PLEURAL EMPYEMA.

ACUTE AND SUBACUTE

With special reference to the Bacteriology of Pleural Effusions and the Nervous Complications occurring during the Progress and Treatment.

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INTRODUCTION.

The subject of Empyema has gained greatly in scientific and clinical interest by the changes in its pathology resulting from bacteriological research. This may be said to be the development of the last decade, approximately, in the progress of Medical Science, for we finds that Bowreet (1888) in his classical work makes but little reference to the organismal sources of pyothorax. And it is more particularly from a diagnostic point of view that our knowledge has been improved; while we now recognize that it is by a more exhaustive criticism of the history, pathology and present condition one must determine, for each individual case, the lines of treatment, of which, nevertheless, the most modern methods are to be regarded as in great measure revivals or modifications of those formerly employed for all purulent thoracic effusions, even from the days of Hippocrates. In this country it has not been customary to differentiate much between serous and purulent effusions; no important monographs have been written on Pleural Empyema "per se", and the more important papers on this subject have to be

Sought for in the pages of our Journals and general Text-Books; on the other hand foreign literature, especially French, has given us the exhaustive + standard works of Netter, Bonveret, Delbve + Courtois-Suffit and Cestan. But it is also noteworthy that recent researches would indicate that the clinical + pathological distinctions between the two varieties of pleuritic effusion are by no means certain. Are we to regard all pleurisies as organismal in origin and toxic in quality? If so, what are the conditions that determine when inflammation of the Pleura will lead to purulent or to serous effusion? The most recent theories would suggest that all acute sero-fibrinous Pleurisies are due to the Tuberculosis Bacillus, that Empyema is of septic origin alone, and that the tubercular variety of Pyothorax is to be regarded as a mixed form or rather that pyogenic infection has been superadded to tubercular at a later date in the clinical history of the case. Mixed infection, except in the true Pneumococcal Empyemata, is most frequently met with, hence a definite classification of the types is rendered difficult; still less can we classify the cases from a clinical standpoint; each particular case

must demand the choice of treatment best suited for that type to which it conforms. Therefore the importance of early diagnosis, of bacteriological examination of the fluid, and of prompt treatment by the various methods which now offer in this, as in all progressive sciences, far greater chances of success. The diminished death rate in cases of Pleurisy & Empyema is the best testimony to the advances made in this direction, and the extensive operations demanded in chronic cases are, without doubt, becoming less frequently necessary. The formation of pus within the pleural cavity, from whatever cause, implies a process of inflammation sufficiently acute to lead to the rapid breaking down of leucocytes and connective-tissue cells; this would imply that sero-fibrinous is less acute than purulent Pleurisy, while on the other hand we cannot regard this as a clinical axiom. Any inflammatory process must have an organismal cause, and possibly it is because of the difficulties of finding particular micro-organisms in the sero-fibrinous effusion that we have hitherto been accustomed to make distinction between this form and that in which pus makes its appearance from the beginning. In any case, we must now

discard the terms "simple" or "idiopathic" as applied formerly to the milder forms of Pleurisy with Effusion. An Empyema, as a general rule, is such throughout its course; the fluid at first may be thin and watery but is always somewhat turbid; when a simple serous effusion becomes septic it would indicate that a secondary infection has taken place, and that the Pleura is undergoing a second & more virulent form of inflammation leading to a greater destruction of tissue elements. As will be observed later, this process is most characteristically seen in the Tubercular type of Empyema where the repeated attacks of inflammation and the secondary infection of the Pleura lead to the most intractable form of Pyothorax. In the greater majority of cases true pus is found in the pleural sac at the earliest stage of effusion, the rapidity of its formation depending, in great measure, on the Etiology & the general physical condition of the system. This latter one finds to have almost invariably suffered previously from some illness, acute or chronic, to which the cause can be traced, or which has predisposed the patient to the attack of the bacteria which are more directly causal. We must, for practical purposes, regard Empyema as a secondary

condition; the 'primary' disease may be slight and even unobserved by patient or physician, or so severe, on the other hand, as to mask the secondary disease whose existence is only noticed when convalescence from the primary sets in.

The various types of Pleural Empyema can be grouped into series according to whether the cause is Intra- or Extra-thoracic; from the point of view of Etiology, primitive or secondary; from their clinical & anatomical aspects; or, as has most frequently been adopted, by the bacteriology of the effusion and the pathological processes which each case exhibits. It would seem best to discuss the latter at greater length; the symptoms & diagnosis, which, on the whole, conform to a more or less general type, do not demand so much attention here; the complications, especially those associated with the progress and treatment of Pleural Effusions are of special interest; and the numerous methods of treatment best suited for the individual or type of case must be dealt with in some detail.

I shall not extend this thesis beyond the subject of Acute and Subacute Empyema, and in doing so shall endeavour to review most of the writings

and researches of authorities of recent date, and sum up the general results of their conclusions; I shall describe in detail a series of illustrative cases that have come under my own experience, supplementing these with others quoted by authorities & writers on the subject.

Empyema in children has, in many respects, a greater importance than in adults; but while such cases are more complex in diagnosis and treatment, on the whole better results have been obtained in the former than in the latter, if we can rely on the statistics furnished from many sources. I shall endeavour to indicate the differences, while at the same time pointing out that no important distinctions can be made except as regards the recuperative powers of youth & their bearing on prognosis.

As regards Bibliography and References, I append (pg. 144.) a list of the Books & Articles on the subject to which I have been most indebted. To furnish a complete list of all the numerous monographs & papers consulted or referred to would be too extensive, but most references required will be found indicated in the text.

ÆTIOLOGY

Sex — is not of marked importance as regards the incidence of Purulent Pleurisy; in childhood we find that females are as frequently attacked as males, but among adult cases there is a marked preponderance of liability in the latter, probably arising from the greater exposure & more trying conditions of life which men have to undergo.

Age — Empyema is more common in children than in adults, especially as a complication of Pneumonia; in the former, owing to the greater intensity of the inflammatory process and the weaker resisting powers of the tissues, pus is more readily produced, & the various acute febrile disorders which are liable to attack serous membranes are most frequently met with in children. The condition is most frequent in children below the age of 6 years and in adults between 20 and 30 years of age, but may of course occur at any age. A senile type, rarely purulent has been specially studied by Lemoine (Journal de Médecine, July 1898).

Constitution and Previous Health — have considerable influence on the occurrence of Empyema; the Tubercular diathesis shews a special liability to Pleurisy

both serofibrinous & purulent; as also in individuals weakened by Alcoholism, Cancer, Renal and Hepatic disease.

Chill —— has long been accepted as a frequent cause, either because the susceptibility to the attack of bacteria is increased by any sudden lowering of the bodily temperature or because the initial rigor that ushers in the disease in many cases is misunderstood by the patient. Lindsay (Encyclopedia Medica Vol IX pg. 352) obtained the history of a chill in 26 out of 74 cases of acute Pleurisy, but considers that, while the influence of chill cannot be Eliminated, too much must not be allowed to the statements of patients as to the actual occurrence of such.

The direct or immediate cause of Empyema is the attack of Microorganisms on the Pleural Membrane Visceral & pleural and its underlying connective tissue; but, while the disease may commence as a primary one in the Pleura, indirectly the sources of infection naturally group themselves as "Intrathoracic" and "Extrathoracic", the former being the more common origin of the disease. Here we may remark that the Pleural Membrane is apparently much less resistant to the attack of septic infection

reaching it from without, i.e. through underlying tissues, than the Peritoneum, a fact which I think is not adequately accounted for by the theory of "tolerance" in the latter (vide Bayard Holmes quoted by Paget, Surgery of Chest)

1. Intrathoracic causes ——— Acute Lobar Pneumonia is the principal source of the majority (60%) of cases in children and of a smaller proportion (25%) in adults; along with this may be placed Bronchopneumonia which doubtless accounts for many of the cases following & attributed to such exanthemata as Whooping Cough & Measles. In children bacteriological & clinical Evidences all indicate that a previous & sometimes simultaneous inflammation of the lung tissue precedes the extension of the microorganisms to the pleural cavity; thus Simmonds (Deutsch. Archiv. für Klin. Med., Bande XXXIV) found 31 cases out of 40 due to Pneumonia, Netter (Soc. Hôt. des Hôpitaux 1889 & 1890) 14 out of 27, Hotthuyer (Thèse de Zurich 1892) 36 out of 43, Hofmokl (Congress de Vienna 1890) 21 out of 28, Holt (Archives of Pediatrics 1892) 19 out of 20, Adam (Archiv. für Kinderheilk, Bande XV, 1893) 22 out of 32. Finkelstein (Thèse de Paris 1890) from collected series found 99 out of 288 cases or 35%, but as these were from records previous to 1890 we must regard it as being an under-estimation. Sutherland (Lancet June 1895) in 21 cases

of double Empyema found 15 due to Pneumonia. From a series of 53 cases in the Royal Hospital for Sick Children in Edinburgh, I found that at least 37 gave a previous history of Pneumonia, usually of lobar type. In adults, on the other hand, Acute Pneumonia does not lead to as large a proportion of cases of Purulent Pleurisy, although by itself it has a much higher mortality than in children. Serofibrinous effusion accompanying or following Pneumonia in adults is of frequent occurrence, and it would appear that in children such effusion shews a greater tendency to be purulent. Dörfler (Munchener Med. Woch. 1892. pgg. 795 + 820) found in adults only 12 out of 21 cases due to Pneumonia, Quest (Munchener Med Woch. 1892 pgg 791 + 817) 12 out of 33, Hofmokl (Congress de Vienna 1890) 37 out of 60, Schede (Handbuch der Penzoldt et Stintzing 1894.) 573 out of 709, and later Hale White finds only 41 out of 325 (vide Lancet Nov. 1900). We thus find that Pneumonia is the cause of Pyothorax in about 65% of cases in children + 25% in adults. Tubercular disease of the Lungs may be regarded as the next most frequent cause, especially in adults; this is especially so when we find that modern research shews that the true sero fibrinous type is in many cases of tubercular origin. Tuberculosis may exist in the Lung + thence spread to the Pleura, or as is not

infrequent a septic infection may be superadded. Further on it will be shewn that the great majority of cases of Acute Empyema which occur in conjunction with Pulmonary Tuberculosis are not tubercular, and it is mostly the slow & chronic types that are truly so. In children, Simmonds (op. citat.) finds 12 tubercular out of 31 cases, Israël (Thèse de Copenhague 1892) 10 out of 59, Finkelstein 29 out of 288 or 10%; in adults Fetter (op. citat.) finds 15 out of 156 or 10% which may be regarded as the most reliable general estimation. Of other Intrathoracic causes, one must particularly mention Bronchiectasis & Pulmonary Gangrene which usually lead to putrid or acutely septic types of Empyema; less frequent are suppurative processes in the Mediastinum & Bronchial Glands, Pericarditis & Endocarditis (the latter more truly classed under Pyaemia), Ulceration of Trachea & Oesophagus. Caries & necrosis of Ribs & Spinal Column, Penetrating wounds & abscess of chest wall & in rare cases Contusions, cannot quite be classed as truly intrathoracic.

2. Extrathoracic causes ——— The part played by the various acute infectious febrile disorders is important; many of these act thus in two ways, viz. firstly as causing direct primary inflammation of the Pleura, and secondly as liable to be complicated by Pneumonia

& Sero-fibrinous Pleurisy whence true Empyema may arise. Thus Measles & Pertussis is frequently followed by Bronchopneumonia, Typhoid Fever & Influenza by Lobar Pneumonia, Smallpox & Scarlatina may occasionally act thus but more usually as direct causes of Septicaemic character. Anthrax & Plague might also come under the same category. Septicaemia and Pyaemia, especially the Puerperal forms, are undoubtedly the most important of extrathoracic sources, more frequent in adults than in children; such Effusions of pus are in most cases found to be due to Streptococci which reach the Pleura indirectly through the Lungs but also directly; under this head we would include Osteomyelitis & Arthritis, Pelvic Cellulitis & Peritonitis, Cerebral Abscess, Venous Thrombosis & Phlebitis.
Diphtheria through the enlargement of glands resulting from Streptococcal infection usually associated with Loeffler's Bacilli. Tubercular glands, cervical, bronchial & abdominal, Tonsillitis & Retropharyngeal Abscess are rarer causes, occasionally reaching the Pleura by direct extension.
Abdominal conditions, in rarer cases, may be source direct or indirect of infection of the Pleura, thus Peritonitis especially Tubercular form, Hepatic abscess & Subdiaphragmatic abscess, Ulceration & Perforation of Stomach, Infection of Umbilical Cord in the newly-born infant &c.

So also more indirectly from Appendicitis, Suppurative Nephritis, Cystitis, Herniae, &c. such cases being probably pyaemic or metastatic in character.

In conclusion, it is to be noted that, in view of recent researches on the bacteriology of Pleural Effusions both sero-fibrinous and purulent, the proportion of Empyemata of Tubercular origin must be increased, and the presence of other pathogenic bacteria than the Pneumococcus of Fraenkel (in the absence of the latter) in the effusion does not negative the existence of a recent Pneumonia.

From careful examination of numerous reports & statistics of recent date, I would tabulate the causes of Empyema in the following proportions,

CAUSE.	IN CHILDREN	IN ADULTS
Pneumonia, Croupous & Catarrhal.	60 %	35 %
Tuberculosis	10 %	25 %
Specific Fevers	20 %	10 %
Other Intrathoracic causes	4 %	10 %
Extrathoracic causes	6 %	20 %

BACTERIOLOGY.

The Bacteriological classification of the different forms of Pleural Effusion, while at considerable variance with the actual clinical types, offers the best method of systematizing our knowledge, and the micro-organisms discovered in any sample of fluid removed from the chest for diagnosis must have an important bearing on the prognosis and treatment of each case. It has been found that bacteria, easily demonstrated in purulent effusions, are also though with greater difficulty to be discovered in serous and serofibrinous pleurisies. The trend of general opinion of late years would indicate that all serous Effusions in which no organism can be discovered are of Tubercular origin; the presence of Pneumococci & Pyogenic bacteria in such has been clearly demonstrated but the exact relationship of microorganisms to serous & purulent effusions is still hypothetical.

I. Bacteriology of Serofibrinous Pleurisy.

Inflammation per se is of bacterial origin in practically all cases, and however much we grant to the predisposing cause it is evident that microorganisms must have or still exist in however small & transient

amount in the inflamed tissues. So, in the case of Pleurisy, it must not be presumed that, because an exudate gives sterile results by all methods of examination, it has an idiopathic origin. That the Tubercle bacillus plays an important part in the causation of Acute Serofibrinous Pleurisy is an undoubted fact but how far we can hold this as a general rule is not certain. The difficulties of finding bacilli, which may be few in number or have perished by their own toxins, are numerous; unless the whole effusion could be carefully examined, after "centrifugalizing", by microscope, culture & inoculation we are not justified in excluding microorganisms. Moreover, as has been pointed out by Shaw, Osler, Fowler & others the causal organisms may remain almost entirely within the substance of the serous membrane and its subjacent areolar tissue, in the fibrinous masses & granulation tissue which thicken the membrane, in detached masses of fibrin, and especially on parts of the Lungs or Pleural cavity not easily accessible. Again the Pneumococcus, as will be referred to later, is an organism of low vitality & soon perishes; and on the other hand Streptococci often shew

Sufficient virulence for a comparatively small number to create an extensive & severe inflammatory reaction in the tissues. Jakowski (quoted by Lindsay Encyclop. Medica Vol IX page 351) sums up his conclusions on the entire subject of the bacteriology of Pleurisy as follows — (1) That all pleurisies depend upon microorganisms though these are not always to be found; (2) That where no organisms are found the case is probably tubercular; (3) That primary genuine pleurisy, not due to tuberculosis, is most often due to the Pneumococcus; (4) That serous exudations in which pyogenetic are found have a greater tendency towards Empyema; (5) That exudations during or after pneumonia are most often dependent on Fraenkel's Diplococcus.

Landouzy (Revue de Médicine 1886) thinks from 70 to 75% of all serofibrinous Pleurisies are of Tubercular origin; later he has placed the proportion as high as 95 to 98 %, but this seems rather excessive.

Germain See (Des Maladies Simples du Poumon, Paris 1891) says "so called simple Pleurisy from a chill is only a tuberculous pleurisy the nature of which has been misunderstood" and "the proportion of such cases is 75%".

Osler (Shattuck Lectures on Tuberculous Pleurisy 1893) reports that from post mortem records he found only 32 cases to be of tubercular origin out of 101 successive cases of

acute Pleurisy. He also says (Principles + Pract. of Medic. 1897) "the more carefully I have studied the question the larger does the proportion appear to be of primary pleurisies of tuberculous origin; the subsequent history of cases of acute pleurisy forces us to conclude that in at least two-thirds of the cases it is a curable affection."

Kelsch and Vaillard (Archiv. de Physiolog. 1886 — quoted by Strauss in La Tuberculose et son Bacille, Paris 1895 page 104) found that of 113 cases of acute pleurisy, nearly 82% proved to be tubercular and the authors conclude that ordinary pleurisy is only the manifestation of local Tuberculosis. They examined 16 fatal cases of Pleurisy, in all of which miliary granulations were found on the Pleura while the Lungs were free from infiltration or presented a few recent lesions. By inoculation of animals Tubercle was reproduced in 2 out of 4 cases of purulent effusion and 1 out of 10 cases of serous effusion.

Gombault and Chauffard (Soc. Méd. des Hôpitaux 1884 + 1886) inoculated 20 guinea pigs with the Effusion withdrawn from 20 cases of serofibrinous acute Pleurisy, and, although in no cases were Tubercle Bacilli discovered in the withdrawn fluid, in 10 of the animals Tuberculosis developed.

Lemoine (Bulletin des Hôpitaux 1895 pg. 256) made cultures

from the Effusion in 32 cases of acute serofibrinous pleurisy in robust individuals with no heredity to Tuberculosis; the results were sterile in 28, and in 4 cases pure Staphylococcus Albus was found; but of these 28 cases only 5 could be classed as cured, for 1 case had pulmonary Tuberculosis, 15 developed it later and 7 showed suspicious signs at the apices.

Mitchell Rudden (New York Medical Journal 1893) found micro-organisms in only 2 out of 21 cases, and the Pneumococcus in 2 cases of Serous Effusion following Pneumonia.

Goldscheider (Zeitschrift f. Klin. Med. 1892, XXI, 363) found Streptococcus in 3 cases of Serous Effusion which did not become purulent and Staphylococcus in 1 case.

Pansini (Centralblatt fur allgem. Patth. 1893) examined 15 cases of Serous + 8 of purulent Effusion, his results were ——

+ Serous Effusion — Tubercle Bacillus in 6 cases
Pneumococcus in 3 cases
Streptococcus in 1 cases
No microorganisms in 5 cases

++ Purulent Effusion — Tubercle Bacillus in 3 cases
Streptococcus or Staphylococcus in 3 cases
Pneumococcus in 1 case
No microorganisms in 1 case.

In one haemorrhagic effusion he found Tubercle bacilli, as did also Hamot (Soc. Méd. des Hôpit. 1893, X, 732). Netter (Bulletin des Hôpit. 1890 + 1891) in 20 cases of acute "Idiopathic" pleurisy by inoculation got Tuberculosis in 8 cases, but only 7 cases out of 12 which were clinically tuberculous. He puts the proportion of cases of Serofibrinous Pleurisy due to Tuberculosis at 68%.

Aschoff (Zeitschrift für Klin. Medic. Band XXIX 1890) found micro-organisms in only 7 out of 200 cases of Serous effusion; in 2 cases following Pneumonia he found Streptococci once + Pneumococci once, similar results also in 2 cases of so called Idiopathic Pleurisy.

By inoculation of the Serous effusion from 57 cases of acute Pleurisy, the results obtained were—

Of 19 cases secondary to Pneumonia, Rheumatism &c. Tuberculosis in 0.
" 12 " certainly tubercular —— " " 7.
" 12 " doubtfully tubercular —— " " 9.
" 12 " of Idiopathic Pleurisy —— " " 9.

Levy (Archiv für Exper. Path. u. Pharmak 1890 + 1895; also in Prager Med. Wochenschrift 1895) examined 54 cases, of which 37 were serous and 17 purulent effusions; In 6 cases secondary to Typhoid, Staphylococcus found in 3 + negative results in 3 cases; In 19 secondary to Pneumonia + Influenza, Pneumococci in 14, Staphylococci in 2 cases

and no microorganisms in 3 cases; Tubercle bacilli could not be found in 14 cases evidently Tuberculous; negative results obtained in 8 cases of serofibrinous Pleurisy secondary to Rheumatism, Heart disease, Nephritis & Cancer; and Staphylococci were found in 6 mixed cases + 1 case secondary to Infarction of the Lung.

Jakowski (Gazeta Lekarska 1892) found microorganisms in 23 out of 30 cases of serous effusion, and his analysis of another series of 48 cases in which microorganisms were present shews one form alone present in 34, of which 10 were Streptococci, 2 the Tubercle bacilli + 1 Staphylococci, the remaining 14 cases shewed mixed infection.

Thué (Norsk Magaz. f. Laegevidensk 1895) found Tuberculosis bacillus present in 1 out of 12 cases of Serous effusion, and (Bulletin des Hôpitaux 1895. 439.) of 30 cases of serofibrinous Pleurisy, the fluid examined by microscope & culture, found 17 negative + 13 positive, thus—

Bacillus Tuberculosis — 1 case
Streptococcus 1 case
Pneumococcus 3 cases, subsequently purulent.
Staphylococcus aureus + albus 1 case.
Staphylococcus albus alone 1 case.
Staphyl. albus, followed by Tuberculosis on inoculation 1 case

Cocci of doubtful nature, 2 cases
Micrococcus cereus, 1 case

Of 33 cases of Serofibrinous Pleurisy, he found that 20 subsequently developed Tuberculosis.

Ernest (Bulletin des Hôpitaux 1895, 145.) found from analysis of 20 cases, 17 of which were "Idiopathic" + 3 following Pneumonia ——

Pneumococcus 4 cases
Staphylococcus 6 cases
Eberth's Typhus Bacillus 1 case
Bacillus Tuberculosis 3 cases
No result in 6 cases.

Sacaze (Revue de Médecine 1893, XIII, 313.) found Tubercle bacilli at the beginning of a serous effusion which failed to show it later, and this result throws light on the difficulty of detecting its presence even when the clinical evidence of Tuberculosis is strong.

Strauss (La Tuberculose et son Bacille 1895) is of opinion that if larger quantities of the fluid had been withdrawn + examined the negative results would have been fewer, and Fowler (Diseases of the Lungs 1898) says while "in the majority of cases no microorganisms can be found and no results obtained either from culture or inoculations, the part played by the Tubercle bacillus in causation of Acute

Pleurisy in individuals of robust physique & free from hereditary predisposition is of great importance; but sufficient examination for evidences of Tuberculosis have not always been made post-mortem, hence we have come to mistrust all records from which mention of such examination is omitted."

The after-history of cases of acute Pleurisy, although details on this subject are rather meagre, tends to further the theory of the Tubercular origin of many cases, thus Fiedler (Volkmann's Sammlung Klin. Vorträge 1882) found that of 92 cases, only 21 were free, two years later, of all signs or symptoms of Tubercular disease and no less than 28 had died of Pulmonary Tuberculosis. Richochon (Étude Experimentale 1887, II, 573) of 33 cases, 14 died of it; Bowditch (Medical News 1889, LV, 63) of 90 cases during a period of thirty years, 30 died of Pulmonary Tuberculosis; and Barr (Brit. Med. Journal 1890 I, 1059 of 62 cases 22 had died within 6 years from the same cause.

The conclusions to be drawn from the above results may be considered fairly definite, in view of our present knowledge of the subject & the advances made in bacteriology. These I would formulate thus—

(1) When no microorganisms can be found in the serous effusion 60% of such cases are of Tubercular

origin, and in such "amicrobic" effusions the results of inoculation are of considerable value in demonstrating the existence of Tubercle bacilli which may be only existing in spore form.

(2) Tubercle Bacilli can only be demonstrated in about 10% of all cases of primary Pleurisy which are evidently of tubercular origin, and this can be proved, from careful examination of the Lungs & Pleura post-mortem or from the subsequent history of the case, in many cases in which a definite microorganism other than the Tubercle bacillus or no bacteria at all can be found in the effusion.

(3) Conclusions from inoculation will alone be trustworthy if a large number are recorded of which a fairly constant number yield Tuberculosis in the animals; and we must remember that, in accordance with known facts about Tuberculosis in any part of the body, non-tuberculous inflammation may so damage the tissues as to render them liable to become the site of Tubercular disease.

(4) Tuberculosis of the Lungs & Pleura is found to develop at a later date in about one third of all cases of Acute Serofibrinous Pleurisy, especially those exhibiting recurrence of the latter.

(5) While the existence of Tubercle bacilli in the effusion

is rare or difficult to discover from whatever reason, the presence of the Staphylococcus Albus alone is always suspicious of Tuberculosis.

(6) In most cases where the microorganism found is the Streptococcus Pyogenes, the Pleurisy is a secondary one, and only a minority of such is of Tubercular origin. If associated with Tubercle bacilli it will be found that the former has been superadded to a primarily tuberculous pleurisy. Effusions arising from Streptococcus infection are more usually purulent or become so, though at first serous.

(7) The presence of Fraenkel's Pneumococcus in a serous effusion implies, in about 70%, a pre-existing & causal Pneumonia or that the so called idiopathic Pleurisy is a primary one due to that microorganism, in which latter case the Symptoms resemble those of Pneumonia as pointed out by Washbourne & Hale White.

(8) In both serous & purulent pleuritic Effusions, it is rare to find Pneumococci associated with the Tubercle bacillus.

(9) Serofibrinous Effusions are for the most part due in adults to Tubercle bacilli or Pneumococci, in children to Streptococci or Tubercle bacilli. Purulent

Effusions are in adults mostly due to Streptococci or mixed infection especially Tubercle bacillus with Streptococcus, in children to the Pneumococcus of Fraenkel.

II Bacteriology of Purulent Pleurisy.

Various forms of pathogenic bacteria are found in the purulent effusion, but of these three special forms, viz. Fraenkel's Pneumococcus, Streptococcus pyogenes, Tubercle bacillus, are most constantly met with in the majority of cases. These may occur in pure form, or we may find two or more of them associated together, or either of them associated with rarer forms of microorganism. Saprogenic organisms as existing in Putrid Empyema may co-exist with any form of pathogenic bacteria. In some cases, though much more seldom than in the case of serous effusions, no microorganisms can be found, either by microscope or culture, in the pus; here again we must depend on the results, not always decisive, of inoculation, and in such cases we shall find the purulent pleurisy due to Tubercle bacilli or Pneumococci.

In view of the more or less constant presence of micro-organisms in both serous & purulent pleuritic effusions, we must recognize that there are types in which

the fluid has an intermediate character; that, although in most true Empyemata the effusion is purulent from the outset, there are transitional cases, in some of which the fluid at first serous becomes purulent at a later stage, in others though having the appearance of pus is not actually so. In the former the change arises either from the continued destructive action of the same organisms & their toxins on the leucocytes, fibrin & connective tissue elements, or from the addition of other microorganisms constituting a "mixed infection"; in the latter as remarked by White & Wood (Therapeutic Gazette, Aug. 1894) "it is a question whether those cases in which the Pneumococcus or the Bacillus Tuberculosis only are found should be classed as strictly purulent collections, although the fluid may be turbid from admixture of fibrin & leucocytes." Whitney (in his article on Empyema in Loomis & Thompson's "System of Practical Medicine" 1897) says "the exudate is not always frankly purulent in its gross appearances, indeed there is no sharp line of distinction, even microscopically, between a serofibrinous and a purulent exudate, since it is simply a question of the quantity of leucocytes".

While I do not think that "the constant presence of microbes in Empyemas" has been established as

possible of demonstration, the results of all observations pathological and clinical go to prove that all true pleuritic effusions are the result of microbic invasion of the Pleura; the fact that we cannot demonstrate the existence of the causal micro-organisms in a certain proportion of cases, most of which are serous and a few purulent effusions does not militate against this theory.

From the clinical & therapeutic point of view, in so far as the bacteriological examination throws important light on the prognosis of each case, Purulent Pleurisies can be divided into two great classes. In the first, only one microorganism is found in the pleural effusion; this class has the greater importance & is termed "Pure" Empyema, thus Pneumococcal Empyema, Streptococcal Empyema and Tubercular Empyema. Other microorganisms, E.g. Friedländer's Pneumobacillus, Staphylococcus Albus, Eberth's Typhus Bacillus, have occasionally been found in a pure state but the rarity of these isolated cases does not allow them to acquire a special clinical type. In the second class there is a mixed infection, several pathogenic microorganisms being associated in the evolution of pus, thus Tubercle Bacilli with Streptococci or

Staphylococci, Streptococci with Staphylococci, Pneumococci with Streptococci, &c. To these we might add a third class, that of Putrid Empyemata, in which various saprogenic organisms are found often associated with pyogenic bacteria.
In the effusion, not necessarily 'purulent' because due to pyogenic bacteria, of Empyemata, the microorganisms found may be grouped as follows ——

i. Common forms, about 80 %.
Streptococcus pyogenes
Pneumococcus (Fraenkel's)
Bacillus Tuberculosis

ii. Less common forms, about 12 %.
Saprogenic organisms
Staphylococcus (alb: & aur:) associated
Pneumobacillus (Friedländer's)

iii. Rare forms, about 8 %.
Staphylococcus albus or aureus, pure
Typhoid bacillus (Eberth's)
Influenza bacillus (Pfeiffer's)
Gonococcus (Neisser's)
Bacterium Coli + other intestinal bacteria

iv. Extremely rare, about 1 % or less.
Psorosperms, Actinomycosis.
Plague bacillus, Anthrax bacillus, &c.

In many cases pure growths may be obtained from the effusion in Streptococcal and Pneumococcal Empyemata, these two microorganisms, however, are frequently found associated with one or more of the rarer forms. Tubercle bacilli, as formerly stated, are usually found thus associated, or can be shewn to be the causal organism in effusions giving negative results. In grouping the associated forms as follows, the order in which these are arranged may be taken to approximately represent the relative frequency of such association, thus

Streptococcus with
(1) Pneumococcus
(2) Staphylococcus
(3) Tubercle Bacillus
(4) Saprogenic microorganisms.

Pneumococcus with
(1) Streptococcus
(2) Pneumobacillus (Friedländer)
(3) Staphylococcus
(4) Influenza Bacillus

Tubercle Bacillus with
(1) Streptococcus.
(2) Staphylococcus.
(3) Saprogenic microorganisms.

The combined statistics furnished by Rosenbach, Fraënkel, Weichselbaum & Renvers on a total of 36 cases

according to Cestan (La Thérapeutique des Empyèmes 1898, 10.) give the following result —

25% Pneumococcus
30.5% Streptococcus
8.3% Pneumococcus associated with Streptococcus
13.9% Staphylococcus
22.3% Tubercle bacillus + all other forms

Marfan (Gaz. des Hôpitaux 1889, 901.) distinguishes only three groups of Empyema, Pneumococcal, Pyogenic (Staphylococcus or Streptococcus) + Tubercular.

Courtois-Suffit (Thèse de Paris 1891), calculating from 64 cases under his own observation + that of others, finds

28% due to Pneumococcus
57% " " Streptococcus pure or associated.
14% " " Tubercle bacillus.

Koplik (Archives of Pediatrics 1890 + 1896) by careful analysis of two series of Empyemata in children obtained —

MICRO-ORGANISM.	1890. 12 cases	1896. 15 cases
Streptococcus	3	3
Pneumococcus	7	9
Staphylococcus	1	2
Tuberculosis Bacillus	1	1

Eberle (Thèse de Berne 1892), of 5 cases in children

found 4 due to Pneumococcus + 1 to Pneumococcus associated with Pyogenic cocci; of 4 cases in adults 1 due to Pneumococcus, 2 to Streptococcus + 1 due to the associahn of Streptococcus with Staphylococcus Breton (Revue des mal. de l'enfance 1892) and Cadet de Gassicourt (Acad. de Médicine 1892) in 23 cases among children demonstrated —

Pneumococcus pure in 10 cases = 76.9%
Pneumococcus associated in 1 case = 7.7%
Streptococcus in 1 case = 7.7%
Tubercle bacillus in 1 case = 7.7%.

Prudden (New York Medical Journal 1893) found Streptococci in 7 out of 8 cases of Primary Empyema and Pneumococci in 9 out of 11 cases of Empyema following Pneumonia; his analysis of 24 cases (Babn Medical Journal 1895, I, 13) was

Pneumococcus in 11 cases = 45%
Streptococcus in 8 cases = 33%
Tubercle bacilli in 1 case = 4.2%
Various bacteria in 4 cases = 16.8%

Thué (Norsk Magaz. for Laege. 1895) by bacteriological Examinahn of 24 cases of Purulent Pleurisy found Pneumococcus in 14 cases (chiefly during an epidemic of Influenza of Pneumonic type), Streptococcus in 5 cases and Tubercle bacillus in 3 cases.

Boncour (Thèse de Paris 1896), of 10 cases in children

found Pneumococcus in 7 cases (=70%), in 1 case the Pneumococcus associated with the Bacillus Pyocyaneus, in 1 Streptococcus, and in 1 Tubercle bacilli associated with Saprogenic microorganisms.

Netter (Bull. Soc. Med. des Hôpitaux, 1890, VII, 441) has furnished an Elaborate analysis of 109 cases of Empyema

MICRO-ORGANISM	NUMBER OF CASES	PERCENTAGE
Pneumococcus	32	26.7
Streptococcus	51	44
Pneumococcus with Streptococcus	3	2.8
Saprogenic bacteria	15	13.7
Tubercle bacilli	12	11
Staphylococcus	1	.9
Staphylococcus with others	2	1.8

MICRO-ORGANISM	1890. 109 cases. Per cent.		1897. 235 cases. Per cent.	
	CHILDREN	ADULTS	CHILDREN	ADULTS
Streptococcus	17.8	53.0	16.0	41.2
Pneumococcus	53.6	17.6	65.4	24.9
Pneumococcus with Streptococcus	3.6	2.5	8.2	
Staphylococcus	—	1.2		
Tubercle bacilli, or 'sterile'	14.3	—	7.4	17.6
Saprogenic bacteria	10.7	8.0		16.3
Tubercle bacilli with Saprog. bacteria	—	25.0		

(the second series in 'Traité des Mal. de l'enfance' Grancher, Comby et Marfan, IV. 279)

Cestan (La Thérapeutique des Empyèmes 1898, 10-12) found in 35 cases of Idiopathic or Primary Empyema that 20 yielded Pneumococcus + 15 Streptococcus; in 22 cases of Secondary Empyema that 11 yielded Pneumococcus and 11 Streptococcus + in the latter 7 were cases consequent upon Influenza + 4 upon Acute Pneumonia. He concludes that, in children more than one out of every two cases of Empyema, i.e 60%, are due to Pneumococci, and in adults less than one out of every two cases, i.e 40-45%, to Streptococci.

Thus, as an approximate estimation of the frequency, per cent., of the various microorganisms in cases of Purulent Pleurisy, the following table, which includes both pure + mixed forms, is offered.

MICRO-ORGANISMS	ADULTS	CHILDREN
Pneumococcus	25	65
Streptococcus	50	20
Tubercle Bacillus	10	5
Saprogenic microorganisms	10	6
Rarer forms	5	4

TYPES OF EMPYEMA

BACTERIOLOGICAL, CLINICAL AND ANATOMICAL.

I. Pneumococcus Empyema.

The constant relation between Acute Pneumonia and Pleural Empyema demands consideration here. In 1881 Gerhardt first employed the term "Metapneumonic" to pleurisies arising during or consequent upon Pneumonia, but in 1890 Netter was the first to point out that each case was its clinical aspects & prognosis & the bacteriological character of the causal microorganism. And it is now evident that, many cases occur in which Pneumonia is the cause but the purulent effusion exhibits other bacteria than the Pneumococcus, and others in which the Pneumococci are found, in pure form, without the Lung tissue having at any time been affected by this microorganism. There can be no doubt that in almost two-thirds of the cases of true Pneumococcal Empyema, especially in children, it is Secondary to Acute Lober Pneumonia; in adults while some cases of true Pneumococcal infection reaching the Pleura from this source do occur, such cases either 'primary' or the Effusion shows

a mixed infection or Streptococci + Staphylococci. Here I should like to point out a fact, not found elsewhere as such, viz. the greater frequency of Lobar Pneumonia in children. Bronchopneumonia, (Lobular or Catarrhal), frequent in the earlier years of life and in the aged, whether consequent upon Capillary Bronchitis or Acute Febrile disorders such as Measles, is in only a small number of cases complicated by Empyema; even then the effusion will usually show Streptococci or Pneumococci associated with pyogenic organisms, having thus a worse prognosis. Pneumococcus Empyema is most common during the first ten years of life, one third less frequent between the ages of ten + thirty, and extremely rare after fifty (Netter). We may distinguish three classes viz (1) Empyema occurring with Pneumonia, "parapneumonic", (2) Occurring subsequent to Pneumonia, "post- or meta-pneumonic", (3) Occurring independent of Pneumonia, "primary"; and of these it is found that Primary Pneumococcus Empyema occurs in 25% + Secondary in 65%. In adults 25% + in children 75% of all Empyemata exhibit the Pneumococcus in pure or mixed forms; of cases in which this microorganism exists pure 17% in adults and 53% in children.

The following characteristics of Pneumococci are here noteworthy in so far as they have relation to the action of the microorganism on the Pleura. While the Pneumococcus occasionally acquires truly virulent qualities as seen in the acute Septicaemia produced by inoculation in animals, and in its metastatic or pyaemic deposits, e.g. Endocarditis, Meningitis, on the whole it is distinguished by its relative benignity in the Lungs and Pleurae. An organism of feeble vitality, it soon loses its virulence, for in cultivation under even better conditions of soil and temperature (artificial temperature 105.5° to 108° F) it ceases soon to grow and in about four or five days the cultures are found sterile. Moreover, when kept for 24 hours at a continuous temperature of 107.6° F. the cultures are found to be absolutely without pathogenic power. The "Capsule", which is not found present in artificial cultures, would seem to possess certain qualities on which the virulence and power of reproduction of the micro-organism itself depends: I am of the opinion that, during life in the tissues, this capsule contains Elements which are essential to the reproduction and invulnerability of the organism it surrounds; that

under altered circumstances in artificial growth these protective elements, not being required, are not developed; that when these essentials (in the capsule or envelope) are diminished, used up or lost, the micro-organism itself ceases to reproduce, is soon killed by its own toxins & more readily attacked by the phagocytic elements of the blood; that the conditions determining the development, continuance & disappearance of such protective qualities in the capsule are ——

(1) Conditions of Soil, i.e. Nature of tissue, or culture medium in or out of animal body.

(2) Susceptibility of Subject and amount of Reaction.

(3) Temperature — Flourishes best in the body at 104° F. or 40° C. (103°-105° F) Thus Sthenic fever with hyper-pyrexia in robust individuals, if not fatal to the patient, will tend to prove more lethal to the Pneumococcus than the continuance of less reaction & lower pyrexia (102° to 105° F).

(4) The association of other bacteria, especially pyogenic forms.

This theory, advanced here specially in regard to Pneumococcal Empyema, is also equally applicable to Acute Pneumonia and has also an important bearing on the existence of the microorganism in

the serofibrinous Effusion of Pleuropneumonia & primary acute Pleurisy.

To return, as regards the Pneumococcus, Castan (La Thérap. des Empyèmes 1898. pg. 14) remarks "Its hurtful action is only a passing one; tel un feu de paille qui s'allume, flambe et s'éteint". The Pus produced is thick, creamy, greenish, nearly homogeneous, not clotted & almost inodourous. Soft false membranes are produced in abundance but these are more or less attached to the two layers of the pleura, rarely loose, and appear to be very easily reabsorbed. The cocci and their pus does not tend to infiltrate the lung, due probably in most cases to there having been a previous or simultaneous inflammation here; too much cannot be allowed to the statement that tolerance is established because the micro-organism exists in about 60% of individuals in the healthy saliva, and even in the parenchyma of the lung.

These facts will, in great measure, explain for Pneumococcal Empyema, the comparatively slight febrile reaction & absence of "Hectic", the fact that it is an easily cured affection and shews little tendency to chronicity. In the ordinary

course of things, under appropriate treatment and frequently with no treatment, after a brief delay cure results in nearly 90 % of cases. Cestan (La Therap. des Empyèmes 1898 pg. 217) from a collected series by various observers including Schede, finds cure resulting in 86.4 % or 443 out of 573 cases. In Pneumococcus Empyema it is thus possible, & only in this variety & get spontaneous cure & reabsorption of the pus. There is a marked tendency for the effusion & be localized & to become Encysted or evacuated through a pleuro-bronchial fistula (vomica), and moreover in such cases (q.v. Treatment) a single tapping may give complete cure.

Primary Pneumococcal Empyema ——— While it is not infrequent for such cases & arise from a direct infection of the Pleura independent of any lung affection, the antecedent or concurrent Pneumonia may be so slight as & escape observation or this may be masked completely by the Pleuritic signs. Again, as pointed out by Washbourne & Fernet, also by Hale White (Lancet 1900, II, 1331), the onset & symptoms of such primary cases may exactly resemble those of Acute Pneumonia; Fowler (Diseases of the Lungs 1898) describes such —

"Single severe rigor, high temperature 102°-104° F, pulse 120 to 140, severe pain in side, cough short dry or with slight viscid frequently blood stained expectration, labial herpes may exist" —. The onset is sudden, the temperature rises sharply to 102° - 105° F, remains for several days oscillating between 101° & 103° F. There may even be a crisis as in Acute Pneumonia about the 7th day, but more usually the pyrexia persists until the Elimination of the pus either naturally or artificially. The effusion is often rapidly formed & large in quantity. In contradistinction to those cases where the patient is weakened by the preceding Pneumonia, we may here find the temperature higher, the pulse harder, & the febrile symptoms more markedly of 'sthenic' type.

Secondary Pneumococcal Empyema —— This is the usual form & undoubtedly the most frequent in children. Here the purulent effusion either coincides with the onset of the Pneumonia; or makes its appearance after the acute symptoms of the latter have passed off, in which case the signs and symptoms appear at an interval of from 1 to 7 days in many cases, in others of from 2 to 3 weeks and even as distant as 2 months (according to Strauss) after the Pneumonic crisis. In

concurrent cases, it may be only when examining the patient for Pneumonia that we discover the existence of a Pleuro-pneumonia, and this is not infrequently a serofibrinous effusion only to be distinguished from a purulent one by the state of the temperature or the use of the exploring Syringe. It is especially in children that we should be on our guard for the purulent character of such an exudate, since it is in particularly in their cases that the Pneumococcus tends to produce a purulent Pleurisy. The crisis may fail to eventuate at its usual time; the dyspnoea may continue, or increase out of proportion to the severity of the Pneumonic signs or increase in spite of a pseudo-crisis; and the tenderness to pressure of the intercostal spaces may furnish an important clue. Otherwise the pleuritic signs + symptoms, though existing before the actual pulmonary symptoms have begun to disappear, may only make themselves evident after an apyretic interval of a few days and thus conform more or less to those of truly post-pneumonic type. In the typical form where the Empyema makes its appearance at a varying interval after the Pneumonia has passed its crisis

and the patient begins apparently to recover from this, we find the temperature beginning to rise and ascending steadily but with variable rapidity to 103° or 104° F, preceded or accompanied by rigors, the dyspnoea and pain in the side reappear increase + may surpass those existing during the Pneumonia, the expansion of the affected side becoming more markedly impaired, and the patient already prostrate by the previous disease falls into an even worse condition than formerly.
But the onset of the Empyema may be latent, the fever of the Pneumonia having passed off by crisis, or lysis in which case there should always be a suspicion of some complication, the patient does not make satisfactory progress, there may be little or no succeeding rise of temperature, and although he still remains ill we may, especially at first, be quite unable to explain the cause of this general malaise. In such cases it has been pointed out that localized areas of tenderness & pressure may be important, but in many such cases the pus may become encysted and escape our notice until evacuated at a distant date by a vomica or a cutaneous fistula simulating a more superficial abscess.

It must not be forgotten that the absence of Pneumonic crisis or the recrudescence of the fever may also be due to some other complication, E.g. Endocarditis, Meningitis, etc., to some associated disease E.g. Typhoid Fever, or to some intercurrent disease E.g. Appendicitis.

Pneumococcal Empyema may occur secondary to some extra-pulmonary focus of the organism but this is of course rare; thus it may ensue after Peritonitis & Appendicitis, Endocarditis & Pericarditis, Meningitis either with or without associated Pneumonia That these inflammations may exist & be due to the Pneumococcus of Fraenkel has been recently demonstrated (vide Experiments of Veillon & Rist: Bullet. Soc. Med. des Hôpitaux 1899., also Fullerton, Brit. Med Journ. 1901, II, 760., & Bryant Brit. Med. Journal 1901 II 767.), but almost all shew the association of pyogenic or other microorganisms. In such secondary cases one would find the Pleural signs and Symptoms superadded & the Elevation of temperature, with or without pronounced oscillations, sustained.

In conclusion & especially with reference to mixed infection in Pneumococcal Empyema, I find the following remarks of Courtois-Suffit (Traitement des Pleurésies Purulentes, Debove & Courtois Suffit 1892 page 150) are

most appropriate. "During the whole course of Purulent Pleurisy due to Pneumococci, the temperature is constantly at a certain Elevation above normal; and in every case where the Pneumococcus is the only organism in the pus, marked oscillations with Evening rise preceded by pronounced rigors do not exist, but are seen especially in Pyogenic Pleurisies. When these oscillations of temperature are found in cases due to Pneumococci, either there has been a secondary infection by pyogenic microorganisms when the Empyema loses its relative benignity & necessitates a different treatment, or the purulent effusion is being evacuated by vomicae (especially if the cavity refills after each emptying) a result which is most frequently met with in this form of Empyema".

The amount of effusion in Pneumococcal Empyema is very variable but considering the more or less subacute character of the inflammation we meet with very large effusions, & double Empyema is frequently of this class. There may be only half an ounce in Encysted forms, and any quantity of fluid up to ten & a half pints in the Pleural cavity at one time; two or three pints is a frequent amount in children &

Even infants.
The duration of this Bacteriological class of Empyema is usually shorter than that of the other varieties, any time from 20 to 78 days on an average for cases under treatment; in children probably shorter than in adults.
Hale White (Lancet 1900, II, 1331.) has recently pointed out that as regards hospital practice there has been an increase in the number of cases of Empyema following Lober Pneumonia; for Guy's Hospital he indicates this from statistics ——

PERIOD	No. of cases of Pneumonia	No. of cases of consec: Empyema	Per cent.
1883 – 1890	445	7	1·57
1891 – 1898	896	38	4·24

Thus clinically it is found that Pneumococcal Empyema, especially in children, presents well defined characteristics in most cases of marked + definite onset, of short duration, of good prognosis, and of favourable termination either spontaneously or under treatment
The average mortality is never more than 15%, about 2·3% in children as compared with 25% in adults; other varieties never less than 25% average.

In accordance with the foregoing observations and results, Pneumococcal Empyemata may be classified thus ——

A. Primary Pneumococcal Empyema

1. True primary or idiopathic.
2. Pseudo-primary i.e. antecedent disease slight transient and unobserved.

B. Secondary Pneumococcal Empyema

1. During Acute Pneumonia { Pneumonic symptoms more marked / Pleuritic symptoms more marked
2. Following Acute Pneumonia { Immediate or Continuous. / After some interval of time
3. From Extra-pulmonary focus.

C. Mixed Infection Empyema

1. Pneumococcus, the important organism.
2. Pneumococcus of minor importance.

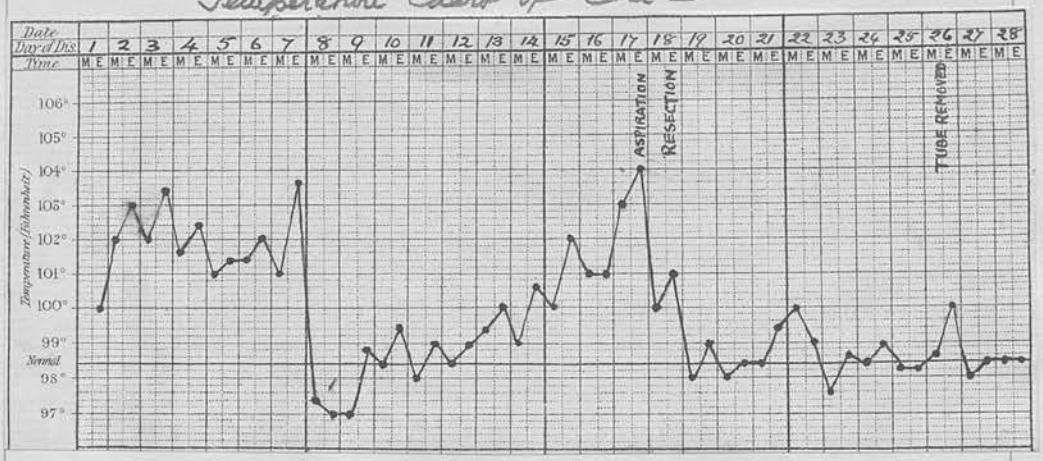
Case I. Typical Pneumococcal Empyema consequent upon Acute Pneumonia in child. Recovery.

A. H. female, aged 9½ years. Good family history & previous health satisfactory. Illness began with "chill", was feverish, coughing & short of breath; patient lived in a lovely district in Country, many miles from the nearest medical practitioner & consequently only seen at intervals of several days. Diagnosed as Lobar Pneumonia of Right side. Appears to have had crisis about the 7th day. Not seen till about five days later, reported meanwhile as progressing well. Condition then found to be changed again for the worse, there was pyrexia, dyspnoea, pain in side, the signs & symptoms indicating Pleurisy with effusion for which treatment prescribed accordingly. Not seen till three days later when condition much worse in all respects, pleural effusion extensive & dyspnoea excessive. Exploring syringe revealed pus. Child then sent to R. H. S. C. Edinburgh, journey tedious & unsuitable. On examination — Orthopnoea & patient lying turned on to right side, cyanosis, pulse 135, respirations 48, temperature 102° F. Whole of right side of chest immobile, interspaces bulging, heart displaced to left so that apex approached the anterior axillary line. Percussion note

dull all over right side except above clavicle where it has tympanitic character, breath sounds absent over two thirds of chest with absence of vocal resonance, did not detect any aegophony. Aspirator with large size of trocar used, between 9 & 10 ounces of thick greenish pus withdrawn when cannula became blocked & was withdrawn; this aspiration was followed by a certain amount of temporary relief, and respiratory movements of chest in upper half re-appeared. Operation next forenoon, chloroform administered & well borne, pleurotomy with resection of 1½ inch of rib below angle of scapula & anterior to it, about 27 ounces of similar pus, two or three large masses of fibrinous material, evacuated along with numerous smaller flocculent masses. No irrigation, open drainage by short tube. Pus & smaller masses of fibrin & false membranes came away during subsequent dressings during next few days; discharge rapidly became serous & tube withdrawn on 8th day. Temperature fell to normal after operation; slight relapse with rise of temperature three days later & again temp rose to 100° F. the evening after tube withdrawn. Complete recovery & discharged from Hospital with wound healed three & a half weeks after operation. Examination of the pus showed Pneumococci in pure

form. This case exhibits a typical course in a case where the purulent effusion was large in amount, a notably satisfactory & early recovery, the benefit of aspiration as a palliative & temporary remedy & the success of pleurotomy with rib resection without irrigation.

Temperature Chart of Case I.



Case II Empyema due to Pneumococcus associated with Streptococcus, consequent upon Acute Pneumonia. Erroneous line of treatment. Recovery.

B.S. male, age 16 years. Family history free from Tuberculosis, but mother had suffered twice from Pneumonia. Had Scarlatina at 11 years of age, "not been strong" for the last few months. Six weeks previously had sore throat & swollen cervical glands from which patient recovered but remained "nervous & irritable". About 4½ weeks before admission to Hospital caught a chill, developed pain in side, vomiting & feverishness

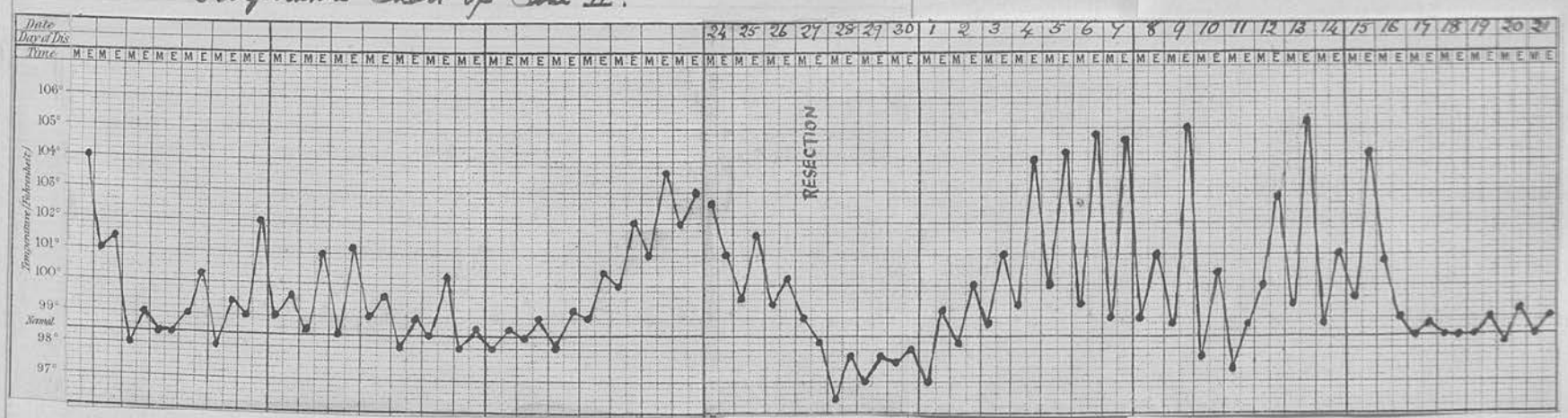
but thought to be only "biliousness". Consulted practitioner three days later who found patient with temperature of 102° F & full developped signs of Pleuro pneumonia, treatment by poultices, medicine &c. Crisis about the 8th or 9th day. Continued improving slowly in general condition, but temperature swinging, occasionally rising over 101° F., up till four days before admission when temperature began to rise steadily, pain in R. side reappeared, dyspnoea, cough, &c. Sweating was a distinct feature; signs pointing to accumulation of pleural effusion, & pus found by exploring syringe. On admission — Patient much prostrated, dyspnoea, rapid pulse & respiration, temperature 102°6° F. Lower half of right side of thorax dull to percussion with absence of breath sounds at the lower margin just above liver, well marked egophony along upper margin of dullness especially beneath the axilla, respiratory expansion of right side much impaired, upper portions of Right Lung shewed Broncho vesicular type of breath sounds with Rhonchi & moist sounds. Condition rather improved & temperature coming down by a pseudo-lysis. Operation on the 22nd day after the crisis of the Pneumonia, chloroform well borne except for tendency to coughing, Pleurotomy with rib resection

Large quantity of pus, rather thin in density & of yellowish green colour, many large masses of fibrin, but total amount not measured. Cavity irrigated freely with hot boracic lotion till fluid returned clear. Drainage tube (open drainage) Patient rather collapsed after operation which was of some duration but rallied well. During next few days there was free discharge necessitating two or three dressings each day, but temperature continued subnormal & general condition improving, except for tendency to copious sweating. There was no repetition of the irrigation which to me did not seem necessary & I am of opinion that had case been treated thenceforwards as in Case I (i.e. without touching & removal of tube when discharge lessened in amount & became serous) an uninterrupted recovery would have followed. But on the fourth day after operation irrigation was resumed, the case having passed out of my hands & soon after the patient began to have marked rigors, sweatings, extreme oscillations of temperature, large clots of pus & sloughy material were discharged & general condition became precarious, as the temperature chart will show. I attribute this unfortunate result entirely to either the irrigation or to want of due antiseptic precautions in the

dressing &c The oscillations of temperature, the cough-ing & the general disturbance of the system could only be due to the addition of saprogenic organisms or to Streptococci (original in pus) reacquiring their virulence. This condition persisted for two weeks ere temperature fell to normal & remained so. Eventual recovery & discharged cured nearly two months after operation.

The pus examined at time of readmission showed Pneumococci abundant, some Streptococci. It was not examined again, so that report on its bacterial qualities during period of rigors &c. is wanting.

Temperature Chart of Case II.

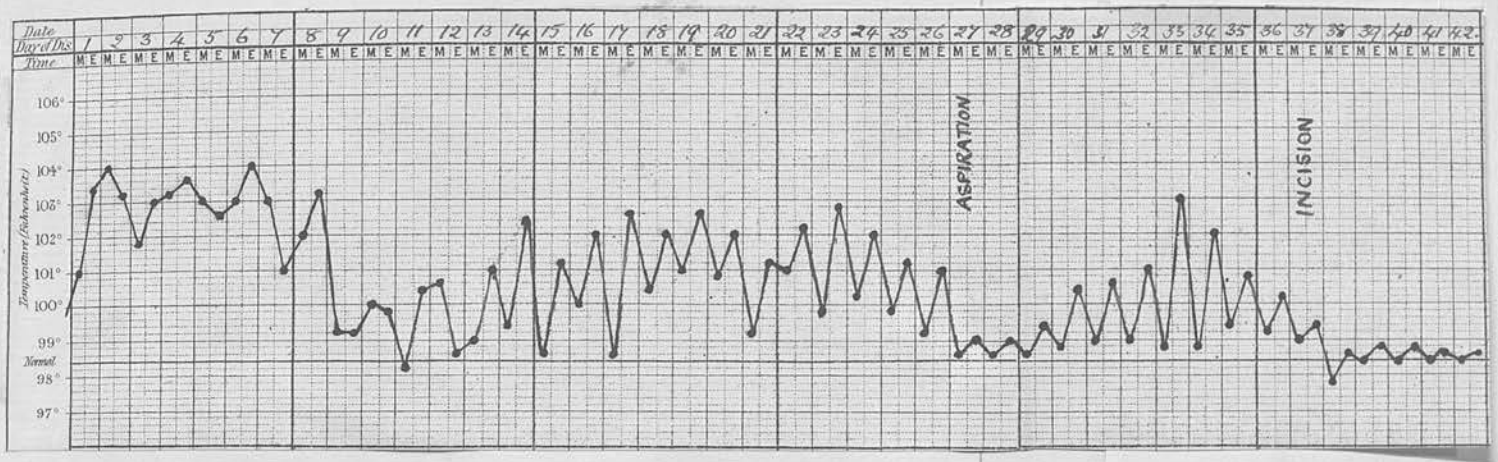


Case III. Pneumococcal Empyema, Encysted type. Cured by Aspiration alone. Child.

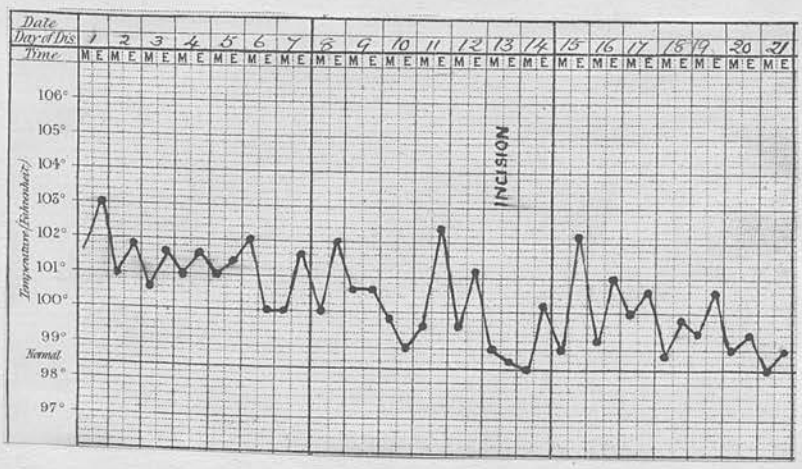
M.S. female, aged 7 years. Admitted to R.H.S.C.

Edinburgh. History of "inflammation of lungs" recently but not been thriving since, had cough, was feverish in the evenings, been losing weight &c. But had no complaint of pain anywhere. Examination of chest revealed an area of dulness in the lower part of left side of chest towards the back part of Pleura, localized, with absence of breath sounds, slight ægophony at upper margin. Temperature on the average about 99°F. with slight evening exacerbations. Condition first regarded as pleural thickening or serous effusion, hence exploring syringe not employed till nearly a week later, when the extraction of pus shew the condition to be one of encysted Empyema. Aspirator with medium-sized trocar then used, & 6 or 7 ounces of typical Pneumococcal pus was withdrawn — microscopic examination shewed this organism in pure form. This appeared to empty the cavity completely. Temperature rose over 100°F after tapping but was normal next morning, and practically remained so thereafter. Physical Examination did not reveal any further reaccumulation of the effusion & lung expanded up to chest wall. Patient rapidly improved & was discharged cured after three weeks in Hospital.

Two characteristic charts in Pneumococcal Empyema.



Temperature Chart shewing Course of Acute Lober Pneumonia followed by Pneumococcal Empyema, in which Aspiration (at a somewhat late date) failed, and reaccumulation of purulent effusion demanding a Pleurotomy to effect cure. Adult male, 27.



Temperature Chart shewing case of Empyema complicated by Pericarditis; Pleurotomy not followed by permanent fall of the pyrexia. Child, 9 years.

II. Streptococcus Empyema.

Purulent Pleurisy due to the Streptococcus Pyogenes differs in many respects from that due to the Pneumococcus, & its characteristics are more those of any suppurative inflammation at any part of the body. It is the most frequent type in adults 50%, but comparatively rare in children 20%. The infection may be primary, but is more often a secondary one; in the latter case the Streptococci reach the Pleura either (1) by direct extension from the Lungs in cases of Bronchopneumonia, Gangrene, Infarction, &c., or from surrounding parts, thoracic or abdominal, where this microorganism has already set up inflammation with abscess formation, or (2) frequently by metastasis from Pyogenic inflammations in distant parts, or (3) in cases following acute febrile disorders e.g. Scarlatina & as part of a general process e.g. Septicaemia, it may be conveyed by the blood & localized in a more acute form in the Pleura. In children according to Holt (Diseases of Children 1899) Streptococcus Empyema frequently shews associated Pneumococci, and most cases secondary to Pneumonia, especially Bronchopneumonia, occur with infectious diseases. It may supervene in the course of or in connexion with a disease whose

specific cause is the Streptococcus e.g. Erysipelas, Puerperal Fever. "That Empyema is not oftener consequent upon general diseases of Infectious character is explained by the apparent necessity, in order to the development of suppuration that the Streptococci should invade the Pleura in considerable numbers, and particularly that there should be some focus close to or communicating with the pleural cavity where the conditions are favourable for their multiplication. The injection of small quantities of a pure culture into the healthy pleural cavity has usually proved innocuous; cases have also been reported (Goldscheider, Zeitschrift f. Klin. Med. 1898) where the presence of Streptococci in a serofibrinous Exudate has shewn no tendency to transform it into pus" (Whitney - Article on Empyema in Loomis & Thompson's System of Prac. Medicine 1897)

In the Pleura, the Streptococcus infection is frequently superadded to a preexisting inflammation due to other microorganisms such as Pneumococci or Tubercle bacilli. In such cases the Streptococcus seems to acquire an even greater virulence because acting on a previously damaged structure or because there is a combination of pathogenic microorganisms, so to speak, complemental to each other, and leads to

a more rapid destruction of tissue elements & pus formation. The Empyema rapidly takes on the characters of the more acute pyogenic infection; the original type, due to less toxinic bacteria, is soon lost; the signs and symptoms become more aggravated; the patient is more formidably ill; the prognosis is considerably altered for the worse, and the treatment, more urgently demanded even in cases of small effusion, requires modification. Although in a few cases the microorganisms may have feeble vitality, for the most part it is characterized in any part of the body by the acute inflammation produced with rapid destruction of tissue & pus formation, and by its endurance & power of reproduction under the most disadvantageous circumstances. The resistance to phagocytes, its own toxin & various destructive (i.e. antiseptic) agents, and its long vitality are characteristic. It is anaerobic (by preference) and this in particular explains that in the Pleura it obtains a suitable medium for development. The virulence of the Streptococcus we find of varying degree, the most extreme being exhibited, on the one hand, in Acute Puerperal Septicaemia an occasional cause of Empyema or in the extremely acute & rapidly

typhoidal type of Empyema described by Fraentzel (Von Ziemssen's Cyclopedia, Article on Empyema.) & Bouveret (Traité de l'Empyème 1889), the mildest type of Streptococcal infection being seen in transient cases of Facial Erysipelas.

The Streptococcus will grow in various media and at the ordinary temperature of the body, is anaerobic at one time & aerobic at another, but will resist considerable heat. It is frequently found in purulent pleuritic effusion, as in most pyogenic suppurations, associated with the Staphylococcus aureus or albus. The pus may be sero-purulent in some cases, but is never very thick or viscid, yellowish grey in colour & without odour except gangrenous or putrid pus. The organism tends to penetrate deeply into the surrounding tissues, & partly from this cause, partly from its great vitality the pus produced is very persistent or readily reproduced. There are usually false membranes, numerous shreds of which float free in the Exudate, and these false membranes much impregnated with the cocci failing to be eliminated are a fruitful source of relapse. The Effusion is rarely reabsorbed, encysted or evacuated by vomica; and the microorganism seems capable of lying dormant

in the tissues for a long time, to regain suddenly its virulent qualities on slight provocation and to reproduce the purulent effusion.

The mode of onset of Streptococcus Empyema may be acute, with severe pain, marked rigors and a rapidly ascending temperature, or it may be insidious. The temperature presents marked irregularities & the pyrexia is often extreme.

Lindsay (Encyclop. Medica Vol IX 395) has seen marked leuchæmia fever, profuse perspiration & washing in cases where, on aspiration, the fluid proved to be limpid serum, and on the other hand has found pus where there was little or no pyrexia or other active symptoms.

When Streptococcus Pleurisy is primary (the exception rather than the rule) the onset is marked, acute & painful, the temperature runs up immediately, long & repeated rigors occur, and the effusion forming rapidly is soon abundant.

When it is secondary or part of a general disease, at first it may remain masked by the local or general signs & symptoms; in such cases the effusion may be evolved slowly & insidiously, escaping notice at first.

During the course of this type of Empyema, the

disease is characterized by marked oscillations & irregularities of temperature at a moderate elevation 101°-103° F., preceded by a sudden rise even to 106° F. — Septic remittent fever with evening exacerbations —, and by the incessant production of purulent exudate which repeated tappings fail to reduce. Along with these, general symptoms, frequently of a serious character occur viz Rigors, Sweatings, Gastro-intestinal disorders especially of "colliquative" type diarrhoea & vomiting, Anorexia, & Emaciation. Relapses are frequent in this variety, even after operation. The patient may succumb to a general pyogenic sapraemia or septicaemia and death may occur at an early stage of the disease; on the other hand, with or without treatment, Streptococcus Empyema may remain almost stationary while the patient sinks into a cachectic state, or the case becomes indefinitely chronic

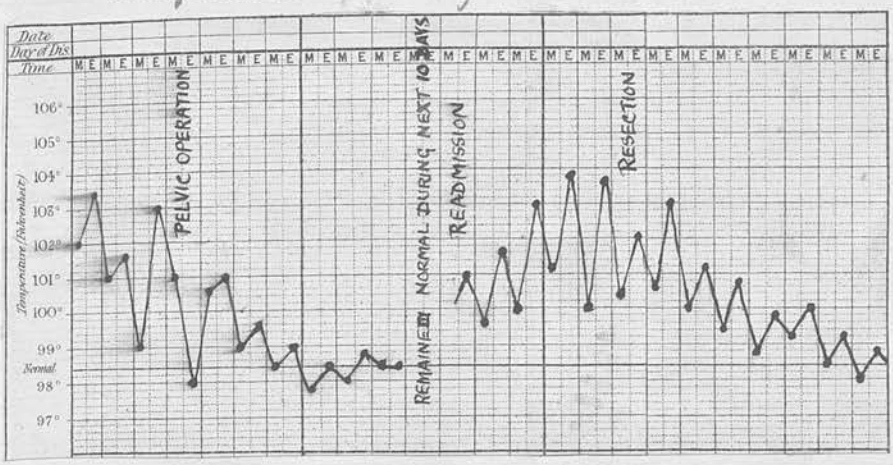
The duration is, on the average, much longer than that of Pneumococcus Empyema, 2 to 4 months & cases not infrequently become chronic.

The Mortality is high, 25% to 30%.

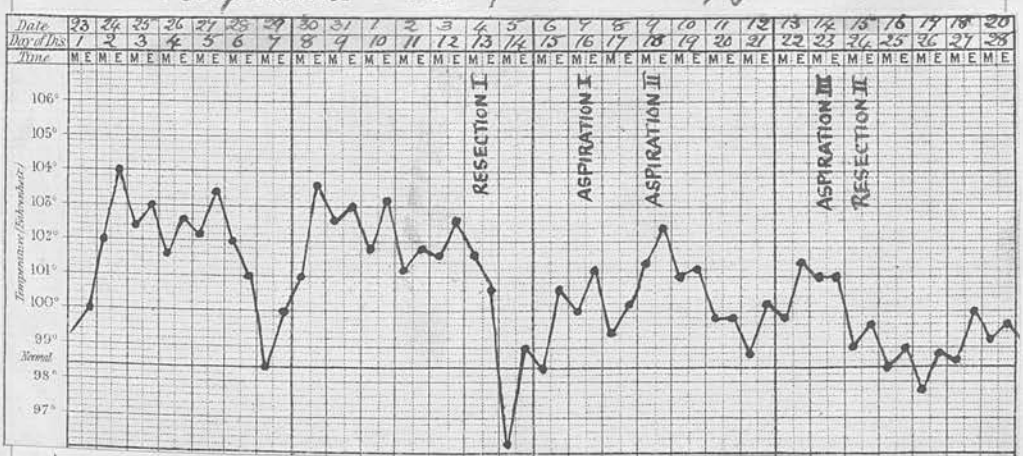
Case IV. Streptococcal Empyema, of Pyaemic origin from Pelvic Abscess in Female.

This case is of interest as exhibiting the direct metastatic infection of the Pleura with Pyogenic bacteria. A.H. Female. 37 years. Had Puerperal Cellulitis resulting in Pelvic Abscess (in the Broad Ligament) which was treated in Gynaecological Ward. Temperature has been erratic & of septic type but not ranging over 103.6° F. Operation Treatment, evacuation of abscess, irrigation, drainage & packing with iodoform gauze. Pelvic condition made satisfactory progress, temperature reached normal by lysis, patient apparently recovered & was discharged after three weeks in Hospital. Readmitted 3 or 4 days later with feverishness, pain in left side of chest, short restrained & rapid breathing & otherwise of developing Pleurisy. Two days later Pleural Effusion evident. Temperature rising to 102° F. with marked remissions Exploring Syringe discovered pus which on examination by microscope & culture showed Streptococci in pure form. Pleurotomy with resection under chloroform no irrigation, open drainage by short rubber tubes Temperature fell by lysis, reaching normal a week later, occasional relapses. Eventual recovery.

Temperature Chart of Case IV.



Temperature Chart of Double Empyema.



Case of Double Pneumococcal Empyema reported By Burn-Murdoch in Edinburgh Hospital Reports 1900 + referred to on page 95 q.v.

Aspiration I gave 26 ounces, Aspiration II 20 ounces + Aspiration III 15 ounces.

III Tubercular Empyema

At the outset we must distinguish cases of Purulent Pleurisy occurring in subjects already affected by Phthisis Pulmonalis from cases due to Tubercular infection of the Pleura of primary character; in the former case the Pleural effusion is a secondary one, analagous to that occurring in Pneumococcus Empyema where the microorganisms are by no means necessarily the same as in the preexisting disease, in the latter the primary, often sole, focus of the Tubercle bacilli is the Pleura, to be compared with the typical "cold abscess" elsewhere but not analagous (vide. Debove & Courtois-Suffit, Traitement des Plem. Purul. 1892 198). The great majority of acute & subacute Empyemata occurring in connexion with Pulmonary Tuberculosis are non-tubercular, and contrary to the general opinion true Tubercular Empyema is not a common form. Netter states that only 10% of all Empyemata exhibit the Tubercle bacilli in pure or mixed forms; to this statement I would here point out that there are cases where the purulent effusion is apparently amicrobic and which may, even in default of results from inoculation, be classed as of Tubercular origin. In a small proportion of cases the Tubercle bacilli are found

pure in the Exudate, in a larger number we find them associated with Streptococci or Staphylococci or both, while in the largest proportion purulent pleuritic effusion, whose bacterial cause is micro-organisms other than the bacillus, arises in the subjects of preexisting Tuberculosis, pulmonary or elsewhere. The frequency of true Tuberculosis of the Pleura causing purulent effusion is stated as 17% for adults & 7% in children; this I think would be more justly stated as 10% & 5% respectively. Tubercular Empyema may occur in the course of Acute Miliary Tuberculosis local or general, of Pulmonary Phthisis subacute or chronic, in individuals apparently robust & free from hereditary predisposition, or by metastatic deposit from some extra pulmonary focus, e.g. Tuberculous Joints, Genito-urinary Tuberculosis, &c. Primary Purulent Pleurisy due to Tuberculosis would seem to be a condition of considerable rarity when compared with similar primary Tuberculosis of other serous membranes such as Peritoneum, Joints. In such cases we may find no tubercular lesions of the lungs or if found are generally of more recent or less active type; moreover these lesions may be older or more marked on the parietal than the visceral layer which would indicate

an extra pulmonary source of infection. Again, in this type in which the Empyema shows lesions solely due to Tubercle bacilli + tubercular pathological processes, the microorganisms do not reach the Pleural cavity so frequently by direct extension from surrounding parts (and this is more characteristic of the visceral than the parietal layer) as by direct transit to the serous membrane through the lymph and blood streams. It is noteworthy that Tubercular Empyema almost never occurs in cases of advanced Phthisis; in cases where an extensive cavity ruptures into the pleural cavity, a pyo-pneumothorax in which we find a truly mixed infection often of hybrid type results; in the ordinary course of Phthisis Pulmonalis the pleural cavity would seem to be shut off by the layers of fibrous connective tissue which result from the chronic inflammation, through which the bacilli cannot penetrate or obliterated by chronic inflammatory adhesions over the affected portion of the lung. When the pulmonary disease has preceded the appearance of the Empyema it may be only from a history of previous Haemoptysis, or other tubercular signs + symptoms that we can have any certainty as to the true sequence of events. Tuberculosis of the Pleura is typically

accompanied by great thickening of the membrane, false membranes of a soft friable nature may or may not be present; the surfaces of the Pleural cavity may shew a rough irregular vascular surface, fibrous in parts or excavated by numerous ulcers of varying depth. This tubercular granulation tissue, while in the more chronic forms tending to fibrosis, in the more rapidly advancing type tends to be very vascular, is liable to small haemorrhages & necrosis; the result of degenerative changes in this (vascularisation) is that the effusion in place of being serous is a quasi purulent fluid which may persist for a long time before going on to actual suppurative changes. Again there may be a constant formation of such false membranes which, undergoing fibrous change & contracting, retains the bacilli but, so to speak, squeezes out the serous effusion into the cavity without much tissue-debris. In other cases there may be a large quantity of serous or seropurulent effusion, while the surfaces show little or no inflammatory thickening, ulceration or degeneration; such cases approximate the type of Acute Pleurisy of Tubercular origin discussed above (v. Bacteriology of

Seroplrunous Pleurisy)
The effusion may appear purulent but so rarely so, such having the true physical qualities of pus is only found in cases where there is mixed infection essentially by pyogenic microorganisms. Sometimes almost clear, frequently turbid but never very thick, yellowish in colour & often watery. May contain curdy masses & shreds of false membranes. In cases where there is marked thickening with ulceration of the Pleura, and in cases of long standing, especially if loculated, there is a fruinous puriform exudate mostly consisting of tissue debris & degenerated granulation tissue in which it may be extremely difficult to demonstrate, except by inoculation, the Tubercle bacillus. It appears to be more difficult to demonstrate the presence of the bacillus in purulent effusions containing associated microorganisms. Auché (Bull. Congrès de Bordeaux 1895) disputes the veracity of the axiom that the absence of microorganisms in any purulent effusion (or serous) would argue the Tubercular origin of such, for he has found dead pyogenic bacteria in Empyema occurring with Pulmonary Tuberculosis.
The onset & course may be acute or subacute, such

cases, on the whole, arising from a subsequent mixed infection; the course of Tubercular Empyema per se is essentially a chronic one. The duration is often very prolonged, and the general health may be fairly maintained in spite of considerable effusion provided that little or no fever or other symptoms which usually accompany Empyema occur.
Two distinctive clinical types are usually exhibited, the one characterized by acute onset, fever (with evening exacerbations) dyspnoea, pain, &c.; the other & more frequent type begins insidiously and is often not recognized until fully developed, there is an absence of active pyrexia, little or no local signs & symptoms, slow production of the effusion which is almost never reabsorbed, indefinite duration, and general symptoms, so frequently present in all forms of Tuberculosis, may even be absent. Cases have been recorded where the thorax has contained an extensive purulent pleuritic effusion for many years with little or no discomfort to the patient, apparently not progressive, showing no tendency to infect the lung or surrounding parts of the chest wall and only discovered during examination for some other disease or other site of Tuberculosis. In primitive Tuber-

-cular Empyema it is found that, even although the lung is involved, the Pleural signs may be the first and the only ones for a long time observed. Again, a Serofibrinous pleurisy may occur in a subject of Pulmonary Tuberculosis, be treated as a "Simple" Pleurisy or as a Pleuro-pneumonia, be apparently cured or recur without any suspicion as to the true cause, & the general health otherwise remaining unimpaired; but suddenly pyrexia or hectic develops, a haemoptysis occurs or the true cause of the Pleural effusion Serous or purulent is explained; Pulmonary Phthisis subacute or chronic is realized or the patient succumbs to acute Bronchopneumonic Phthisis or even acute Miliary Tuberculosis. The tendency to the excessive formation of granulation tissue with or without much necrobiotic change, which is characteristic of Tuberculosis in any organ, results in the case of the Pleura in serious damage to the lung tissues even if the latter remains quite uninvaded by the bacilli. The thickened membrane with its adhesions, fibrosis & ulceration, in addition to the effects of the effused fluid, compresses the lung & will not allow it to re-expand.

It may remain in a state of atelectasis, crushed against the Vertebral Column or otherwise bound down by adhesions, and in this condition may become attacked by the Tubercle bacilli, or pyogenic bacteria, and the ordinary treatment fail to ensure the reexpansion of the lung & the obliteration of the cavity. Hence the tendency for such Tubercular Empyema to become chronic, the long duration of such cases with or without treatment, the ready reproduction of the effusion, the liability to chronic fistula & the frequency of mixed infection. Tubercular Empyema always offers an unsatisfactory prognosis Even in its earliest stages, and this is even more marked for Pleural than for Pulmonary Tuberculosis. The more favourable results are only obtained in cases where the Pleurisy is primary & especially of serofibrinous character, is detected at an early stage, where active operative interference is not demanded, the patient reacts well to treatment and the disease can be controlled or overcome by hygienic, dietetic and climatic measures. But from the therapeutic point of view, as Courtois-Suffit has remarked, we must not altogether, as many authorities have done, regard Tuberculosis of the Pleura as

a case of "Noli me tangere". In cases where active treatment is demanded, three courses are open, viz. Aspiration, repeated if necessary; Aspiration with permanent drainage; Pleurotomy, preferably with resection. There is always a tendency to the formation of chronic fistula in all tubercular cases, and the risks of mixed infection must accompany all methods, but ones seem more easily controlled or obviated by free incision & drainage. The results of the various methods are compared in tables furnished by Cestan (La Therap. des Emp. 243 & 244) from collected series of 168 recorded cases —

METHOD OF TREATMENT.	No. of cases.	Cured	Resulting in Chronic Fistula	Deaths
Aspiration (alone)	9.	2 (22%)	5. (55%)	2. (22%)
Aspiration with drainage	20.	6. (30%)	5. (25%)	9. (45%)
Incision	30	9. (30%)	7 (23.4%)	14 (46.6%)
Incision with Rib-resection.	103 *	24 (23.3%)	8 (7.7%)	71 (69%)
Total	162	41	25	96
		25.3%	15.5%	59.2%.

* 6 of these cases recorded by Beck are doubtful.

Hence we see that the mortality for Tubercular Empyema in Acute & Subacute forms, for untreated cases stands at 75% & for cases under treatment by any method at 60%.

IV. Staphylococcus Empyema.

The Staphylococcus albus or aureus as the direct cause + existing in pure form in the effusion of Pleural Empyema is a rarity, but in association with other microorganisms viz Streptococcus, Pneumo-coccus + Tubercle bacilli (in relation order of frequence) it is frequently encountered in Purulent Pleurisies. Recent pathological researches throw considerable doubt on the pus producing capabilities of this micro-organism per se, but show that its association with Streptococci gives a greater virulence to the activity of the latter. It is maintained that Staphylococci are not pyogenic when infecting serous membranes such as Pleura, Peritoneum or Meninges, but Veillon (Archiv. de Med. Experim. 1897) has shewn that the Staphylococcus pyogenes aureus is the chief microorganism in many cases of Osteomyelitis, which may especially in children be followed by both secondary + primary types of Pyogenic Empyema. Cases of pure Staphylococcus infection of the Pleura do occur + of the two varieties of this microorganism the S. aureus may be found alone, the S. albus practically only in association with the former. Netter (Soc. Med des Hop. 1890 + Traité de Medicine, Paris 1893) records only one case, Fraenkel has furnished

some cases, Rioblanc (Lyon Médical. 1896, 152) gives a typical case, and the whole subject with several illustrative cases has been dealt with by Lop et Monteux (Des pleur. purul. à Staphylocoques – Revue de Médic 1898 xviii). Koplik (Arch. of Pediatrics 1886) 2 cases from Tonsillitis. Whitney (Article on Empyema in Twentieth Century Pro. of Medicine) says that the Staphylococcus is found pure or associated in cases of Empyema resulting from penetrating wounds, in Empyema following Bronchopneumonia and Ulcerative Endocarditis.

It would seem evident that, whereas the Staphylococcus aureus is most frequently found associated with Streptococci in true Pyogenic Empyema, or in cases where pyogenic infection has been coexistent with or superadded to purulent Pleurisy caused primarily by Pneumococci or Tubercle bacilli, the Staphylococcus albus is most frequently associated in the effusion with Tubercle bacilli – especially in cases of acute serofibrinous pleurisy (v. supra. conclusion 5. pgg 23-24) Staphylococcus Empyema in pure form may be considered as offering a better prognosis than Streptococcus Empyema or that in which both are associated, but calls for similar treatment.

The presence of the Staphylococcus in association with Tubercle bacilli alone in Tubercular Empyema,

in which the Effusion is frequently serofibrinous or seropurulent, while tending more to be chronic in clinical aspect, implies a worse prognosis because it is a mixed infection, and necessitates treatment of a more drastic character than might be required in cases where Tubercle bacilli exist in pure form. Rare in adults, 1·2% according to Netter, is even more so in children.

V. Empyema due to rarer Microorganisms.

(1) The Pneumobacillus of Friedländer —— as so frequently found associated with the Pneumococcus in Pneumonia, is also found thus in Pneumococcal Empyema. Cases have been recorded by Lebelle, Netter, Achalme, Wolff + others, also by Sirodey and Grospiau (Soc. Med. des Hôpitaux, Feb. 1897) of Purulent Pleurisy in which this was the only microorganism found in the effusion. How far it is capable of causing pus by itself is still doubtful, but it is recognized that when causing Acute Pneumonia this disease is one of greater virulence + that acute septicaemia can be produced in certain rodent animals by inoculation of pure cultures. Moreover, it grows more readily in culture than the Pneumococcus of Fraenkel, and

is said to be a "facultative saprophyte", thus would explain that in certain cases the organism is found in effusions due to Pneumococci but which have become devitalized & destroyed leaving the Pneumobacillus alone. Might be found associated with Streptococci alone but the Empyema would tend to have the characters of cases due to the latter microorganism. Prognosis said to be good, even better than Pneumococcal type. Treatment is on same lines as indicated for Pneumococcal Empyema in pure or associated form.

(2) Eberth's Typhoid Bacillus —— has been met with as the only cause of the occasional case of Empyema. Erlich (Bacteriol. des Empyems, in Berliner Klin Wochenschrift May 1888) found the bacillus in 1 out of 6 cases of post-typhoid pleurisy. Loriga & Pensuti (Riforma Medica 1890, 1282) recorded one case of Typhoid Bacillus in pure form in Empyema. Weintraub (Berliner Klin. Wochen. 1893, 15) another. Achard (La Semaine Médicale Oct. 1898) gives 2 cases of such Typhoid Pleurisy, one of which was purulent. Cases are more frequent of the association of Eberth's bacillus with Pneumococci & Streptococci in Pneumonia complicating Typhoid Fever — I have found Eberth's bacillus associated with Pneumococci in the sputum of a case where the

true cause of the Pneumonia was not evident till typical signs & symptoms of the Fever developed some days later —— and such association may also be found in cases of post typhoid Empyema Delay in operation on cases of Typhoid Empyema seems undesirable; Achard (op. citat.) recommends delay in treatment till the intestinal ulcers have healed; Ewart (Progressus Medicus III 1899.) says "the patients condition may forbid interference, in such cases simple aspiration of the pus, repeated if necessary in a few days, affords temporary relief & allows the postponement of incision & drainage to a later date.

(3) The Gonococcus —— Two cases of Pleuritis Gonorrhoeica have been recorded by Rudis Jicinksy (Journal American Med. Assoc. February 1899) & Fisher (Chicago Med. Journal) reported a case. In these the Effusion was seropfibrinous & it would appear that the association of pyogenic organisms is necessary for the production of a truly purulent Effusion

(4) Influenza Bacillus of Pfeiffer —— May in some rare cases find this microorganism in the Effusion usually in association with the Pneumococcus.

VI. Putrid Empyema.

The presence of Saprogenic microorganisms in the Pleura may be brought about in two ways, either as a primary infection they reach the Pleural cavity, often in association with pyogenic bacteria & set up the foetid type of Empyema, or they may be superadded to a previously existing purulent pleuritic effusion. The mode of access is either through the Bronchi as in cases associated with Pulmonary Gangrene, Phthisical cavities, Bronchiectasis, &c, or through the Gastro-intestinal tract from the Mediastinum in cases of Cervical abscess, Cancer of Oesophagus &c and from below the diaphragm in cases of Subphrenic Abscess, Ulceration of Stomach & Intestine &c. Putrid infection may, in rare cases, reach the Pleura by external wounds, or may be superadded to Chronic Tubercular cases with fistulae.

Gangrenous Pleurisy practically never exists as a primary condition; Pulmonary Gangrene, the most frequent cause of Putrid Empyema, may be an extensive one but is usually small necrotic areas arising from Bronchopneumonia (often tubercular) or small Embolisms or septic infarctions.

Various & often very numerous microorganisms are found in the pus, thus chains & clumps of bacteria, micrococcus

tetragenus, leptothrix, spirilla & flagellate bodies, amoebae, & fungi; Bacterium Coli & other intestinal forms. Pyogenic microorganisms are always more or less associated, especially the Staphylococcus aureus; and Tubercle bacilli, with or without such pyogenic forms, are often associated with the saprophytic germs.

The pus is usually thin & sanious, but may be thick, brownish-yellow in colour, shews numerous shreds of false membrane & pieces of necrosed tissue; may be simply foetid or have the obnoxious odour of gangrene. Microscopically it shows white & red blood corpuscles, tissue debris & clumps, fat globules, fatty acids & cholesterine crystals, varying microorganisms. Pneumothorax is a common complication. The effusion has a tendency to become encysted, even at an early stage; the sputum may become foetid but not necessarily from the communication of the empyema with a bronchus although vomicae are frequent; the patient may vomit or cough up much foetid pus.

The onset is sharp, often violent; the initial pain often of great severity & remarkably persistent; the pyrexia high with great oscillations of temperature (2 or 3 degrees); but the most characteristic feature is the constitutional disturbance which is

often very rapid in development & advance, and may become markedly "typhoidal", with brown fur on tongue, abundant sordes, great prostration and asthenia, stupor and tendency to delirium & coma. Prognosis is always the gravest, death ensues in majority of cases, sometimes with great rapidity (24 hours - Bouveret, Traité de L'Empyème)

Treatment must be prompt & radical whatever the physical condition of the patient is. Pleurotomy is universally recommended & should show very free incision. Douching the cavity with antiseptics is required both at time of operation & subsequent dressings, repeated according as the pyrexia & general condition indicates its necessity. Fistulae seem less likely to ensue in Putrid cases than in Tubercular cases or those in which Tubercular & Septicemic infections are mixed.

vide next page (80) for case of Putrid Empyema.

Following the above Bacteriological types, we must now turn attention to some important types of Empyema whose peculiarities depend more or less on the clinical aspects and the anatomical relationships of the Purulent Effusion.

Case VI. Putrid Empyema. Cutaneous external fistulae + communication with Intestine. Type Tubercular with Saprogenic + Intestinal infection.

R. S. Male. 18 years. An ill developed lad with a markedly Tubercular family History. Admitted to Hospital for treatment of an abscess with two sinuses extending over a small area on left side of the Thorax corresponding to the 6th + 7th ribs Said to have been caused by blow + been in existence for two or three months, but this cause was doubted in view of the presence of carious bone detected by probing, his bad family history + tubercular appearance + the fact that the apices of his lungs showed Phthisical signs. By operation carious portions of two ribs removed, cavity scraped + packed with iodoform gauze. Wounds did not heal well but patient sent home 4 or 5 weeks later; at this time there was never any evidence of the involvement of the Pleural cavity. Three months later patient was readmitted, the caries had extended below + laterally to the original focus; there were numerous tubercular sinuses over the lower half of the left side of chest + one higher up below the axilla; the pleural cavity found to be involved + patients general condition was

again much deteriorated. The pus discharged was thin, brownish & had a somewhat offensive odour. Temperature markedly of septic tubercular type with erratic oscillations & generally elevated. Operation somewhat extensive, irrigation free but caused coughing when patient under anaesthetic. Temperature thereafter at a lower level but not normal for some time; the discharge from the wounds, which required constant dressing, became more & more offensive & acquired a faecal odour. Later it was found that in the lower parts of the chest the discharge at times consisted of actual faecal material mingled with a thin staining pus and tissue debris, it was then evident that the purulent cavity within the chest had eroded through the diaphragm & formed a communication with the Splenic flexure of the Colon. Nevertheless this fecal discharge after continuing for nearly a fortnight began to improve, faecal matters ceased to come away from the side of the chest probably because granulations had in their growth occluded the Pleuro-colic communication. The pus became less offensive & more truly purulent in character, & the patient seemed to have considerably recovered and several sinuses healed completely when he was discharged from Hospital after more than two & a half months stay.

1. Encysted or Encapsulated Empyema.

In a considerable number of cases of Empyema, the Pleurisy does not involve the entire cavity but is frequently localized to a variable extent of it; this may result from the inflammation being localized at the commencement & the effused pus confined by recent or old costo-pulmonary adhesions or from the effusion at first poured into the general pleural cavity becoming thus localized by subsequent adhesions. Under this term we may include all special forms such as 'Mediastinal', 'Empyema at the Apex', 'Interlobar' &c. There may be more than one localized cavity in one or both Pleurae, or again one larger cavity may be more or less subdivided into loculi by bands & layers of pleuritic adhesions, this latter termed 'Multilocular'. Encysted types more readily occur in cases where the purulent effusion is slowly evolved as in Tubercular Empyema or where the pleuritic exudate forms in connection with a localized area of pulmonary disease as in Pneumococcal Empyema with Acute Pneumonia. The presence of such encapsulated purulent effusion, especially if of small amount, frequently escapes notice; the chief interests attaching to these are concerning

their signs and diagnosis; exploratory puncture may be absolutely necessary but may fail to discover the purulent collection for various reasons; and the differential diagnosis from localized areas of parenchymatous lung disease such as cavities phthisical or bronchiectatic, consolidation or gangrene, may be extremely difficult. The localized area of dulness, the absence or diminution of breath sounds & vocal resonance, &c. may be suspicious but the small size of the effusion, perhaps with contiguous areas of compressed or consolidated lung, are apt to produce confusing modifications of these signs. The absolute dulness may shade off above & below into zones of impaired percussion note with bronchial breathing, External to this an area of tympanitic percussion-note is obtained; this sign may be diagnostic but is not always so (Contou Suffisance du Traitement des Pleur. Purulentes. 1892. 201) Encysted Empyema is frequently found on the lateral & posterior aspects of the Pleural cavity towards its upper part, hence on suspicion of such we must examine the axillary & interscapular regions. Evacuation by vomica is not infrequent, may be the first & only indication of its existence, and

in some cases, especially due to Pneumococci, a spontaneous cure may be effected by such evacuation or by reabsorption of the exudate. The prospect of complete closure of the cavity by operative treatment, (even in cases demanding extensive rib resection), is greater in loculated than in general Empyema.

Apical Empyema, according to most authorities, would seem to offer a less satisfactory prognosis than encysted forms elsewhere. While it may arise from any microorganismal cause, it is frequently associated with Apical Phthisis, or by extension of cervical glandular abscesses. Diagnosis may be difficult & confusing owing to its simulation of phthisical consolidation or cavity so frequent in this part of the lung. Treatment would be rendered difficult because of relation of the effusion to important structures & the physical difficulty of draining the cavity.

Multilocular Empyema demands careful topical diagnosis to ensure in treatment the complete emptying of the cavities which may or may not intercommunicate. Cases have been recorded where one portion or tapping gave purulent effusion & another portion clear serous fluid.

Velimirovitch (Etude sur la pleurésie mediastinale, &c. Paris 1892) says "Mediastinal Pleurisy may produce an area of flatness which includes the whole width of the Sternum + extends some distance beyond on either side; when on the right it may displace the Heart towards the left, and by pressure on the great vessels cause marked cyanosis, dilatation of the superficial veins of the chest, puffiness of the face, cold extremities and oedema of the upper part of the body".

If the loculated character of the effusion is suspected, two or more exploratory punctures at different points should be made, & in operating it may be well to compare the amount of fluid escaped with the amount relatively indicated by previous local examination.

Mediastinal Empyema is a rare condition, seldom diagnosed during life. The purulent cavity is localized between the mediastinal parietal layer of the Pleura and the internal surface of the Lung behind or in front of the 'hilum'. Dieulafoy & Thoinot (Presse médicale 1896, 45, 281, Bulletin médical 1896, 78, 832) from examination of all records could only find 5 cases, 4 of which were only discovered post mortem. Bouveret (Traité de l'Empyème 1888) records fully one case. Godlee (Brit. Med. Journal 1892, II, 832) reports a case of left pleural empyema where the pus came across the anterior mediastinum & pointed in the Epigastric fossa. Huber (Archives of Pediatrics 1890 431.) a case of Empyema with anterior mediastinal abscess following deep-seated cellulitis of the neck in a child, who recovered two years later. Dieulafoy records a case cured after Evacuation by tonica. Differential diagnosis is often difficult, & treatment much complicated by the site of the pus.

Case VII. Apical Empyema of Tubercular origin.

W.D. Male, 42 years. Admitted to Hospital for treatment of an acute Abscess in lower + anterior part of the posterior triangle of the Neck on the Left side. Family history bad as regards Tuberculosis. Had suffered from several attacks of "Inflammation of Lungs" + he was considered Phthisical by his own medical attendant. The right apex showed on examination many signs of Phthisical consolidation, + below the Left clavicle the breathing was of bronchial type if somewhat distant. He had double "malar flush"; had been losing flesh, feverish more so at night, + sweating. Appearance of abscess that of a tubercular cervical one as if from suppurating tubercular glands. Temperature 103° F. Operation revealed that there was a larger cavity + containing more pus than was indicated by External signs; cavity extended downwards outwards + backwards. Drainage free but requiring irrigation at each dressing during which it was observed that the fluid was affected by respiration + had tendency to induce coughing. Cavity closed + wound healing when patient discharged, but temperature had remained

swinging with Evening Exacerbations to 102° F. The signs in the lungs pointed to advancing Phthisis. It was afterwards reported that the patient died two months later with Evidences of a rather rapidly advancing type of Phthisis. Pus not examined for microorganisms but its characteristics macroscopically were tubercular, probably this Empyema was a mixed infection case with Streptococci or Staphylococci associated by Tubercle Bacilli.

2. Interlobar Empyema

This anatomical type arises from Purulent Pleurisy localized to the Interlobar fissures of the Lungs Always a condition of great interest from a clinical point of view, its differential diagnosis usually presents difficulties & the condition may even be undiscoverable with any certainty. The effusion may be, and frequently is, of small amount but may attain considerable size while completely shut off from the general Pleural space; more commonly occurs between the upper & middle lobes of the right Lung; cavity may be rounded in the smaller forms but when the effusion is large it tends to be flattened & follow the outline of the interlobar fissure, in the latter case the lung externally may be much compressed consolidated or sclerosed and pushed out into contact (& adhesion) with the parietal pleura. The condition is of greater frequency in children than in adults; the bacteriological type is frequently Pneumococcal, & Evacuation by Vomica a common occurrence which may alone furnish the diagnosis & in some cases lead to spontaneous cure. Exploratory puncture is apt to be uncertain, especially as cavity may be very small & deep-seated; the local signs are

apt to be masked by the intervening layers of lung tissue; radioscopy by fluorescent screen might afford some help in diagnosis. The symptoms are usually ill defined, the onset may be acute or latent, pain & even fever may be absent; but in cases where history signs & symptoms (pain deep seated, dyspnoea, oscillations of temperature, dyspepsia & other general symptoms) would indicate a suppurative inflammation of the Pleura rather than the Lung, and the area of dulness to percussion with absence of breath sounds corresponds to the direction of the interlobar fissures, we may feel justified in suspecting Interlobar Empyema. In treatment we cannot delay on the chance of spontaneous cure by tonics, pleurotomy is indicated in order that the interlobar fissures may be explored by finger, adhesions broken down & pus evacuated with drainage. Unless the Empyema cavity lies near the surface, tapping whether for diagnostic or curative purpose is to be deprecated because the trocar will almost unavoidably pass through lung tissue to reach the pus & a septic pneumonia may ensue.

3. Diaphragmatic Empyema.

In this type of encysted Empyema the pus is accumulated between the upper surface of the Diaphragm & the lower surface of the Lung, and more or less localized by pleuritic adhesions. It not infrequently follows from Peritonitis in the upper part of the abdomen, from suppurative inflammations of the abdominal organs in the Hypochondriac regions especially the liver & from subphrenic abscess. Again in post pneumonic forms it may be associated, especially in children with a basal pneumonia; or from almost any microorganismal cause the purulent pleurisy may be a primary one in this situation.

The onset is usually abrupt & the fever pronounced, the initial pain, often very severe, may be referred to a distance but tenderness & pressure is usually localized along the costo-phrenic attachment. The great tenderness of the inflamed diaphragm leads to its inability for movement, abdominal respiration stops, breathing being rapid shallow & of costal type alone. The abdomen may be extremely sensitive to pressure and the abdominal muscles corresponding to the affected side are tense. Hiccough & frequently vomiting may occur, groans

important but misleading signs; the bowels often are constipated, and delirium is not infrequent. The physical signs characteristic of Pleurisy are usually absent because owing to the inability of the Diaphragm respiratory signs at the base of the chest are deficient or absent. Thus special interest attaches to the diagnosis of Diaphragmatic Pleurisy because of its clinical resemblance to Peritonitis; of 5 cases observed by Fenwick (Lancet 1893) the condition was erroneously diagnosed as acute Peritonitis, Gall Stone, Appendicitis. History of the case is important; frichni sounds if detected, characteristic points of tenderness, absence of abdominal distension, and the more marked dyspnoea will aid the differential diagnosis. Prognosis on the whole is favourable except in cases arising from abdominal sources of infection. Some cases are evacuated by vomica. An exploratory puncture or incision may be employed, taking care to enter above the level of the 10th rib in the axillary line, otherwise resection of a rib with exploration of the diaphragmatic surface by the finger will be necessary.

Case V. Putrid or Gangrenous Empyema.
Septic Pulmonary Infarctions. Diaphragmatic Type.

R. M. Male, 20 years. Had Scarlatina about three years before, complicated by Otitis Media resulting in intermittent attacks of pain & purulent discharge from the Left ear ever since. The discharge had ceased for some time, & pain in left ear & left side of head was very severe. On admission to Hospital the Signs & Symptoms all pointed to the suppurative process having extended to the Mastoid Antrum. Temperature was 102.4° F. Antrum was opened by chisel, rather foetid pus found; free opening into middle ear & externally made & cavity irrigated with antiseptic lotion & packed with gauze. Temperature fell to 99.8. Thereafter during next few days discharge continued rather copious & offensive, temperature showing marked exacerbations with rigors & sweatings, pain in left side of head intense. About ten days later the mastoid region was further opened up by trephine & the Lateral Sinus found blocked by foetid smelling thrombus & thick (suppurated) pus. At this time he complained much of pain in the left side of the neck below the left ear & there was suspicious tenderness along the line of the Jugular

Vein. Then patient grew steadily worse, acute rigors with sweating & temperature rising to 105° & 106° F. Two days later he began to complain of pain in the abdomen, factor of the wrath appeared but few or no signs to be made out on examination of the chest, and condition misleadingly appeared like Peritonitis with distension & tenderness of the abdominal cavity, short suppressed respirations & constipation. Patient died on morning of 6th day after second operation. Post mortem examination revealed extensive septic Thrombosis of the Lateral Sinus extending down into the upper part of the Internal Jugular Vein. The lungs showed numerous small foci of septic gangrene in the lower parts of both; on the under surface of the left lung there was found a localized diaphragmatic Empyema with serious and markedly focal Effusion corresponding to several separate infarctions which had here reached the Surface of the lung & eroded through into the Pleural cavity

This case is interesting in view of the diaphragmatic Pleurisy simulating Peritonitis. The pus was not examined, but would undoubtedly have shown Streptococci & Staphylococci associated with various Saprogenic microorganisms.

4. Double Empyema

Cases of purulent effusion occurring simultaneously, or almost so, in both Pleural cavities, do sometimes occur & have been specially studied by various observers chief of whom we would mention Copland and Pearce Gould (Transactions. Clin. Soc. of London XXIV, 82) & Sutherland (Lancet 1894, I, 1430). In the great majority of recorded cases the Effusion has been due to Pneumococci & followed double Lobar Pneumonia, Sutherland finds 14 out of 21 or 66% thus & 3 out of 21 were primary cases or 14%. In cases due to Bronchopneumonia or of metastatic origin both effusions may show the Streptococcus, Aust (Münchener Med. Wochenschrift, Nov. 1892) reports a case in adult female from puerperal cellulitis. It would seem extremely rare for such cases to be of Tubercular origin.

The greater, almost exclusive, incidence in children is noteworthy, but this would follow from the greater frequence of Pneumococcal Empyema in them. We may find both purulent effusions occurring simultaneously, or as is more frequent the onset for each side is at a varying interval from the other; the causal pneumonia usually occurs with an interval between the attack on

the separate lungs; but in any case a time arrives when there is a purulent Exudate present in both pleural cavities, one of which usually presents more urgent signs & Symptoms than the other. One or both Empyemata may be encysted or localized by adhesions. The temperature may not be much elevated above the usual pyrexia for single cases but may shew more marked oscillations & longer sustained, especially if we expect a fall of temperature having operated on the first & as we think only affected side; naturally the dyspnoea is further increased & may be excessive; general toxic symptoms are frequently marked with cyanosis & often extreme prostration. Burn-Murdoch (Edin. Hosp. Reports 1900) has reported an interesting case of simultaneous double Empyema in a child of 8 years, treated by rib-resection & recovery. As regards mortality, Sutherland had only 1 death out of 21 cases but these were selected ones hence this is far from the actual average; Cochen (La Thérap. des Empyèmes page 253) from a collected Series of cases reported by various authors found that the mortality was 13 out of 50 or 26%, but Wightman & Batten (Lancet 1895) found 9 deaths in

15 cases or an average mortality of nearly 60%; thus the fatal risk in cases of double Empyema is always a grave one with or without Treatment. In treatment, most authorities agree in recommending that the two sides should be attacked at an interval of time from each other, usually from 1 to 7 days later. Aspiration, though useful to palliate or temporize, could only be available for cure in cases where the cavities were very small & encysted; repeated aspirations are both useless & dangerous, according to Sutherland. The syphon-drainage of Playfair-Bulau, recommended by Quist (Münchener Med. Woch. 1891 45-46) Bohland (Deutsch. Med. Woch. 1896) & Schede (Handbuch f. Spec. Therap von Penzoldt et Stintzing 5-25-573), and favourably considered for such cases by Castan (La Thérap. des Empyèmes 254), as also the Tachard-Revilliod method of aspiratory drainage after pleurotomy, might be suitable in a few cases when patient is cyanosed, prostrated & in imminent danger of death But these methods have not been regarded favourably by British & American physicians. Incision, with or without resection, and open drainage would seem the right method of treatment, receiving the support of Gould, Huber

Cautley, Fox, Cassel, Beck, Godlee &c. The conclusions of Copland & Gould may be here quoted "1. Double Empyema, in place of being a contraindication to, is rather a more urgent indication for incision & drainage because of the great obstacle it offers to the cardio-pulmonary mechanisms.

"2. Aspiration may be suitably employed previously, in the hope of obliterating the abscess cavity & of favouring the formation of adhesions.

"3. It is much better to delay for some days between the two operations, in which case one ought to open the most extremely affected side, or if in doubt the left before the right because it stands in closer relation to the heart & moreover because this side heals perhaps the quicker, and to relieve the other side at the same time by one or more aspirations.

"4. If it is impossible to delay owing to the urgence of the general or local state, the two effusions should be carefully aspirated some hours previous to operation on both simultaneously. Thus we may diminish the risks of shock from sudden reduction of the intrapleural tension & aid the re-expansion of the lungs, thus avoiding the chief danger attending simultaneous drainage of both pleural cavities."

5. Pulsatile Empyema.

In almost all cases of pulsating pleural effusion, in which the fluid acquires a rhythmical beat visible or palpable, synchronous with the beats of the heart, the exudate is a purulent one. Moreover this pulsating collection of pus is almost invariably on the left side, anterior to the mid-axillary line, and between the 2nd & 6th ribs. Of 42 cases 39 were on the left side (Osler. Pract. of Med. 1897, 579). Attention was first directed to this rare type by Macdonell in America (1844) & since then over fifty cases have been recorded & studied by observers in this & other countries. There are two varieties; in the one case the Empyema is entirely Intrapleural, usually large in amount & occupying the pleural pleural cavity, & the pulsations are perceived over a variable extent of the chest wall in the intercostal spaces; in the other where the effusion may be smaller or more localized by adhesions, the Pleural abscess is found to have migrated externally to form an external tumour, more or less circumscribed, in which we observe the rhythmical pulsations this is termed "Empyema Necessitatis Pulsatilis" & is, of the two, perhaps the more frequent variety. In the great majority of cases the Empyema

is of some standing, & of tubercular origin even although the pus exhibits various microorganisms. Comby (Traité des Maladies de l'Enfance. Paris 1897) finds that the condition is frequently but not always complicated by Pneumothorax. The heart is often much displaced towards the right side, pericarditis may coexist. Beyond the constant relation of the effusion to the pericardium, the condition is difficult of explanation. Traube & Bouveret (Traité de l'Emphysème 1888) have advanced the theory that the necessary conditions are a considerable degree of fluid tension with a locally diminished resistance of the chest wall; which proposition is favored by the fact that the pulsations are readily checked by aspiration of a small quantity of the effusion. Féréol, Comby, Weill (of Heidelberg) & Stokes think the transmission of pulsation accounted for by the association of a certain quantity of air (shut off from the bronchi) with a fairly large amount of fluid. Courtois-Suffit (Traité des Plèvr. Purul. - Debove & C-S. 1892 pg. 219) suggests that the pulsations arise from their transmission through sclerosed lung on a fluid bed, the condition being a chronic one the lung is retracted & bound down to the pericardium.

The impulse may be heaving, often very marked; may

be diffuse & extend over the whole left side of the thorax as in a case recorded by Stokes (quoted by Delorme & Courtois Suffit - Traitement des Pleur. Purul. pg 215); is frequently situated about the sternal region, sometimes most marked near the angle of the scapula.
Sometimes pulsation may be communicated to an ordinary case of pleural effusion serous or purulent by a co-existent & adjacent Pericarditis with effusion.
In diagnosis we have to carefully distinguish the condition from Aneurism, the pulsating expansile movements may resemble each other in both cases but in Pulsating Empyema the movements are less forcible & localized, thrill is absent, and the pulsations are affected by the respiratory movements of the lungs & chest.
Prognosis is never favourable because of the frequent tubercular origin and the chronic nature both before & after operation treatment.
Treatment is in no way affected by the mere presence of the Pulsation; incision or resection with drainage is indicated, but we must avoid probing or exploring too freely and lavage of the cavity is extremely inadvisable; chronic fistula very apt to ensue

Vomica or Pleuro Bronchial Fistula

Spontaneous Evacuation of an Empyema by Vomica is a more frequent occurrence than Evacuation by an External or Cutaneous Fistula. The condition is most frequent in cases of Encysted type, especially Interlobar & Diaphragmatic forms; and is usually Pneumococcal in origin which bacteriological type, as has been shewn, shows a special tendency for Encystment of the effusion. The Event may occur at almost any period in the progress of the disease, it may eventuate early but is most commonly a late phenomenon 2 or 3 months after onset or very much later. The onset of the vomica is frequently but not constantly preceded by an attack of coughing with mucous or muco-purulent Expectoration, occasionally a little haemoptysis. There is frequently at the same time a sudden rise of temperature and, depending on the size of the bronchus opened into & the amount of pus in the Empyema cavity, the patient coughs up a variable amount of pus, or may vomit. The temperature may fall immediately afterwards, and there is a general sense of relief; pyrexia may reappear & oscillate for a day or two, but finally

becomes normal; with small localized effusions spontaneous cure may be thus effected. On the other hand there may be only a short remission of the febrile symptoms, and the pus again reforms in the Pleural cavity. Again small amounts of pus may be coughed up at intervals during several successive days.
With large effusions, or when smaller collections of pus are suddenly, thus Evacuated, the occurrence may prove Extremely distressing & Even prove fatal by suffocation; it may also be dangerous to the other parts of the same or the opposite lung by the discharge being sucked back on respiration
In cases where the discharge continues to come away in small amounts slowly or when the purulent expectoration is Excessive & continues so, especially if there are signs of insufficient outlet, dyspnoea, bad fits of coughing, irregular temperature, &c. the indications are for an Early pleurotomy.
When the Bronchus opened into is a large one a true Pneumothorax with amphoric or cavernous type of breath sounds may result; again, we may have to distinguish the condition, physical signs being

misleading, from Bronchiectasis or Pulmonary Phthisical cavity, here we would have to depend largely on the history & the existence of the Tubercle Bacillus in the Sputum.

Spontaneous Rupture externally may occur but is not common except in very large effusions or long standing neglected cases. Most usually this Pleuro-cutaneous fistula is in the 5th space just beyond the lower edge of the Pectoralis Major, but may occur high up or as low down as the 10th or 11th intercostal space. Simulates an ordinary cold abscess but amount of pus discharged is not of proportion to external signs. As has been shown such external abscess may pulsate. Otherwise various migrations of the pus have been from time to time recorded; Gaillard (Medicine Moderne January 1896) has studied these & records 8 varieties thus e.g. Sub-phrenic Abscess, Umbilical, Inguinal, &c. The pus may pass into the Sheath of the Psoas & Simulate a psoas abscess, or may point in the lumbar region.

COMPLICATIONS

The following pathological conditions may accompany or follow any type of Empyema, the first nine of these especially in Acute & Subacute forms of Purulent Pleurisy ——————

1. Compression of Heart & Lungs with sometimes fatal interference with the Cardio-respiratory mechanism.
2. Pulmonary Oedema with "albuminous expectoration", in rapidly-formed large effusions & from too rapid aspiration.
3. Thrombosis of Heart or Pulmonary Artery.
4. Pericarditis } usually by direct extension.
5. Peritonitis }
6. Abscess in Lung
7. Septicaemia & Pyaemia
8. Various Nervous Phenomena
9. Sudden Death.
10. Amyloid Disease of various organs.
11. Phthisis, acute or chronic.
12. Valvular Heart Disease, especially Malignant Endocarditis
13. Chronic Nephritis
14. Caries or Necrosis of Ribs & Sternum.

The complications involving the Nervous System both

during the course of and consequent upon treatment of Pleural Empyema form a most interesting subject of study clinically & pathologically; and seem to me to be alone worthy of analysis here.

Pathological Phenomena in the Nervous System complicating Empyema

First made the subject of detailed study by Raynaud (Soc. Méd. des Hôpit) in 1875, these phenomena have since been fully examined by numerous observers of whom we may specially mention Aubouin (1878), Landouzy (1882), Bouveret (1888), Jeanselme (1892 & 1895) and Cestan (1898). Nervous complications are always rare, but it is to be noted that the great majority of such phenomena in cases of Pleural effusion have occurred with Empyemata; only 4 out of 86 cases recorded by Jeanselme & Cestan were cases of sero-fibrinous Effusion. Their occurrence is essentially associated with some operative treatment, even so slight as aspiration or exploratory puncture, but a few cases have been recorded where such complications have ensued independent of any manipulation or operation. Many cases have occurred consequent upon the douching out of the cavity

of the Empyema with water or some antiseptic solution, a proceding now recognized as unnecessary for most Empyemata and fraught with danger in cases where it may be absolutely necessary, but others have arisen during exploratory puncture, aspiration (whole or only some of effusion removed), pleurotomy with and without resection, exploration by finger or probe, and even when patient was under an anaesthetic but the operation treatment hardly begun. Cases of sudden death in Empyema of both small & large effusion in which the cause is unexplainable are doubtless due to such nervous complications.

In classifying the somewhat varying signs and symptoms whose origin is primarily caused by the pleuritic effusion & secondarily exhibited in the nervous System Central & Sympathetic, I have thought best to adopt with slight modifications the classification formulated by Ceslan (La Thérapeut. des Empyèmes 1898. pg 126).

1. Transitory Vasomotor & Trophic disturbances
2. Embolism, Cerebral or elsewhere.
3. Syncope
4. Convulsions (Pleural Eclampsia)
5. Hemiplegia
6. Sudden death.

1. Transitory Local Phenomena

In a few cases it has been noted that aspir-ation or irrigation of the purulent cavity has produced local disturbances of the Vasomotor & trophic functions as patches of redness, sometimes accompanied by local sweating of the skin of the corresponding side of the Thorax. In other cases, localized oedema of angio-neurotic type has occurred; this must be distinguished from the extensive oedema due to pressure or sepsis. Again in spite of the most rigidly antiseptic precautions, following aspiration or irrigation there may be a sudden rise of temper-ature even to 105° F. which can only be regarded as of neurotic origin. We occasionally find that some cases exhibit a hyperaesthesia, the pain due to the disease itself or during treatment being out of proportion to the severity of the case and much greater than in similar circumstances in other patients. Such results would indicate either a neurasthenic subject or some abnormal excitability of the reflexes, and that the occurrence of Syncope, convulsions or sudden death after aspiration & irrigation (v. infra) are also due to reflex action.

2. Cerebral Embolism and Abscess.

Empyema is rarely complicated by Pyaemia with the formation of metastatic abscess as sequelae, but several cases of Abscess of the Brain have been recorded from time to time, and there are a few cases on record of Embolic lesions Elsewhere. Thus, Vallin + de Valicourt (Thèse de Paris 1875) describe one case of Pyaemic ulceration of the Foot, Laveran (quoted by Debove + Courtois-Suffit) a case of Renal Infarction with Haematuria, Courtois-Suffit (Traitement des Pleur. Purul. de Debove et C.S. 1892. pg. 116) a case of Multiple Arthritis consequent upon Streptococcal Empyema.

In view of the microorganismal causes of Empyema the embolic theory with localization of septic emboli in the cerebral vessels would offer a rational explanation of such Cerebral Abscess, but post-mortem examination has not always demonstrated the presence of such infarction although clinically the signs have indicated the Existence of such. The condition does not necessarily follow soon after any operation on the chest, and may be quite independent of any interference with the Effusion. Bouveret (Traité de L'Empyème 1888, 301) collected 5 cases recorded by Vallin, Laveran, Potain, Durozez and Robinson, Cordua adds 2 cases recorded by Turner

(Brit. Med. Journal 1897 ii 1412) + d'Hauschatter (Rév. Méd. de L'Est Jan. 1896). Schede (Handbuch der Spec. Therap de Penzoldt et Stintzing) two cases, one doubtfully of pyaemic origin; and Gabler has recently recorded another five cases. In 4 out of the first 7 of these no Exploratory or operative measures had been employed, + in only 2 was it consequent upon Irrigation, in 1 it resulted from Pleurotomy. Moreover two of the cases (Putnam; Vallin) showed serofibrinous effusion. In contradistinction to these cases of nervous phenomena of functional character discussed later, pathological lesions of the Brain were discovered at the autopsy.

The cerebral abscess may lead to an area of softening with sclerosis + consequent permanent Hemiplegia involving the face + limbs usually on the right side with concomitant Aphasia; the Embolus shows a special tendency to affect the Left Anterior Cerebral Artery + the left Lenticulo-striate branch of the Middle Cerebral Artery, but any part of the Brain may be attacked. The Symptomatology is similar to that of other cases; in the midst of acute febrile symptoms the cerebral phenomena suddenly develop with pain in the head, sometimes Syncope, paralysis, delirium often with convulsions; may go on to coma + death or slowly recover leaving

permanent sensori-motor defects. Bouveret explains the origin of such Cerebral Embolism as due to "the compression of the lungs & heart by the Pleuritic effusion embarasses or suspends the cardio-pulmonary circulation, this favours the production of Pulmonary Thrombi, and, if, from any cause such as the relief of tension produced by aspiration or the increase of tension from injection of fluid, there is further disturbance the thrombus is liable to be detached & carried with the arterial circulation."

We must distinguish such Embolic cases of Cerebral Abscess from cases where Tubercular disease of the Meninges or Cerebellum have been found (as in one of Schede's cases No 9. quoted by Paget. Surgery of Chest pg. 270) post mortem in patients suffering from Emphysema, or cases where pyaemic deposits have taken place simultaneously in the lungs & the Brain from some other focus of infection.

The mortality is high, 7 out of 8 cases results in death more or less rapidly after development of signs.

3. Syncopal Attacks.

Syncope occurring consequent upon the treatment of Empyema has been recorded in upwards of 20 cases, 5 of which were by Jeanselme (Revue de Médecine 1892 VIII 502), 15 by various observers collected by Castan (La Thérap. des Emp. pg 126), excluding 2 slight cases recorded by Wagner (vide Bouveret, Traité de l'Empyeme p. 42) & Vernueil (Etudes sur la tuberculose 1891 III 32). The onset is sudden & unexpected either during the course of the primary operation or during the subsequent treatment. Raynaud (Soc. Méd des Hôpit 1895) has recorded one case, and Paget (Lancet 1895, 1099) another where fatal syncope occurred at the moment when the bistoury touched the soft parts before the Pleural cavity was reached. The position of the patient during operation, while it may predispose to such an accident, is not an essential factor; and according to Laborde (Bull. Acad. de Médicine, May 1892) "the rôle played by the Intercostal Nerves as the medium of reflex inhibition of the Heart" would seem to offer an explanation in these two cases. On the other hand Syncope has occurred during an aspiration, case reported by Morton (Annals of Surgery 1895, XXII, 119); and most often happens during irrigation either at the time of Pleurotomy, 2 cases

reported by Desplats (Semaine Médicale 1888 pg 251) or in the weeks subsequent, case reported by Vigenaud (Archiv. de Méde Militaire 1890, T, 27), even at a considerable interval of time after as in our chronic case recorded by Cestan (La Therap. des Empyèmes pg 128) where fatal syncope from irrigation occurred 2½ years after the initial pleurotomy. In a case of Gayet's (Bull. Congrès de Nantes 1875, 1052) serious syncopal attacks occurred every time irrigation was employed, and death ensued 24 hours after one of these.

Sudden death may occur without the patient making a single movement or cry; but more usually he suddenly falls back, is pallid, perspires, has a vacant look, the pupils are dilated, the pulse small & rapid, the respiration shallow. Under the influence of stimulating measures this apparent death may pass off & the patient recover without any recollection of the attack, or an actually fatal result may ensue, although de Cérenville (Revue Méd. de la Suisse Romande 1888) disputes this latter. It has been demonstrated that the use of too hot lotion or too much force used in injection especially if not sufficient free outlet for the fluid renders syncopal attacks liable to ensue.

The prognosis is always serious, mortality being

as high as 80%, 16 out of the 20 cases recorded. (Case recorded by myself. vide end of this chapter, page 127)

Syncope may be succeeded by transitory attacks of convulsions or spasms & tremors. 9 such cases have been collected & recorded by Jeanselme & Cestan Curiously enough, the prognosis in such cases would seem better than in cases of Syncope alone, for 6 of these cases recovered giving the average mortality as 33%. Spasmodic movements of one or both arms, trismus; transitory facial paralysis on the same side as the Empyema; clonic movements of the eyeballs, conjugate deviation or Strabismus have been observed. Goodhart (quoted by Bouveret & Jeanselme) reported a case in which, an hour after the Syncope, there was angeio-neurotic oedema of the face, arm & hand on the side corresponding to the Empyema. Allen (Lancet, May 1895) a case of spasmodic contractions of the fingers & toes with urethral spasm causing retention of urine. De Cérenville (Rev. Méd. de la Suisse Romande 1888) a case in which Syncope was followed by clonic spasms of the arms with Strabismus & Claudot (Arch. de Méd. Militaire 1895, I, 44) a case exhibiting various tremors in the limbs.
Such cases would seem, so to speak, intermediate

between pure Syncopal & pure Convulsive attacks which we must now pass on to discuss.

4. Convulsive Attacks.

The so called Pleural Epilepsy or Eclampsia. 29 cases have been collected by Bauselme & Castan, 27 of these were cases of Empyema, and 2 were cases of serofibrinous effusion (Lamande These de Paris 1896 & Talamon Medic. Moderne 1893, 314). Practically all the cases have occurred from irrigation of the cavity & the case recorded by Talamon was the result of a simple thoracentesis.

There may some preliminary malaise or even a sort of "aura" but the attack usually begins with some faintness & pallor; the characteristic cry is seldom exhibited. Then follows suddenly the three typical stages of tonic & clonic spasms passing into coma. The clonic convulsions are always most marked on the same side as the Pleurisy but may affect the face, upper & lower limbs separately, or both sides or all together; Rendu (Clinique Médicale 1890, I, 254) has noted them altogether on the opposite side from the Empyema. The ensuing coma may pass off with varying rapidity or a fatal result follow. Several attacks may ensue, sometimes with such

frequency as to constitute a "status epilepticus". The pulse (150) and respirations (60) are rapid; there may be Cheyne-Stokes breathing; the temperature may rise, especially in cases of rapidly succeeding attacks & fatal cases, even to 105° or 106° F; vomiting, also involuntary passage of urine & faeces may occur. True Syncope may pass to this Convulsive form in all its stages, in other cases Hemiplegic symptoms & signs may follow directly. In general, the total duration of the attack is rarely more than 1 to 2 days in cases that recover but may last much longer if stupor or other mental symptoms ensue. In cases where the exit from the attack is unduly prolonged, we may expect another seizure or a fatal issue to follow.

The average mortality is 45%, 13 out of the 29 recorded cases died. Where there were repeated attacks (14 cases) the mortality was 50%, but when only one seizure (15 cases) reduced to 40%.

The Convulsive Attack may be followed by Hemi-plegia or Monoplegia, the paralysis, or rather paresis, being noticed first when the patient emerges from the comatose state. Jaccoud (Rév. de Méd. 1892)

maintained that such paralysis occurs almost regularly on the same side as the Empyema but only in 7 out of the 13 recorded cases was this so; Costan finds that, in all cases of Hemiplegia, transitory or permanent, occurring as a complication of Pleurisy with effusion, the paralysis was on the same side in 11 out of 18 cases or 61%. Walcher (quoted by Bouveret Traité de l'Empyeme) recorded a case where the paralysis changed sides after two successive convulsive attacks. Archawski (Revue Médic. de la Suisse Romande 1891, 369 + 441) & Trousseau (quoted by Bauceline, op. citat., 31) have recorded cases of left facial paralysis alone; a case of Paraplegia affecting both lower limbs has been reported by Vernueil (Thèses sur la Tuberculose 1891, III, 320) There may be "Crossed Paralysis", also choreiform movements of the affected parts.

Such paretic phenomena are usually only transitory and pass off after an interval of time varying from 15 minutes (in case recorded by Dr Montpellier) to several days (in case recorded by Vernueil); but this is not always so, death may ensue or the successive attacks result in permanent paralysis. A certain amount of permanent muscular feebleness often remains, but there is no tendency to the contractures or amyotrophy observed in

true Hemiplegic attacks (discussed later). Of 13 cases recorded by Jeanselme & Laban, only 3 did not recover & one of these was shewn by the autopsy to have associated Pericarditis; hence again the prognosis is rather better than in the pure convulsive form, the mortality being 23%. Various mental symptoms may ensue & last for a variable length of time; there may also be transitory sensory, vasomotor & trophic disturbances. These have been tabulated by Jeanselme (Rév. de Medic. 1892 VII 510 & Medic. Moderne 1895 208) as follows ——

(a) Intellectual Disorders — Torpor & Catalepsy, Delirium followed by Melancholia or Mania, Hallucinations & Delusions.

(b) Speech Disorders — Aphasia, in all its forms.

(c) Sensory Disorders — Bilateral usually. Hemianaesthesia & rarely Hyperaesthesia, Visual disturbances such as Amblyopia & Amaurosis, or Contraction of the visual field.

(d) Vasomotor Disorders — Erythema. Angeio-neurotic oedema.

(e) Trophic Disorders — Ulcerations

(f) Thermogenic Disorders — Subnormal Temperature. Hyperpyrexia.

5. Hemiplegia or Paralytic Attacks.

This may occur with preliminary Syncopal attack but without any convulsive phenomena. 5 cases

are collected by Jeanselme + Cestan. The resulting Hemiplegia or Monoplegia, in 3 out of 4 cases on the opposite side from the Empyema, is followed by contractures, spastic phenomena and muscular atrophy more or less permanent. The paralytic symptoms may be transitory + pass off completely in 25 minutes (case recorded by Forgues, Archives de Méd. Milit. 1894 II 26) up to two days (case recorded by Fisher, Lancet 1894 I 668) after the Syncopal attack. The paralysis may reappear if the original stimulus (crossing with inspiration) is repeated as in cases recorded by Archawski (Revue Int. de la Suisse Romande 1891 IX.) + Djouritch (Thèse de Genève 1892 V.); but frequently remains permanent as in cases recorded by De Cérenville (Revue Méd. de la Suisse Romande 1888) + Djouritch (loc. citat. supra)

Recovery is rarely complete but in no cases of this type has death been recorded.

Hemiplegia, without preceding Syncope or Convulsions, followed by Sensori-motor disturbances more or less transitory, may occur in rare cases. It is characterized by extreme pain in the thorax, sometimes in the limbs (Hyperalgesia) with superficial anaesthesia and paresis of parts. Hemiplegia

and Hemianaesthesia on the same side as the Empyema, with ocular & visual disorders occurs; occasionally Paraplegia or Monoplegia; but always without vasomotor or trophic disturbances.
Jaccoud has classified this type as of purely hysterical character, the "Hystero-Traumatism" of Potain.
One death is recorded by Labbé (quoted by Jaccoud op. citat. 20) in case of left hydropneumothorax. Three recovered completely and two remained in statu quo for an indefinite period.

Hemiplegia, without Syncope or Convulsions, may be followed by Sensori-motor phenomena which appear slowly but remain permanent. The paralysis may be Monoplegic or Hemiplegic but apparently is always confined to the same side as the Empyema. 4 cases collected by Jaccoud & Cestan, one of which made a recovery. In the case recorded by Weill (quoted by Bouveret, Jaccoud Cestan & Courtois-Suffit) there was muscular atrophy with athetoric or choriform movements in the affected side & limbs, and hyperaesthesia of the thumb.
Lépine has recorded a case of localized patches of oedema, sweating & leucoderma, with shooting pains in the affected limbs.

6. Rarer Complications of Nervous Origin &c.

Melancholia resulting alone has been recorded in one case by Mabille & Lallemand (Bull. Soc. Med. des Hôpitaux 1890, 483) & in another by Holmes (Journal of the American Medical association 1891, 477) Mania in a case recorded by Bates (Lancet 1895, I, 815)

Hypertrophic Pulmonary Osteo-arthropathy, a condition connected in some obscure way with trophic changes in the nervous system, has not infrequently been found associated with Empyema usually of chronic type, vide Thorburn Brit. Medic. Journal 1893. I. According to Marie the bone & joint changes are due to an auto-intoxication by reabsorption of septic products in the purulent pleural effusion.

7. Sudden Death.

A not infrequent occurrence in cases of Empyema, may occur independent of any manipulation or treatment of the effusion, but usually are the result of such or of sudden movements of the patient, especially if the effusion is a large one. Some cases doubtless result from the above mentioned nervous causes; while others are due to cardiac failure caused by the pressure of the fluid on the heart which is often displaced & degenerated, or by

sudden disturbances (especially the relief or increase of the intrapleural tension) of the already disordered cardio pulmonary mechanism.

Analysis & Theories.

These Nervous phenomena as complications of Empyema would seem to be more common in the male sex; most of the cases have occurred during early adult life 20 to 30 years of age; and of 86 cases only 5 were in children below 12 years of age. While the majority of the cases have occurred during or consequent upon some interference with the Empyema, it is to be noted that some have been in cases of Serofibrinous effusion, and others in the absence of any manipulations diagnostic or curative. The most frequent cause is irrigation of the Empyema cavity, this was found in 27 out of 45 cases recorded by Isanselme, i.e. 60%. They occur unexpectedly and cannot as a rule be guarded against, but the following premonitory symptoms have been described (1) Inequality of the pupils, especially dilatation of the pupil on the same side as the Empyema occurring at the time of irrigation (2) Hyperaesthesia of the Pleurotomy wound (3) Irritability of the cavity,

especially the presence of capillary haemorrhage from the interior.

The relative proportions as regards type of phenomena mortality is seen in the following table ——

PHENOMENA.	NUMBER OF CASES.	CURED	DEATH.	AVERAGE MORTALITY PER CENT.
Cerebral Abscess	13	2	11	84·6
Syncope alone	20	4	16	80
Syncope with Convulsions	9	6	3	33
Convulsions alone	29	16	13	45
Convulsions with Hemiplegia	13	10	3	23
Hemiplegia with Syncope.	5	5	0	0
Hemiplegia with Sensori-Motor Phenomena { 1. Slowly developed + permanent	4	1	*	0
Phenomena { 2. Rapidly developed + transient	6	3	1 †	16·5

* 3 cases † 2 cases IN STATU QUO.

Thus out of a total 99 cases, an equal number were cured or died (viz. 47) roughly 50%; Excluding the first group whole mortality is high we find that purely functional or quasi functional disorders only result in a mortality of 42%. Various theories have been advanced to explain the occurrence of these nervous complications of Empyema, the best of these are somewhat hypothetical

+ the true pathogenic sequence of events has yet to be demonstrated. These theories may be grouped under three classes viz Toxic, Mechanical, Nervous, + I shall discuss them Seriatim.

1. The Toxic Theory.

Uraemia has been brought forward as an explanation + might account for the purely convulsive type of phenomena but will not explain the paralytic results; moreover Albuminuria has not been found to coexist at any stage, and for the most part the Symptoms + Signs do not indicate a condition analagous to even the Puerperal type of Eclampsia

Auto-intoxication, the theory advanced by Marie, Sanctus + others will not explain the fact that so many cases have resulted from purely physical causes such as exploratory puncture or irrigation. A certain amount of autointoxication must exist + Sperhaps a malignant influence on the Cerebro-Spinal Nervous System predisposes to such attacks, the reflex mechanisms being more excitable and more readily responding to External influences.

2. The Mechanical Theory

The Embolic theory has had many supporters, but in almost all cases no emboli or cerebral lesions which might be accounted for by such Embolisms

have been found by the most careful examination post mortem, except in cases of Cerebral Abscess as described. In addition, the nervous phenomena are characterized by their multiple & complex forms, they are changeable & transitory, and do not correspond with the absolutely constant & fixed results of Cerebral Embolism from other causes.

The Cardiac Compression theory, first promulgated by Auboin (Thèse de Paris 1878) & Bouveret (Traité de l'Emphysème 1888) is held to explain the Syncopal attacks, but to fail for the convulsive & hemiplegic types, and has been of late rejected in favour of the Nervous or Reflex Theory. But I am of opinion the causal element in the production of all these nervous complications is in great measure due to alterations in the cardiopulmonary mechanism produced by sudden changes i.e. increase or decrease in the intrapleural tension. These will have undoubtedly varying effects on the Cerebro-Spinal Circulation, producing therein alterations in its vascular tension, hence transitory anaemia or congestion which may result in the transitory Syncopal or convulsive phenomena on the one hand, and by consequent areas of local haemorrhage on the other hand produce the permanent motor, sensory

trophic disorders. This theory would receive further support from the fact that most of the cases have occurred when the Effusion was aspirated i.e. sudden reduction of intrapleural tension, or when fluid (or air. Of case of Lamandé's Thèse de Paris 1896) has been injected either with too much force or too rapidly or with insufficient outflow i.e. sudden increase of intrapleural tension.

2 The Nervous or Reflex Theory.

According to this theory, the convulsive attacks caused by irritation, the Syncope & the paralytic phenomena by inhibition of the nerve centres situated in the Brain & Spinal Cord. The medium of conduction of these stimulations (the centripetal arc) have been much debated; Goodhart maintained it was through the Vagus nerve; Raynaud and Rendu through the Phrenic nerves — Laborde held that the Phrenic nerve was entirely centrifugal, but it has been since proved by Pauniza, Gybulski & Auerp to contain some centripetal fibres — Laborde (Bull: Acad: de Médicine 1892, 709) has given to the Intercostal nerves the most prominent place as the centripetal path of the reflex stimuli, and this especially from their intimate connexion with the Sympathetic System & thus with the Cardio-

pulmonary Plexuses. Hence the Vagus, the Phrenic and the Intercostal Nerves associated with the Sympathetic Nerves & ganglia, probably all play a part as the paths by which the Pleural irritation stimulates the nerve centres.
Those who support this theory all agree that the reflex centre itself must be Bulbar in situation, for such position alone would explain the Syncope, convulsions, paralysis, vasomotor & trophic disturbances when coexistent.
Hystero-traumatism (Hysteria is too readily regarded as an "olla podrida" in which are grouped many nervous phenomena whose pathological processes we are ignorant of) and Epilepsy may account for exceptional cases.
Auto-infection may play a not unimportant part but it is to the Reflex Theory that we must refer many cases, while others must be attributed to sudden changes in the vascular tension of the Central nervous system produced by sudden changes in the tension of the cardio-pulmonary mechanism; the latter two theories combined more or less will explain other cases which neither alone would.

Case VIII. Syncope occurring during operation on Encysted Empyema. Recovery.

M. L. female, 12½ years, admitted to Hospital for treatment of a small lump below & outside the left nipple, which had first appeared there about three weeks previously. Delicate-looking girl, but previous health & family history fairly satisfactory. There had been an ill-defined illness with feverishness about two months before, when patient had kept in bed & the house for about a week, but was not seen by any doctor, hence no diagnosis certain. The "lump" was found on examination to be an abscess which was beginning to "point" in the 4th intercostal space on the left side, thought to be a cold abscess connected with caries of rib, did not seem deep seated & the total size of it was about that of a pigeon's egg. Ruptured & discharged twelve hours after preliminary carbolic fomentation applied, probe did not detect any carious bone. Anaesthetized by chloroform, easily opened up & explored, found to pass backward & outwards between 4th & 5th ribs from which it did not arise. Opening enlarged & probe passed in for distance of under two inches from surface.

The patient up to this time, i.e. for about 15 minutes, had taken the anaesthetic well, and pulse & respirations regular & good. Suddenly the breathing stopped, pulse became small & rapid, extreme pallor ensued, pupils dilated especially the left one & death seemed imminent. Various stimulating measures employed succeeded in resuscitating patient, wound was hurriedly dressed with drainage tube & loose packing & patient returned to bed. Remained rather collapsed for several hours, but condition improved by next day. Afterwards wound very sensitive but healed up rapidly, & no recurrence of syncopal attacks during subsequent dressings.

This was evidently a case of localized Empyema in which reflex nervous phenomena resulted from the probing of the cavity. The anaesthetic had no blame in the matter unless as predisposing cause, but was being carefully, yet sufficiently, administered up to the time when probe used. It was thought that the probe had touched the Pericardium, but it was being lightly used & its contact with the latter does not seem sufficient to have caused the syncopal attack.

TREATMENT.

The Treatment of Acute and Subacute Empyema has been the subject of much discussion by authorities & writers on the subject, but the general opinion at the present time is almost entirely in favour of treatment by Pleurotomy (with or without resection of a portion of rib) and open drainage. Less severe methods may have their own indications in special cases, but An Empyema must be regarded as demanding the treatment accorded to all cases of acute abscess, viz. free incision & efficient drainage under antiseptic precautions.
We have here to examine shortly the various methods adopted with reference to the pathological & clinical types of case & the results obtained from these.
Numerous methods have found temporary favour, and some of these, now obsolete, given satisfactory results, but practically only four are now in vogue with physicians & Surgeons, British, American & Continental, (1) Aspiration, (2) Syphon-drainage (3) Incision or simple Pleurotomy (4) Resection or Pleurotomy with Resection of Rib.
The objects to be aimed at in treatment are ——
(a) Removal of Effusion exerting pressure on Lung.
(b) Prevention of reaccumulation of the Effusion.
(c) Ensuring the re-expansion of the Lung and the

obliteration of the cavity.
(2) Prevent deformity of the Lung or Chest wall.
The means by which the reexpansion of the lung is brought about has been the subject of numerous theories; it would seem to result from a combination of circumstances, viz. Natural Elasticity of the lung brought into play by the removal of pressure, the mechanical action of the chest wall + diaphragm previously much embarassed, the addition of a larger volume of blood which rushes into the Expanding lung (Pilcher Pallard. Brit. Medic. Journal 1895, II, 1130), the cicatricial contraction of the granulating surfaces and adhesions (theory of Rosser + Gobbe) and by the resulting changes in the intrapleural tension due to renewed action of the respiratory "pump" (West - Allbutt's System of Medicine pages 364-366)
The occlusion of the Empyema cavity is brought about by drainage, reexpansion of the lung, ascent of the diaphragm + contraction of the chest wall.
The occurrence of artificial pneumothorax by free opening externally would not seem to have much deterring effect on the reexpansion, in such cases the intrapleural tension will be reduced from a "plus" quantity to zero, the atmospheric pressure being less than that of pus.

I Aspiration. —— including Exploratory Puncture.
The preliminary use of the Exploring syringe as an indispensable means of diagnosis and a necessary process previous to further treatment, is here included; the needle should be of fairly large calibre & have a sharp but somewhat truncated point; should be used at the centre of the effusion where the dulness & percussion is most marked; and we must beware of erroneous conclusions from negative results because the point may be entangled in thickened pleura or adhesions, may pass through the effusion and enter the lung tissue, may pass into a true pulmonary abscess, or entirely miss the effusion if small encysted or deep seated. If in doubt, the exploration may be at several places & in various directions.
The pus withdrawn should be submitted to an immediate bacteriological examination, the results of which will have an important bearing on the prognosis & method of treatment to be adopted.

The use of the Aspirator as a means of cure has only a very limited range & must not be relied on solely; or again it may be useful

as a temporary or expedient remedy in other cases
As a curative measure it may especially be tried
in cases of children especially if as is usual
the effusion is due to Pneumococci & localized,
but if aspiration of the purulent effusion fails
to effect a cure after one, or at the most two,
applications the indications are for further methods.
Aspiration may be specially required as an
expedient & temporizing method in cases where
from prostration or very large effusions with
dyspnoea, cyanosis & threatening asphyxia the
patient cannot immediately undergo operative
treatment; so also in cases of double Empyema
where the one side is submitted to pleurotomy
the other may be temporarily relieved
As a palliative, and here it may be the only
treatment permissible, it may be employed in
slow Tubercular Empyema, in cases where the
lungs show evidences of advanced Phthisis, and
in cases enfeebled by Pyaemia, malignant Disease
or old age.
On the whole, this operation is one of urgency
or expediency, not of choice; and although it may
avoid the risks of open incision & drainage as
well as the use of a general anaesthetic, should

not be preferred to pleurotomy. As regards results numerous statistics can be found of which that by Steele (Jour. Amer. Med. Assoc. 1898 — quoted also by Holt) is an average one viz of 121 cases treated by aspiration 23 were cured. The average accordingly may be regarded as Cured 22%, Death 22%, Requiring Pleurotomy later 56%.

II Aspiration with Syphon Drainage.

(a) Method of Playfair-Bulaü —— consists in the introduction of a continuous drainage by attaching to the cannula of the aspirator a long rubber tube filled with an antiseptic solution and passing at its lower end into a vessel containing similar solution placed at a lower level i.e. under the bed of patient. The method might be tried without danger & favourable prospects of success in Encysted & Pneumococcal types or as a palliative measure in double Empyema or cases much prostrated from whatever cause unable for a pleurotomy. In Tubercular Empyema, the method is contraindicated & said Even to be dangerous. But it is unsuitable & troublesome; the tube is apt to be blocked or to slip out; and is not

infrequently followed by an intractable sinus or fistula; it does not afford the conditions necessary for the reexpansion of the lung. Still, it has given good results on the Continent. Cestan (La Thérapeutique des Empyèmes page 4) from collected series of reported cases (which must be regarded as specially selected by the observers) found that of 300 cases, 220 were cured = 73%, whereas only 80 or 27% were unsuccessful or died. Aust (Münchener Med. Woch. 1891) & Bolland (Deutsch. Med. Wochn. 1893 & 1896) have tabulated the indications & contraindications for this method

Indicated in — (1) Cases prostrate, dyspnoeic, cyanotic &c. (2) Double Empyema. (3) Empyema of benign type idiopathic or metapneumonic.

May be employed in — (1) Putrid Empyema, if no Pneumothorax. (2) Chronic cases where lung still capable of reexpansion.

Contra-indicated in — (1) Metastatic Empyema (2) If any complications coexist (3) Tubercular Empyema.

(b) Method of Tachard-Revillod — In this pleurotomy is first performed, the drainage tube inserted & fixed in situ, and the wound is then sutured up so as to close tightly round the tube; this ensures that at the outset there is complete evacuation of the pus & removal of-

the false membranes (loose) & masses of fibrin. The rubber tube leading from the pleural cavity is furnished with a ball valve and the distal end passes into a special flask filled with antiseptic solution; by raising this vessel above patient & squeezing the ball we commence an action by which the antiseptic solution is carried into the Empyema cavity, then by lowering it below the patient & again squeezing the ball the fluid & pus flows out by syphon action. The method is an improvement on the last mentioned one but even more complicated in apparatus; and good results have been obtained, notably those of Archawski (Revue Méd. de la Suisse Romande 1891, 369 & 441) who got 20 cases cured out of 25 treated thus. Djouritch (Thèse de Genève 1892) Hill (Boston Med Journal 1893, 668) & Lop (Archives Gener. de Medic. 1893, 420) have also recorded successful cases. Hence out of 31 cases, 26 (83%) cured, 4 (13%) died & 1 (4%) resulting in chronic fistula. Perthes (Mittheilung. f. d. Grenzgebieten der Med u. Chir. VII, 5, pg 595) reports favorably on the method of Rehfisch.

III Pleurotomy — with open drainage.

In practically all Acute & Subacute Empyemata this is the operation of choice, and has yielded by far the most satisfactory results both in children & adults. Simple incision of the Empyema through an intercostal space, with drainage is doubtless the simpler of the two forms of the operation, and previous to the introduction of Pleurotomy with Resection gave the most satisfactory results, many still hold to this method and it may be suitable & preferable in certain cases. It would seem better in infants, although it is more the severity of the disease in the earliest months or years of life that tells against statistical accounts; it may be employed in cases of urgency & in cases where the patient is too weak to stand the more thorough method from whatever cause & moreover it may be accomplished if necessary without a general anaesthetic. But the disadvantages resulting from the close proximity of the ribs especially in children & at the posterior part of the chest where one preferably makes the Pleurotomy, the tendency for the tube to become nipped between the ribs, the fact that without an unnecessarily large incision or from the

closeness of the adjacent ribs we may be unable to introduce the exploring finger and if necessary irrigate with safety the cavity, may be held to outweigh the advantages of such simple incision. The comparative results of the two methods as regards prognosis & treatment may be well seen in the following table of collected cases given by Ceelen (La Thérap. des Empyèmes pgg. 193 & 215) ———

OPERATION	NO.	CURED		DEATH		UNSUCCESSFUL		AVERAGE DURATION
Incision	578	420	76%	94	17%	34	7%	52 days
Resection	687	586	85%	81	12%	20	3%	49 days

These figures speak for themselves, Pleurotomy with resection of a portion of rib is the operation for acute Empyema & gives uniformly the best results. Koplik (Archives of Pediatrics Aug. 1897) says that for children in private practice resection gives better results than in hospital.

I shall not enter into the details of this method of treatment but only indicate the important points to which attention must be paid to ensure the best results.

As regards the influence of the age of the patient on treatment, it is found that healing and

cure after Pleurotomy is more rapid in children than in adults, thus for the former an average duration of 35-42% rises to 49% as the minimum duration in the latter; this result may in great measure be attributed to the greater incidence of the benign types of Empyema in children in whom also spontaneous cure by reabsorption or spontaneous evacuation is most common.

As regards the influence of the bacteriological type of Empyema on the results of treatment by Pleurotomy, this is well indicated in Schede's tables (Handbuch f. spec. Therap. de Penzoldt et Stintzing) ——

TYPE.	No. of CASES	CURED	DEATH		AVERAGE DURATION
Tubercular	45	10	35	78%	136 days
Metapneumonic	573	443	70	13.5%	79 days
Idiopathic	101	93	8	7.9%	66 days.
Secondary or Metastatic	66	34	32	48.5%	—

For the time of operation it is undoubted that whenever we have determined the existence of a Pleural effusion + that it is a purulent one, the earlier the operation is performed the better for the rapid + satisfactory cure.

The anaesthetic used should be chloroform because

it excites less coughing + has a less irritating effect upon the Bronchial mucous membrane than Ether; in a few cases only local anaesthesia may be permissible when cocain should be injected + the skin surface frozen with Ethyl chloride and in such cases only Incision (without resection) should be attempted. There is much unnecessary fear in the administration of general anaesthesia, the dangers in cases of operation for Empyema are not much worse than for any other condition in which the action of the lungs + heart is embarrassed; the dangerous + even fatal syncope which may occur is much more likely due to reflex nervous stimulation produced by the incision, exploration or irrigation than to the effect of the chloroform in cases of Empyema.

The position of the patient is an important item; he must not be turned much towards the sound side so as to interfere with the action of the only functioning lung. The position recommended by modern surgery (vide Fowler + Godlee Diseases of the Chest 1898) is that the patient should be kept lying flat on his back, the affected side should project over the Edge of the table + the operator perform from below; moreover this

position ensures opening the pleural cavity at the most dependent part so that all the pus can escape & be easily caught in a vessel placed underneath for this purpose.

The position of the incision should be parallel to the ribs, corresponding to the 9th rib at a point midway between the posterior axillary line & the angle of the scapula, this is the most dependent part & allows the best drainage whether the patient is lying down or sitting up. In children the 7th or 8th rib should be attacked owing to greater height of the diaphragm in them.

About 1½ inches of rib should be resected, preferably subperiosteally, not because the gap may be thus filled up later by new bone but in order that the incision into the Pleural cavity may be made at a point corresponding to the middle of the rib & thus most satisfactorily avoid wounding the intercostal artery

The finger should be introduced to explore the cavity & if necessary by blocking the opening control the too rapid exit of the effusion especially if large & under great tension; you can thus also remove clots & masses of fibrin, can

assure oneself that the Empyema has been all emptied i.e. there is no loculus not reached, and also ascertain if the lung is expanding well. It is unwise to break down adhesions.

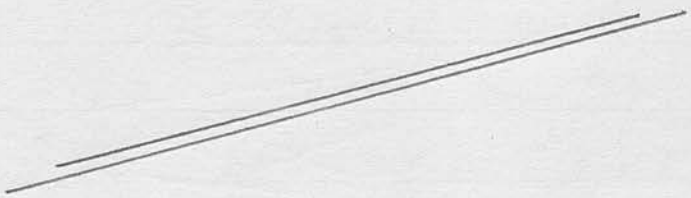
Irrigation of the cavity is quite unnecessary, save in putrid types, either at the time of operation or subsequently; in most cases it serves no useful purpose + is even dangerous; and the results are not so good with as without it as shown by Rumeberg (Berliner Klin. Wochen. 1890. XXVII + Hospital Tidende, Helsingfors, 1892)

IRRIGATION	CURES	AVERAGE DURATION
None.	96%	52 Days
Single, at time of operation	78%	88 Days
Daily — repeated	30%	111 Days

Drainage should be by short red rubber tube, 2 or 1½ inches in length just sufficient to project slightly into the pleural cavity, with flange or other attachment to prevent it being drawn into the chest. A long tube is bad except perhaps in cases where there may be necessity for a counter opening when such a tube with lateral perforations may be carried from one opening to another but should be kept thus only for the

first few days or if irrigation required for longer.
Calibre of tube should be large = No. 16–20
The time of removal of the drainage tube is determined by the discharge becoming serous and the temperature remaining normal, the lung well expanded & the external wound contracting; in children it may frequently be removed about the 7th day after operation, in adults usually on the 21st to 28th day, for ordinary uncomplicated & more benign types of case.
Valved drainage tubes such as those of Northrup or Shutton are troublesome, easily blocked if pus thick or there are many clots or false membranes and the necessity for securing the flaps of upper portion tight enough to chest to ensure the exclusion of air entering from external surface & the due function of the valve ensured, is irksome to the patient & embarrasses the re-expansion of the chest generally.
Open drainage is best; the distal end of tube covered with antiseptic gauze loosely placed over its mouth, wool arranged so as to avoid direct pressure on end of tube ("bird nest") abundant supply of absorbent wool & bandage applied not too closely but sufficiently firm to ensure

the proper & constant application of the dressing. If irrigation required best to use a copious supply of weak antiseptic lotion, and I think Perchloride of Mercury 1 in 5000 or 8000 best; the antiseptic qualities of boracic or any so-called innocuous antiseptic are useless to overcome the virulent microorganisms whose presence demands a more thorough antiseptic treatment.



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