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PRIMARY PNEUMOCOCCUS PERITONITIS.

by

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Introduction.

Since Weichselbaum in 1889 observed the presence of the pneumococcus in a case of peritonitis, there has been an increasing recognition of this condition.

Previous to Weichselbaum's observation there were one or two observers who suspected the presence of the pneumococcus but did not associate it with the cause of the condition but rather as an extraneous organism, e.g. da Bozzoto in 1885, who describes a case of infection of several serous cavities with capsulated cocci following an attack of acute nephritis. Since the cause of the vast majority of all peritonitis cases could be referred to some gross lesions in the intestines such as a perforation, an acute obstruction, a gangrenous appendix, etc., it was not thought necessary to seek any further and in those few cases in which search failed to elucidate any such lesion, it was inferred that there was such a lesion but of such a minute character that it had been overlooked. But with the introduction of a routine method of examining the pus from all cases of peritonitis and with the growing tendency to do exploratory laparotomies in doubtful cases, there has been an increasing recognition of primary infection of the peritoneal cavity.

Some ambiguity arises from the use of the word primary in connection with this form of peritonitis. Only those cases which show the first symptoms in the

peritoneal cavity will fall under this heading. There are many cases which are due to secondary invasion from some near (viz. lung) or distant focus (viz. middle ear). Some, however, fall under neither heading. These are the cases in which it is practically impossible to tell which lesions began first, or whether they began simultaneously. It is best to classify these separately.

This disease seems specially prone to attack children. Up to 1903, of 72 cases recorded, 57 were children all below 15 years of age giving a percentage of nearly 80. Of the 91 cases Annand and Bowen[2] found recorded, 63% were children. In adults the disease is rare.

Ashdown[3] in his researches came across 31 cases of adults in all, the first records being two cases described by Weichselbaum in 1889. Not only are children specially liable to be attacked but the female sex largely predominates. Of all the primary cases found recorded by Annand and Bowen, females constituted 84 per cent. and of all cases females were affected in 73 per cent. This great predominance of females affected seems to point to the genitalia as possible the portal of entry for the coccus, but of pathological support to this theory (as will be seen later) there is practically none. The predominance of the females exists not only in the primary but in the secondary types of this disease and this therefore constitutes rather an

argument against the female gesitatia being the rule than otherwise, if it is borne in mind that the vast majority of secondary cases are due to infection from a pneumonic focus in the lung. Of the other possible modes of infection the two chief are (a) from the blood-stream, and (b) from the viscera lined by the cavity, and the arguments for and against these modes will be fully dealt with later.

There are two recognised types of this disease, (1) the circumscribed, and (2) the diffuse, though the difference is one of a degree. The circumscribed tends to become chronic but like the diffuse form, its onset is sudden. The diffuse passes rapidly on to a fatal issue. The cases are equally divided between these two types. Of 46 primary cases, 26 were circumscribed. In the circumscribed an abscess forms in the cavity and slowly enlarges and the case soon presents features closely resembling those of a tuberculous peritonitis. It is a remarkable fact that when Annand searched the reports of the cases at the East London Hospital for Children for the last ten years, not a single case of intraperitoneal abscess due to the pneumococcus had been recorded as such. Doubtless if a routine method of examining the pus had been adppted a good many of the cases would have been proved to have been due to the pneumococcus. That the neglect of such a method has caused a great loss to the literature

on the subject may be inferred from Carmichael's Statistics[5] where he asserts that of all cases of peritonitis admitted during the year to a General Childrens Hospital, 5 to 10 per cent. are due to the pneumococcus.

It will be seen from the above introductory remarks how the whole subject has been neglected in the past and is only now in its infancy. The very mode of infection is still hotly disputed and when one takes into consideration the sudden onset, the severity of the symptoms and the rapidly fatal issue, it will be recognised how important it is not only to have a sound basis upon which to found a prophylactic treatment, but in addition a method by which an early recognition of this disease can be found, a most important point for the apparent absence of any gross lesions in the abdomen has caused men to adopt a conservative treatment towards it and to treat it as a suspected typhoid or a tuberculous peritonitis and to await more definite symptoms. As will be seen this conservative treatment is disastrous, the only hope lying in an early laparotomy.

It is with such thoughts in my mind and with the hope that a critical review of the subject and a little fresh material in the shape of ~~four~~ five cases hitherto unpublished, two of which came under my own personal observation from admission to hospital till death (and upon which I performed post mortems) and two others

which came into hospital shortly before I arrived and the notes of which I possess, may shed a little more light upon this somewhat obscure disease, has led me to adopt this subject as my thesis.

Historical Outline.

Previous to Weichselbaum's demonstration of the diplococcus pneumoniae in a case of acute peritonitis, cases of peritonitis due to this organism were unknown and probably relegated to that nondescript class of idiopathic peritonitis. During the next few years a few isolated instances were brought to the notice of the profession mostly from abroad. Cornil performed a necropsy in a case of pneumococcal peritonitis following pneumonia and associated with double empyema and pyopericarditis. In 1890 Nelaton undertook the first operation for the relief of this condition in a woman (aet. 32) without success. Gellerd and Sevestre also operated during the same year on a case of pneumococcic peritonitis. Sevestre's case was a child with apparently primary involvement of the peritoneum. The latter case recovered and remained well. The disease was now becoming more generally recognised. The disputed mode of infection stimulated various observers to experiment. Brien, abroad and Bond in England upheld the female genitalia as the usual route in the great majority of cases. Bond experimenting on female rabbits demonstrated the existence of ascending mucous currents in uterus and fallopian tubes by which pneumococci may be rapidly carried the whole length of the genital canal within a few hours.

Masello's researches on the relative obsorbtion powers of different regions of the peritoneal cavity and Dudgeon and Sargent's[7] observations on the cytology of the normal cavity as contrasted with the inflamed have thrown light on the possibility of a transdiaphragmatic and a transvisceral mode of infection. Jensen in addition did a good deal of experimental work on mice in connection with the supposed transdiaphragmatic mode. And finally the whole literature on the subject has been revised and brought into a connected form by the researches of Annand and Bowen which were published five years ago in the Lancet. Since that date there have been many recorded cases of this disease, amongst these observers may be mentioned Carmichael[6] whose observations led him to believe that 5 to 10% of all cases of peritonitis treated in a childrens' hospital are due to the pneumococcus.

The work of the above observers has done much to revolutionise prevailing ideas on the surgical treatment of peritonitis especially on the dangerous habits of irrigating the peritoneal cavity, swabbing away of the protective lymph and temporary evisceration for better observation.

Modes of Infection.

There are four possible modes of infection in this disease.

(1) From the stomach, intestines, in inflammatory conditions, appendicitis or foci in the abdominal viscera.

(2) Through the bloodstream from distant or near foci.

(3) From the pleura through the diaphragm (a special instance of a near focus).

(4) Through the Fallopian tubes.

(1) On reviewing the cases of peritonitis due to the pneumococcus, we are struck with the fact that the vast majority of them begin with some gastro-intestinal disturbance. It may have been a diarrhoea or constipation lasting over a week or two, or else the sudden onset of pain after a meal. Of Annand and Bowen's cases published in the Lancet, ii. 1906, out of 45 primary cases they collected, from the clinical side there is the fact that in 35 out of 45 cases, the onset of the illness was a sudden pain in the abdomen with vomiting or diarrhoea. In 26 out of the 35 cases both vomiting and diarrhoea were noted. In a very few cases there is some history of an indigestible meal. It is open to argument that the vomiting, etc. were due to the commencing peritonitis, but the very frequent occurrence of an early diarrhoea points in favour of

these symptoms being those of an enteritis rapidly passing on to peritonitis.

P.M. results in the condition of the bowel in the cases is scanty. Of the 21 primary cases with a fatal result, there is no report. Of the remaining six, in four it is spoken of as being healthy and in two cases swelling of Peyer's patches is noted. A swollen patch cut and stained showed in one case pneumococci in the mucous membrane only, in the other case no organisms were found. There is now no doubt as to the occasional presence of the pneumococcus in the lumen of the bowel. Weichselbaum and Flexner and other authorities have pronounced definitely as to its presence. With disordered digestion and reduction of acidity of the gastric juice, the pneumococcus could pass through the stomach uninjured. In adults numerous cases of enteritis due to the pneumococcus have been recorded. In some peritonitis also occurred.

Jensen experimented on animals with a view to testing the possibility of bowel infection. Two young mice and two young rabbits were each given through the mouth 10 c.c. of a highly virulent culture of pneumococci. One rabbit got diarrhoea and died in four days. General fibrino purulent peritonitis was found, the gut was strongly infected but not ulcerated, though the Peyers patches were necrotic. Pneumococci were found in pure culture throughout the body, but did not

show symptoms of septicaemia. The general infection was therefore late.

In two thirds of the cases the peritoneum is probably infected from the bowel. No microscopic lesion is as a rule found.

From the cases that have occurred at this hospital. Three had a history of abdominal pains extending over 6 to 10 days accompanied with vomiting. The bowels in each case were rather constipated.

One had a history of sudden onset some time after a meal. Diarrhoea was present here.

Again quoting from Nothnagel "Diseases of the Peritoneum."

"There are two conceivable paths by which pathogenic bacteria might gain an entrance into the peritoneal cavity without leaving any trace at their point of entry into the organism and without leaving any recognisable evidence of their passage through certain organs. In the first place the female genital organs ..... In the second place bacteria or their products may enter the body through the intestine especially during certain disorders (diarrhoea, faecal accumulation)."

Of the 31 cases collected by Ashdown, Lancet i. 1906, five had beensuffering from affections of the stomach (three a perforating ulcer, one a chronic ulcer and in one carcinoma). In the above cases there was

little doubt that the source of infection originated from the intestinal tract.

Bryant suggests that the diarrhoea which is so often present may be evidence of a gastro-enteritis which determines the passage of the organism.

Bond in the B.M.J., 1905 says, "It is not necessary to have an actual perforation of the intestinal wall in order to allow the egress from the bowel of pathogenic organisms, their presence in a hernial sac in the absence of gangrene demonstrates this fact, and is brought about by migration of organisms through the inflamed coats of separate portions of the intestinal tube as successive evils become involved by inflammation, glued together by sticky exudation and distended by gas and faeces."

He sums up the conditions necessary for migration.

"Distended condition of bowel, retarded blood supply, and the presence of lumen of a faecal culture medium and organisms of exalted virulence."

We will now consider what role the appendix may take in this form of peritonitis.

I quote the evidence of Dudgeon and Sargent in their book "The Bacteriology of Peritonitis."

"In one of our instances of appendix abscess, we isolated the pneumococcus with the colon bacillus. This is the only case in which we cultivated the pneumococcus either from the pus in the appendix abscess or

in the peritoneal exudate in peritonitis associated with appendicitis. There is little doubt that if the pneumococcus was the important organism in appendicitis, which it has incorrectly been assumed to be, we should have obtained pure cultures of the organism from the peritoneal exudate in some of our cases quite apart from the presence of the coccus in a localised abscess."

On the other hand there is T. H. Bryant who has offered the suggestion that the pneumococcus might possibly be found to be a very important organism in this disease, if only a more careful search were made.

Again quoting from Nothnagel "Diseases of the Peritoneum" (1904) "The result of the greater number of bacteriological investigations reveals therefore, that in the common forms of appendicitis itself and of secondary perityphlitis, we are dealing as a rule not with a pure but with a mixed infection, the most important organisms being the Bacillus Coli Communis, the Streptococcus Pyogenes, the Diplococcus Pneumoniae and the anaerobes."

From the above we can reasonably infer that the diplococcus pneumoniae is rare but is certainly responsible for some cases of appendicitis.

In considering foci from the abdominal viscera apart from the alimentary tract, they must be rare if we exclude a general septicaemia. No foci were found in the recorded cases of Annand and Bowen (Lancet, ii.

1906), but theoretically it is quite possible, e.g. pancreas which could be invaded direct from the alimentary canal by way of the Duct of Wersung.

In reviewing the arguments for and against this mode of infection (1) there is first the fact that the pneumococcus is either a constant or at least a common inhabitant of the intestine. (Nothnagel, Diseases of Peritoneum, 1904) Secondly that the peritonitis is in the great majority of cases accompanied with or preceded by some intestinal disturbance, either diarrhoea or constipation. The intestine is therefore rendered more permeable to pathogenic organisms. Hence it can be explained the passage of the pneumococcus through the gut wall. It is impossible with these arguments before one not to deny that this mode of infection is probably one of the important modes and possibly is the important one in the causation of Primary Pneumococcal Peritonitis.

The route of infection via the female the female genitalia seems at first sight the most likely, especially when one considers the vast preponderance of females over males who are affected with this disease. The sex incidence as found by Annand and Bowen in their researches were, of all cases both primary and secondary, 73 per cent. were females. Of the primary cases females were 84 per cent. and of the secondary cases 67 per cent. It is difficult to account for these figures for it seems likely that there must be some

common factor in both primary and secondary cases to produce such a preponderance. In considering secondary cases, of which the great majority start from a pneumonia the question of the genitatia does not arise. Therefore it is possible that we must seek some other factor to explain this preponderance. It is in addition a fact that the genital organs in the great number of females affected are found normal. Brien (Beitrage zur Klinischen Chirurgie, 1903) lays great stress on the genitals as being the portal of entry of the pneumococcus, but in only two of his cases was a congested tube found. In a case recorded by Dudgeon and Sargent (Lancet, i. 1905) pyometra was present with gonococci but no pneumococci in the pus. Slight vulvitis was present in one case and slight vaginitis in another, but there was no bacteriological record made. In the cases recorded at this hospital in which all were females, there was no instance of a vulvitis or vaginitis though careful search was made. In one p.m. the tubes were found slightly congested but this may have been secondary to the general peritonitis condition.

On the other hand, Bond (B.M.J. i. 1905) has made a study of the wave currents in the vagina and uterus. There are ascending mucus currents in uterus and fallopian tube which may rapidly carry the pneumococcus up the whole length of the genital canal within a few hours without dwelling long enough in vagina or uterus

to show any symptoms there. I quote from one of his cases. A child aet. 3, died of acute pneumococcal peritonitis. The gram staining capsulated diplococcus was found lying upon and amongst the epithelial cells lining the fallopian tubes without any evidence of infiltration of mucous or submucous tissues. It may however, be agreed here that the organism could have been conveyed from the peritoneal cavity to the tubes by way of the finbriated open end of the fallopian tube.

I do not think that the above instance carries much weight either for or against this mode of infection. We have the fact of the almost entire absence of genital disturbance in these cases, and I think we must therefore set aside this route of infection as possible in spite of the preponderance of the female sex.

(3) In considering this mode of infection it is necessary to review the most recent knowledge we have about the structure of the peritoneum. The normal peritoneum (Dudgeon and Sargent, Bacteriology of Peritonitis, 1905) is save for the exception of the Fallopian tubes, a closed sac closed microscopically as well as macroscopically. It is no longer held that the cavity communicates directly with the lymphatic system. Muscatello has shown that the picturesque stomata of the older writers to have no greater significance than

errors of histological technique. His researches show that not only are there no stomata between the endothelial cells but there are not even any subendothelial lymphatic spaces over by far the greater part of the serous membrane of the abdominal cavity. The lymph spaces underlie the endothelial covering of the diaphragmatic peritoneum, but are absent from the rest of the peritoneum covering the viscera and abdominal wall.

Quoting from Bond (B.M.J. i. 1905), "From the work of Muscatello it is now recognised that the upper dome or diaphragmatic portion of peritoneum is by far the most active area in the absorbtion of both fluid and solid particles."

He deduced this by experiments with carmine in the peritoneal cavities of dogs, and he further found out that there is normally a lymph flow towards the diaphragm independent of, but influenced in point of time by gravity. In the above experiments it was found that the transfer was carried out entirely by means of phagocytosis, and was accomplished with extraordinary rapidity, for particles of carmine were found in the thoracic duct only seven minutes after intraperitoneal injection.

From some work of Burckhardt in "Beitrage zur Klinischen Chirurgie, 1901," he relates one case of pneumonia. He examined the diaphragm microscopically and found pneumococci in the pleural serosa subrerosa,

while they were absent from the deeper layers. In a second case the organisms were found in great numbers throughout the whole thickness of the diaphragm. This case however, had endocarditis and abscess in the shoulder joint and therefore was of a septicaemic type, the diaphragm would then be just as likely invaded by bloodborne organisms.

Experiments have been made on animals and the results have been such that to produce a penetration of the diaphragm from the pleura, virulent cultures must be used and the endothelium of the pleura must first be destroyed by some chemical poison.

From the above it will be seen that only in cases in which a virulent culture and a specially damaged surface of the pleura, can an emigration of pneumococci through the layers of the diaphragm take place. Such artificial conditions must be rare in the usual cases of pneumonia which occur. Muscatello's experiments show of course show that there is a lymph flow from peritoneal cavity to pleura, and therefore pneumococci penetrating the peritoneum from the pleura would necessarily have to proceed against the current in the vessels. In addition it is an established fact that septicaemia is present in practically every case of pneumonia, so that we have here an instance of peritonitis secondary in its nature to set up by blood borne organisms.

Annand and Bowen furnish evidence in their own cases (of peritonitis) of the septicaemic nature of a pneumonia.

Of 22 cases of peritonitis of pulmonary origin, in four remote lesions occurred late (otitis media, arthritis), these must have been brought about by blood-borne organisms.

In the remaining 18 there is no direct evidence as to the path of infection.

(2) This mode of infection if it occurs at all in primary cases must be very rare indeed. In secondary cases where the disease partakes of a septicaemic character, there is no question that the peritoneum can be infected by blood-borne organisms. The vast majority of all pneumonias become septicaemic in time and probably other lesions, e.g. otitis media, arthritis, may possibly after a time set up a septicaemia. But in primary cases where the peritoneum is alone infected, is very rare. A priori it would seem very strange that the only serous membrane of all the other serous membranes of the body to be attacked, should be the peritoneum. It may be argued that that happened to be the one weak spot in the body. It is possible of course but the chances that in a given number of people their only weak spot was the peritoneum would be remote.

Nothnagel in his "Diseases of the Peritoneum" has no doubt about the rarity of this mode of invasion of

the peritoneum.

"It is well known that in the great majority of infective diseases haematogenous peritonitis is a very rare event; we may even go so far as to say that in m many of these diseases it probably never occurs. This also applies to the influenza bacillus an organism which, as we know, does damage to the greatest number of organs; in influenza for instance pleurisy often supervenes, whereas according to Leichtenstern there is no recorded case of primary haematogenous infection of the peritoneum..... It seems probable that occasionally peritonitis may occur by way of the blood in cases of pneumococcus infection."

Allbutt and Rolleston in their "System of Medicine," Vol. iii. 1907, do not mention this route as a possible mode of infection. I think we may therefore safely assert that primary pneumococcal peritonitis is rarely if ever, set up by an invasion from the blood, and if it is there is good reason for thinking there must have been some focus in the body previous to the invasion of the blood, in which case of course the peritonitis is not primary.

Report of Cases of Acute Pneumococcal Peritonitis of Primary Origin.

Case I. D.C. aged 11.

The father reported that six days before admission the girl seemed to be perfectly well, took her breakfast and went to school. During school-time the child complained of pain in the abdomen and asked the mistress to allow her to go home, which request was granted. She complained of pain chiefly in the hypogastric region. She took no food for dinner and vomited frequently. In the evening the pain got worse and a doctor was called in and prescribed morphia, which eased her slightly. The next two days the symptoms showed no abatement, diarrhoea began and continued with increasing severity. The stools were of a pea-soup character and the vomiting bilious.

She was admitted to the Royal Berkshire Hospital, Reading, on November 4th, 1911.

On admission her face was pinched and drawn with an anxious expression. Her temperature was 101°, pulse 116 and respirations 40. Tongue dirty and dry. The abdomen was distended and rigid. Any attempt at palpation was followed by great distress. There was no specially tender part. The liver dulness was present. Rectal examination showed nothing abnormal. A few crepitations present at bases of both lungs. The

stools were pea-soup in character. Her mental condition was quite clear. She spoke collectedly and gave an account of her illness.

It was suspected at first that this was a case of typhoid, but the sudden and severe onset of the condition contra-indicated it. An exploratory laparotomy was therefore decided upon.

Operation. The abdomen was opened by an incision between pelvis and umbilicus.

In the peritoneal cavity was found a large quantity of greenish-yellow pus and shreds of lymph. The appendix was first suspected as the cause of the condition but on examination proved normal. The tubes and uterus showed nothing abnormal nor did any of the other abdominal organs. There was a large collection of pus in the pouch of Douglas. The intestines showed acute inflammation of their serous coats, some were matted together and in the meshes of the coils were shreds of whitish lymph (some partaking of a gelatinous character), While moving the intestines about during the operation, it was noticed that they bled very freely; this was not due entirely to breaking down of recent adhesions for on passing one's hand over the free surface of a loop of bowel quite an ooze of blood was produced over the surface.

A drainage tube was inserted and the abdominal wound sewn up.

Patient passed a delirious night. The diarrhoea continued. Subcutaneous injections of salines were tried, but with little effect. Patient died the following morning, twenty-four hours after admission and seven days from the onset of the symptoms.

No permission for post mortem was obtainable so operation wound was enlarged.

Abdomen. Greenish yellow pus present. A few recent adhesions. Some of the mesenteric glands showed enlargement especially in the mesentery attached to the small intestine. The peritoneal cavity presented a typical acute inflammation. All the abdominal organs were found normal.

Heart and pericardium. No vegetations present in heart valves.

Lungs. No pleurisy present. Acute congestion of bases of both lungs, with small consolidated patches here and there - a condition of early broncho-pneumonia - the right base being in a more advanced state.

The brain was not examined owing to the reason given above, but her mental condition was quite clear when she was admitted into hospital and the father told me that he had not noticed any retraction of the neck not anything that could be associated with meningeal trouble beyond the vomiting.

The pus was sent to the Clinical Research Association and the following is the report:-

Smear preparations show cellular debris associated with a small number of gram positive diplococci indistinguishable from the pneumococcus.

Inoculated media yield cultures of this organism.

Case 2. M.S. aet. 6.

Patient (girl) has had several attacks of abdominal pain during the last few weeks, colicky in character and accompanied by vomiting. Last attack occurred about a fortnight ago. Two days before admission patient complained during the afternoon of a stomach ache. At 10 o'clock that evening violent abdominal pains came on accompanied by vomiting which lasted all that night.

The next day the vomiting continued though with less severity. The bowels had been rather constipated so she had a dose of salts and they were then opened four times. The doctor attending the case said that there was nothing unusual about the stools. The temperature was normal and the pulse 120. Slight rigidity and tenderness all over the abdomen. Later that evening, temperature 101° pulse 144.

Patient was admitted on November 3rd.

On admission her temperature was 101.6°, pulse 136, respiration 44. Her expression was anxious and the face pinched. The abdomen showed deficient movements on respiration and was rigid all over. On palpation special tenderness was made out in right iliac fossa where some dulness was also present. Fulness

round umbilicus. Rectal examination revealed some fulness high up on right side. Nothing abnormal was made out in the lungs.

Operation. An exploratory laparotomy was decided upon. Median incision from umbilicus to pubis. General purulent peritonitis present. Greenish-yellow pus and flakes of lymph all over the peritoneal cavity. No focus of infection was found. Appendix and tubes normal as were all the other abdominal organs. There was a decided enlargement of the mesenteric glands. A drainage tube was put in and wound sewn up.

Next day the patient was delirious and the respirations were embarrassed. Patches of dulness on both lungs, harsh breath sounds and crepitations present all over.

The following day patient died, four days from the onset of the severe symptoms.

Again in this case permission for a full post mortemwas not obtainable so the brain could not be examined.

Abdomen. Peritoneal cavity contained a large quantity of pus and shreds of lymph (an almost exact replica of the condition found in D.C.). Intestines inflamed generally but much more marked in certain coils. A few recent adhesions present.

Heart. Normal. No vegetations present on valve.

Lungs. Recent pleurisy with lymph. Bases of lungs and right upper lobe showing signs of early broncho-pneumonia.

The pus was sent to the Clinical Research Association.

Report. Smear preparations show cell debris associated with a fair number of diplococci resembling pneumococci.

Media inoculated yield cultures showing fair numbers of the diplococcus which is indistinguishable from the pneumococcus.

There are also a few small gram positive bacilli and an occasional coloring of the staphylococcus albus which is probably of extraneous origin.

Case 3. F.P. aet. 9.

Five days before admission (October 4th, 1911) patient was taken ill with pains in the abdomen. The pains were not localised but appeared all over the abdomen. She vomited several times the day before admission. Bowels had not been open since the attack.

Condition on Admission. Temperature 101.6, pulse 140, respirations 36. Tongue dry and dirty. Anxious haggard face. Abdomen was distended and moved badly with respirations. Rigidity and tenderness existed all over the abdomen. Rales and rhonchi over both lungs. Dulness present at right base V.R. increased. Patient showed signs of low delirium.

An exploratory laparotomy was decided upon. An incision was made through the lower part of right semilunaris, thick yellow pus with shreds of lymph found on opening peritoneal cavity. Recent fibrinous adhesions present everywhere. Appendix was coated with lymph. An appendicectomy was performed but the appendix on further examination seemed to be quite normal. The viscera were examined but no focus of infection could be made out.

Patient died next morning October 5th.

No post mortem was performed nor was any pus examined but from the appearance of the pus which was identical with the appearances presented by the other three, and the complete absence of any definite focus in the abdomen there can be little doubt that the infection was due to the pneumococcus.

Case 4. E.K. aet. 3 years 7 months.

Patient was taken ill four days before admission with fever and pain on the right side of the abdomen. Vomiting took place each day till the day before admission. Bowels were opened daily with salts. The child was quite healthy before the attack.

Condition on Admission. Temperature 100.6°, pulse 144, respirations 48. Tongue was dirty. Abdominal movements diminished. Tenderness and rigidity all over. Specially noticeable in the right iliac fossa. The note over this region was dull.

An exploratory laparotomy was decided upon. An oblique incision was made over right iliac fossa. Large amount of sero pus found over whole peritoneal cavity with shreds of lymph on coils of intestine. The inflammatory signs were most intense in the right iliac fossa but appendix except for its serous coat showed nothing abnormal. Search was made in the abdomen for any possible focus but none was found.

The next day, abdominal condition was satisfactory but respirations very laboured and rapid. Patient died on the fourth day of respiratory failure. Death occurred eight days after the first symptoms had set in and four days after admission.

Case 5. A.P. aet. 8.

Child was quite well up till four days before admission when she was taken with diarrhoea, and sickness. Her brothers and sisters have all been ill with diarrhoea and sickness. This condition persisted till Saturday morning, January 8thm 1912, since when she has had pain all over the stomach. On Saturday morning vomiting ceased but diarrhoea persisted.

A good many of the children at the school have shown the same symptoms of diarrhoea and vomiting.

On admission. Temperature 101.8°, pulse 140, respirations 32. Tongue dry and furred.

The abdomen was rigid all over. There was no special point of tenderness as it was tender all over.

Liver dulness was present. Practically no movement with respiration. Herpes labialis well marked.

Dr. Maurice performed an exploratory laparotomy. Median incision. Peritoneal cavity full of greenish yellow pus identical with that seen in the other cases. A large quantity of lymph present in flakes as well as adherent to coils of intestine and parietal peritoneum.

There was no focus of infection found. Appendix and tubes were normal.

The cavity was drained. There had been no attempt at shutting off.

When patient was got back to bed, she was practically moribund. I inoculated two agar tubes with blood from a prick in the fingers, and also took two blood slides. No pneumococci were made out in the films and the agar tubes produced no cultures.

She was put on continuous oxygen and brandy every two hours. Also she got an inoculation of pneumococcal vaccine (20 millions). After a bad night she seemed to improve in the morning of the next day. Three days after (December 7th) she was again inoculated with 30 millions. The temperature had been nightly up at 101°. After the injection maximum temperature was 100°.

The next injection was given on December 11th when there was a further drop to 99° (as a maximum). On the fifth day after the third injection her temper-

ature oscillated a little from the normal for some time.

The patient made an uninterrupted recovery, at the present moment there is still a sinus persisting. She is otherwise quite fit and well.

Pathological Anatomy.

In the two cases upon which autopsies were performed at the Royal Berkshire Hospital, the following were the features common to both.

The peritoneal cavity was lined with a dull greyish layer of lymph. The intestines were matted together and the intervals between the coils were here and there filled with shreds of lymph. A large quantity of fibrinous greenish-yellow pus exuded from the wound as soon as the incision into the cavity was made. The pus was mixed with a number of shreds of lymph. The shreds of lymph were tough in consistency and somewhat transparent.

There was no macroscopic lesion of the stomach, intestines or appendix. In both cases some enlargement of the mesenteric glands was found. An early condition of broncho-pneumonia was also noticeable in both cases. If we take into consideration the fact that one patient had been ill for six days before admission and the other at least two days before, that in one only slight changes in the lung were met with and in the other nothing abnormal at all on admission, then we must regard this condition of the lungs as almost certainly secondary to the peritonitis.

In the case marked D.C., it was noticed at the time of the operation that on passing one's hand over the free surface of a loop of bowel, it bled freely.

The pus was odourless in both cases.

From a survey of the cases quoted by Annand and Bowen (B.M.J. ii. 1906) the following are the features presented by the majority. The pus was greenish-yellow or greenish-brown in colour, and was odourless. T he pus is fibrinous in character. "Its fibrinous character is shown by the layer of lymph on the wall of the cavity and by the presence of jelly-like masses in the pus, this last appearance being due to an intimate mixture of the purulent and fibrinous elements of the exudate." Jensen lays stress on the fibrinous character of the exudate. So constant is this character and so much a part of the action of the pneumococcus in a serous cavity that the diagnosis can always be made on macroscopical examination of the pus. After the first two cases had been operated upon at this hospital we were, so to speak, on the look out for the type of exudate and as soon as the abdomen was opened in the remaining cases, we were quite sure of the pneumococcal character of the pus.

As a further description of the fibrinous character of the pus, we may quote the following, Annand and Bowen, B.M.J. ii. 1906, "The fibrinous layer covering the surface may appear simply as a layer of lymph dull and whitish-grey, or by the presence of pus in and between its layers, it may assume the form of a yellowish or greenish yellow gelatinous membrane which may usually

be peeled away from the lining wall of the cavity."

We may now compare the nature of the exudate with those obtained in a streptococcus and color bacillus invasions of the peritoneal cavity, which are the two great causal agents of peritonitis. In the case of a streptococcic peritonitis there is usually no pus, the exudate is fluid, clear and odourless. Flakes of lymph are present but there is usually so little resistance on the part of the individual invaded that the lymph is scanty and the intestines not matted together. The coils of intestine are red and distended.

In the case of the colon bacillus, there is present a great quantity of foul smelling pus. The intestines are as in above reddened and distended and usually matted together.

The exudate cannot be confounded with that found in a tuberculous peritonitis as there will be a sufficient number of tubercles scattered over the wall of the cavity to show the nature of the invasion.

Symptoms, Diagnosis, and Prognosis.

In the five cases described in these notes, the sudden onset of pains in the abdomen were the first signs of the disease. The pain was very severe in character and in two cases was referred to the Right Iliac Fossa. This condition was shortly followed by vomiting which was a constant feature of all the cases. In one case there was a history of several attacks of abdominal pain, colicky in character, extending over some weeks until finally one attack more severe than the others, caused the patient to take to bed. In another case the pain in the abdomen came on with such rapidity that the patient, seemingly quite well in the morning was seized with such pain in the abdomen in the afternoon that she was forced to leave school and go to bed. This gave rise to the idea that some injudicious food had been taken but the evidence on this point was slight and I could not elicit from the father that the child had taken any food other than that she was accustomed to.

These cases were all sent in as Acute General Peritonitis following Acute Appendicitis. On admission to hospital each case presented an almost typical picture of a general invasion of the peritoneal cavity. There was nothing to indicate its differentiation from any other form of peritonitis. There was the same board like condition of the abdominal wall, the diarr-

hoea, vomiting and pain. The facies was typical of the abdominal type, the eyes were sunken, the nose pinched, the colour grey, the tongue dry, and the pulse quick and thready. The fever was not very high averaging between 100° and 101.8.

On looking through the records of diffuse pneumococcal peritonitis cases, the above is the usual description of the symptoms. With the circumscribed varieties the picture presented is somewhat different. They all pass through a precisely similar acute stage, but after a varying interval the acute symptoms subside. This interval as given by Michant (Annand and Bowen, B.M.J. 1906) lasts from 10 to 14 days. The second stage usually described as the "Exudative Stage" consists of an exudation into the peritoneal cavity with the formation of a local abscess. Pain, tenderness or discomfort are not marked and a slow formation of fluid proceeds. Jensen (Archiv. fur Klinischen Chirurgie, 1903) drew an analogy with the formation of of an empyema following the acute pleurisy of a pneumonia.

Local swelling and dulness is observed and on palpation there is usually some tenderness unassociated with muscular rigidity. The swelling proceeds to slowly increase in size and may fill the abdominal cavity. One marked peculiarity of these intra-abdominal pneumococcal abscesses is their tendency to point

at the umbilicus. In connection with this it may be noted as an interesting point that in one of the cases admitted to this hospital, it was noted down that there seemed to be increased distension in the region of the umbilicus. During this stage the temperature is slightly elevated, the diarrhoea has ceased, vomiting is uncommon and constipation is usually present. Swelling and oedema of the legs may be present due to pressure on the iliac veins.

The next stage will follow as a natural sequence if operative interference is not brought about. This is by no means an uncommon sequel, for the low temperature and complete lack of urgent symptoms, all indicate a conservative line of treatment to be undertaken. The abscess may spontaneously rupture in the neighbourhood of the umbilicus. After spontaneous evacuation a curve may result, but more commonly there is some retention of pus and a large incision has to be made. I quote Von Brunn regarding the diagnostic significance of spontaneous evacuation through the umbilicus. "It is so frequently an occurrence in pneumococcal peritonitis as to be one of the most characteristic features."

In the secondary varieties both of the circumscribed and diffuse the symptoms vary according to the lapse of time which has taken place before secondary infection has taken place. In a great many cases the signs of pneumococcal infection are obscure. A conjunctivitis

or a tonsillitis may be the only sign of primary infection and it often passes unrecognised as cultures have not been taken. In many of the secondary diffuse varieties the onset of the secondary symptoms may follow so quickly on the primary that they may completely obscure the latter.

In comparing the above symptoms with those shown in acute general peritonitis of other causation, it will be seen that the symptoms in both the diffuse (throughout) and the circumscribed (in the first stage) correspond very closely with those shown in general peritonitis from acute appendicitis or perforation of intestine. There are, however, a great many which exhibit the symptoms usually associated with typhoid and some show symptoms certainly pointing to an abdominal infection but not sufficient to permit a diagnosis of peritonitis.

It is in the secondary types of these diseases that some clue may be hoped for which will differentiate it from that caused by the more common agents of a general peritonitis, but as will be shown later the primary focus of a pneumococcal infection is often very difficult to locate.

The invasion of the pneumococcus into other organs of the body does not produce such a great constitutional disturbance as is shown by its invasion into the peritoneal cavity. The symptoms exhibited by a pneumonia

correspond most closely to this disease as there is often a good deal of abdominal tenderness and a certain amount of prostration. It is not an uncommon occurrence for cases of pneumonia to be operated upon for acute appendicitis, the symptoms corresponding very closely in many cases.

Diagnosis.

The diagnosis of this condition presents a great many difficulties. It must be borne in mind, however, that in the great majority of the diffuse varieties, the symptoms presented are those of acute general peritonitis and being diagnosed as such there can be but one course adopted and that is early laparotomy. The remainder of the above variety present either a picture of typhoid, acute tubercular infection or else some other abdominal infection not sufficient to permit a diagnosis of peritonitis. In these cases conservative measures will be taken and the cases watched. From typhoid fever the diagnosis proves difficult especially if the diarrhoea persists and the temperature remains raised. The absence of the rash, no splenic enlargement, and a leucocytosis as opposed to a leucopnaemia and a negative Widal are all points against the fever.

In the primary circumscribed varieties before a definite swelling can be made out the symptoms are closely approximate to those of a typhoid fever especially as the vomiting ceases and though the temperature

tends to fall, it still remains sufficiently elevated. But the differentiating points above mentioned should be sufficient to eliminate typhoid. In the latter part of the secondstage of the circumscribed varieties, the picture presented is almost typical of a tuberculous peritonitis. It is all important to obtain the history in such a case as the history will then show an acute stage preceding the present symptoms, such a stage being absent in the great majority of cases of tuberculous peritonitis. A further differentiating point may be mentioned for in the latter cases on palpating the abdomen several masses may be made out which are wholly absent from the abdomen of a pneumococcal peritonitis.

In the secondary varieties if the primary focus is found, thenmthe diagnosis can be easily made, but frequently this is a matter of great difficulty. A pneumonia (which is responsible for the great majority of these secondary varieties) may be obscure in some cases. The presence of a central pneumonia is often a very difficult matter to determine. To show this difficulty, I will quote a case recorded by Annand and Bowen. "We recently saw a case of fever lasting over a week and falling by crisis in which all the pulmonary signs recognised by skilled observers pointed to diffuse bronchitis only. Typhoid fever was thought of but Widal's reaction proved negative. After the

fall of temperature the patient expectorated a muco-pus which was examined for tubercle bacilli; these were absent but numerous bacilli and diplococci were present. The diplococci were gram positive and morphologically identical with the pneumococcus, and we are of opinion that what might have been a very obscure case but for this examination, was a case of central pneumonia giving practically no physical signs of consolidation."

Only the other day a soldier from the barracks in Reading was admitted into hospital with a diagnosis of typhoid fever. His temperature remained about 102° for three days when it fell by crisis. On admission there were rhonchi all over both lungs, no dull area could be made out. There was some tenderness in the abdomen, but there were no spots and no enlargement of his spleen. The Widal was negative. His history showed nothing distinctive from the insidious onset of typhoid except that the lung symptoms predominated. Unfortunately no bacteriological examination of his spectum was made, but there can be little doubt that this was another case of central pneumonia giving practically no physicalsigns.

If a pneumonia can be so obscure, much more so a conjunctivitis or a tonsillitis of like origin.

Prognosis.

Prognosis in a case of diffuse pneumococcal per-

itonitis is very grave as may be shown by the statistics given by Annand and Bowen (B.M.J., 1906). Of 46 cases of the diffuse variety, 18 were operated open. Six of the 18 recovered, and all those not operated upon, died.

Recognising that the lesion here is essentially one of acute general peritonitis, there can be no surprise regarding the sequel of the cases operated on, nor the high mortality of those operated on.

Early recognition and early laparotomy is the only chance for such cases.

The mortality in the cases occurring at this hospital was 80 per cent.

In the case of the circumscribed variety, of 45 cases, 44 were operated on and of these 37 recovered and 6 died; in two the result was uncertain.

In the secondary types with pneumonia as a primary lesion, the chances of ultimate recovery are still more imperilled.

Treatment.

All the cases came in as "Acute General Peritonitis" cases and laparotomies were performed on all of them as speedily as possible. The patients had been suffering from the condition on the average for at least four or five days, they were in a very collapsed condition and this may account for the high mortality following the operation. Continuous saline infusions per rectum were given to them during the night together with brandy, twenty minims, every hour.

The remarkable recovery of case V. following a condition in every way as severe as the other four is very instructive. We are very tempted to ascribe it to the vaccine injection, but of course as this is only an isolated case I am afraid it cannot be accepted as sufficient evidence of the efficacy of this treatment. Still the coincidence of the injection with the improvement of the patient is very significant. It is a very disputed point whether the anti-pneumococcic serum or vaccine influences favourably or unfavourably the progress of a pneumonia; so it would be rash to be positive of the beneficient effect of the vaccine in this case. I would, however, lay down a general rule that the vaccine should be injected in all future cases until it has been definitely proved useless, in which case the remedy is obvious. I do not think that the lack of success following the injections in pneumonia

cases should influence one in these cases of general peritonitis.

I would add a word of warning regarding the treatment of the peritoneum when opened into. As little of the lymph covering the parietal wall and intestines should be removed as possible. Owing to the researches of Dudgeon and Sargent the importance of this fibrinous deposit has become more and more evident. This deposit limits the absorption of toxic material into the subperitoneal blood vessels and it also prevents the further egress of organisms from the intestine into the peritoneal cavity. Another way in which this fibrinous deposit serves as a protective measure is by the agglutination of intestinal coils, whereby a localization of infection may be brought about. The absence of agglutination of intestinal coils in streptococcal peritonitis with its extreme rapidity of onset, and almost invariably fatal issue are all points in favour of the protective nature of this deposit.

The whole cavity should be lightly swabbed with for preference some soft lint. No irrigation should be employed, and no attempt should be made to detach the coils of intestine from each other.

The treatment of these cases (diffuse variety) does not differ from that employed in cases of acute general peritonitisfrom any other cause with this exception that a serum should be injected when the lap-

arotomy has cleared up the diagnosis.

I may point out that previous to admission two of the cases had cathartics administered to them (their nature I was not able to determine) early in the course of the disease and this of course may have materially helped to spread the sepsis in the cavity by vigorous action of the bowels, and turned a possible circumscribed variety into a diffuse. The cases were diagnosed as possible acute appendicitis cases so there seemed to be no reason to depart from the orthodox rule of giving purgatives if at all with the greatest caution.

To sum up the treatment of these diffuse varieties we may say that since they assume very rapidly the aspect of general peritonitis, laparotomy should be performed as early as possible, and on the nature of the pus being observed, an antipneumococcal serum should be injected as early as possible. There is not sufficient evidence to point to whether the serum should be administered immediately after the operation (as was done in one of these cases) or the following day. A large drainage tube inserted and continuous rectal salines should be administered.

With the circumscribed variety as explained under 'Diagnosis', a somewhat similar picture will be presented, of an acute onset, abdominal pain, diarrhoea, and vomiting. These symptoms tend to subside sooner or later, the tenderness in the abdomen will be more

localised and will be diagnosed sooner or later since an abdominal abscess will form. In the secondary circumscribed and diffuse a clue may be obtained from the primary lesion, but experience has shown how obscure pneumonia may be in some cases, much more so a tonsillitis or conjunctivitis due to a pneumococcus.

Here the treatment will be incision and drainage as soon as the abscess has become definitely recognised. Even if no pneumococcal lesion has been recognised elsewhere to give a clue to the condition, the old dictum "where there is pus let it out" will still hold true.

Summary and Conclusions.

The number of recorded cases have been steadily year by year on the increase, but this does not necessarily point to an increase in the actual number of cases, but rather to an improved routine method of submitting the purulent material to bacteriological investigation and also to the fact that after the researches of Annand and Bowen a sharper lookout was kept for these cases. The majority of these cases occur in children and in addition the great majority occur in the female sex. That the female genitalia are not responsible for this cause or possibly only in a few of the cases is evident by the fact that the condition is rarely accompanied by any signs of vaginitis or uterine disturbance whatsoever, and further that in the secondary types of this disease, where pneumonia is the chief cause, the female sex is still predominant. Some other factor must therefore be sought for possibly dependent on the greater susceptibility to the pneumococcus of the peritoneal cavity of the female as contrasted with that of the male. There can be little doubt that the principal, probably the only route of infection in primary cases is through the alimentary tract.

We have direct evidence of its invasion of the cavity consequent on a gross lesion of the tract, viz. in quoted cases of gastric ulcer perforation and also some cases of appendicitis. Furthermore it is known

to be an inhabitant of the tract under normal conditions. The constant feature of gastro intestinal disturbances preceding the peritonitis and causing a greater permeability or rather a lowering of the resisting power of the wall of the gut all tend to point to this mode of infection as the most likely. In secondary cases the blood stream is the mode of infection. The majority of secondary cases follow a pneumonia. The difficulty of diagnosing these secondary cases occasionally when pneumonia (central) has been the primary lesion was pointed out.

The symptoms are very constant, gastro-intestinal disturbances with either diarrhoea or constipation occurring over a variable period and preceding the acute onset. The acute stage is indistinguishable from that occurring at any other acute infection of the peritoneal cavity though there are degrees of acuteness which cause the symptoms to assume those of typhoid or tuberculous infection. It is here that the great danger lies, for operation is put off and a waiting policy pursued. Some of the cases pass on to the circumscribed variety with an abatement of the acute symptoms and all may be well provided the abscess is opened and even if it is not recognised, it may burst through the abdominal wall and recovery take place. With the diffuse varieties a waiting policy is disastrous and it is therefore in these cases that the

the greatest difficulty will be encountered as to what plan to pursue. In the secondary diffuse varieties a careful search over the body may lead to the discovery of a primary focus, but in the primary diffuse varieties there will be no such clue. A careful enquiry into the history of the cases particularly directed into whether there have been any other similar cases occurring perhaps at the school where the patient goes to. That such an enquiry may lead to some clue leading to the nature of the condition is shown by Case 5. A sudden onset with previous good health is very suggestive and almost pathognomonic.

Still there are cases of the diffuse variety which are impossible to diagnose, and will remain so until some routine method of diagnosis analogous to the Widal test in typhoid be established and will prevent the waiting policy so disastrous in this disease.

In the treatment emphasis should be laid on the fact that where you have an acute onset on abdominal pain occurring in a patient with previous good health, the greatest care should be taken that mild cathartics, if at all, should be given, and that enemata would be far more preferable. Seeing that half the cases are circumscribed it is possible there is a good deal of ability on the part of the peritoneum to withstand the invasion and localise it, a state of affairs we see with tubercular invasion of the cavity; a much greater

tendency to limit than we ever see with invasions of B. Coli or Streptococcus Pyogenes, etc. Therefore a line of treatment directed to keeping the bowels at rest would be the sounder policy to pursue and would certainly prevent the conversion of a circumscribed into a diffuse variety. The above treatment does not of course refer to those diffuse cases where there is obvious general peritonitis, early laparotomy is the indication then, but only in those borderland cases where the abdominal symptoms are not so well marked, and insufficiently indicative of general peritonitis. Wherever the probability of the pneumococcus being the cause of the condition, Anti-pneumococcus serum or vaccine should be injected, though as I stated before sufficient evidence as to its efficacy is not as yet forthcoming.

The prognosis in diffuse varieties is gloomy especially with delayed laparotomy. The prognosis in the circumscribed varieties is hopeful and recovery should be the general rule.

I am afraid little light can as yet be thrown on the practicability of a diagnosis in the so-called borderland cases, but no doubt one will be forthcoming when a more extended survey of this disease has been undertaken. As regards prophylactic treatment seeing that the infection takes place primarily per **oram**, the mouths of children, as is insisted upon in so many other prophylactic treatments should be kept clear and

foul breath removed.

A nd finally the possibility of this disease being infectious must not be lost sight of.

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