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THESIS for the Degree of M. D.

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" A Clinical Study of Pleural Effusions with
Special Reference to Diagnosis and
Treatment."

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M.B., Ch. B.



INTRODUCTION.

While a Resident Physician in the Royal Infirmary, Edinburgh, I studied a series of cases of Pleural effusions in adults, which illustrated many points of diagnostic difficulty. I resolved to treat the subject chiefly from a clinical standpoint, and as a House Physician in the Royal Hospital for Sick Children, Edinburgh, I continued my observations on the same pathological conditions in children and compared them when possible.

Pleural effusions may be serous, sero-fibrinous, haemorrhagic or purulent. Fluid effused into any of the serous cavities of the body is either the result of circulatory disturbances or of inflammatory processes. When the former is the cause, the elimination of water by the kidneys is diminished and the retained fluid collects in the serous sacs as Transudates. In the case of the latter where the pathologic process is of an inflammatory nature, fluid also collects in the serous sacs, and is known as an Exudate. While the causal influences which produce these two conditions are widely different, they often give rise to similar clinical manifestations, so that at times it may be difficult to determine to which group a given fluid belongs.

The pleural sacs in health contain just sufficient fluid to permit of the free movement of the visceral and parietal layers of the pleura upon one another.

Why does fluid accumulate in the pleural sacs and how is it got rid of when it is left alone?

These questions have been excellently answered by West as follows :- "The pleura is a lymph sac connected through the stomata or small pores with the lymphatics of the lungs on one side and of the thoracic walls/

walls on the other. The lymph trunks on both sides have valves directed away from the pleura. Such an arrangement of valves indicates a circulation and there is such a circulation of lymph in health through the pleural sac, lymph passing into the sac from the blood vessels and being removed by the lymphatics, and these processes are so adjusted that no fluid accumulates in the pleural sac. The sac is accordingly often described as dry, but it is not dry; it always contains a little fluid though not more than enough to keep the surface moist, for it is removed as fast as it enters.

This action may be called the "lymphatic pump". The movements of respiration work the pump. Inspiration sucks lymph in; expiration, by the help of the valves, drives it out; the direction of the lymphatic circulation being in the lungs from the pleura to the root of the lung and in the thoracic walls from the pleura to the adjacent lymphatic glands. Fluid might therefore accumulate in the pleura in two ways.

On the one hand, more fluid might enter than could be removed (this is what probably occurs in hydrops pleurae or dropsy); on the other hand, owing to some interference with the pump mechanism, less might be removed than is necessary. In inflammation of/
of/

of the pleura both causes are in action, the inflammation causing increased exudation, while the inflammatory swelling and fibrinous exudation choke the stomata, so that the fluid exuded cannot enter the lymphatics easily and be pumped away. When the effusion has reached a considerable size the direct pressure exercised by the fluid upon the stomata and superficial lymphatics creates a further obstruction. Lastly, a large effusion makes difficulties for itself by greatly reducing or abolishing the respiratory movements - that is to say, the force by which the lymphatic pump is worked. As the effusion grows in size, the respiratory movements on the affected side become less and less and ultimately cease, so that the pump stops working. When this point has been reached, even if the effusion increases no more, what is already in the pleura cannot be removed, for the pump does not work. Absorption might still act, but the small part which it plays is now obvious. The removal of some fluid now will start the pump again. Thus we have an explanation of what is otherwise not easy to understand, viz., the removal of only a few ounces of a large effusion being followed by the gradual disappearance of the rest."

SEROUS and SERO-FIBRINOUS EXUDATES.

The fluid is generally quite clear or opalescent, of a yellow or greenish colour, and without smell. Sometimes it is turbid from the presence of corpuscles. Not infrequently it contains a few flakes of fibrin, or on standing it coagulates, and a clot is produced which is generally rich in fibrin. It becomes solid on boiling from the albumin present. The fluid may develop a whitish colour if allowed to stand for some time.

The specific gravity varies from 1008 - 1025.

According to Halliburton² the "inflammatory effusions as compared with the dropsical are of higher specific gravity and are richer in proteids and in fibrin and approach more nearly to the constitution of lymph than serum".

Microscopically a few scattered red blood corpuscles, some polynuclear and lymphocytic cells and possibly a few endothelial cells may be found. In undoubted tubercular cases there is usually a predominance of lymphocytes.

TRANSUDATES.

Transudates are non-inflammatory, serous fluids and are practically free from red and white corpuscles. They are generally of straw colour, but sometimes sanguineous from the admixture of blood. They contain much albumin and are usually below 1010 in specific gravity. They do not coagulate spontaneously when allowed to stand.

Microscopically there may be a few endothelial cells.

In the following case, the fluid that developed on both sides of the chest was peculiar in many respects. - A girl, aged 9, came under my observation in December, 1908. She had a much enlarged liver (probably lymphosarcomatous) extending as low as the umbilicus. Soon there were signs of fluid in both sacs. Paracentesis of the right pleura required to be performed, 18 ounces of straw coloured fluid being withdrawn. This had all the characters of a transudate. About 7 weeks later the breathing had become so embarrassed that both sacs were tapped. The fluid had now a yellowish milky appearance and resembled chyle very much. 17 ounces were removed from each sac/

sac. A few days later Paracentesis of the left sac yielded $20\frac{1}{2}$ ounces of similar fluid.

The fluid was examined by Dr. James Ritchie, who reported as follows :-

"Specific gravity ... 1017

Reaction Alkaline.

Total Proteids - 7.93 per cent.

Globulin ... - 4.67 " "

Albumin ... - 3.26 " "

By the phosphorus test shows a small amount of lecithin, also slight traces of fat. No sugar present. The opalescence is probably due to the globulin in combination with the lecithin as has been shown in other cases".

PURULENT EXUDATES.

The characteristics of these vary considerably in different cases. They are usually of a creamy consistence and colour. But sometimes they are thin and turbid and on standing separate into two layers - a deposit of pus, and a supernatant turbid fluid. Such are sero-purulent.

The reaction is almost always alkaline.

They have generally a faint smell, but occasionally it may be extremely fetid, this being very characteristic of streptococcal empyemata in adults. In such cases the pus is of a dirty brown colour, which means the admixture of altered blood.

In pneumococcal empyemata the pus is viscid, of a greenish colour, without odour, and is said not to separate on standing into layers. In several of my cases I have found the reverse.

In Streptococcal empyemata the exudate is thinner, less purulent and shows a tendency to separate into two layers, the supernatant fluid being sero-purulent and the sediment consisting of greyish pus.

HAEMORRHAGIC EFFUSIONS.

May be dismissed with the statement that the larger proportion of blood which they contain is the only difference between them and sero-fibrinous exudates.

PRESSURE EFFECTS of EFFUSIONS .

Fluid must displace the lung from its relations to the diaphragm and the walls of the chest. The lung becomes collapsed in proportion to the size of the effusion. When there is a limited effusion at the base, the collapse of the lung will be partial.

If the fluid accumulates to a further degree, the diaphragm is depressed and the adjacent organs are displaced.

Left-sided effusions -

The heart may be much displaced to the right. The apex beat frequently cannot be felt as the apex of the heart lies beneath the sternum: or, in some few cases, the displacement is so great that the heart is felt beating under the right nipple.

Traube's space is obliterated.

The Spleen may be palpable.

Right-sided effusions -

The liver is often much displaced downwards. The heart may be displaced towards the left, the apex beat being felt external to the nipple line. As long as the effusion of fluid takes place slowly the action of the heart and the circulation through the vessels are little disturbed.

E T I O L O G Y .

For the purpose of comparison and as a contribution to the study of pleural effusions, I have reviewed the clinical histories of 327 cases of pleurisy with effusion at all ages, treated in the wards of Professor Wyllie and Dr. John Thomson, in the Royal Infirmary and Royal Hospital for Sick Children, respectively.

I find that there are 134 cases occurring in children under 10, and of these 54 are non-purulent and 80 purulent; whereas of the 193 cases occurring in patients over 10, 174 are non-purulent and only 19 purulent.

It will be seen that there is a great difference between the frequency of serous and purulent effusions in children and adults respectively.

In discussing the Etiology of pleural effusions it will be more convenient to speak of purulent effusions first, as the bacteriological factor is easier to determine in them than in serous effusions.

Purulent effusions.
Empyemata.

(a) In Children :

The purulent effusions total 83: 34 on
the/

the right side, 46 on the left, and 3 double. There is no reason why one side should be affected more than the other.

Of these cases there are 49 males and 34 females.

Age-distribution :

The period during which empyema is unusually frequent is from a few months old to 5 years of age. I find that 60 out of the 83 cases occurred under 5 years of age.

Mortality :

There is no doubt that purulent effusion during childhood is a much less serious condition than during adult life. But this assertion requires to be qualified, for it cannot be denied that empyema is a very serious condition in infancy.

The following table will show the mortality at the different ages :-

Age	Under 6 months	6 months to 1 year	years 1-2	years 2-3	years 3-4	years 4-5	years 5-6	years 6-7	years 7-8	years 8-9	years 9-10	years 10-11	years 11-12
Number	1	6	24	9	10	7	4	7	5	3	3	2	2
Recoveries		2	16	7	9	5	4	7	5	3	3	2	2
Deaths	1	4	8	2	1	2							
Right side		3	8	7	3	3	1	4	1	1	1	2	2
Left side		3	14	2	7	4	3	3	4	2	2		
Double	1		2										

Total 85 cases.

From the above we obtain the following results:-

Mortality between	6 months and 1 year	67 per cent
" "	and 2 years	34 "
" "	and 3 years	25 "
" "	and 4 "	10 "
" "	and 5 "	28 "

Morbid Anatomy :

The amount of pus present in the pleural sac will depend chiefly upon the efficiency of drainage.

The pleura is greatly thickened and presents a greyish white appearance.

There is usually marked collapse of the affected lung, which may be bound down by adhesions.

In 4 cases the pericardial sac contained a few ounces of pus, and the liver and heart were markedly fatty. In two of the double empyemata there were patches of broncho-pneumonic consolidation and septic infarcts here and there on the surface.

It is not unusual to find only collapse of both lungs with an enormously dilated heart.

Bacteriology :

The organisms I find connected with empyema in children are the pneumococcus, streptococcus, and staphylococcus. In the majority of cases the pneumococcus only has been found pure. When these organisms are associated together, one form is usually predominant.

	<u>Number of cases</u>	-	83
Pneumococcus	67 or 80.7%
" and Streptococcus	16 or 19.3%
Streptococcus	0.

Pneumococcal Empyema :

The pus is thick, viscid, greenish in colour, odourless and without any tendency to settle out. The amount of fibrin is large and may float in the fluid as large masses. These fibrinous masses frequently interfere with drainage, and also make efficient aspiration almost impossible. Although these characteristics are present in the majority, yet in a definite number the fluid is sero-purulent and rapidly separates into two layers, the upper of which is clear and abundant.

The organisms frequently stain badly and this defective staining, it has been stated, is an evidence of diminished virulence. In some cases they occur in chains and resemble streptococci so much that it is necessary to employ cultivation to prove their nature. It is not uncommon to get no growth, and when associated with other bacteria it is apt to be overgrown by the latter.

In the large majority of cases pneumococcal empyema follows upon a well marked pneumonia. Lobar pneumonia as compared with broncho-pneumonia cannot be termed a common affection in children.

In 64 of my cases there is a definite history of pneumonia 4 or 5 weeks previously or even longer, and it/

it rather points to the lobular type, a most frequent condition in children. There is a history of the child getting over the pneumonia, and then two or three weeks later "he seemed to fall back again." The pus slowly accumulates.

In a second class, the onset is acute and the child rapidly becomes very ill. The pneumonia and the empyema become manifest concomitantly. The exploratory puncture reveals a thin watery purulent fluid. If under 2 years of age such cases usually die. I find 7 of these cases in my series.

It has been stated that pneumococcal empyema may be primary, i.e. may develop without any antecedent pneumonia.

Scarlet fever, Measles and Whooping-cough were the starting point in the remaining cases.

Streptococcal Empyema

is very uncommon in children. The streptococcus occurred alone in none of the cases examined.

³
Holt found it in 3 out of 19 cases.

While the streptococcus may occur alone, it is usually associated with the pneumococcus or staphylococcus. Emanuel ⁴ states that "Streptococcal empyema may be

- (1) secondary to pneumonia, especially the pneumonia which complicates or follows acute infectious fevers, Measles, Scarlet fever and Diphtheria.
- (2) Secondary to inflammatory lesions elsewhere than in the lungs, e.g. suppurative otitis media.
- (3) May arise primarily like primary pneumococcal empyema."

The effusion is usually rather sero-purulent than purulent.

Staphylococcal Empyema :

in none of the cases examined was it found to occur alone. Holt ³ has found the staphylococcus alone in 1 case out of 19 successive cases.

According/

According to West , Staphylococcal Empyema is usually secondary to suppuration of other parts of the body, e.g. ulcerative endocarditis or pyaemia.

Tubercular Empyema :

As in adults this is seldom associated with the tubercle bacillus and the term has come to be used for any empyema occurring in the course of phthisis.

I had only one case and it was due to the pneumococcus. This occurred in a girl aged 10. The pus presented the usual characters of pneumococcal pus.

(b) In adults :

The number of cases examined was 16.

Of these 16 cases, 9 were males and 7 females.

The right side was affected in 8 cases, and the left in 7. There was one double empyema.

The period during which it was found to be most frequent was between the years 15 and 25.

Three died and nothing other than was described under children was found post-mortem.

Bacteriology :

The organisms most frequently present are the Streptococcus, Pneumococcus. and Staphylococcus. These are sometimes associated together, but in the great majority of cases one or other exists alone. The Streptococcus occurs much more frequently than the pneumococcus.

<u>Number of cases</u>...	...	16.
Streptococcus ... ..	...	10.
Pneumococcus ... ..	...	4.
Staphylococcus ... ..	...	0.
Streptococcus † Pneumococcus ...	...	2.

Streptococcal Empyema :

Streptococcus is the commonest cause of Empyema in adults. Sometimes it is difficult to determine/

determine the source of infection. According to West,⁵ the primary lesion may be some suppurative affection of the peritoneum, pelvis, mediastinum, tissues of neck or chest walls; or in others there may have been a blood infection in connection with ulcerative endocarditis or general pyaemia.

In a small percentage, the infection is undoubtedly from without owing to careless paracentesis.

The lung is the source of infection in the great majority of cases.

The fluid is seldom pure pus and has a tendency to separate into two layers, the pus forming a greyish sediment and the supernatant fluid is of a sero-purulent character.

Pneumococcal Empyema :

The pus and characters of organism are as described.

Every empyema complicating pneumonia is not due to the pneumococcus. It usually follows a well-marked pneumonia.

Staphylococcal Empyema :

As in children this form is extremely rare. G. A. Gibson⁶ records 1 case in an analysis of 118 cases of pleurisy.

Tubercular Empyema :

Empyema, complicating phthisis, is seldom associated with the tubercle bacillus. It is more frequently due to the streptococcus or pneumococcus. I had under my observation one case (a man aged 33) in which the Empyema was due to the Streptococcus.

The effusion reached a large size, was sero-purulent and deposited a heavy, white, powdery sediment.

SEROUS EFFUSIONS.

In adults, of the 172 cases examined, 130 were males and 42 females. Pleurisy is said to be more common on the right side than the left. My own figures yield the following result -

66 were on the right side, 100 on the left and 6 double.

The serous effusions in children numbered 56. Of these 43 were boys and 13 girls. The left side was affected in 24 cases and the right in 32.

There is no age which is exempt. Pleurisy is far more common in males than in females, so that sex is a strongly predisposing factor. "This relation holds throughout life for all ages and can't, therefore, be simply referred to the greater exposure of the male sex". (West)⁵.

"Difficult as it sometimes is to determine the bacterial agent in empyemata, it is still more difficult to determine it in the case of serous effusions, for in the majority of these no micro-organism can be found by the staining of films made after centrifugalising a clear exudate or by cultural methods or even after inoculations have been made into animals. "

(Emanuel)⁴.

Pleurisy with effusion as a complication of rheumatic fever is by no means common. The type of pleurisy is usually fibrino-plastic and seldom requires tapping. That rheumatism may cause a clear pleural effusion is not commonly held, so that the following case in which the bacteriological evidence supported the clinical diagnosis is worthy of record:--

A case of Serous Pleural Effusion following
Acute Rheumatic Arthritis and
⁷
Pericarditis.

(Under the care of Dr. Cecil Wall.)

"A man, aged 44, was admitted into the Poplar
 "Hospital under the care of Dr. Cecil Wall on
 "August 19th, 1904. The patient had been ill for
 "14 days with acute rheumatic arthritis. There
 "was nothing of importance in his previous history
 "or in his family history; he had not previously
 "suffered from rheumatism. On admission his temper-
 "ature was 102.4° F.; many joints were hot, red,
 "tender, and swollen, and there was much sweating.
 "The heart was not enlarged but a systolic murmur
 "was heard at the apex and in the axilla accompany-
 "ing a weak first sound. He was put on full doses
 "of/

"of salicylate of sodium and the temperature fell
"rapidly and reached normal on August 22nd. On
"the 23rd the temperature rose to 100° and loud
"to-and-fro pericardial friction was heard; during
"the next few days the temperature continued to
"rise and reached the maximum of 104° on the 29th.
"Between these two dates a large pericardial
"effusion developed and the patient became delir-
"ious. After the 29th the temperature began to
"fall and the pericardial effusion to lessen. On
"September 6th the area of cardiac dulness was only
"slightly larger than normal but for some days the
"temperature remained between 100° and 101°. On
"September 7th and 10th the patient had syncopal
"attacks from which he recovered under the in-
"fluence of stimulants. Between the 6th and the
"15th the pyrexia continued, there was a good deal
"of diarrhoea, and the patient sank to a typhoid
"state. Tested on September 14th the blood did not
"give Widal's reaction. On the 13th signs of
"pleurisy at the right base developed and an
"effusion formed of which 29 ounces were evacuated
"on the 16th. A report upon this fluid is append-
"ed. The temperature now gradually fell to normal
"and/

"and on the 20th there was no evidence of pleurisy
 "or of effusion on the right side. Pleural
 "friction, however, was heard in the left axilla.
 "At the beginning of October a fresh effusion form-
 "ed in the right pleural cavity and 11 ounces were
 "removed by aspiration on October 4th. The signs,
 "however, at the right base persisted, and the
 "temperature again rose. An exploring syringe was
 "again inserted on the 21st but only three ounces
 "of fluid were obtained. After this the signs
 "cleared up, the temperature became normal, and
 "the patient made rapid progress towards recovery.
 "He was discharged to a convalescent home on
 "November 22nd. On discharge and when seen about
 "a month later the heart seemed a little enlarged
 "but no murmurs could be heard. In all other re-
 "spects he seemed perfectly well."

Report on the pleuritic fluid by Miss H. L.

Billett of the Laboratory of Pathology
and Public Health :-

"Microscopical examination of the centrifugal-
 "ised deposit from the fluid showed it to consist
 "chiefly of red blood discs, with a fair number of
 "leucocytes/

"leucocytes and a small number of endothelial
"cells. The blood discs are of good colour and
"the leucocytes appear to be chiefly of the poly-
"morphonuclear type. The coagulum shows a similar
"composition with the addition of fibrin. No
"tubercle bacilli have been found in a stained
"specimen. Plate cultivations were made from the
"centrifugalised deposit, and an organism was iso-
"lated which is similar in microscopical appearance
"to the rheumatic diplococcus, appearing in pairs,
"groups, and short chains. This was inoculated
"into various media; a characteristic fine growth
"was seen on the solid media, and the production
"of acid was noted in most of the liquid media,
"with a sedimentary growth. It does not liquefy
"gelatine; this organism is thus seen to corres-
"pond in many respects with the characters of the
"diplococcus of acute rheumatism."

Report on the fluid obtained on October 4th
by Dr. C. E. Ham, Chemical Pathologist
to the London Hospital.

"The following is a report on pleural fluid
"sent to me on October 5th. Colour; very pale
"straw/

"straw; specific gravity 1018: reaction to litmus
"very faintly alkaline. Chemical examination;
"proteid (albumin and globulin) about 1.5 per cent.
"and a substance which reduced Fehling's solution
"slightly. No formic acid and no lactic acid
"could be detected. Microscopically practically
"nothing was seen under oil immersion except a few
"leucocytes."

In only 7 cases was a definite rheumatic history obtained.

The pneumococcus in a small percentage of cases causes a serous effusion. This especially occurs with apical pneumonias. The pneumococcus is commonly associated with empyema. I found no example of serous pleurisy due to the pneumococcus in my series of cases.

There still remains the class of so called cases of idiopathic pleurisy, cases of pleurisy with sero-fibrinous effusion often following a chill. These cases have attracted a great deal of attention of late years, and the evidence has been accumulating in favour of the tubercle bacillus being the causal agent in such cases. The plan adopted has been to analyse the subsequent histories of these patients.

From/

From the 172 clinical histories of pleurisy with effusion in adults, I obtained a history of inheritance in 21 cases, i.e., fully 12%; in 12 cases, i.e. 7% the effusion complicated phthisis; also in 12 cases there was found some obvious antecedent tubercular lesion in the glands or elsewhere; 17 cases, i.e. nearly 10% were, clinically, considered to be tubercular in origin; and 6 cases died in hospital, tubercle being found in the pleura in all. In addition 7 cases gave a positive reaction with tuberculin by ophthalmic instillation (Calmette.)

So that we may conclude that of cases of pleurisy with effusion in adults at least 40% are tubercular in origin.

8

Osler examined 101 cases post mortem and found that 32 were of a tubercular nature (i.e., 31%) There was no evidence of tubercle in the rest.

"Bacteriological investigation often fails to
 "throw any light on the question. In the majority
 "of cases serous effusions are sterile, that is to
 "say no bacilli can be discovered by the microscope
 "or cultivated in the usual media." (West).⁵

The commonest causes of haemorrhagic effusion are
 tubercle/

tubercle and cancer. It is stated that it is associated with acute tubercular processes in the lung or pleura, rather than with the chronic. Professor T. R. Glynn⁹ writes that "pleuritic effusion frequently complicates intra-thoracic malignant growths and occurred in 7 of my patients. The fluid was removed but little or no relief was afforded by the operation. In 5 cases the fluid was sanguineous and in one of these purulent as well; the latter was a case of primary cancer of the right bronchus."

"With regard to serous effusions in children in whom rheumatism in one or other of its varied manifestations is so common a disease, the question arises as to whether some of these primary effusions are not possibly rheumatic in origin. Poynton and Payne have found in pleural effusions the diplococcus associated with their names in cases of rheumatic polyserositis and have been able to produce pleurisy experimentally".

⁴
(Emanuel)

Of the 56 cases of serous pleurisy in children I found a definite history of inheritance in 12 cases, i.e., 21%; 13 cases were, clinically, considered to be tubercular in origin. In addition 2 cases gave a positive Von Pirquet cuti-reaction. This yields a percentage/

percentage of 45 and represents the probable percentage of cases of a tubercular nature.

D I A G N O S I S .

The diagnosis of pleural effusion seems simple: the physical signs - immobility, dulness on percussion, absence of breath sounds, vocal resonance and fremitus - are well known to everyone. An opinion in a pulmonary case should not be given from a consideration of the physical signs alone, but in addition the patient's general symptoms, history of his illness, and the special peculiarities of the patient (for example, type of constitution, hereditary tendencies) must be taken into account. We must endeavour to ascertain what pathological condition is present - that is, whether there is adhesion, thickening or effusion; and if there is effusion, its situation, physical effects, nature and cause. Both parts of the diagnosis are surrounded by questions of considerable difficulty, and a careful consideration of these will greatly conduce to the correctness of diagnosis.

We may divide modes of diagnostic inquiry into two groups -

1. Clinical examination consisting in
inspection, palpation, percussion,
auscultation, and mensuration.

11 Special/

11. Special methods - Cyto-diagnosis, bacteriology, examination of blood, sputum and urine, and ophthalmic and cutaneous reactions to tuberculin.

Before taking up these groups in turn, it will be convenient at this stage to consider briefly the general symptoms. A history of acute pulmonary trouble recently may direct one to an examination of the chest. In children, such a history will frequently point to an attack of pneumonia, from which the patient has never thoroughly recovered. Several weeks or months may elapse after an attack of pneumonia before medical advice is sought, but an imperfect recovery from pneumonia should always put us on the qui vive for empyema. Many cases appear to be primary as there is no history of previous illness.

The symptoms are frequently much less than the physical signs would lead us to suppose. Thus a little shortness of the breath may be the only symptom when one side of the chest is full of fluid. On the other hand, when the effusion is moderate, the symptoms may be very well marked. Why should this be so? An explanation must be sought for in the rapidity with which/

which the fluid has formed, and the physical effects. Even without marked dyspnoea, the respirations are often much accelerated. This may depend upon pain, but should the temperature be high, the fever also must be to some extent responsible. In the case of large effusions the size of the effusion and the consequent congestion of the opposite lung are the chief causes of the dyspnoea.

It is quite plain that with one lung rendered practically useless as a breathing organ, the slightest change in the other may result in a marked exacerbation of symptoms and that with a large effusion dyspnoea may occur suddenly and quickly become urgent.

In very young patients it is most probable that these symptoms will be overlooked.

Cough is usually absent. When present, it is of a sharp, useless, irritating character. As a rule, it depends upon the 'bronchitis' (or congestion) of the opposite lung. But when it assumes a frequent, violent, paroxysmal character, it becomes of importance as being indicative of an empyema on the point of bursting through the lung, and the necessity for immediate paracentesis.

When the empyema has burst and is discharging freely/

freely through the lung, the cough is frequently short and slight. But it may occur in paroxysms of great severity and be accompanied with a purulent sputum.

Pain is less significant a symptom of pleural effusion than it is of any pleurisy, and is often entirely absent. In localised effusions the 'stitch in the side' may be felt at the margin where the two layers of the pleura are in contact. After the fluid has been absorbed and the pleural surfaces are apposed again, the pain may return (Redux pain). The pain of a pointing empyema is throbbing in character and the overlying skin is tender to the touch. In children pain is sometimes referred to the epigastrium and in a few cases to the right iliac fossa, when appendicitis has been diagnosed.

Temperature:

The degree and type will be largely dependent upon the nature of the effusion, the course of the case, and the causal influences at work. If in a case, with physical signs pointing to a small effusion, the temperature is irregularly hectic, it is strongly suggestive of empyema.

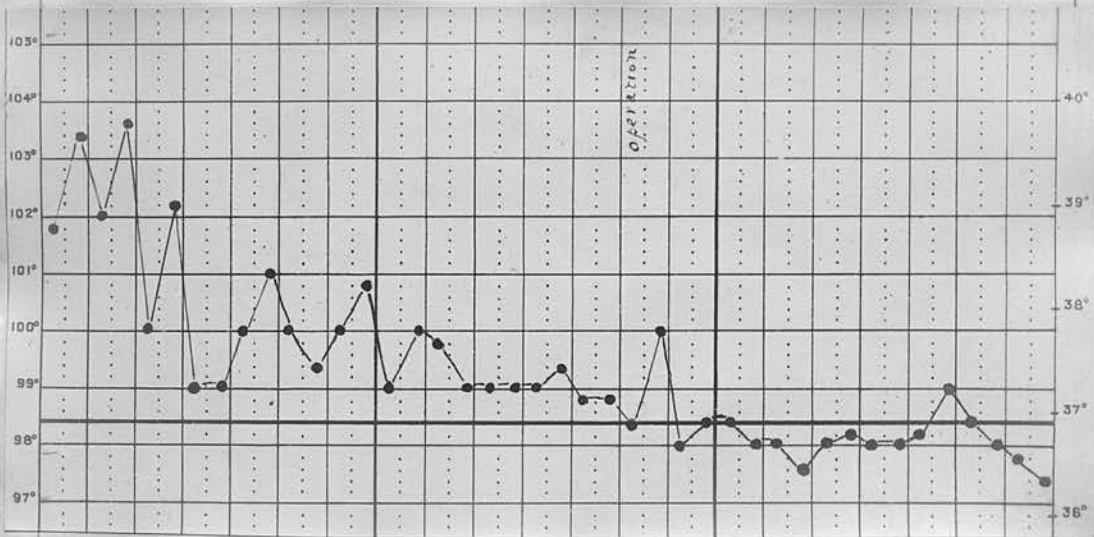
Both serous and purulent pleural effusions may be associated with a temperature which is normal or slightly raised at night.

11.

Pneumococcal Empyema.

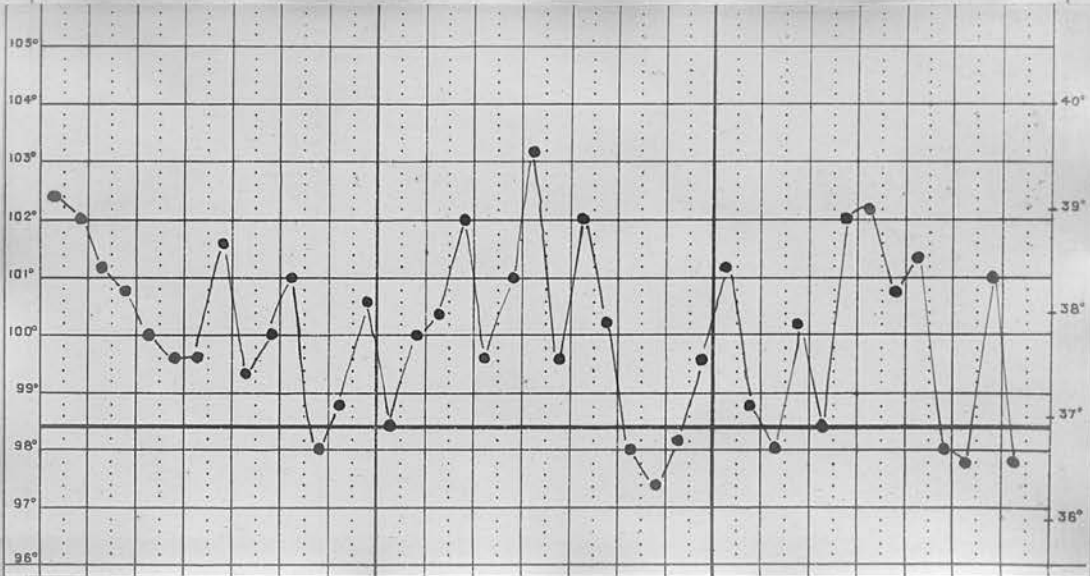
J. McK., aet. 5.

Pneumonia and Empyema concomitant.



Double Empyema.

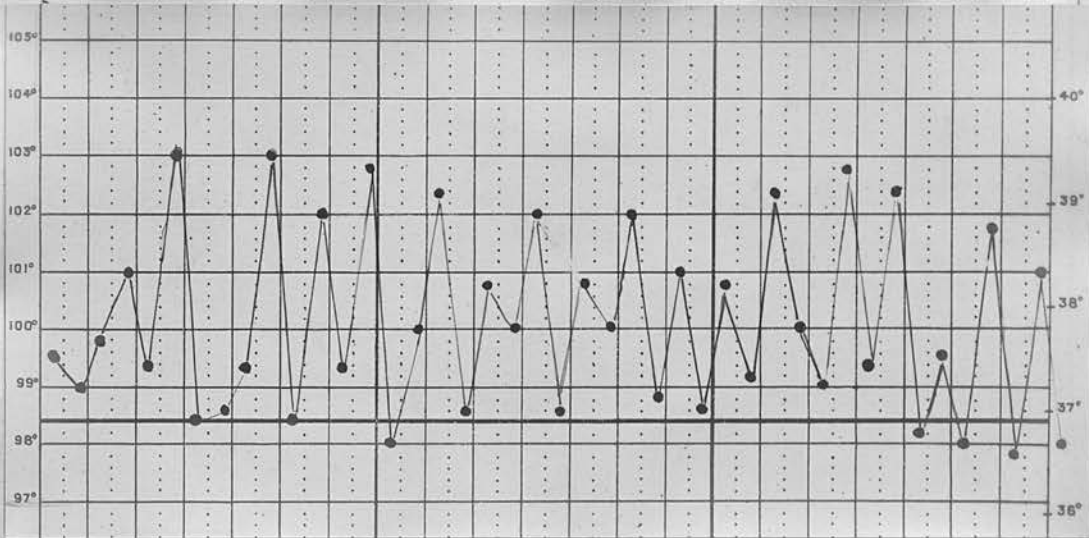
J. R. aet. 1 $\frac{11}{12}$.



1V.

Tubercular Empyema.

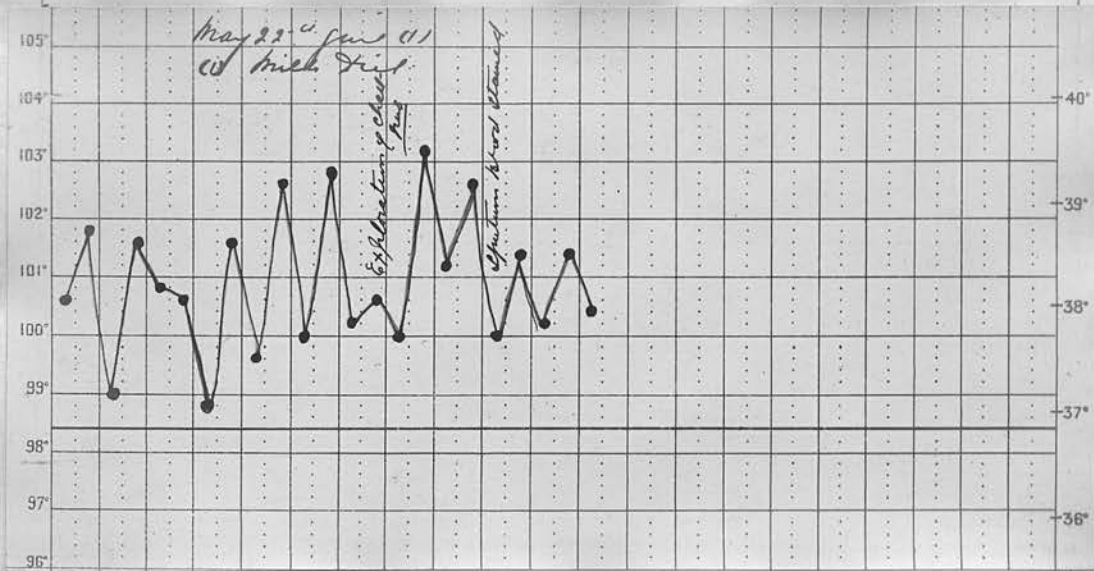
G.G., aet. 4.



V.

Streptococcal Empyema.

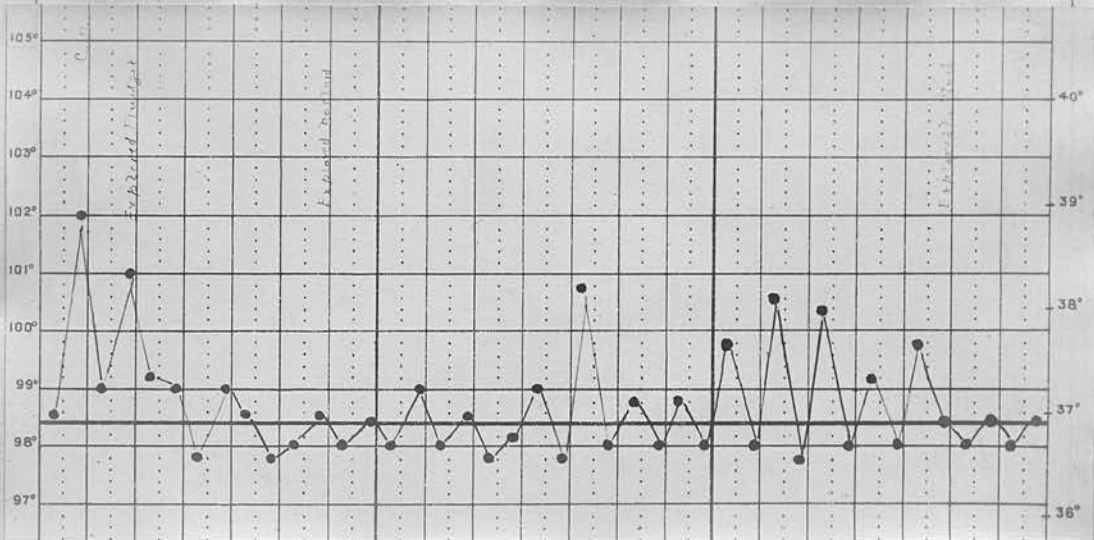
H.S., aet. 36.



VI.

Pleurisy with effusion

W. H., aet. 1 year.



But in every case we must never forget the possibility of the temperature being due to the disease which caused the effusion, e.g., tubercle. In short, no definite information can be obtained from the temperature chart.

Decubitus :

The patient naturally assumes that position in which he feels the least pain and breaths most easily.

When the effusion is of moderate size, the usual position is to lie with the body turned slightly to the affected side. This enables the upper portion of the affected lung to take its share in respiration, owing to the weight of the fluid being chiefly supported by the lower ribs. Whereas with a large effusion it is common to find a patient lying almost flat on his back or else completely on the affected side.

In such a position the breathing may be quiet and easy. But if he sit up, the dyspnoea becomes well marked, as the whole weight of the fluid falls on the diaphragm. This is noticed more in children than in adults, owing to the breathing in the former being chiefly abdominal, i.e., diaphragmatic. Or should he lie/

lie on the sound side, not only is the expansion of that side interfered with, but the breathing capacity of that lung is greatly impaired.

In all cases of pleural effusion of several weeks' duration anaemia is to be noted. This is present both in the skin and mucous membranes. A peculiar yellowish white or straw coloured tinge of the skin of face and body generally is frequently to be observed in purulent effusions. Rapid development of clubbing of fingers without cyanosis is considered by some authorities as diagnostic of purulent effusion. This is especially the case in children.

Wasting, while not characteristic of simple serous effusion, is frequently present in empyema.

Cyanosis seldom occurs as, in the majority of cases, the presence of effusion in the pleural sac or sacs has been diagnosed earlier and the fluid removed. When it is present, it always points to a large effusion with cardiac embarrassment.

While the general symptoms of pleural effusion are, as a rule, indefinite and of doubtful value, the physical signs in the chest are usually much more precise, and to a consideration of the latter I now propose to proceed.

CLINICAL EXAMINATION.

The most convenient order of examination of the lungs and pleura is as follows :-

1. Inspection and Mensuration.
2. Palpation.
3. Percussion.
4. Auscultation.

The physical signs, to some extent, vary with the amount of the fluid, i.e., the size of the effusion.

Inspection and Mensuration :

Too much importance cannot be attached to the value of careful inspection.

Inspection shows more or less immobility on the affected side, depending upon the size of the effusion. The affected side may be more prominent than the sound side, and in large effusions the measuring tape sometimes shows a difference of an inch or so as compared with the opposite side. But accurate measurements of the size of the chest are difficult to make, and consequently we are very apt to come to a wrong conclusion. This difficulty is put very plainly in the following passage from Gee's ¹⁰ well-known work : "Circumferential/

"Circumferential measurements of the two sides are often made, but be it remembered, first, that considerable increase in the sectional area of the chest may occur, and the length of the periphery remain the same, by the passage of the elliptical form into the circular; and, next, that the displacement of the mediastinum, which accompanies unilateral enlargement, thrusts the heart into the unaffected side. And this consideration, too, that the walls of the healthy side must follow the antero-posterior projection of the diseased side; and then it will be plain why, as a matter of fact, the perimeter of the expanded side often measures very little more, nay, even less, than that of the side which is not diseased."

The intercostal spaces are obliterated and bulging of them is excessively rare.

The apex beat is displaced towards the sound side.

Some oedema of the side is common enough when an empyema is pointing.

P A L P A T I O N.

Palpation enables us to determine the deficient expansion of the affected side.

The position of the apex beat should be defined with the utmost care, as a wrong diagnosis may be the consequence of neglecting this rule. And the importance of this is put very concisely by Kingston Fowler :- "The position of the cardiac impulse is the key to the diagnosis of many affections of the chest."

Vocal fremitus is greatly diminished or absent.

If the effusion is small, there may be only enfeeblement. Absence of vocal fremitus is a valuable physical sign of effusion.

The retention of vocal fremitus in large effusions in children is worthy of note.

¹¹
Lindsay writes as follows - "the state of the vocal fremitus is always a point of great importance where the diagnosis of pleural effusion is in question.

Increased intensity of vocal fremitus is strongly suggestive of consolidation. Exceptions to this rule occur under the same circumstances as weakening or absence of breath sounds. The fremitus is very rarely/

rarely increased in effusion. Diminution of the vocal fremitus must be interpreted with some caution. It is the rule in pleural effusion, but it is not uncommon, as a temporary condition in pneumonia when the tubes are blocked by secretion".

P E R C U S S I O N .

The limits of an effusion can usually be easily defined by percussion, and so we are able to estimate its size.

The upper border of an effusion is stated to vary at different points on the chest . It is said to form a curved line - (Ellis's or Damoiseau's Curve) highest in the axillary region and falling towards the front as well as towards the vertebral column thus forming a S-shaped figure. Of course it is essential that the patient be sitting up. It is also stated that this curve is met with only in moderate effusions, the line becoming straight and more or less horizontal as the fluid increases. Although these points can be made out in a great many cases, I do not think they are of great practical value.

In very large effusions the dulness may extend beyond the sternal margin of the opposite side.

The degree of dulness is not affected by the character of the fluid, it being the same whether the fluid is serous, passive, purulent or haemorrhagic.

The note obtained by percussion depends upon :-

(a) Condition of chest wall, e.g. elasticity and thickness.

(b) Degree of collapse of underlying lung.

In moderate effusions where the lung still contains some air the percussion note is wooden in quality. And with large effusions the note is stony, dull and points to an airless condition of underlying lung. Dulness increases in intensity towards the base.

Above the limit of dulness the relaxed lung frequently yields an unnaturally resonant or even tympanitic note. When fluid is abundant, it will be easy to recognise the marked sense of resistance. It is only from experience that it is possible to detect the marked sense of resistance on percussion over an effusion. It is quite different from that felt in pneumonia.

In children, percussion should be light and gentle, as the chest walls are so yielding and it is easy to displace fluid, and elicit a resonant note where it should have been dull.

On the right side the dulness passes without change into that of the liver. On the left side in the nipple line it extends to and may obliterate Traube's semilunar space.

A U S C U L T A T I O N .

Where there is only a thin layer of fluid the breath sounds may be fairly well marked and vesicular in character. But usually in small effusions the breathing is weakened or distant.

In most cases of pleural effusion bronchial breathing is heard in the interscapular region at some stage of the process. This is due to the collapse and condensation of the lung around its root. These cases seldom give rise to any difficulty. But there are those important and exceptional cases in which as distinct bronchial breathing is heard over the entire affected side as it is possible to hear over a solid lung. Besides, vocal fremitus and resonance may be exaggerated and bronchophony and distant pectoriloquy may be present. Such cases are commoner in children than in adults. This is difficult of explanation. Wyllie has suggested the possibility of the ribs and bones in general in children being excellent conductors of sound, and that the "tubular breathing may be conducted by the spinal column and ribs from the roots of the lungs and the bronchial tubes of the other side." This explanation will not suffice for most adult cases as/

as bronchial breathing may be absent or less distinct in interscapular region, while it is well marked over the rest of the affected side.

11

Lindsay considers the explanation not difficult. He states that there is no reason why bronchial breathing should not be present in pleural effusion, if the large bronchi remain patent, as he believes that fluid is a good conductor of sound.

Is it possible to distinguish the bronchial breathing of pleural effusion from that of pneumonic consolidation? Over fluid it is usually feebler and distant, but, in some cases, it is indistinguishable from that heard over consolidation.

Vocal resonance, as a rule, is diminished. In some few cases, owing to adhesions, it may be increased and even bronchophony may be present.

Posteriorly in the scapular region, the vocal resonance often becomes aegophonic and retains this character so long as the layer of fluid is thin.

There are no morbid accompaniments unless in a case of pleurisy with effusion with commencing absorption when friction is usually audible and perhaps also a few medium crepitations.

The breath sounds on the healthy side are exaggerated.

In dealing with children some care is required in applying the information gleaned from adults. The auscultatory phenomena of fluid in the chest, viz., absence of breath sounds, vocal fremitus and resonance are seldom present in children. Bronchial breathing and bronchophony over the fluid are common in children and are generally more distinct the greater the effusion.

Vocal fremitus being difficult to elicit is of no consequence.

Another difference, which is very striking, is the great variability of the signs; an examination one day elicits dulness and bronchial breathing; another day the dulness is much less and the breath sounds almost vesicular. This rather bears out what Lindsay says about the causation of bronchial breathing in effusion. In children, the bronchi are much larger comparatively than in adults, are frequently blocked with mucous and then cleared out by coughing.

Having given the indications of the presence of fluid, I now pass on to a consideration of the cases in which difficulties may arise. These will be found to occur chiefly with serous effusions of moderate extent in which the percussion note is more muffled than dull.

If over the seat of a pleurisy the percussion note be found dull, it is sometimes of great importance to determine whether the pathologic process has been one of pleuritic thickening or pleuritic effusion. The distinction of these two conditions is not always easy. It is common in ordinary cases of acute pleurisy towards the completion of recovery to find slight dullness and some enfeeblement of the breath sounds at the affected base. This is due to thickened pleura and is generally of no importance. But should "this condition be mistaken for a residual effusion, errors both as regards prognosis and treatment will arise". (Lindsay)

How shall we decide whether we are dealing with a small residual effusion or thickening of the pleura?

I suggest the following aids to diagnosis :-

1. - Position of the apex beat.
2. - Degree and extent of dullness.
3. - State of vocal fremitus.

"If/

"If the dulness be slight in degree and rather extensive in area, if the vocal fremitus be fairly well marked, and the position of the cardiac impulse be normal, we are probably dealing with a thickened pleura. If the dulness be marked, the vocal fremitus weak or absent and (above all) if the heart be displaced, fluid is present." (Lindsay)^{11.}

Thickening of the pleura may occur in any part of the chest, but fluid is usually found at the base, unless there are adhesions when it will be localised.

Therefore, the seat of dulness becomes an important point in diagnosis. In examining the records of 228 cases, the favourite seat of effusion is found to be the base behind. Fluid is hardly ever a cause of dulness in the upper parts of the chest, the impaired note generally being due to a thickened pleura. Likewise in the middle regions of chest thickening of the pleura is the common cause of dulness, although a localised effusion might possibly account for it.

It is in acute cases that pleural effusion and pneumonia may be confounded together. The chief difficulty will arise in a case of pleural effusion of moderate extent which has given rise to a group of physical signs, viz. dulness, bronchophony and tubular breathing hardly to be distinguished from those of pneumonia.

pneumonia. The fact that bronchial breathing may occur in both must ever be remembered.

The following points will help to make the diagnosis clear :-

I - Differences in the onset :-

- (1) A sudden onset may occur in either condition, but is much commoner in pneumonia.
- (2) An insidious onset extending over a few days is very suggestive of pleurisy.
- (3) A well-marked initial rigor is very characteristic of pneumonia.
- (4) The flushed face, with the leaden hue, of pneumonia.
- (5) Herpes Labialis is extremely common in pneumonia, but can't be relied on.
- (6) The tongue in pneumonia generally presents a thick, creamy fur. This is not the case in pleurisy.
- (7) Usually in pleurisy there is no high temperature and the course is different.
- (8) A well-marked leucocytosis points to pneumonia as against serous effusions.

- (9) Dyspnoea is more urgent in pneumonia.
- (10) The pulse respiration ratio is much altered in pneumonia.
- (11) The pneumonic patient is much more physically prostrated than the pleuritic.
- (12) Nervous symptoms, e.g., delirium, are much commoner in pneumonia than in pleurisy.
- (13) Absence or deficiency of chlorides and frequently a trace of albumin in the urine of pneumonia are very characteristic; the same cannot be said of the urine of pleurisy.
- (14) In pneumonia the sputum is rusty and so viscid that it often will not fall out of an inverted spittoon; but in pleurisy we find that it is usually catarrhal in type.

11. Certain physical signs:

In pleural effusion an important point is the character of the dulness. That curious stony dulness so strongly presumptive of pleural effusion rarely occurs under any other conditions. The marked sense of resistance, and the diminution or absence of vocal fremitus are strong evidence of pleurisy .

Attention to the outline of the dulness may help in keeping you right. In pneumonic consolidation the dulness follows the line of the interlobar fissure, whilst with an effusion the upper limit of the dulness forms a more or less curved line.

The auscultatory phenomena constitute the chief trouble. It is the persistence of tubular breathing especially of a high-pitched degree which has led to errors in diagnosis. This type of breathing, the rule of pleural effusions of children, is comparatively rare in adults. The intercostal spaces are more frequently obliterated in pleural effusion than in pneumonia.

There is no more reliable sign of effusion than the displacement of organs for this seldom occurs with other conditions. With left-sided effusions Traube's space is frequently diminished. In consolidation of the lung, on the contrary, this area will not be diminished.

In quite a number of cases of small effusion in children, there is no displacement of organs, and it is impossible to say whether the condition is one of thickening of the pleura or effusion without the use of the needle.

The/

The following case, which was under my own observation, is fairly characteristic of how a case may have all the appearances of being pneumonia and yet be a pleural effusion :-

The patient, a fruit salesman, aged 34 years, was admitted on February 28th, 1908 with severe pain in the left side and cough. Five days before, he had fainted, felt feverish, and had pain in the side. He became very short of breath and was sorely distressed with a short cough two days before admission. Three years before he had had dry pleurisy.

His temperature was 102.4°F . The respirations were 40 per minute. The aspect of the case was that of pneumonia and not of pleurisy. Expansion of the left chest was small.

The cough was short and suppressed. The sputum was thick and tenacious but not rusty. Microscopically no pneumococci could be detected. There was slight dulness over the whole of the left lower lobe with slight impairment of vocal fremitus and resonance. The breath sounds were feeble in the same area. The leucocytes numbered 12,190 (polymorphic increase).

On the fifth day the physical signs changed, there being a great increase in the extent of ~~pleural~~ dulness/

dulness, and bronchial breathing was heard all over the left lower lobe, with increased Vocal Resonance. A needle was introduced in the usual site and a syringeful of opalescent fluid obtained. Following this, 20 oz. of fluid were withdrawn by the aspirator. The patient felt much more comfortable and the rate of respiration fell to 28 per minute. The pulse became stronger and the temperature fell to 99°F., much lower than it had been. The following day there was evidence of re-accumulation and the breathing became more difficult. On the next day it was necessary to aspirate again, 25 oz. of clear fluid being withdrawn. From this date the dulness began to decrease. The temperature continued to swing long after the dulness had disappeared and the breath sounds at the left base remained feeble for some time.

Four weeks after the second tapping he was allowed to sit up in a chair.

Calmette's ophthalmo-tuberculin reaction was positive. The blood was examined frequently after the acuteness of the attack passed off, and the leucocytes never numbered more than 9,000 per c.cm.

Examination of Pleural exudate :

Opalescent Reaction alkaline.
 Specific gravity - 1021
 Highly albuminous.
 Microscopic examination - numerous lymphocytes but also some polymorphs.

In a second group of cases the difficulty arises because in a pneumonia with blocking of the tubes by secretion instead of the vocal resonance, fremitus and breath sounds being much exaggerated, they may be greatly diminished or absent. Here again the position of the apex beat is a valuable aid to diagnosis and by attending to the nature of the onset, the character of the sputum, the outline of the dulness and remembering that blocking of the tubes is only a temporary condition, the correct diagnosis may be arrived at. Removal of the secretion is followed by the immediate re-appearance of the characteristic signs of pneumonia.

These difficulties will most frequently occur with moderate serous effusions at the base of the lung. A localised effusion in any other part of the chest would most probably be of a purulent nature and there would be other symptoms indicative of empyema.

The next most important diagnostic difficulty is to determine the condition of the apex on the affected side, this being of considerable importance in concluding the possible cause of the effusion. Any lesion of the apex would be strong evidence of a tubercular origin.

The/

The physical effects of the fluid must be borne in mind. In large effusions, with some adhesions at the apex, it is by no means uncommon to get bronchial breathing and even bronchophony with a few medium crepitations. In other cases where tubercular disease of the apex does exist, it may be missed owing to the absence of the characteristic signs.

In the great majority of cases these suspicious signs disappear with the fluid and the apex is found to be healthy. The advisability of withholding an opinion as to existing phthisis during the course of a pleural effusion cannot be too strongly emphasised. But if tubercle bacilli have been found in the sputum, the diagnosis is quite clear.

Cases of pleural effusion whose physical signs simulate those of tubercular excavation of the lungs
 10
 have been excellently described by Gee . I shall give his account in full :- "At places the breath sounds, (i.e. in pleural effusion) may be bronchial in all degrees of intensity up to a hollow resonance, such as Laennec himself would have supposed to leave no doubt of cavity. Add to the physical signs hectic fever, and we cease to wonder that pleurisy of this kind is usually mistaken for phthisis more or less advanced.

However, the pleuritic patients recover completely, without a vestige of disease left behind, save, haply, a slight unilateral retraction of the chest, or cup-like depression. Whenever the signs of a supposed phthisis are in some respects peculiar, whenever they indicate advanced disease limited to one side of the chest, whenever cavernous signs are heard in unusual places, it is well to weigh the possibility of simple pleurisy. The most useful guide to physical diagnosis is this : that, as a rule, the signs of pleurisy are more marked in the lowermost part of the chest, and that the signs of phthisis are more marked at the upper part".

Some of the most difficult cases to diagnose are those in which a localised empyema requires to be differentiated from certain suppurative conditions below the diaphragm, viz., subphrenic abscess, cancer, hydatid or abscess of the liver, cancer or hydatid of the spleen and similar conditions of the kidneys.

All these conditions act in the same way as an effusion, i.e., they compress the lung and produce similar physical signs - dulness, loss of vocal fremitus, resonance and breath sounds.

The/

The upper limit of the dulness must be carefully determined. The upper line of dulness is frequently convex upwards in the nipple or mid-axillary line and is not more or less horizontal in front and highest posteriorly as in pleural effusion. The lower border of the liver will be depressed, no matter whether the disease is in the liver or between the liver and the diaphragm. This means that the right lobe is either pushed down or enlarged.

12

Sir R. Havelock Charles states with regard to Tropical abscess of the liver:- "That the pleural effusion may be premonitory of the abscess travelling to burst into the thorax. Again before an abscess gets through the diaphragm it may be preceded by a serous effusion in the thorax."

8

Osler records a case of Cancer of the kidney in which the diaphragm involved at an early stage caused signs of pleurisy for months before the renal condition was discovered.

In all these conditions the exploring needle must be used to settle the diagnosis.

Hydatids of Lung and Pleura :-

According to Osler primary hydatids in
pleura/

pleura are rare but are of comparatively frequent occurrence in the lung.

When a hydatid cyst develops into the pleural cavity, the physical signs produced simulate those of pleural effusion. The area of dulness is usually more or less spherical. The breath sounds, vocal fremitus and resonance will be greatly diminished or absent over such an area. The expansion of the chest in the same part may be deficient. If displacement of the heart or liver has been produced, the difficulty of diagnosis will be much increased. Should complications occur such as inflammation of the pleura, the effusion will be either serous or purulent. As a rule it is purulent and is secondary to lung condition, i.e., rupture takes place.

These points make it clear that the diagnosis is no easy matter. In fact, it is stated that the majority of these cases recorded are not diagnosed during life but only discovered post-mortem.

It is seldom the diagnosis is arrived at before rupture takes place. If hydatid membrane is expectorated, it is so characteristic that it cannot be mistaken - viz: the lamination and cross-striation of the membrane. The membrane may be bile-stained and in such/

such cases it is reasonable to suspect the liver to have been the primary seat of mischief. The sputum must be carefully examined for the presence of hooklets or pieces of membrane. If not found, the diagnosis would remain undetermined.

"Hydatid fluid is, of course, easily distinguished from serous effusion by the complete or almost complete absence of albumin and by its low specific gravity, so that in the rare event of there being a hydatid only in the pleura and no effusion the diagnosis would be made by exploratory puncture, but if a serous effusion were present too, there would be no means of determining its cause." (West)⁵.

As already stated, the effusion is not always purulent but may be serous. From a localised empyema the diagnosis is difficult and often impossible.

The following case, which was under my own observation, is a good example of diagnostic difficulty. The diagnosis was made of empyema. The case proved to be one of multiple Hydatid cysts (some suppurating) of the right lung, of the liver, spleen and left suprarenal, complicated by a right sided empyema:-

G.J., a fairly well nourished man, of sallow complexion, aged 36 years, and a native of Shetland, was admitted on the 3rd July, 1908 with stitching pains in the/

the right side and shoulder, and a short cough causing him pain on that side.

For 7 or 8 years previous to admission he had be troubled at odd times with dull pains just below the right costal margin in front, but for three months before admission the pains became more stabbing in character, were felt higher up and aggravated on taking a deep breath.

His previous health had been good.

He rented a croft, and kept some sheep and one dog.

His temperature was 101.8°F. The respirations were 28 per minute. Examination of the blood:-

Haemoglobin	...	...	...	64 per cent.
Red blood corpuscles	...	...	...	4,470,000 per c.cm.
White	"	"	...	8,000 " "

Differential count

Polymorphs	.....	64 per cent.
Lymphocytes		
(small)	...29	" "
Large Mono-		
nuclears	.....	2.5" "
Eosinophils	....	4.5" "

The breathing was easy. He had some cough with

a/

a small amount of muco-purulent sputum. Microscopically, this contained many pus cells and numerous cocci, some occurring as diplos and others in chains. No elastic fibres or echinococcal hooklets were found.

Expansion of the right side of the chest was deficient. Measurement of the two sides gave :-

<u>Left side</u>	17 $\frac{1}{2}$ inches (in expiration)
<u>Right "</u>	18 $\frac{1}{2}$ " " "

The vocal fremitus was markedly lost over the right lower lobe anteriorly, laterally and posteriorly, but over the left upper lobe anteriorly and posteriorly it was somewhat increased.

There was an area of almost stony dulness on the right side, reaching to the level of the third costal cartilage in front, the third rib in the axilla, and the eighth Dorsal vertebra behind. The line of dulness was almost horizontal, but sloped slightly towards the spine behind and the sternum in front.

The note over the right upper lobe in front was distinctly hyper-resonant.

The breath sounds were feeble and distant, and the vocal resonance diminished in the dull area. But at the/

the upper level of the dulness there was distinct aegophony. There were no morbid accompaniments.

The left lung was healthy.

There was no increase of the liver dulness downwards. The apex beat was not displaced. A few days after admission an exploring needle was introduced below the angle of the right scapula, and no fluid obtained.

The sputum was becoming more purulent. A week later the right pleura was again explored and a syringe-ful of pus easily withdrawn. This was examined by Dr. Shennan who reported as follows:-

"Direct films contain large numbers of Gram
 "positive cocci, nearly all in pairs of 4 - 8
 "members. None are of typical lanceolate form.
 "Cultivation on Agar yields a growth chiefly of
 "diplococcus pneumoniae together with a few
 "colonies of Streptococcus pyogenes."

The leucocytes were steadily increasing - now numbered 12,000 per c.cm.

After this second exploration the septicity of the sputum increased and the sputum was frequently blood stained.

Arrangements were made with Mr. Caird to resect a portion of rib and drain the pleural cavity, but on performing/

performing the usual preliminary exploratory puncture no pus was obtained, and he advised delay of the operation.

The sputum was frequently examined for hooklets but the result was always negative.

Fully a week after the second exploration he was suddenly seized with a most violent fit of coughing, bringing up almost a pint of stinking pus. Floating in this was noticed a bile stained mass about the size of a walnut. It resembled very much a piece of orange which had been partially digested. On washing it in water it was found to be of a membranous structure, and it showed a tendency to curl upon itself. Microscopical examination revealed the typical lamination and cross striation of hydatid membrane. No hooklets could be discovered in the pus.

The patient felt greatly relieved and he looked better.

The physical signs changed. The dulness disappeared from the front of the chest and the upper limit behind was considerably lower. In the scapular region behind and in the 3rd and 4th intercostal spaces in front the percussion note was highly tympanitic suggesting the presence of air in the pleural cavity/

cavity or a large cavity in the lung. No other signs of pneumothorax could be elicited.

For the next few days he continued to cough up small quantities of pus and on one occasion a very large piece of bile-stained hydatid membrane. The cough became almost incessant and opiates had little effect.

He began to complain of severe pain over the liver and could not bear pressure in the lower intercostal spaces. There was no hydatid thrill.

The leucocytes now numbered 15,000 per c.cm.

The right pleura was explored in the scapular region - no fluid was obtained, and on palpating with the point of the needle it felt embedded in lung tissue.

From this date he steadily went down hill.

The dulness behind increased, becoming stony dull again.

Mr. Dowden, in the absence of Mr. Caird, saw the patient and advised a portion of rib to be resected. This was done and a small amount of pus escaped. The liver was explored through the same incision enlarged and a large abscess was tapped and drained.

Two weeks later the patient died and the following was the result of the post mortem examination :-

Hydatid cysts of liver, right lung, spleen and left suprarenal. Most of those in the liver and lung were suppurating. There was a passage from the cyst in the liver into the right pleural cavity.

The right pleura consisted of three compartments separated by adhesions.

There was suppurating Peritonitis and right empyema.

Pericardial Effusion :

A special difficulty may arise in differentiating between a large pericardial and pleural effusion. The cone shaped area of dulness, the tympanitic note in the axilla, the retention of vocal resonance at the base, the absence of dislocation of the apex beat to the right of the sternum, the muffled heart sounds, the feebleness of the pulse, and dyspnoea severer than can be explained by the size of the effusion are the main points to be remembered in making a correct diagnosis possible.

Localised abscess in chest wall :

It/

Localised abscess in chest wall :

It may be difficult to distinguish this from a pointing empyema. The clinical features of a pointing empyema are indicative of a more acute process, viz., - greater heat, pain and redness. There will be absence of physical signs pointing to mischief in the lung or pleura.

Hydrothorax:

in some few cases of cardiac disease may be unilateral and present physical signs identical with those of sero-fibrinous effusion. There is usually some local cause to explain this, e.g., an old pleurisy on opposite side obliterating the cavity by adhesions, or the presence of a tumour on the affected side. Hydrothorax being generally a part of general dropsy should lead you to think of the cause. Examination of the fluid will materially help to clear up the diagnosis, the characters of non-inflammatory and inflammatory effusions being entirely different.

Malignant disease of the Lungs :

sometimes gives rise to physical signs almost indistinguishable from those of pleural effusion. The history of rapid loss of flesh or some peculiarity in the effusion may help you.

It/

It must not be forgotten that pleuritic effusions frequently accompany many intrathoracic growths. The fluid may be serous, haemorrhagic or purulent. A haemorrhagic effusion is extremely suspicious but not conclusive. Glynn⁹ has found post mortem that when the pleura is the seat of secondary malignant growths the fluid is not necessarily haemorrhagic. In two such cases there was a simple serous effusion..

When the passage of air through the tubes has been blocked by new growth for some time, the part of the lung corresponding with the obstructed air tubes passes into a condition of solid oedema and over this the breath sounds and vocal resonance are much diminished. Here the diagnosis is often impossible without the aid of an exploratory puncture. Rise of temperature as a result of inflammatory or degenerative changes in the collapsed lung will increase the difficulty of diagnosis as it introduces the possibility of empyema.

Glynn⁹ records a case of primary sarcoma of the left pleura, the symptoms and physical signs of which in the early stage of affection resembled those of pleurisy with effusion. "There was a history of pain, breathlessness/

breathlessness, and dry cough of three months' duration. The left side was absolutely dull throughout; the heart was somewhat displaced to the right. Respiratory sounds were absent excepting in the interscapular and left subclavian regions, where they were slightly bronchial; vocal resonance was also absent; the jugulars were slightly distended: respirations were 40 and the pulse 120. There was hectic fever. On aspiration 46 ounces of clear fluid were obtained but no relief afforded. A week afterwards the aspirator was again used and a little blood only was withdrawn. A week or so later evidence of intrathoracic pressure became positive, the heart was much more displaced, the jugulars were distended, superficial veins appeared over the chest, the left pupil was contracted, and the left radial pulse was smaller than the right. Further, the percussion dulness extended gradually across the upper part of the sternum to quite an inch beyond its right border and a systolic murmur developed at the base of the heart. There was never any enlargement of the left side of the chest but rather diminution. The opposite lung became more and more emphysematous, as indicated by gradual increasing depression of the liver".

It is advisable in all doubtful cases of diagnosis to explore with a needle. The site of the puncture may be chosen according to the results of the physical examination, but, generally speaking, an area just below the angle of the scapula behind, or in the 5th, 6th interspace in mid-axillary region is selected.

There is more in this simple operation than appears at first sight. By careful attention during the introduction of the needle several important bits of information may be obtained :-

1. The sensation of point of needle being embedded in lung tissue may be experienced.
2. It may be possible to tell whether pleura is thickened or not.
3. By moving the needle up and down, its mobility will determine the presence of a cavity. This will help to decide the best position for drainage in an empyema.

If fluid is found, well and good. But if no fluid is obtained what are the possibilities?

1. It will be well to make sure that the needle has not become plugged when passing through the chest wall. This is an uncommon cause.

2. The more common cause of failure is that frequently we have penetrated too far or not far enough. There may be great thickening of the pleura, and thus the needle may not have pierced it: or the effusion may be small and the needle have penetrated too far. This could quite well occur with an effusion complicating pneumonia.

3. The effusion may have been missed altogether. In some cases a slight push or withdrawal of the needle is all that is necessary to obtain fluid. But in others the partial withdrawal and change in direction of needle are successful.

The operation should be repeated in another place in all cases where the physical signs point clearly to the presence of fluid.

When a sufficient amount of fluid is obtained by exploratory puncture, its examination in detail may be proceeded with. The naked eye appearances will probably be sufficient to determine whether it is a serous or purulent fluid. But a microscopic examination frequently furnishes very important information, e.g., the presence of leucocytes, red blood corpuscles, and especially/

especially of bacteria. These will be considered more fully later.

"The presence of pneumococcus is of favourable significance as such cases usually get well rapidly, even with a single aspiration. The streptococcal empyema is the most serious form and even after a free drainage the patient may succumb to a general septicaemia. A sterile fluid indicates in a majority of instances a tuberculous origin." (Osler)⁸.

There is a curious result I have noticed, especially in children, to occur after exploratory puncture, which has withdrawn only a few drachms of fluid. The patient suddenly improves and the physical signs rapidly disappear, apparently as the result of the puncture. I can offer no explanation of this remarkable occurrence.

The needle does not always convey the truth.

13

Norman Moore records two cases bearing on this :- "A patient in St. Bartholomew's Hospital had complete dulness up to the third rib on the right side and some depression of the liver. She was tapped in the fourth interspace and three pints of pus let out. She sank rapidly/

rapidly - it was a huge hepatic abscess which had been tapped. A child had signs of pleurisy on the left side and was tapped and pus let out. At the end of a week it died. The trocar had reached a purulent pericardial effusion but a contemporaneous empyema at the base surrounded by adhesions had been passed over and remained undrained."

It is worthy of note that exploratory puncture is not free from danger. Although I have never experienced it or found it noted in any of the cases reviewed, several fatalities as a sequence to this supposed trifling operation have been recorded. The subject was touched upon at a Meeting of the Society for the Study of Disease in Children in December, 1904, and was considered very fully in the October(1905) number of the journal of the Society. ¹⁴ The following were the cases narrated :-

1. "Dr. George Carpenter in 1893 recorded the case
 "of a girl, aged 5 years, who was suffering from
 "cirrhosis of the lung and whose chest was ex-
 "plored by the house-physician. She coughed
 "after the needle was inserted; blood began to
 "pour from her mouth and nostrils and she died
 "asphyxiated. Post-mortem the lung was found to
 "be cirrrosed. The stomach was full of blood,
 "there was some in the duodenum, the bronchi were
 "filled with blood stained mucous which extended
 "on the right side as far as the medium sized
 "bronchi and on the affected side into the
 "smallest tubes.
2. Dr. Josph Wilks records the case of a girl,
 "aged/

"aged 3 years, in which the insertion of a needle
"into the left side of the chest for supposed
"empyema was almost instantly fatal.

"No anaesthetic was used and the child was
"kept lying down. The puncture was made in
"the eighth space, just below the angle of the
"left scapula, and a few small flakes of 'curdy'
"pus were withdrawn, with some blood. Immediate-
"ly afterwards blood, of a darkish hue, was seen
"to be issuing in a continuous stream from the
"needle, and almost simultaneously the child gave
"a cough, and expelled some blood from its mouth
"on to the pillow. The pupils dilated, the
"sphincter ani relaxed, the lips changed colour,
"and no efforts at respiration were made. The
"child appeared to be moribund at once, and it
"was apparent from the first that its condition
"was extremely grave. Artificial respiration
"was continued for an hour, but from the first no
"sign of recovery was shewn.

"At the post mortem examination the left pleura
"was found to be adherent to the chest wall all
"over and also to the diaphragm. There were a
"few small clots on the surface of the lung at
"the/

"the site of puncture. The site of puncture
 "by the needle was seen about an inch from the
 "base of the lung, whose substance it had pene-
 "trated for a short distance. Pressure at this
 "point caused blood to flow out and section through
 "the puncture showed an absence of healthy lung
 "tissue which had been partially replaced by more
 "solid and indurated areas containing a number of
 "small caseous foci. The smaller bronchi were
 "occupied by blood clots and puriform exudations,
 "which were easily dislodged by squeezing. The
 "larger bronchi and trachea were full of blood
 "stained frothy mucus. Microscopical examination
 "showed the left lung to be tuberculous.

"The lower lobe of the right lung was en-
 "gorged and appeared to be in an early stage of
 "red hepatitis, and there were also a few
 "scattered miliary tubercles.

"Death was attributed to cardiac failure in
 "a debilitated patient."

3. Three cases were recorded by Dr. A. E.

Russell in 1898 :

(a) "In a girl, aged 8 years, one exploration
 "was made into a presumed empyema. A small
 "amount/

"amount of frothy blood appeared at the mouth,
"lividity supervened, associated with strong
"double convergent squint and rigidity of the
"arms. The pulse stopped, and breathing con-
"tinued irregularly for a minute or two after
"that. The post mortem showed the presence of
"acute inflammatory mischief in a lung undergoing
"fibroid change from antecedent disease.

(b) "In a girl, aged 7 years, suffering from
"bronchopneumonia, the chest was explored. The
"child immediately lost consciousness, turned very
"pale on the right side of the face, and also
"slightly cyanosed. Two hours after that she
"became convulsed and did not regain conscious-
"ness, and died five days later. The lung was
"in a condition of collapse, with some broncho-
"pneumonia. The brain was much injected, but
"there was no excess of fluid in the ventricles.

(c) "The third case happened in an adult with
"old pulmonary tuberculosis, who had chronic basal
"pneumonia. A second exploration was followed
"by syncope - irregular and spasmodic heart beats-
"and immediate cessation of respiration, convul-
"sions/

"convulsions, left hemiplegia with blurred optic
 "discs and a flame coloured patch at one of them,
 and death three days later. There were no coarse
 "cerebral lesions. The heart showed some de-
 "generative changes."

Dr. Russell attributed the fatal event in the cases
 narrated to reflex inhibition of the respiratory and
 cardio-inhibitory centres in the medulla following
 irritation of the terminal filaments of the pulmonary
 fibres of the vagus. Cerebral anaemia was accounted
 for by cardiac inhibition and lowered blood pressure.
 The persistence of cerebral symptoms he attributed to
 degenerative changes in the nerve-cells of the cortex
 from circulatory disturbances.

4. -- Dr. Thomas Oliver reported two cases in 1904:

"In one the man fell back dead directly after a
 "second puncture was made. No fluid was with-
 "drawn, but there was pus in the pleura and
 "the lung was consolidated.

"In the other, puncture was followed
 "by heightened respiration-rate, and a few hours
 "later by delirium and death.

5. Dr. Fortescue-Brickdale in 1904 narrated the
 "case/

"case of a rickety child, aged 2 years, whose
"chest was explored for a supposed empyema. Noth-
"ing but blood was withdrawn by the syringe.
"almost immediately a little blood was coughed
"up, cyanosis appeared, and the child died in
"about ten minutes after the operation. There
"was no postmortem examination."

II. SPECIAL METHODS.

A. Cytodiagnosis.

This method, based upon the observations of Widal and Rivaut, may help to decide the cause of the effusion. I agree with Sahli¹⁵ that it should never be employed as the sole foundation of a diagnosis.

Pleural effusions may contain organisms, endothelial cells and blood corpuscles. Of the cells from the blood, the leucocytes are the most important and occur in two forms viz., polymorphs and lymphocytes. The proportion of each varies and the former frequently show degenerative changes, for example, glycogenic and fatty.

"The observations of primary pleurisies have shown that with a slight irritation the exudate contains at first lymphocytes, endothelial cells, and a moderate number of polynuclear cells but that after a few days an almost pure lymphocytosis is present.

Lymphocytosis may, therefore, be accepted as a sign of slight irritation, and, as such irritation is usually tuberculous, may be accepted as a proof of the tuberculous/

tuberculous nature of the pleurisy. Endothelial cells in an exudate are only of diagnostic value if they are present in large numbers. They are then characteristic of dropsical effusion or new growth and exclude the possibility of an inflammatory exudate, that is, they exclude a diagnosis of tuberculous pleurisy. A large number of polynuclear leucocytes point to a more acute irritation of the pleura of an infectious nature and are only found in tuberculous pleurisy in very recent cases or in cases of mixed infection." (Jorge Vargos-Suarez)¹⁶ .

"Cytodiagnosis will not assist in distinguishing a tuberculous from a rheumatic effusion for, in both cases, it is the rule to find a preponderance of lymphocytes."⁴ (Emanuel) .

B. EXAMINATION of SPUTUM, BLOOD and URINE.

1. Sputum.

The examination of the sputum, from the standpoint of diagnosis, becomes most helpful as several diseases are associated with characteristic sputa. Thus we have the rusty, viscid sputum of pneumonia and the nummular sputum of phthisis. The expectoration in pleurisy with effusion is very often catarrhal in type and consists of a serous fluid containing desquamated endothelial cells from the respiratory tract. A suppurating hydatid cyst which has ruptured into the pleural cavity and then into a bronchus will be associated with a copious purulent sputum, which is only pathognomonic when it contains hooklets or portions of hydatid membrane. Should the membrane or the sputum be bile-stained it would be fair to conclude that the liver was the prime seat of the cyst.

When an empyema is threatening to perforate the lung, the expectoration will gradually become of a purulent type. Once perforation occurs large quantities of almost pure pus will be coughed up from time to time.

The/

The Presence of the pneumococcus, streptococcus, staphylococcus or tubercle bacillus in these circumstances will afford valuable information. It may be noted that children do not begin to expectorate naturally until between 5 and 7 years old. Before this age the sputum is swallowed. If a specimen is required, sufficient may be obtained on a throat swab from the epiglottis or pharynx.

2. B l o o d.(a) Serous effusions.

If anaemia be an early symptom and well marked, it is shewn by a moderate diminution in the number of red blood corpuscles and in their amount of haemoglobin.

In the early stages there may be a distinct leucocytosis, the polymorphs being predominant. But in a large number of cases there is, if not at the outset, at any rate in the later stages, a definite leucopenia, which is held to be very suggestive of tuberculosis.

In every case in which I examined the blood, both in children and adults, I found a leucopenia to be a constant feature, especially after the acuteness of the attack had passed off. In addition those cases in which the records were reviewed, yielded the same result.

(b) Purulent effusions. -

There is usually a well marked leucocytosis. I find that it ranges from ten to forty thousand per c.cm. The increase is polymorphonuclear.

Osler/

Osler records a fatal case of empyema in which the leucocytes numbered 115,000 per c.cm.

The following case of empyema reported by Dr. Bunting¹⁷ gave a much higher leucocytosis :

The patient was a girl aged 6 admitted to Birmingham General Hospital on March 21st, 1907. The right chest was dull from apex to base. The temperature was 103.4⁰F, the pulse 168 and a blood count showed 41,5000 leucocytes per c.cm. on admission. Bacteriological examination revealed the presence of pneumococcus and streptococcus pyogenes.

Progress.

March 22nd	...	53,600	leucocytes.	
March 23rd	...	66,700	"	
March 24th	...	75,000	"	
March 25th	...	140,000	"	
March 26th	...	214,000	"	On a differen-

tial count the

Polymorphs	-	82.2	per cent.
Lymphocytes	-	14.8	"
Hyaline cells-		2.8	"
Eosinophiles	-	0.2	"

The last count (214,000) was repeated an hour later and the blood was taken from the patient's thumb instead/

instead of from the lobe of the ear, in order to obviate any suggestion that the enormous leucocytosis found might be largely a local one due to some inflammation caused by the previous punctures of the ear.

The glycogenic reaction is always well marked.

*

3. Urine.

The chlorides are markedly diminished or entirely absent in croupous pneumonia. This is of great diagnostic value and is especially useful in the diagnosis of pneumonia from empyema and pleurisy in which they are not affected. Of course in children when the empyema and pneumonia are concomitant the chlorides are frequently diminished.

Albumoses may be tested for: not being pathognomonic of empyema they are less important. They were present in two of my cases.

C. Ophthalmic and Cutaneous TuberculinReactions.

The observations of Wolff-Eisner and Calmette have shown that one or two drops of purified Tuberculin (solution 1 in 100) placed in the conjunctival sac of a tuberculous patient produces a characteristic reddening of the conjunctiva, accompanied by lachrymation and by the formation of a fibrinous exudate.

This test should be tried in all cases of pleurisy with effusion in adults where there is a suspicion of tubercle being the cause. If the reaction is positive, then in conjunction with the other observations, it may help in diagnosis, but is not to be regarded as an infallible index of the presence or absence of tubercle.

It is essential that there should be no pre-existing conjunctivitis or other disease of the eye.

I have already noted that the test was positive in seven cases and proved of diagnostic value.

C. Von Pirquet's cutaneous reaction has been found useful chiefly in children. "Old" Tuberculin is employed. The method adopted in Dr. John Thomson's ward is, after cleaning a portion of the skin of the forearm/

forearm, to apply two or three drops and introduce it by slight boring with a knitting needle which has been boiled.

Two cases of sero-fibrinous effusion which were definitely tubercular gave a positive reaction.

In the case of a positive reaction, after from 24 - 48 hours, a local reaction, beginning as an oedematous redness and developing into a papule, appears and when this heals some pigmentation may be left for two or three weeks.

Pirquet considered that the reaction was not diagnostic of tuberculosis in adults on account of the influence which old healed tuberculous processes had on the organism.

T R E A T M E N T.

Having determined by means of the needle and the microscope the nature of the effusion and in all probability its cause, we can now intelligently treat the case.

In considering the treatment of pleural effusions I will deal firstly with simple serous effusions.

Serous Effusions.

For convenience hydrothorax will be considered separately.

During the febrile stage the patient should be kept warm in bed. The diet should be light and nourishing - chiefly liquid, such as beef tea, milk, soups.

A mild diaphoretic may be given - for example, *Liquor Ammoniae Acetatis* 1-2drachms every 4 hours. The general treatment need not detain us long as there are no remedies which are known to influence directly the absorption of a pleural effusion. Many drugs have been vaunted as being of use in promoting the absorption of fluid from the pleural cavity. Chief amongst these is Potassium Iodide, one of our stock remedies, which I have frequently used for chronic cases in which there/

there has been considerable delay in the absorption of the fluid. I have been led to feel somewhat doubtful of its efficacy since, after trying it in many cases for weeks or months, there has not been the slightest benefit. In other cases where improvement took place it may have been the result of a natural process.

Salicylates I have found to be of little use further than reducing the temperature and relieving the pain where there is a rheumatic history.

Sodium Salicylate in doses of 10-15 grains every four hours, I have usually employed.

Certain symptoms presenting themselves may require to be relieved, for example, should the cough be troublesome the opiates have proved in my hands to be most efficacious. Pain is sometimes severe and demands relief. The application of warm fomentations or a mustard poultice will usually suffice. In very severe cases strapping the side with plaster so as to limit the movement is often useful.

Local measures are worth a trial in all cases of moderate effusion.

Counter-irritation is of great value. Equal parts of the tincture and strong liquor of iodine (Wyllie) painted on the affected side every other day/

day have proved of the greatest use in combating the condition. The application of one or two small blisters is another excellent mode.

, In a large number of cases of pleural effusion of moderate extent the tendency is for them to disappear without any treatment at all.

The indications for paracentesis are determined largely by the degree of dyspnoea and also by the size of the effusion and its duration. The following rules (as taught by Professor Wyllie) may be laid down as the chief indications I have found useful in deciding whether paracentesis is required:-

1. The operation should be performed at once if the effusion fill the whole of one side of the chest; with the exception that in neglected cases, where the heart has returned to its normal position and the lung is encapsulated with fibrous tissue so that it cannot expand, the bronchi dilate and the chest falls in. Paracentesis in such a case would cause dilatation of the heart with possible sudden death and also over-expansion of the opposite lung.
2. When the effusion is at the level of the 4th rib, the operation is indicated if dyspnoea is paroxysmal or constant when the patient is at rest and the pulse is feeble.
3. When one side of the chest is half full, the operation only sometimes requires to be practised.

But if after ten days or so there is no diminution in the size of the effusion, perform the operation as it leads to re-expansion of the lung.

Paracentesis is such a simple and safe operation that there should never be any hesitation in performing it whenever it is indicated.

It is wise in every case to perform a preliminary exploratory puncture before tapping.

In a large number of cases the removal of a comparatively small quantity of fluid is all that is necessary.

The amount of fluid withdrawn in most cases at one sitting should never exceed 30 ounces or so. Of course, in exceptional circumstances, it may be necessary to withdraw a larger amount of fluid. Dr. Biddle¹⁸ records a case from which $4\frac{1}{2}$ pints were withdrawn on the first occasion, and the operation required to be repeated in five days' time, when two pints were withdrawn.

There is no need for a large cannula. In fact, in many cases, especially in children, I have found a large aspirating needle quite sufficient. This can be fitted on in the same way as the cannula and introduced with much less pain to the patient.

The/

The fluid should be gradually and slowly drawn off. It is important to remember the great risk of powerful suction upon the contents of the thorax. The sudden withdrawal of fluid and the change in the lung from the condition of collapse to one of distension may lead to considerable cardiac embarrassment which may result in fatal syncope. In some few cases these changed conditions in the thorax are responsible for the occurrence of congestion or oedema of the opposite lung, and produce a rare condition termed serous or albuminous expectoration. This was not mentioned in any of the cases examined.

The suction force can be quite easily regulated by the stop-cock between the exhausted bottle and cannula. When the following symptoms arise, the operation may require to be stopped:-

1. Cough usually occurs towards the end of the operation. It may be due to irritation of the pleura with the cannula or needle, or to expansion of the lung. Not infrequently it is severe and paroxysmal.

The patient should be warned to say whenever he feels inclined to cough, and the cannula/

cannula may be withdrawn slightly and then pushed in another direction.

2. Pain occasionally occurs and is generally felt in the upper part of the affected side. It is supposed to be due to the stretching of adhesions. Stopping the operation for a few seconds is usually sufficient to enable you to remove some more fluid.
3. Dyspnoea is seldom a serious hindrance to proceeding with the operation.
4. I find that faintness is not an uncommon occurrence.
5. Haemoptysis, Cyanosis and epileptic convulsions are also said to occur. But I have never seen any of these.

Certain accidents may arise during paracentesis,
the most important being :-

1. Pneumothorax: this occurred in one case (adult) after an exploratory puncture.
2. Subcutaneous Emphysema not uncommonly develops from the point of puncture without any pneumothorax.

3. Wounding of an intercostal artery is rare.

13

Dr. Norman Moore records the following case: "A man in my ward at St. Bartholomew's Hospital, aged 59 years, who had a dense, new growth in his liver, mesentery, pleurae, and kidneys, and within his cranium (right frontal sinus) was tapped several times for ascites and after three months had a large effusion in the left pleura. His dyspnoea increased so much that paracentesis was performed in the left intercostal space. A few ounces of clear serum came out, followed by serum more and more blood stained and then by pure blood. The cannula was withdrawn: a quarter of an hour later the patient's pulse was very feeble and grew worse and he died an hour later. The post mortem examination showed that the intercostal artery in the ninth space had been punctured and the left pleura contained 20 ounces of blood clot and 36 ounces of dark blood stained fluid and liquid blood. This is the only example of death from wounding of an intercostal artery I have seen."

O P E R A T I O N .

An anaesthetic is quite unnecessary in most cases. It is often advisable in children who are nervous and easily frightened to employ a local anaesthetic - for example, 10-15 minims of 1-2% solution of cocain injected subcutaneously. In adults I have found the ethyl chloride spray of the greatest use.

The aspirator generally used is Potain's.

The place of puncture:-

A point should be chosen as far as possible in the centre of the dull area, at which there is little risk of injuring the heart, liver or lung. The points for puncture are either :

1. Below the inferior angle of the Scapula in the eighth space - usually about two inches below and external to the angle. This is the common spot.

2. The mid-axillary line in the 6th space.

I usually select the former of these two sites unless there is any obvious reason to the contrary. The advantages and disadvantages of these points of election for puncture have been put very shortly by

11

Lindsay as follows:-

The/

The advantages of the former are:

1. It is remote from important vessels and viscera.
2. It facilitates the assumption of the correct posture by the patient.
3. It prevents the patient from observing the details of the operation.

The disadvantages :

1. Chest wall may be difficult to pierce owing to muscle or fat.
2. Pleura is often much thickened at this point.
3. Ribs are sometimes pressed down one upon the other in this situation, so that there is a difficulty in effecting an entrance.

The advantages of the latter site are :

1. Chest wall is easily pierced.
2. Pleura is not usually much thickened.
3. Ribs are not pressed down upon each other, and there is usually ample room.

The disadvantages of this site are :

1. There is some (not much) danger of wounding/

wounding important vessels.

2. There is a possibility of injuring the heart or liver. This danger is not serious.

Strict antiseptic precautions should be taken. The skin at the point of puncture must first be thoroughly washed with weak lysol and then rubbed with ether. In adults a weak carbolic soak (1 in 60) may be put on for 20-30 minutes before the operation.

The trocar and cannula or aspirating needle should be boiled.

It is important to test the apparatus beforehand by drawing it through some sterile water.

In all my cases I have given a dose of brandy before the operation - half a drachm - half an ounce according to the age. This has been repeated or a half to one drachm in water of the following mixture.

Sp. Chloroform.

Sp. Ether.

Sp. Ammon. Aromat. aeq. part.

has been administered where the patient felt faint during, or immediately after, the operation.

The patient should be placed in a semi-recumbent position and the arm raised so as to widen the intercostal spaces.

If/

If the trocar and cannula are used they should be introduced slowly and steadily with the knob of the trocar pressing against the ball of the thumb. Avoid wounding the intercostal artery by inserting the trocar just above the upper border of the rib.

Once the trocar and cannula are inserted, half open the stop-cock which shuts off communication between the cannula and the exhausted bottle. The fluid will now be withdrawn slowly. Should fluid fail to come even when the stopcock is fully open, withdraw the cannula slightly and push it in another direction. The point of the cannula may have been buried in adhesions. If it still fail to come, push in trocar to make sure that the cannula is not blocked. If this prove unsuccessful and there is no doubt about the diagnosis, another point for puncture should be tried.

After a sufficient quantity of fluid is considered to have been aspirated, the cannula is withdrawn, and the opening is covered by collodion and several thin layers of cotton wool.

All that has been said is equally true of the treatment of serous effusion in children.

In the great majority of cases absorption takes place/

place in the course of a few weeks under simple tonic treatment.

Convalescence is apt to be slow and it may be some months before recovery is complete.

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A few words about hydrothorax will complete the treatment of serous effusions.

The general treatment will be that of the condition causing the hydrothorax which is usually part of a general dropsy. Many of the cases are of cardiac origin so that tonics such as Strophanthus and Digitalis are called for.

In addition a short course of diuretics and purgatives are useful to get rid of the general dropsy. A combination of potassium citrate and diuretin proved to be most efficacious.

In the majority of cases, paracentesis required to be performed. The method of operation is the same as already described.

PURULENT EFFUSIONS - EMPYEMATA.

When it has been decided by the exploratory punct-
ure that the effusion is purulent, the sooner it is
let out the better -

(a) - In Children :

Aspiration alone was employed in 27 cases. Of
these 5 completely recovered after two or three tap-
pings. Two were cured after one tapping. But with
the rest, the pus re-accumulated and the chest required
to be opened and drained.

Allowing that aspiration may be sufficient to
cure an empyema, it is necessary to inquire into the
conditions under which it may be practised.

Firstly, aspiration can do no harm even if open-
ing of the chest ultimately becomes necessary. Indeed
it has certain advantages. For example: it is ex-
tremely useful as a preliminary to incision or re-
section in cases where there is a large effusion caus-
ing considerable embarrassment of breathing. This is
especially important in babies as they are very prone
to collapse after the chest has been opened. Seeing
that it is all that is required in some cases, I
strongly advocate one or two trials before proceeding
to incision.

Secondly, aspiration is of the greatest value in double empyema, a very serious and comparatively rare condition even in older children. The death rate is very high under two years of age, and, therefore, the most favourable operative treatment should be adopted. The incision should be made on one side first, whilst aspiration is employed on the other side, and may be repeated once or twice before the second pleural cavity is opened. I found this method extremely successful in one case I was fortunate in getting.

Double empyema may be treated by opening both sides of the chest and the following successful case reported by Dr. L. Morrison in the British Medical Journal is worth quoting.

I will give it more fully perhaps than is necessary but I wish it in addition to illustrate the course of a double empyema, and it will also prevent repetition, viz., my recording a similar case, which I had under my own observation.

"G.S., a fat, healthy-looking boy, aged 7
 "years, was admitted to the East London Children's
 "Hospital, Shadwell, (under the care of Dr. J. A.
 "Goutts)¹⁹ on August 9th last, with a one day's his-
 "tory/

"history of pain on the left side of the chest
"below the nipple. The temperature was 103°
and the pulse 136.

"Immediately below the left nipple there was
slight dulness, harsh breath sounds, and pleuritic
"friction. Two days later the dulness had ex-
"tended round to the back, and faint bronchial
"breathing was heard at the left base. By August
"17th, the breathing had become much distressed,
"and altogether he appeared extremely ill. There
"was absolute dulness and aegophony at the left
"base, with some impairment of resonance also at
"the right base. On the left base being explored
"thin pus containing pneumococci was obtained.

"Next day a piece of rib was resected and
"6 ounces of pus evacuated.

"On August 23rd the wound was discharging
"freely, but the breathing was still very dis-
"tressed.

"On August 27th, as the dulness at the right
"base had increased, it was explored, and thin pus
"containing pneumococci found. Under cocaine, by
"simple intercostal incision, about 6 ounces of
"pus were then evacuated.

"On/

"On September 4th the patient began to improve
"and the discharge from the empyema wounds became
"less. Both wounds were quite healed on September
"18th.

"The boy was discharged on September 24th.

"This case seems worthy of record as shewing
"the advantages of treating certain empyemata by
"the method of simple intercostal incision as
"opposed to resection of a piece of rib. In this case
"the empyema on the left side was operated on by
"resection of rib nine days before the right side
"was opened by simple incision, yet the latter
"drained quite as freely, and the wound had healed
"up on the same date as the one operated on first.

"The advantages here of treatment by simple
"incision were therefore great, for at a time when
"the patient was very critically ill, it was
"possible to operate speedily under local anaesthesia
"without the slightest shock to the child, and with
"a more favourable result."

When aspiration is performed for empyema it
is necessary to avoid using too forcible suction as
there is a great risk of causing rupture of the lung.

15 cases were treated by simple incision through an intercostal space. Of these 12 recovered and 3 died. The drainage provided in every case treated in this way was very efficient. The incision must be made wherever the pus is, but in a large effusion where a choice can be had, I prefer the 7th or 8th space in the posterior axillary line. As the pus is evacuated, the diaphragm rises, so that if the incision is made too low down, the tube will not run straight into the chest and thus interfere with drainage.

Two drainage tubes of moderate size transfixed by a large safety-pin are passed into the pleural cavity. Too much of the tubes should not project into the pleura. Two tubes diminish the danger of blockage by fibrinous masses. During the first two days, the dressings should be changed twice and for the next two weeks once a day. The tubes ought to be shortened at each dressing. Usually by the end of the third week, it is possible to dispense with the tubes altogether, and the tract is kept open by a narrow strip of gauze.

If the mortality affords any proof of the advantage or disadvantage of one operation over another then

I/

I firmly believe that a simple incision and drainage between the ribs is the best mode of treatment for all cases under two years. The operation is simple and can be done in a very short time under a local anaesthetic (cocain 1-2% with 10-15 minims adrenalin chloride to ounce of solution.)

Lastly, the shock is much less, a very important point in babies, who cannot withstand so severe a shock as older children.

Resection of rib :

This should not be performed as a matter of routine. It is usually done with the belief that more perfect drainage is obtained and that it facilitates the evacuation of fibrinous masses.

If adequate drainage can be secured without it there is no reason why it should be performed. Resection is considered to be necessary more frequently in children than it is in adults. This is explained by the intercostal spaces being wider in adults than in children.

Out of the 83 cases examined, I find that a portion of rib was excised at once in 38 cases. 80% of these were in children over 2 years of age. 32 cases recovered and 6 died.

Further, in 22 cases repeated Aspiration was given a trial, but in every case resection of a portion of rib was ultimately found necessary owing to the re-accumulation of pus.

Of these 14 recovered and 8 died.

Dr. John Thomson and Dr. Eustace Smith have come to the conclusion, after having tried both simple intercostal incision and resection of rib and noted the results in each, that the former is the preferable operation.

(b) - In adults.

In the great majority of instances incision and resection of a portion of rib are performed as a matter of routine in adults. The main object in adopting this method is to provide efficient drainage. In addition any adhesions may be broken down and masses of lymph removed from the cavity. Local anaesthesia should be employed wherever possible e.g., subcutaneous injection of cocain and adrenalin.

The patient is laid flat on his back and he is brought to the edge of the table so that the affected side is slightly projecting. The usual antiseptic precautions are taken.

In every case a preliminary puncture must be done. This is a rule laid down by Trousseau many years ago.

The incision is made over the rib to be resected. In empyemata of considerable size this will be the 7th, 8th or 9th rib in the mid. or posterior axillary line.

"The incision which is about $2\frac{1}{2}$ inches long is made in the long axis of the rib and is carried down to the bone dividing the periosteum freely. The skin should/

should be pulled up slightly over the rib before the incision is made to insure that, when the chest falls in after withdrawal of the pus, the opening in the soft tissues will be opposite the opening through the rib. The periosteum is then raised from the bone all round with a curved separator, care being taken of the intercostal vessels which run in the groove on the under edge of the rib. With a suitable pair of rib forceps a portion of the rib, about an inch and a half long, is resected. The pleura is opened by pushing a director through it and the finger introduced through the opening thus made. Before the pus escapes, the cavity should be explored with the finger to determine its extent and the condition of the lung.

The pus is allowed to flow out slowly in order that the heart and lungs may gradually accommodate themselves to the altered conditions of pressure within the thorax. Two large sized rubber tubes are introduced side by side so that they project about a quarter of an inch within the parietal pleura. The advantage of two tubes is that the risk of blockage is diminished, and that, at the subsequent dressings, one tube can be removed at a time, the other keeping the wound open and facilitating re-introduction. The outer end of each/

each tube should be transfixed with a large safety-pin to prevent its being sucked into the pleura during inspiration." (Miles and Thomson)²⁰ .

AFTER TREATMENT.

The patient must be encouraged to lie on the affected side as much as possible to favour the escape of the discharge. The amount of the discharge will determine the frequency of dressing. There should be no hurry to remove the tubes. In a simple, straightforward case the tubes should be regularly shortened so that in a short time they are required no more.

Taking out the tubes too soon usually results in re-accumulation of the pus. Of course it is impossible to say how long they will require to remain in in any particular case. It may be stated that if they are not out within three weeks they will probably remain in for months.

Breathing exercises are important in that they may greatly facilitate the re-expansion of the lung on the affected side.

A convenient method is the use of Wolff's bottles which are so connected with tubes that an expiratory effort forces the water from one bottle into the other.

There is no doubt that, both in children and adults, granting that the temperature is normal and the case in other respects is progressing satisfactorily, the sooner the patient is up and going about the more/

more rapid will be the recovery. The erect posture conduces greatly to the re-expansion of the affected lung.

MODE of CURE .

The cure of an empyema is by expansion of the lung and falling in of the side.

Adhesion of the parietal and visceral pleura is said to take place and so permanently obliterate the cavity. But in some instances this does not occur as is proved by cases of recurrent empyema, in which a second empyema occurs some time afterwards upon the same side. The following case illustrates this rare occurrence :-

"A boy, aged 14, was admitted to the Leicester Infirmary under the care of Reginald Pratt, M.D.,²¹ M.R.C.P., on September 1st, 1908. There was a history of pain in the right side of the chest on taking a deep breath and difficult breathing for a month previous to admission.

He was operated upon in a Manchester Hospital for an empyema on the right side, following Scarlet Fever, when 1 year and 10 months old. He remained in the Hospital for seven weeks, and the wound had completely healed nine weeks after the operation.

In his present illness the result of examination was in favour of a moderate effusion at the right base, as high as the 3rd intercostal space in front. The scar/

scar of the previous operation was present in the 6th intercostal space. The right pleura was explored with an aspirator needle and pus obtained. A portion of a rib was resected, the incision being within half an inch of the old scar, and twenty ounces of pus were evacuated, under chloroform.

This was the first case that had been seen in over 20 years' hospital experience."

In cases successfully treated by aspiration alone absorption of the residue of the empyema must have taken place, as it is practically impossible to empty the pleural sac completely by paracentesis.

A localised or deep seated empyema, which has existed for some weeks and not been recognised or treated, may spontaneously perforate through the lung and so cure itself.

Thus I watched the progress of the following case admitted to the Royal Infirmary, under the care of Professor Wyllie :

The patient, a pale, delicate-looking man, aged 30, was admitted on August 12th, 1908, with a troublesome cough and shortness of breath on the least exertion. Five week's before admission he was/

was suddenly seized with stabbing pains in his left side. His doctor told him he had a slight attack of pneumonia and pleurisy. He remained in bed for a fortnight making very unsatisfactory progress. From this date his cough steadily grew worse, the shortness of breath became almost constant, and he began to sweat profusely at night. He was losing in weight steadily. His previous health had been good.

On admission the temperature was 100.6°F and the respirations 36 per minute. The leucocytes numbered 10,000 per c.cm. (polymorphic increase) The cough was frequent and paroxysmal, being accompanied by a small amount of muco-purulent sputum. Microscopically this contained pus cells and a few chains of streptococci.

The odour of the breath was rather foul, especially after a fit of coughing.

The expansion of the left side of the chest was very small. Vocal fremitus was much diminished over the left base posteriorly.

The apex beat was not displaced.

On the left side of the chest posteriorly there was increasing dulness from the level of the 2nd rib downwards/

downwards. At no point was the note stony dull. There was Skodaic resonance over left apex anteriorly.

The breath sounds were distant and feeble, and the vocal resonance diminished at the left base posteriorly. But in the left Scapular region they were faintly tubular, and the vocal resonance in same area was much increased = pectoriloquy.

The right lung was healthy.

A needle was introduced in the left Scapular region and no fluid obtained. A few days later the left pleura was explored for a second time in the same area, and still no fluid obtained. The sputum was steadily becoming more purulent and the temperature kept about 101°F., swinging in a manner very suggestive of pus.

On the 4th September 1908 (i.e., 23 days after admission) he was suddenly seized with a violent fit of coughing, bringing up about 8 ounces of pus.

From this date the temperature began to settle and the dulness gradually cleared up. He made a complete and uninterrupted recovery, increasing his weight on admission about 7 lbs.

Lastly those cases in which a discharge has persisted for months and the cavity of the pleura will not close, it may be necessary to consider the advisability of an extensive operation, viz., Estlander's operation, which consists in the removal of portions of several ribs. This, being a serious operation, not always successful, and attended with great deformity of the thorax, requires the most careful consideration.

Fortunately it is seldom found justifiable.

Among the 83 cases of empyema in children collated there was only one in which a thoracoplastic operation was performed.

In conclusion I would express my thanks to Professor Wyllie and Dr. John Thomson for their courtesy in allowing me to examine the records of the cases of pleural effusion that have been under their care and to utilise the results for my Thesis.

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