had not been there.

Empyema not
an ordinary
abscess

Those who oppose the employment of Aspiration, make a strong point in comparing an Empyema to an ordinary abscess, and that being so, say a free exit to the pent-up matter must be established. But is an Empyema an ordinary abscess? In my opinion it is not. Undoubtedly if we were to define an abscess as being a collection of pus, an Empyema would be one. But in a true abscess, there is destruction of tissue, and this destruction is wanting in an Empyema. Besides, the walls of the cavity of an Empyema are entirely different. They are formed of a membrane, covered it may be with lymph or fibrin, and capable of

of absorbing very readily.

Other
Objections
to
Aspiration

But I have not yet exhausted all the arguments advanced in opposition to the employment of Aspiration in Empyema. Thus, Glifford Allbutt says "Aspiration does not prevent the formation of a Pulmonary Fistula: neither does it prevent hectic occurring, but rather favours it, as by the presence of a full cavity absorption is often prevented and fever absent: whereas if we draw off some of the pus, the pressure is relieved and absorption begins."

I shall first take up the question as to the formation of a Pulmonary or Bronchial Fistula. As I have already said in a former part of my paper, the usual ideas as to its causation are, that it results from a necrotic process taking place in the pleura, or from the pleural lymphatics and those of the interlobular pulmonary septa being engorged with pus. Surely therefore, if we remove pus from the neighbourhood of these weak parts, we shall tend to diminish the conditions favourable for a further progress of the destructive changes. It may be argued that when the lung expands, it will tend to the separation of say, a necrosed portion of lung tissue: but as I shall show afterwards, expansion of the lung also

also takes place even when a Thoracotomy, with or without excision of a rib, has been performed, and this risk is therefore present in all these operations.

It is quite true that Case IV. seems to uphold the statement of Allbutt: here however, I believe the same result would have followed, whether we had aspirated, performed Thoracotomy or excised a rib. The formation of a bronchial fistula had extended so far with him, that nothing could have prevented it. Besides, as I shall be able to show later, a bronchial fistula is not always by any means an unfavourable occurrence. Finally, with regard to the statement that absorption often follows after Aspiration, with all the accompaniments of hectic, I do not by any means believe that this holds true: let us look at the temperature charts of any case which has been aspirated and what do we see?- nearly always there is at once a fall in the temperature, and this fall remains until perhaps there is an increase in the amount of pus. Granting that this increase in temperature does occasionally ensue immediately after the operation: it occurs also frequently after tapping a simple effusion. It is due either to incomplete aspiration, or to reaccumulation of pus

pus after complete aspiration, and in the latter case it indicates the necessity for repetition of the operation.

Other
Points in
Favour of
Aspiration

Before going on to the description of the operation, I shall mention a few other points all of which are I think distinctly in favour of Aspiration as compared with Thoracotomy or other operation.

There is better chance of an immediate and more complete expansion of the lung: for in all other operations, except with siphonage, air is introduced into the pleural cavity. Again, in many cases, the lung is from the first coated by an exudation layer of great thickness, which will in time strongly contract and prevent the lung expanding again. By Aspiration we expand the lung before this contraction occurs, whereas after Thoracotomy especially with excision of a rib, the expansion is less complete, at least for a time, through air being present in the pleural cavity, and before the expansion is fully established, this layer might have contracted.

Removal of the pus by Aspiration allows the false membrane, on the re-expanded portion of lung, to come into contact with the thoracic wall, and hence there is a tendency for adhesions to be formed between the

the lung and thorax: there will therefore follow a diminution in the size of the cavity, with corresponding diminution in the secreting surface and in the space where the pus can collect.

Although expansion of the lung often takes place immediately after Thoracotomy, yet the expansion is not so thorough as after Aspiration, and so if adhesions occur here, they may do harm by preventing the ultimate full expansion of the lung. Aspiration prevents the entrance of air into the pleural cavity and therefore diminishes the tendency for the pus to become foetid.

It is far less formidable to the patient than an incision, and he often would be willing to give his consent to this, when he might refuse a cutting operation.

Potain's
Aspirator
the best

Whenever I have employed the Aspirator in Empyema, I have always used the improved pattern of Potain's and invariably found it to answer admirably. It consists of a rubber cork which fits into a large-sized bottle: this cork is fitted with two stop-cocks which are connected by rubber tubes with the aspirating canula and an exhausting air-pump. By/

By means of this pump we are enabled to produce any desired degree of vacuum in the bottle, and then, simply by reversing the stop cocks, this vacuum is put into communication with the pleural cavity. The canula is provided both with air-tight trocars and air-tight perforators, and on the canula a stop cock can be turned, so that when it is introduced, the trocar can be withdrawn without any air entering. The perforators are of use in removing any solid particles which may obstruct the canula. I think it is very bad practice ever to use the needle canula which is usually included in the case of a Potain's Aspirator. The objection to using it is, that the lung as it expands runs a great risk of being injured by the sharp point, which can hardly occur if the canula be blunt.

Prelimin-
aries to
Aspiration

As in every operation, the strictest aseptic care must be employed. The trocar and canula chosen, but not the stop cock, should be boiled and then placed in a 1-20 solution of Carbolic Acid. If the stop-cock is boiled, it may be rendered unworkable. The skin of the patient over the selected site and around it, must be carefully purified, first with soap and water, then with ether to remove any grease

grease which may be present, and finally, a compress of a 1-2000 solution of Corrosive Sublimate is to be put on, and left for at least one hour. Our hands too, must be carefully attended to. Before going on to Aspiration, the exploring needle should always be used first, as in the interval which has elapsed since we first obtained pus, there may have occurred absorption of the greater part of the pus. One little practical point to be observed is that the needle of the exploring syringe and also the trocar and canula of the aspirator, if they have been lying in Carbolic Acid solution, should finally be washed in Boracic Acid lotion, because Carbolic Acid has a coagulating action on albumen and this might cause choking of the aspirator. The patient should be maintained absolutely in the recumbent posture, with his arm resting above his head. By insisting on this, any possible risk there may be of syncope, will be greatly diminished.

Recumbent
Posture
necessary

Site
chosen for
Puncture

With regard to the site chosen for puncture, there have been various ones recommended. Thus, some always choose the fifth interspace in the anterior axillary line, but this point is, as often as not, quite useless, as the pus does not necessarily extend

extend so far forward. Others say that the trocar and canula should not be entered posteriorly any lower than the seventh interspace. I am greatly in favour of going as low posteriorly as we think we can go with safety. I believe that by so doing we have far more chance of removing the pus which is present in the pleural cavity, though of course, I am quite aware that we cannot hope ever to completely empty the chest of its contents. It is interesting to note that Hippocrates devised a method for the complete emptying of an Empyema. He inserted a bladder deep into the pleural cavity and then inflated it, the pus finding its way out of a canula simultaneously introduced. Another method formerly employed for this purpose was the injection of air and water. This has lately been revived so late as 1886, and I shall again have occasion to refer to it. A great deal has been said as to the danger of wounding the diaphragm, if we enter the trocar too low down. To me it seems that too much has been made of this. We are always advised in the books to perform Thoracotomy at a low level: if it is safe in one, surely it is so also in the other. That it is quite safe to enter the canula at a low level, is evident from the

the advice given by some authors. Thus, one says to enter it at the back in the ninth or tenth inter-space in a line with the angle of the scapula, two inches above the lowest limits of the sound lung on the opposite side: another says that in 56 out of 74 times he chose the eighth, ninth, or tenth inter-costal space.

Although we must in every case be guided altogether by the physical signs, and the locality of the diaphragm, I would say that between the eighth and ninth, or ninth and tenth ribs in a line with the posterior fold of the axilla is the best place. Any spot where respiration is heard and fremitus felt must be avoided, as probably here the lung is bound down by adhesions. I always limit the extent to which I let the trocar enter, by having my finger on it about one and a half inches from the point, so that it cannot possibly advance any further. Descent of the diaphragm occurs more frequently in Empyema than in sero-fibrinous effusions, but admitting that no descent has occurred, there is always bound to be a layer of pus between the diaphragm and the costal parietes. Whitney remarks "Even should puncture of the diaphragm occur during aspiration, it is very

"very doubtful if any untoward result will follow."

I have not been able to come across any description of complications arising from it, and Whitney admits having punctured the diaphragm, lung, liver and spleen without any unpleasant consequences.

How to use
the
Aspirator

It is often recommended that, having chosen the interspace, the skin over it should be drawn up, and it is asserted that by this procedure the track of the canula is efficiently closed when we withdraw it: I do not think this is at all necessary. The forefinger of the left hand is pressed firmly into the interspace chosen, and the trocar with its canula, with our finger on it acting as a guard to prevent it entering too far, is pushed in boldly, so as to penetrate the thickened pleura and false membrane. It is often recommended to guide the instrument close to the upper border of the lower rib of the intercostal space chosen, as by this means it is said the risk of injuring the intercostal artery is lessened. This is quite unnecessary: in fact it may do harm through injuring the periosteum, and may as a result give rise to some caries of the rib. We should rather go right through the middle of the intercostal space, and no harm can then possibly result to the

the intercostal vessel. Watching carefully the manipulation of the different stop cocks etc., the trocar is withdrawn and communication between the bottle and the chest established. Should the pus cease to flow, the point of the canula is moved about, and if then it ceases again we cautiously introduce the perforator to remove any solid particles obstructing the opening. It must not be forgotten to direct the point of the canula to the lowest parts of the pleural cavity. If any faintness manifest itself, or a feeling of tearing or coughing come on, the operation should at once be stopped: the latter indicates probably some breaking down of adhesions. After waiting some time and giving a stimulant, we may again begin cautiously, but if these symptoms recur, stop at once. On withdrawing the canula the patient is directed to hold his breath, and as it is withdrawn our finger closes over the opening and remains there until we seal it with some wool and collodion.

All the Pus
should be
drawn off

When we have introduced the canula, the question comes to be determined as to how much of the pus we should remove. I am strongly of opinion that we should remove as much as possible, for, as I have

have already indicated, I think that thus there is a much greater likelihood of cure. But it is said, if we remove all the fluid at once, that there is a risk of fatal syncope. Certainly many deaths have been recorded as occurring from this cause, but an analysis shows that the danger is increased by the age of the patient, by exhaustion, anæmia and alcoholism. These conditions would have an influence in any operation performed. Besides, a certain number of these cases were not treated properly, inasmuch as the sitting position was assumed during or soon after the operation: it is possible too that a few were due to thrombosis in the pulmonary artery. One most important fact to bear in mind is, that in many of these cases of fatal syncope, the amount of fluid drawn off had but little influence - the danger lay in the rapidity with which it was removed. Even Hippocrates recognised the danger of too rapid evacuation, for he remarks in one of his aphorisms "Those cases of Empyema or dropsy, which are treated by incision or the cautery, if the pus or water flow rapidly all at once, certainly prove fatal." If it is dangerous to remove all the pus in aspiration, surely in Thoracotomy, especially if excision of a

Indication for subsequent Tappings

a rib is also carried out, the danger is equally present. Since then the danger lies in too rapid evacuation, this of itself is a strong argument in favour of aspiration (by which we can draw off the pus as slowly as we like) as contrasted with those operations in which the pus escapes rapidly.

Aspiration should be done slowly

We should therefore employ a canula which is not too large and there should not be too much suction power. There should be just enough to let the pus escape: should any faintness come on, we can stop for a time, and if it still continues, we can cease altogether and repeat the tapping afterwards. Pneumothorax and hæmorrhage from the lung and pleura have been said to occur during aspiration: the cause of this is not far to seek - too much suction power had been employed. The bottle therefore should not necessarily be exhausted: all that is required is just enough negative pressure to enable the pus to escape.

After-treatment

The after-treatment consists in the recumbent posture being absolutely maintained and great quiet enforced for several days afterwards. The patient too, after a day has passed, should be advised to take plenty of full breaths, so as to expand his

his lungs well.

Indications
for
Subsequent
Tappings

The indications for again resorting to aspiration are shown by the temperature chart and the physical signs. Immediately after an aspiration, the affected side should be examined carefully, and the extent of the dull area marked out. We may take it, that when the temperature again rises and the physical signs, especially the dulness, show re-accumulation of pus, it is time to again aspirate. I lay great stress upon the importance of examining the side after the aspiration. It is quite possible that even after a considerable quantity of pus has been removed, the dulness and other physical signs still remain but little changed. This would indicate some large mass of lymph. Without this precaution, a future examination would lead us into the error of believing that the pus had returned. This was evident in Case II.

I should like to mention here, a peculiar phenomenon which I have noticed on more than one occasion when employing aspiration in Empyema. Occasionally when the pus has almost ceased to flow, there have appeared, in the glass tube which is in the central portion of the rubber tube, bubbles of

of air passing along, and often one of these bubbles forms a huge blob at the end of the tube leading into the bottle. Whence do these bubbles arise? One is apt to suspect that the instrument is not quite airtight, but I have tried it afterwards and found it to be quite right. Our care in introducing the trocar justifies us in saying no air can have entered then. We are thus left to look for the cause as arising inside the chest itself. As the cases where I have seen it happen were not septic, there was no chance of gas having formed as a result of decomposition. The only conclusion I can arrive at is, that the air must be derived from the pus, which always contains some in solution. By aspiration, especially if this be too strong, some of this air is set free and appears as bubbles.

General
Remarks
as to
Aspiration

To sum up with regard to the use of Aspiration in Empyema:- It should always be employed, unless there is some strong contra-indication, e.g., putrid cases and where there is a bronchial fistula (vide Thoracotomy). It is specially indicated in those cases, both in children and adults, which are of Pneumococcal origin: it is also of great value in some Empyemata which are Tubercular in origin. We

We should not go too high, but rather as low as possible: avoid too rapid evacuation and too strong an aspiration power: remove as much pus as possible from the pleural cavity. The recumbent posture must be strictly maintained both during the operation and for several days afterwards. One tapping is usually not enough: try it at least three times or even oftener, before resorting to anything else.

Tubercular
Empyema

I may here make a few further remarks with regard to Tuberculous Empyemata, associated with Pulmonary Phthisis. The less we interfere with such cases, the better it is for the patient. There is no doubt whatever, that a collapsed tubercular lung is in a far more favourable condition to become quiescent, than it was before: besides, there are many cases which prove that a patient with Phthisis, and whose chest was nearly full of pus, has managed to get along very comfortably for many years. Should however, the pus accumulate to such an extent as to necessitate operative interference, most certainly aspiration is the best thing to do, and it should be tried again and again. Often such cases if aspirated do not recur for a long time, and even absorption of the chylous or

or fatty exudation may take place. Most books recommend that, if an Acute Empyema occurs in a patient with only a slight degree of Phthisis, incision with drainage is the proper treatment. This, I firmly believe should be only a last resort in such cases: aspiration again and again should be employed, because after incision most usually a permanent fistula is left which will refuse to heal, and I believe the pulmonary condition becomes greatly aggravated.

I propose to give here a few notes on Tubercular Cases, illustrating what I have just said.

Illustrative Cases

Case III. Dr James' Series: a man aged 32 years, a shepherd, was admitted into Ward XXX.R.I.E. on October 28th, 1894. There was every indication of Phthisis at both apices: on the right side posteriorly there was marked dulness and the signs of fluid, extending as high as the eighth dorsal vertebra. On employing an exploring needle to this dull area, some very thick creamy pus was obtained. Two or three ounces were all that could be drawn off by an aspirator. After this the patient improved slightly, the dull area becoming somewhat less posteriorly. Nothing further was done, as it was

was considered that harm would ensue if Thoracotomy were performed. He was discharged December 29th, much improved.

Case V. of my own Series. A boy aged 13 years was admitted into Noble's I.O.M. Hospital on March 1894.

There was a large Empyema on the left side: a distinct history of Phthisis was obtained. He was aspirated twice and on each occasion upwards of twenty ounces of pus were removed. It was then decided to perform Thoracotomy. This was done and the wound dressed twice daily for a long time. No improvement took place and the cavity was then washed out with Corrosive Sublimate lotion, but all to no avail. He finally left Hospital and died three months afterwards from exhaustion and waxy disease and with a fistulous opening in the thorax.

Case V. Dr James' Series. A man aged 26 was admitted into Ward XXX.R.I.E. on January 17th, 1894. There was distinct Phthisis. He had a pulsating Empyema on the left side. On January 19th, the skin over the tumour was incised and much pus escaped: an opening was found in the fourth interspace internal to the nipple line. A second incision was made over the fourth rib in the anterior axillary line,

line, (this being the posterior line of adhesions limiting the Empyema) and $\frac{5}{4}$ inch of rib excised: a drainage tube was inserted and twenty-five ounces of pus escaped. It was noticed that the heart did not return to its normal position. During the rest of January the wound was dressed daily: everything seemed to be going on well, the tube only occasionally becoming blocked. In February, when a finger was introduced into the lower wound, the lung was felt to be expanding from the back. Eventually a clear serous fluid gathered behind the posterior layer of adhesions, and this on examination gave Tubercle bacilli. He gradually improved, the Empyema cavity becoming smaller. On March 20th, severe headache developed, and delirium came on. No improvement took place and he died on March 25th. The diagnosis arrived at was, Empyema: General Pulmonary Tuberculosis: Tubercular Meningitis.

Case VII. Dr James' Series. A man aged 50 was admitted on November 24th, 1894, into Ward XXX.R.I.E. He had been ill for two and a half months. He was found to have a Tubercular Pleurisy on the right side, extending as high as the fourth rib posteriorly. This was aspirated on December 18th, and $8\frac{1}{2}$ ounces of

of clear fluid removed: again on the 22nd, and 6 ounces were taken away. On the 27th, 50 ounces were removed: on the 29th, $8\frac{1}{2}$ ounces: on January 7th, 3 ounces: January 15th, $13\frac{5}{4}$ ounces: January 22nd, $10\frac{1}{2}$ ounces. On January 30th, aspiration in the fourth and fifth spaces gave no fluid. On February 1st, $6\frac{1}{2}$ ounces were obtained: February 9th, 20 ounces. On February 22nd, the left side became affected. On February 26th, the dulness in the left side had greatly increased and the patient had dyspnoea. A severe attack of dyspnoea took place on March 2nd, : the effusion on the left side was very marked, reaching to the sixth space in the posterior axillary line. On March 3rd, the patient became collapsed through the dyspnoea: 60 ounces of fluid were removed from the left side and he recovered: the right side was also done and 20 ounces of yellowish pus removed. On March 5th, 30 ounces of sero-fibrinous fluid removed from the left side: March 14th, 40 ounces from left side, sero-fibrinous: March 28th, 25 ounces left side. Between this and April 19th, patient was slightly better and then the temperature began to go up, and on April 22nd, the left side was incised and drained. The wound was

was dressed twice daily afterwards. He gradually got worse however, and died on April 27th. The Post-mortem examination showed the left pleural sac obliterated by adhesions: miliary tubercle in great abundance. Fluid in the cavity bounded by the lower lobe which was collapsed: the pleural surface was thickened. The right lung was much collapsed and riddled with miliary tubercles. The pleural surface was thickened and a large quantity of pus was in the pleural cavity. The Peritoneum was studded with miliary tubercles and so also were the spleen and the kidneys.

Siphon-
Drainage

Method of
"Bulau"

Siphon-drainage, also known as the "Method of "Bulau," is practically never used in this country, but it is employed a good deal in Germany. The following is the technique of the operation. The chest is first punctured with a large trocar and canula: most of the pus is withdrawn and a soft rubber catheter is inserted through the canula into the chest, and over it the canula is withdrawn. To the catheter a long rubber tube is attached, the lower end of which passes to the bottom of a vessel half filled with some antiseptic lotion, and thus continual siphon-action is obtained. Sahli treated

treated 12 cases by this method, all successfully, the duration being from 12 to 72 days. Curschmann had 75 cases with 63 good results. I think it is a method which might be of value in some Tubercular Emphyemata.

Potain's
Method

Another method of Siphonage was formerly greatly used. It is known as Potain's. His description is as follows. A piece of rubber tubing at least 30 centimetres long, is filled with water and pushed through the canula after the trocar is withdrawn, until the end touches the opposite side of the cavity. The outer end is immersed in a basin of water and controlled by a serre-fine. A branch tube runs to a reservoir, so that fluid can be alternately poured into the chest through the upper opening and then siphoned off through the dependent branch until water is substituted for pus. This method is very good in theory, but bad in practice: it often cannot be done on account of flocculi and coagula which obstruct the tube, and the results have not been encouraging. Goodhart had 30 cases treated in this manner and his results were, as follows:-
Deaths 13: Cures 12: Fistula Remaining 4: Dying of Chronic Lung Disease 1.

Method by
Perflation

This was introduced by Ewart in 1886. He makes two openings in the thoracic wall and then through a bottle containing a disinfectant, he blows in air at one of the openings. This forces the pus and other debris out at the other opening. He repeats this perflation at each dressing. He claims good results and asserts that he has never seen any bad effects or discomfort.

Thoracotomy

The operation of opening into the pleural cavity through an intercostal space and inserting a drainage tube (Thoracotomy) may be considered to be indicated under the following circumstances.

Indications
for

Where aspiration has not been successful, or where on aspiration, no pus can be got away. Occasionally the latter does occur, and it may be due to the canula not having reached the purulent accumulation, or through it being persistently blocked by means of fibrin: here alteration of the site of entrance should be tried. In very rare cases (and these must be of very old standing) the explanation is, that the lung is not able to expand and that there is great rigidity of the diaphragm and costal parietes. The operation is further indicated when there is pointing of the pus, in order to prevent sepsis and any

any possibility of burrowing.

Where the pus is fœtid from any cause it is indicated: so also when a bronchial fistula has been established and there is no likelihood of a natural cure taking place.

Thoracotomy
in
Bronchial
Fistula

In this last class of case I believe we should not be in a hurry to operate, even if air has entered the pleural cavity, forming a pyo-pneumothorax. Cure often does take place after a bronchial fistula has been established, and I shall give two cases in illustration, one of which I was able to follow pretty closely. In both the ultimate result was all that could be desired.

Case IV. A man aged 44, housekeeper in a large public building, was first seen on the 16th December, 1896. He was then complaining of severe pain in the Epigastrium, accompanied by a rise in temperature and quick breathing. He had previously been treated for Influenza. A physical examination revealed nothing, and some morphia was injected with great relief.

The question arises, when one considers the subsequent history of this case, whether this pain did not indicate either diaphragmatic pleurisy, or the pain of an ordinary pleuritis mis-referred. For several

several days afterwards, he seemed much better, but the temperature still remained up. Physical examination now revealed some dulness on the right side, and this gradually became more and more pronounced. On the 25th December he was complaining of shortness of breath, sweatings, cough and loss of flesh. Some pain also, was felt over the Infra-scapular area on the right side. The temperature was 101° : pulse 94: in appearance he was decidedly run down and thin. Physical examination of the front of the chest on the left side revealed nothing but some exaggerated vesicular breathing and an occasional rhonchus and crepitation, enough to account for the cough. He is the subject of slight chronic bronchitis. Percussion over the right apex was tympanitic and the breathing broncho-vesicular in character. Physical examination of the back of the left side gave a somewhat hyperresonant percussion note with exaggerated respiratory murmur. On examining the right side, one was at once struck by the appearance of bulging, extending from the infra-scapular region to the base of the lung. There was total loss of movement of this part of the thoracic wall, during respiration: the intercostal depressions had also gone. Palpation over

over this area revealed total immobility and total absence of vocal fremitus. Percussion from the base posteriorly to about 2 inches from the angle of the scapula, gave a note which was absolutely toneless and with a very resistant feeling: above this the note gradually improved, until above the level of the angle of the scapula it became resonant. This dullness extended round to a line corresponding with the anterior axillary fold. It was highest in the axilla, but fell away both in front and behind. Change in position made no difference in the dullness. Auscultation showed total loss of breath sounds, until the infra-scapular region was reached, when the breathing assumed a tubular character: there was absolutely no vocal resonance in the dull area. The temperature showed variations between 100° and 102° and as pus was obtained on an exploratory puncture, the diagnosis of Empyema was arrived at. On the 27th December after all due precautions, aspiration was performed. I entered in the line of the posterior axillary fold between the eighth and ninth ribs. The canula being moved about in all directions, 40 ounces of pus were removed. The pus was wholly purulent, with no fibrinous matter and perfectly sweet. The wound was

was closed with collodion. I desisted from removing any more pus, as some faintness came on and the patient began to cough violently. On the evening of the same day the temperature was 98.8: he had partaken of his dinner and tea with great relish. The condition of the chest was vastly improved, the percussion note being very much clearer, although at the base it still remained quite dull. His condition showed improvement for three to four days, when his expectoration, which up to this had been white and frothy, became somewhat purulent. His temperature too, began to go up again, while the dulness increased. Six days after the aspiration he had a slight tickling in his throat and there came on an attack of coughing, lasting an hour, and accompanied by the expectoration of large quantities of pus, which made him think he was choking: it simply welled up into his mouth. Altogether he must have brought up over 20 ounces altogether. On the following day his temperature was 99.8° in the morning: 100° in the evening. The cough did not trouble him again until the next day, when it once more started, accompanied by the expectoration of pus, and continued all day. From this time until the 8th January,

January, his condition showed gradual improvement, the temperature rarely going beyond 100° . The cough would cease at times, but recurred at intervals, and he would then expectorate large but diminishing quantities of pus. On the 8th, physical examination showed the condition to be greatly changed for the better: expansion was good and breath sounds could be heard distinctly, except at the extreme base. At 5 p.m. he had again a sudden suffocative attack of coughing and about 10 ounces of pus were discharged. From the 9th to 20th January, there was gradual daily improvement, vocal fremitus becoming better and better. The temperature now rarely rose above 99.2° : he was given grs. II of Quinine, four times daily. January 20th to 25th: allowed out for one hour daily: chest moves as freely as its fellow: sounds are heard all over it, with the exception of a space three fingers breadth in size at the base posteriorly, where the percussion note is absolutely dull. Expectoration white and frothy except in the evenings and early morning when it became purulent and easily brought up. January 24th to February 4th: the temperature now varies between normal and 99° : general condition is

is excellent, and the patient is gaining weight rapidly: no sweating. Percussion and auscultation still further improved: the percussion note is only slightly duller than on the good side, and breath sounds are heard all over except at the extreme base. The expectoration is daily getting less, practically no pus being brought up. He was seen in April, and he stated he felt as well as he ever did: it was difficult to make out any difference between the two sides.

Case VIII. Dr James' Series. A man aged 54 was admitted July 5th, 1895, into Ward XXX.R.I.E. complaining of shortness of breath, cough and foetid spit. The duration of illness was stated to be seven weeks, and had followed on a pain in the left side. Between two and three weeks after he first became ill, he had a severe attack of coughing and then expectorated a yellow spit tinged with brown, which had a very bad smell. This time he must have brought up about 4 ounces. This cough and spit continued more or less, along with severe shortness of breath. When he was admitted, the foetid spit was still present and on microscopical examination it showed Streptococci and Diplococci but no

no Tubercle bacilli. Physical examination on the left side revealed an impaired percussion note from the apex to the infra-spinous region, on a level with the sixth dorsal vertebra: there was diminished vocal resonance and vocal fremitus in this area with faint bronchial breathing accompanied with some crepitations. The diagnosis arrived at was Left Apical Pneumonia, followed by Empyema which had ruptured into the lung. On July 7th, he felt a sudden inclination to cough, and then brought up about 15 ounces of very foetid purulent matter. On July 9th, another attack of coughing came on, but the expectoration was less in amount. July 13th: a recurrence of coughing, but the amount brought up was comparatively little. From the 13th to the 23rd July, he had no attacks of coughing. July 30th: cough and spit practically nil and hardly any foetor. He was discharged on August 6th, much improved: there was absolutely no foetor in the spit. On August 14th, he again presented himself and reported he had had no cough or spit since dismissal. Physical examination showed dulness over the affected area to be much less, and the breath sounds were practically the same on both sides. The only treatment employed was Intra-tracheal

Intra-tracheal injections of Menthol.

It is not always that such a favourable result follows the formation of a bronchial fistula. Very often it happens that the suppuration continues long and protracted and gives rise to risk to death from hectic or waxy disease, while in children through the sputum being swallowed, diarrhœa may ensue.

The plan of procedure I would recommend in cases of bronchial fistula is as follows. Do not be in too great a hurry to interfere, allowing especially more time to an adult than to a child. Be guided by the condition of the lung, which we should examine daily, watching whether the dulness is decreasing: and also by the nature of the expectoration. The degree of fever and the patient's general condition must also be considered. In children I would be inclined, if there were no improvement in a week, to open the thorax and drain, on account of the risk of diarrhœa supervening, and of the risk of fatal asphyxia if air should enter the pleural cavity.

Thoracotomy
in
Putrid
Cases

It seems so evident why Thoracotomy should be carried out in fetid Empyema, that it is almost unnecessary to discuss it. However much we might

might try to empty the thorax by aspiration, some of the pus would always be left behind, and from the fact of its being fœtid, the severe hectic which is usually present, would still continue. Apart from this, it is quite possible that such pus from its nature may exert a more devitalising action upon the surrounding structures, and give rise therefore to a greater liability to perforation of the lung and diaphragm etc. Drainage of a fœtid Empyema (i.e., where there is no bronchial fistula) is the only way in which we can hope for a cure, because by this means we give free vent to the fœtid pus.

Site
chosen for
Incision

The site chosen for incision should be low down and somewhat posterior. We thus ensure the best drainage, since the patient generally lies on his back. A low opening gives a further advantage in that it aids in getting rid of the solid masses in the pus, which tend to fall to the bottom of the cavity, and we can often remove some of these masses by means of dressing forceps.

In a line with the posterior fold of the axilla, is I think the best situation for two reasons, viz., it is easily got at for dressing and it enables us during the dressing to occasionally turn the patient slightly

Site for
Incision
in
Empyema
Necessi-
tatis

slightly over the bed, as it were, and so assist in getting away the pus. Some even go further back than the line of the posterior axillary fold, when making the incision. There are differences of opinion with regard to the intercostal space we should select. In my operations I selected the seventh or eighth space, and on one occasion when I entered the pleural cavity behind the posterior axillary fold, I chose the ninth space. It has been stated in objection to going too low down, that we might injure the diaphragm or liver. I cannot see how this can occur if the operation is done carefully and in a proper fashion: from the shape of the liver and diaphragm, we are bound at the lower part of the pleural cavity, to have an appreciable amount of pus between the costal wall and these structures. In most of Dr James' Cases also, the opening was made at the above-mentioned intercostal spaces. Of course, as in aspiration we are guided to our final decision by the condition of things revealed by the physical examination.

Site for
Incision
in
Empyema
Necessi-
tatis

In an Empyema Necessitatis we do not always enter the pleural cavity at the sites I have just given: our choice will depend entirely upon the

the place of pointing. If the pus be pointing in the lower part of the thorax, it is undoubtedly the best plan to open there, simply making an incision through the skin and endeavouring to get the opening in the pleura, by letting the drainage-tube go its own way, so to speak. We are thus often enabled to follow the track made by the pus, and so reach the pleural cavity. But it is when the pus is pointing at the upper part of the thorax, that the question arises as to where we should make our incision.

Many recommend that we should open at the point where the pus is showing itself, and undoubtedly this is often quite sufficient. I shall give here a short account of a case which I had the opportunity of seeing, where this was borne out.

Case III. I was called in to administer chloroform to a little boy aged 8 years, who, as a sequel to Pneumonia had developed an Empyema. It was on the left side and had manifested itself about three weeks after the Pneumonic crisis. There was great displacement of the heart to the right side. A fluctuating tumour was apparent in the region of the left nipple: over it the skin was red and thin, and it pulsated visibly with each beat of the heart.

heart. This tumour was incised and at least 30 ounces of pus escaped. A drainage-tube 5 inches long was inserted and the wound dressed antiseptically. There was a free discharge and the wound was dressed daily for the first week, after this being dressed every second or third day. The tube was occasionally removed whenever it appeared to be foul, and a fresh one inserted. According to the notes I obtained from the Doctor in charge, the tube was kept in for 3 weeks, when the wound closed and a perfect recovery resulted. Three months afterwards, the boy was looking strong and healthy: the lung was acting well and faint vesicular breathing could be heard over the base: there was, however, some slight retraction and falling in of the side.

But others hold that a second opening is necessary in the usual position, so that thorough drainage may be ensured: while still others maintain that the low opening is alone quite sufficient. My own idea is, that we should first perform an ordinary Thoracotomy and then incise where the Empyema is pointing. One would imagine that having made the lower opening, there would be no risk of a spontaneous high opening. But according to several

Steps of the Operation
several authorities this does often occur, and besides, the pus that has infiltrated the tissues may do harm if not removed by incision. This wound should heal rapidly.

Description of the Operation

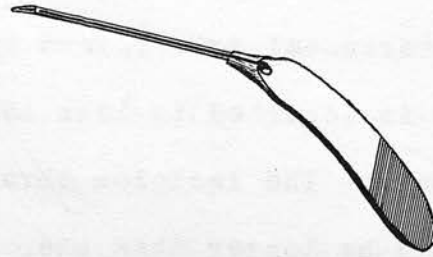
What I have already said about the aseptic condition of everything used in aspiration, applies with equal force here. Everything must be scrupulously clean, instruments, hands, and patient's side. On one occasion I did the operation without administering any anæsthetic, merely employing a 1 per cent solution of Cocaine after Ehrlich's method: but the mental condition of the patient, when I introduced my finger into the pleural cavity, was such as to greatly interfere with the operation. There is no doubt that chloroform is the anæsthetic we should use: never under any circumstances employ ether. Already the breathing is affected and with ether the mucus and saliva would be apt to collect in the throat and bronchial tubes. Another element of danger with ether is that it frequently causes impeded aeration of the blood. The chloroform should be given with great care and only lightly: as soon as the pleural cavity is entered and the finger swept round, cease at once the further

Anæsthetic should be Chloroform

Steps of
the
Operation

further administration. The site for incision having been chosen, the skin and muscles are divided to the extent of $1\frac{1}{2}$ to 2 inches. It is usually advised to go carefully along the upper border of the lower rib of the selected interspace. I fail to see any reason for so doing. It seems to me that if we keep strictly to the middle of the space, no harm can happen to the intercostal artery, and by doing this, the tube when it is inserted is less likely to cause injurious pressure. The incision through the skin and muscles should be longer than the one we make in the pleura, as by this means we tend to prevent the occurrence of surgical emphysema and of burrowing of the pus along the cellular tissues. When the pleura is reached we should endeavour, if possible, to get hold of it with a pair of dissecting forceps and to draw it out slightly through the skin incision. If we can manage this, the membrane is cautiously snipped with a pair of scissors and a grooved director introduced. Should we fail to draw the pleura slightly out of the wound, the point of a knife is just allowed to pierce it and no more, and then through this little opening the grooved director is passed as before. The incision in the pleura is

Further administration. The size for incision having been chosen, the skin and muscles are divided to the extent of 1/2 to 3 inches. It is usually advised to go carefully along the upper border of the lower rib of the selected interspace. It fails to see any reason for so doing. It seems to me that it



occurrence of surgical emphysema and of burrowing of the gas along the cellular tissues. When the pleura is reached we should endeavour, if possible, to get hold of it with a pair of dissecting forceps and to draw it out slightly through the skin incision. If we can manage this, the membrane is cautiously stripped with a pair of scissors and a grooved director introduced. Should we fail to draw the pleura slightly out of the wound, the point of a knife is just allowed to pierce it and no more, and then through this little opening the grooved director is passed as before. The incision in the pleura is

is completed to the desired extent by a probe-pointed bistoury, the blade of which must be held parallel to the ribs. Never under any circumstances are we warranted in plunging a knife into the pleural cavity: if we were to do so, there is no knowing how much mischief might be done.

The instrument which I have figured on the opposite page, is one which I think might prove very useful in this operation. It is recommended by Garland. It is simply a needle-pointed director which is grooved, having a flat handle bent at an angle of 45° . In using it the director is pushed through the intercostal space chosen, keeping close to the costal surface when once it has reached the pleural cavity. The groove would here serve a double purpose: it would act as a trough along which the pus could flow as soon as it had entered the pleural cavity, (so acting as an exploratory needle) and it also would serve as a guide to the knife.


The knife is prevented from cutting the lung or other structures, by the presence of a little bridge just at the back of the point. The next step in the operation is the introduction of a finger into the pleural cavity, sweeping it round to find out the

Intro-
duction of
the
Finger

the condition of affairs internally and to break down walls of loculi, should any be present. At this stage the administration of the chloroform should be ceased. Very often, especially should the patient begin coughing, the lung can be felt by the finger to expand soemwhat. How this is brought about I shall describe later on. The finger should now be withdrawn, and as we do so a pair of sinus forceps should be introduced, so that by opening or closing them, we can limit to a certain extent the degree of rapidity with which the pus escapes. By a judicious use of the forceps too, directing them specially towards the bottom of the cavity we are frequently enabled to get away large masses of fibrin which would be very liable to block the drainage tube afterwards.

The next thing is the introduction of a drainage tube. I believe strongly that by means of a proper tube, we can get perfect drainage and cure of the case without having to perform Excision of a Rib. Why is it that excision of a portion of rib is advised? Because it is stated that frequently, especially in children, the space between two ribs is not large enough to allow free drainage and that

Intro-
duction
of
Drainage-
tube

that the ribs, should retraction take place, will approximate and occlude the opening of a flexible tube. Hence solid canula have been employed but the objection to their use is that they cause great pain and even caries of a rib. In all the cases in which I have performed Thoracotomy and used the tube which I am about to describe, I got none of these bad results, the drainage being perfect, the patient in no way complaining of pain from the tube and no caries of the rib occurring. The tube was after a pattern obtained from Messrs Hawksley of London. It is made in two sizes, large and small, for adults and children respectively. It consists of two parts which we may designate the shield and the neck. The shield is of thick silver wire and is of service in preventing the tube from slipping into the thoracic cavity. It is so arranged as to be perfectly mobile and thus, with each movement of the ribs the neck can move with them, and any possible irritation is diminished. The neck is made of silver about the thickness of a sixpence and on section is of this shape,  so as not to take up too much room between the ribs. It is somewhat under half an inch in length and over it is slipped a rubber drainage

Form of
Tube used

drainage tube. The rubber drainage tube does not require to be too long - two to three inches is quite sufficient. We guard against it slipping off the neck by passing a silk thread through it, and this is made fast to the shield.

Mode of
Dressing

A little Iodoform should be dusted about the wound: then two or three layers of moistened antiseptic gauze should be placed between the shield and the lips of the wound, to prevent any irritation. The shield is made fast to the side, by thin strips of creolin plaster. The dressing proper should consist of several layers of antiseptic gauze (I prefer cyanide gauze) and these should be of a good size, so as to prevent any possibility of their being drawn in through the tube into the pleural cavity, as has been known to occur. It is sometimes advised, that a piece of macintosh larger than the antiseptic gauze, should next be applied, so as to overlap all round. It is said that this macintosh applying itself firmly to the skin all about the dressing, allows air to escape during coughing or other exertion, at the same time tending to prevent any ingress of air and favouring expansion of the lung. What I have always done myself, has been to

After
Treatment

to apply the absorbent dressing immediately on the top of the antiseptic gauze, using for this purpose several layers of Hartmann's absorbent sterilized wood-wool. Finally the whole dressing is secured firmly by means of bandages. The bandages require to be firmly applied, more especially towards the margins of the dressing, otherwise the discharge is apt to run down between the dressing and the skin. Besides, if firm pressure be not applied, with the saturation of the dressing and the movements of the patient, the dressing may slip away from the wound. I have always found the application of an elastic bandage to answer admirably, as by it we get firm accurate pressure and at the same time allow air to escape from the pleural cavity, by the forcible effort of coughing, more readily than it can regain entrance. The patient is advised to lie a good deal on the affected side, for thus better drainage is obtained.

The dressing should be changed as soon as it becomes saturated: frequently we require to do it at least twice a day for the first few days, but not so often afterwards. Great care must be exercised when we remove the gauze dressing from the wound:

After
Treatment
Expansion
of the
Lung
occurs

wound: we should have a fresh dressing in readiness to apply at once, as soon as the old one is removed. We should therefore have the fresh gauze in our right hand, letting the little finger rest just at the margin of the wound: with our left hand the soiled dressing is removed and the fresh one immediately takes its place. The patient is directed to hold his breath during this manœuvre. Sometimes the tissues about the wound tend to become puffy and œdematous, with unhealthy granulations. This should not occur if proper care be taken with the dressing, but if so, the granulations must be touched up with blue stone or such like. Should it be necessary to interfere with the tube, say for blocking or in order to remove fibrinous masses from the pleuritic cavity, everything should be done as much as possible with the opening of the tube guarded by gauze. The reason for this care is, that we seek to prevent entrance of air as far as possible, thus lessening the risk of the pleural contents becoming septic.

In our form of dressing and in its repeated applications we should, if it is in our power, favour expansion of the lung. By expansion of the lung there is diminution of the space where the pus

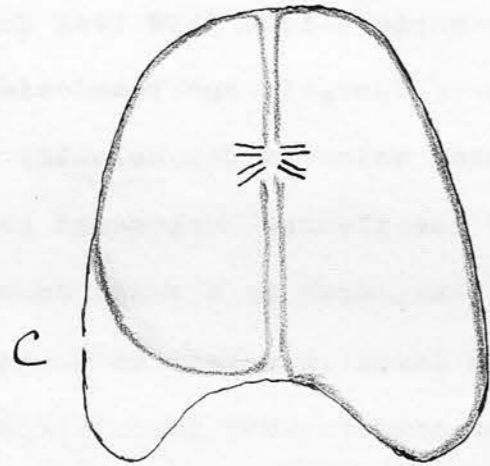
How
Expansion
of the
Lung
occurs

pus can form and collect: the expulsion of the pleural contents more especially at the base of the cavity is favoured, and the chances of retraction of the chest occurring are greatly diminished. Now, how does expansion of the lung take place when there is an opening in the thoracic wall? Undoubtedly it can occur, for at the time of operating on an Empyema, the finger in the pleural cavity can often feel the lung expand. This is due to the lung expanding by virtue of its resiliency (when it has been not only collapsed but pressed on) aided to some extent by the partial re-establishment of its circulation. But these two factors must aid to only a slight degree. Inspiratory efforts can not have any effect upon the lung because the external opening is large and free. We are thus driven to the conclusion that expiratory efforts must be the cause. It is not at all difficult to understand how they work. Say the patient coughs, the chest wall contracts: the glottis being closed air is pressed by this contraction from the good lung over into the affected one and expansion occurs. At the same time the contraction of the costal parietes on the affected side acts on the air and pus in the pleural

pleural cavity, and they are to some extent expelled. Of course, when the cough has ceased and the chest wall again expands, air rushes in and we get no further advanced than we were. But, when all goes well after a Thoracotomy we almost invariably find that the lung maintains some of the advantage it gains during these forced expiratory efforts. Many ingenious explanations have been given to elucidate this. Thus, it has been said to result from the cohesion which exists normally between the two layers of the pleura. Although there is evidence to show that there is a cohesion existing between the two layers of the pleura, yet experiments show that under normal conditions this pleural cohesion cannot resist the retractile power of the lung. It is possible however, this pleural cohesion may be increased in diseased conditions. Another explanation offered is by O'Dwyer, and it is, viz., that all the air which is forced into the pulmonary alveoli cannot wholly and immediately escape, and that perhaps there is a certain amount of attraction between the oxygen of the air and the hæmoglobin of the blood in the pulmonary capillaries, which might exercise a certain restraining power on the air.

physical cavity, and they are to some extent expelled. Of course, when the cough has ceased and the chest will again expand, air rushes in and we get no further advanced than we were. But when all goes

Diagram to show how the lung maintains some expansion after forced expiration, through the difficulty of air entering by the opening C, when the dressing is carefully and closely applied.



may be increased in diseased conditions. Another explanation offered is by O'Dwyer, and it is that all the air which is forced into the pulmonary vessels cannot wholly and immediately escape, and that perhaps there is a certain amount of attraction between the oxygen of the air and the hemoglobin of the blood in the pulmonary capillaries, which might exercise a certain restraining power on the air.

air. Again, it has been suggested that a lung which has been long compressed, may have temporarily lost much of its retractility. Although it is possible all these causes which I have just given may aid to some extent in preventing the lung from again collapsing, it appears to me that we do not require to seek so far for the main cause. There are two channels by which air reaches the chest during inspiration after a cough, viz., the bronchi and the opening in the pleura. If these two channels were allowed to remain equally patent, the lung would go back to its condition of collapse. But by our dressing accurately and closely applied over the wound in the thorax, we make it difficult for air to enter here. The result is that the air chooses the readier entrance by the bronchi and the lessened pressure in the pleural cavity maintains some expansion of the lung, that is, overcomes some of the retractile power of the lung. The repetition of forced expiratory efforts thus brings about gradual and more or less complete expansion. Thus, the pleural surfaces come into contact, adhesions form and assist in bringing about a cure: if they should form before expansion is complete they are harmful and retraction

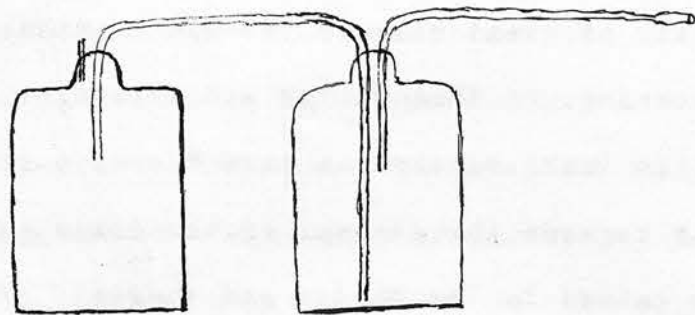
retraction of the chest wall takes place. Hence the necessity of great care in the close application of the dressing, so that we may aid expansion and assist in bringing about a more speedy cure.

Removal
of
the Tube

As regards the removal of the drainage tube we are guided by the nature and quantity of the discharge and by the extent of the cavity in the pleura. Small size of the cavity, the discharge changing its character from purulent to serous and becoming small in quantity are our guides. Dr James, who very rarely resorts to any other operative procedure than Thoracotomy, gives as the average duration of time for the retention of the drainage tube, two to three weeks.

After-
treatment

The patient if progressing at all favourably, should not be kept too long in bed, and there is no reason why he should not be allowed to go out, if all is going well, even if the tube be still in. Milk is of great value in these cases, so also is pure air and hence the reason for sending the patient out as soon as possible. It is a very good thing to instruct the patient to take several deep inspirations during the day, and an exceedingly useful procedure is to order the patient to daily blow water



water from one bottle to another by an arrangement of tubes, as this aids lung expansion. Should retraction occur, it is often of great advantage to advise light dumb-bell and gymnastic exercises, with the view of favouring the lung expansion and of strengthening the muscles on the affected side. I may remark in passing, that it is wonderful how pronounced retraction may disappear in course of time.

Irrigation

As yet I have said nothing about the advisability of using irrigation in Thoracotomy. This was formerly always employed both at the time of the operation and at the subsequent dressings. It is interesting to note the various substances which have been lauded for irrigation. Oil and wine were used by Hippocrates and honey and water by Galen. In later times, lotions of nitrate of silver, hyposulphite of soda, chloride of sodium, permanganate of potash, eucalyptus, iodine, quinine, salicylic acid, biborate of soda, carbolic acid and perchloride of mercury and many others too numerous to mention, were employed. Some of these undoubtedly had much to recommend them, while others, experience showed, were hurtful rather than beneficial. Thus, permanganate of potash is of little use in preventing sepsis

After-treatment

in quantity are our guides. Dr. James, who very rarely resorts to any other operative procedure than Thoracotomy, gives as the average duration of time for the retention of the drainage tube two to three weeks. The patient is progressing as all favourably, should not be kept too long in bed, and there is no reason why he should not be allowed to go out, if all is going well, even if the tube be still in. With it of great value in these cases, so also is pure air and hence the reason for sending the patient out as soon as possible. It is a very good thing to instruct the patient to take several deep inspirations during the day, and an exceedingly useful procedure is to order the patient to daily blow water

sepsis and is liable to form a solid precipitate at the bottom of the cavity: solutions of iodine have caused iodism and injured the tube. Gradually however, irrigation became less and less used, as it was found to be sometimes very dangerous causing "pleural epilepsy" and other grave conditions, even sudden death. The results of Runeberg prove, I think conclusively, that apart from being dangerous to the patient, irrigation also tends to prolong the suppurative process in a simple non-fœtid Emyema. From 1876 to 1880, all his cases of Emyema were irrigated daily: the average duration of each case was 101 days and there were 30 per cent of cures. From 1883 to 1885, one irrigation at the operation only, was done in all his cases: the average duration now decreased to 84 days and there were 70 per cent of cures. From 1885 to 1890, irrigation was entirely discarded by him except in putrid cases: the average duration now fell to 52 days and there were 96 per cent cured. Instead therefore, of employing irrigation in simple non-fœtid cases, the following plan has been recommended to assist in getting rid of the pus. The patient lies as much as possible on the affected side. Four times daily

daily during the first week, and later two to three times daily, the patient is lifted by an attendant in the following ways. While in the lateral posture he is raised by the trunk and lower extremities so as to rest for a few moments upon the shoulder: this ensures drainage from below. Then he is lifted by the shoulders to ensure drainage from above, and finally the first movement is again repeated. Such a postural method might, I think, be of some advantage in a few cases where the drainage was defective.

Irrigation
necessary
in Fœtid
Cases

Irrigation is however, most distinctly indicated in fœtid Empyemata. It might also prove valuable I think, when employed to a modified extent in those cases where there are large masses of fibrin at the bottom of the cavity which are not escaping by the tubes, or where the pus is thick and tenacious, and also in a few tubercular cases. The best irrigation solution I have found to be corrosive sublimate 1-5000: it must not be stronger or there will be danger of absorption of the mercury. A reference to the table of cases shows the employment of irrigation in two of them: one, Case V. was under my own care: it was distinctly tubercular in origin and undoubtedly irrigation was beneficial. The method I employed

employed with him answered admirably. The lotion, a 1 in 5000 solution of corrosive sublimate was at a temperature of 100^oF: the lad was directed to lie on his back and the lotion was allowed to run in slowly from a height (care being taken that no air entered, and that too great a fall was not employed). Altogether from 15 to 20 ounces were allowed to run in and then the patient was turned on his side, so that the opening in the chest was really over the edge of the bed: thus the lotion ran out bringing with it a considerable quantity of pus and fibrin. If the tube got blocked during this procedure, we removed it altogether and let the contents of the chest escape through the opening itself. Some recommend that in the washing out of a fœtid Empyema, a catheter should be used which can be directed into all the spaces where the pus is likely to gather, especially in the space between the diaphragm and the ribs: I believe this is unnecessary. Another method recommended is the insertion of two tubes of unequal length: the lotion is allowed to run in at the shorter one and as a result flows out by the longer tube. There are said to be a few exceptionally rare cases where some of the discharge gets

gets gathered up in nooks and crannies. In such, after having tried all other means it is recommended to have resort to a counter opening: a curved probe is passed in at the opening already made, and caused to project at some lower point where it is then cut down upon, and after all bleeding is stopped, the tube is carried through both openings.

Dangers in
the
Operation
of
Thoracotomy

With regard to the dangers of Thoracotomy, everything depends upon the care with which the operation is done and the subsequent dressings performed. The chief danger is that of the pus becoming septic. The cause generally lies in some fault in our asepsis and therefore every precaution must be taken with the instruments, drainage tubing, dressings, hands, etc., not only at the initial operation but at every subsequent dressing. Gradual marasmus and exhaustion may occur through the discharge being excessive and prolonged, leading to lardaceous disease. Such a discharge must be due to the non-obliteration of the cavity and is really of exceptional occurrence in properly treated cases. In such cases irrigation would be indicated, employing stimulating lotions, such as solution of iodine (1 part of the tincture to 4 of water with 1 per


per cent of iodide of potassium). Iodine is used for the same reason that it is employed in intractible hydrocele, viz., to excite inflammation and so obliterate the cavity by causing adhesions. A counter opening will occasionally also be beneficial. It has seemed to me that, as the non-obliteration of the cavity, where the lung refuses to expand, must be due to rigidity of the chest wall, we might be justified in trying curettage of the costal pleural surface. By this the chest wall might be enabled to fall in, through some of the greatly thickened pleura being removed, and at the same time we would get a healthier surface and so a better chance of adhesions forming. Fatal hæmorrhage from an intercostal artery is stated to have occurred as a result of Thoracotomy. Such an accident would indicate some fault on our own part, although it must not be forgotten that occasionally one comes across an intercostal artery abnormally placed. Emphysema of the cellular tissue and infiltration of the integuments with pus, may very rarely ensue. We prevent to a great extent any such occurrence by making the pleural incision less in size than the one which goes through the skin and muscles, and by having a

a well-fitting tube which is maintained accurately in position by suitable strapping. Caries of the rib most authorities assert, nearly always results from using a solid drainage tube: as I have already said I have not seen this occur in any of my cases. I consider the flattened shape of the tube I use tends greatly to prevent this, as well as the presence of the rubber tube over it.

Results
obtained
by
Thoracotomy

Following upon the performance of the operation, there is decline in the fever, accompanied by a fall in the pulse and respiratory rates. It must be noted that the fever does not always subside rapidly, probably on account of some inflamed condition of the lung and pleura being present: however, this is the exception and not the rule. A free exit for the pus and fibrinous matter is obtained, and the amount of pus will be found to diminish rapidly, and very frequently a change in its character takes place becoming sero-purulent and then serous. What we hope for most of all is expansion of the lung and thus obliteration of the cavity, and undoubtedly this very frequently occurs as is seen in Cases VI. and VIII. Less happy results follow when the lung does not re-expand and retraction takes place. Still when

when retraction does occur, one should not be too despondent, as very frequently in the course of time, even in months, there may be recovery of the lung expansion and with it disappearance of the retraction. This was certainly what took place in Case VII. A glance at the Tables I have given at the end, shows that the ultimate result in my three cases, where I performed Thoracotomy, was eminently satisfactory.

Dr James in one of his cases No. IX. performed what may be termed a Modified Thoracotomy. The patient, a woman aged 35 had a primary foetid Epyema on the right side. A bronchial fistula had become established and she was expectorating large quantities of stinking pus. The absolute dulness extends as high as the eighth dorsal vertebra behind. She was given chloroform, and into the marked dull area posteriorly a trocar and canula of the size  was introduced at a point in the tenth interspace, 5 inches posterior to the posterior axillary line. A drainage tube 5 inches long was inserted through the canula which was then withdrawn. The drainage tube answered admirably and did not get blocked. On the

the 16th day after the tube was introduced it was removed, and the patient left the Hospital cured, all that remained being some dulness at the base, probably through thickened pleura.

Thoracotomy
with
Excision of
Rib

We now come to another method of treatment recommended in Empyema, Viz., Thoracotomy plus the excision or resection of a portion of a rib.

Description
of the
Operation

Before discussing its value, I think it will be well for me to describe the operation. Chloroform should be administered with great care, and all aseptic precautions employed. An incision, two to two and a half inches long is made over the rib selected, through the skin, and the bone is carefully cut down upon. The soft structures are now held widely apart by means of retractors. The next step is to carefully strip the periosteum off the rib by means of a periosteum elevator, over an area corresponding to the skin incision. The excision is done by means of suitable bone forceps. All bleeding is now stopped and the further steps in the operation are exactly as described under Thoracotomy.

Discussion
of
Treatment
by
Excision

Many eminent authorities assert that treatment of an Empyema by excision of a portion of a rib,

rib, should be the only method employed. I have endeavoured to the best of my ability to show that aspiration or simple incision is in many cases all that is required: and I have also advanced arguments in favour of the more extended use of these two methods, more especially the former. Those who recommend excision of a rib, maintain that by it freer drainage can be obtained and that there is no possible risk of occlusion of the drainage tube by pressure. But is this so? Garland states that when an inch of rib is removed, the cut ends immediately drop together, so that really no more space is left than formerly existed, and all that is obtained is a broken rib in addition to the other casualties of the case. While not going so far as this, I believe that the space gained by excision is not so great as is generally supposed, and also that the cut ends of the rib may set up some local irritation. Simple Thoracotomy with a rigid tube is stated to give rise to caries, though my own experience does not bear this out: but even if caries does take place, we can remove the diseased bone and turn the case into one similar to an excision. I hold too, that good drainage can be obtained in

in simple Thoracotomy. But I think a great objection to the operation of excision is, that by it we increase the probability of retraction taking place: for when we excise a portion of a rib, there is a weak point in the thoracic wall and the whole side tends to fall in somewhat. Another objection is the great risk there is, when we remove the tube to allow the opening to close, of a mass of callus being thrown out by the periosteum which may bind together several of the ribs and so interfere with the action of the chest wall. My last objection to excision is, that an opening has been established which we cannot get to close so readily as a simple incision and thus the case is more prolonged.

Treatment
of Empyema
by
Excision
of
Portions
of
Several
Ribs

The method of treatment known as Estlander's Operation or Thoracoplasty consists in the removal of the bony wall of the chest over an area corresponding to the cavity in the pleura, thus allowing the soft parts of the chest wall to come into contact with the surface of the lung. This has to be resorted to in those cases in which the Empyema continues to discharge for months after trying the methods of treatment already described. Such a result is due to the non-expansion of the lung and to

to rigidity of the chest wall, so that the pleural surfaces cannot come together and so obliterate the cavity of the Empyema. It has seemed to me that one important factor in the non-obliteration of the cavity may be, that the ribs are prevented from falling in by the greatly thickened pleura, and in the performance of Estlander's Operation, it is always recommended to remove this along with the portions of ribs excised. Might we not therefore in cases where this severe operation is indicated, try in the first instance if we could not do good by curetting the costal pleura. The two difficulties which make themselves at once apparent are, firstly, the difficulty of getting at the surface to be curetted, and secondly, the fear of serious hæorrhage. With regard to the former we might, if necessary excise portions from one or even two ribs, and this would give us plenty of room. The risk of hæorrhage is not very great for the intercostal arteries are almost obliterated by the dense tissue formed.

Descript-
ion of
the
Operation

Should we decide upon Estlander's Operation, the first thing to be done is, to determine the size of the cavity, for according to its size will

will depend the size and number of the portions of ribs we excise: this is ascertained by careful probing. The size of the cavity being determined, an incision is made so as to expose fully the whole area from which the bone is to be removed. The incision may be vertical or in the form of a large flap. The ribs being exposed, the periosteum to the desired extent is freed from each one in the manner already described under "Excision of a Rib": we then remove by bone forceps the requisite amount from each rib. The next step is to remove by scissors the periosteum with the greatly thickened pleura. All bleeding having been stopped, the skin incision is brought together with sutures and a dressing applied. The after-treatment is as in any ordinary wound.

Before closing I may mention that I have seen a case where this operation had been performed. The patient, a man had been operated on at Bristol, seven months previously: there had existed ever since a certain amount of discharge. I used a probe and found it went straight in some little distance, and downwards for a considerable distance. On the whole the result of this case could not be called satisfactory.

FINIS.

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No	Sex	Age	Nature	Side	Extent	Length of Ill-ness before Interference	Methods of Treatment employed	Further Treatment	Result	Remarks.
I	F	24	Primary, foetid	Left	Moderate	5 Weeks	Aspiration: 22 ounces of stinking pus removed.			This patient left Hospital without further treatment. I think this a well-marked example of a primary foetid Empyema. From the imperfect after history which I obtained, the pus seemed to have burrowed, as an oedematous swelling appeared over the kidney, which proved to contain foetid pus.
II	F	5	Primary	Left	Moderate	11 Days	Aspiration twice in 8th interspace: 6 ounces the first time and 2 ounces the second. Thoracotomy in 8th interspace one week after Aspiration	Dressed the day after incision and then every 5 or 6 days: tube shortened slightly at each dressing: absolutely no discharge.	Cured	This Case proves possibility of spontaneous cure: Thoracotomy was unnecessary.
III	M	9	Sequel to Pneumonia. Empyema Necessitatis.	Left	Large	3 Weeks	Incised just under the nipple, where the pus was pointing: about 25 ozs. of pus escaped.	Drainage tube inserted: dressed every 2nd or 3rd day: tube occasionally replaced	Cured in 3 Weeks	An example of Pulsating Empyema, with satisfactory result from a high opening.
IV	M	44	Influenzal: Primary.	Right	Moderately large	12 Days	Aspirated between 8th and 9th ribs: 40 ounces of pus removed.	Bronchial Fistula became established after 6 days after Aspiration	Cured in about 5 Weeks	Result very satisfactory: no retraction of any kind. This case showed spontaneous cure with bronchial fistula: also peculiar intermittent expectoration of pus: no Pneumothorax.
V	M	13	Tubercular	Left	Large	Over 2 Mths.	Aspiration twice in 8th interspace: 25 ounces of pus the first time: about 30 ounces the second time: Thoracotomy in 8th interspace about 3 weeks after	Dressed twice daily for 3 weeks. Latterly irrigated daily with 1-5000 Sol. of Corrosive Sublimate	Died, 4 Mth after operation	Phthisis Pulmonalis present from the first. Thoracotomy established a permanent fistula with copious discharge: death resulted from Marasmus and Lardaceous Disease

No.	Sex	Age	Nature	Side	Extent	Length of Illness before Interference	Methods of Treatment employed	Further Treatment	Result	Remarks.
VI	M	36	Sequel to Influenzal Pneumonia	Right	Large	4 Weeks	Aspiration in 8th inter-space & 24 ozs. of pus removed. Thoracotomy in 8th inter-space 8 days afterwards: 50 ounces of pus escaped	Dressed at first twice daily: latterly once daily: free discharge with large masses of fibrin	Cured in a little over 4 weeks after incision	Very satisfactory result: follows occupation as brewer's carter: tube throughout answered admirably: no retraction.
VII	F	8	Sequel to Catarrhal Pneumonia	Right	Moderate	3½ weeks	Aspiration in 8th inter-space: 4½ ounces of pus removed. Thoracotomy 9 days after, in 8th inter-space, 4 ozs. of pus obtained	Dressed daily: only slight discharge	Cured in 4 weeks	Tube throughout answered admirably. A large amount of retraction took place: after 3 months this had diminished very much
VIII	F	20	Sequel to Pneumonia	Left	Large	20 Days	Aspiration once in 9th interspace. 37 ounces of pus removed. Thoracotomy in 8th inter-space, 7 days after: 22 ounces of pus escaped.	Dressed daily: free discharge with large masses of fibrin	Cured in 3 Weeks	Admirable result. Tube throughout answered very well.

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Dr JAMES' SERIES.

No.	Sex	Age	Nature	Side	Extent	Length of Illness before Interference	Methods of Treatment employed	Further Treatment	Result	Remarks.
I	M	46	Following on Simple Pleurisy	Left	Moderately large	2 Months	Thoracotomy below 9th rib: 45 ounces of pus escaped	Dressed twice daily: fresh tube inserted: latterly cavity syringed with Boracic lotion	Died, 10 Days after operation	No Post-mortem. Hæmaturia developed before operation and increased after it.
II	M	49	Fœtid, following an injury	Right	Large	4 Weeks	Thoracotomy in 8th interspace: 80 ounces of pus escaped.	Dressed daily: large quantities of pus: marked bogginess of skin developed in region of incision	Died, 8 Days after operation	P.M. showed a large abscess cavity: no cause for fœtid condition discoverable. Before operation explored twice without any result except fœtid odour in syringe: the third time obtained fœtid pus, which microscopically showed Coccal Bacteria (Leptothrix).
III	M	32	Tubercular	Right	Moderate	Indefinite	Aspirated and 3 ounces of very thick creamy pus removed with difficulty.	None	Discharged after 2 months, relieved.	Marked Phthisis both apices. Examination of pus:- Dr Noel Paton found pus breaking down: oil globules: cholesterol crystals and no organisms. Dr Muir failed to find any organisms, even after cultivation.
IV	M	21	Nephritis present	Right	Large	12 Weeks	Aspirated & 30 ounces of pus removed: Thoracotomy in 8th interspace, 4 days after and 50 ounces of pus escaped.	Dressed as required	Died, 3 Days after operation	On evening of operation, great distension of abdomen came on, which gradually got worse. Oedema in back, legs and feet became excessive. No P.M.
V	M	26	Tubercular Empyema Necessitatis	Left	Moderately large	Unknown	Opened where pointing, and portion of 4th rib excised: 25 ounces of pus escaped.	Dressed daily: the tube occasionally removed through blocking	Died, 2 months after operation	A typical example of pulsating Empyema. After operation heart did not return to normal position. Death from Tubercular Meningitis and General Pulmonary Tuberculosis.

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No.	Sex	Age	Nature	Side	Extent	Length of Illness before Interference	Methods of Treatment employed	Further Treatment	Result	Remarks.
VI	F	5	Primary	Left	Small, localised at base.	2½ Weeks	Exploring needle in 4 different places obtained no pus: nothing further done.	Creosote internally	Cured	An example of Spontaneous cure.
VII	M	50	Tubercular (Primarily Sero-fibrinous)	Right and left	Right, large. left moderately large.	2½ Months	Right side aspirated 11 times. Left side (which developed 2 months after the right) aspirated 3 times and then Thoracotomy performed.	Dressed twice daily	Died, 5 Days after incision	P.M. revealed Tubercle in Lungs Peritoneum, Spleen and kidneys.
VIII.	M	54	Sequel to Pneumonia: Fœtid.	Left	Localised to upper part of chest, from apex to 6th D.V.	7 Weeks	Bronchial Fistula had been established: no operative treatment.	Intra-tracheal injections of Menthol.	Cured, 5 Weeks after admission	Spontaneous cure a bronchial fistula pus discharged intermittently and shed Streptococci and Diplococci: no Pneumothorax.
IX	F	35	Primary: Fœtid.	Right	Moderately large.	7 Weeks	10 ounces of fœtid pus removed by a large trocar and canula at 10th interspace, 5 inches posterior to axillary line, and a drainage tube inserted.	Dressed daily: tube removed in 16 days. Intra-tracheal injections.	Cured	A bronchial fistula existed before admission: Tube answered admirably. Result very satisfactory.