THE DIAGNOSIS OF CEREBROSPINAL FEVER (Meningococcal Meningitis)

INCORPORATING THE DIFFERENTIAL DIAGNOSIS OF MENINGITIS

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I. DIAGNOSIS OF CEREBROSPINAL FEVER

Early diagnosis in cerebrospinal fever is of paramount importance as the earlier treatment is instituted the greater are the chances of the patient's recovery from the disease. Conclusive diagnosis cannot be made on clinical evidence alone; the initial question is what factors justify the opinion that a particular patient is suffering from cerebrospinal fever and demands lumbar puncture to confirm the provisional diagnosis? In the early or septicaemic stage of the disease, before the development of meningitis, early diagnosis is extremely difficult and often impossible. Certain facts, however, may raise the suspicion of cerebrospinal fever, especially when the disease is prevalent. A sudden onset, beginning with rigors, increasing headache and the appearance of vomiting within the first twenty-four hours is suggestive; the presence of a petechial or purpuric rash is highly suspicious and demands treatment pending the result of blood-culture and further observation.

The more characteristic muscular rigidity does not appear until the meninges are invaded by the meningococcus; in the presence of such rigidity, the cerebrospinal fluid in some cases may still appear clear to the naked eye, but diplococci are seen on examination of the centrifuged deposit. A certain degree of rigidity of the posterior cervical muscles is one of the earliest signs and is of cardinal importance; the neck muscles, therefore, must be carefully examined in all cases in which cerebrospinal fever is suspected. Head-retraction as a sign is useless if diagnosis is to be made early, as it seldom develops before the third or fourth day of illness and, in many adult cases, is absent throughout the course. To ascertain the presence or absence of neck rigidity, the following method is useful: with the patient lying on his back, the observer places his hand beneath the head and endeavours gently to draw it forwards. In meningitis (with the occasional exception of the tuberculous variety) the head cannot be brought forwards for more than two or three inches beyond the line of the long axis of the body; quite often, indeed, it cannot be flexed past this line. This sign is sometimes present within four or five hours of the onset, and usually within twelve hours; in fulminating cases it may be absent.

Kernig's sign, which also depends upon the symptom of muscular rigidity, is one of great diagnostic value in all cases above the age of two years. The test as originally described by Kernig is as follows: the patient, in bed, is propped up into a sitting position, the thighs forming a right angle with the abdomen. When the sign is positive, the legs will be found flexed at the knees and, owing to rigidity of the hamstring muscles, they cannot be extended completely until the back is lowered to form more than a right angle with the thighs. A modified method of eliciting the sign which I have found most useful and constant is the following: with the patient lying supine, the thigh is placed at a right angle with the trunk; while the thigh is maintained in this position, an attempt is made to extend the leg on the thigh. If it is found impossible to bring the shank beyond an angle of 45° of a horizontal line passing through the knee, the sign is considered positive. Kernig's sign is often positive within twelve hours of the onset, can usually be obtained within eighteen hours, and is almost invariably positive at the end of twenty-four. The sign is of no value in infants below the age of two years owing to the physiological muscular rigidity usually present up to this age.

Various conditions, in addition to the different forms of meningitis, which may give rise to a positive Kernig's sign are: disuse of the legs, e.g. confinement to bed for long periods; upper neurone lesions of the spinal cord; lesions of the cauda equina, sciatica, uraemia, cerebral and subarachnoid haemorrhage, and lesions involving the base of the brain. With the exception of the latter four, however, these disorders are rarely mistaken for meningitis.

Early delirium occurring in a pyrexial patient, especially with headache, is of significance and should lead to an examination for muscular rigidity. In infants, tension and bulging of the anterior fontanelle is an early and important sign. When the fontanelle is closed, Macewen's

sign may be elicited. This sign is present when a dull tympanitic note is elicited by percussion of the skull in the fronto-parietal region; in adults, the thickness of the skull renders the sign uncertain.

A comparatively slow pulse, associated with a high temperature is often of subsidiary value. Retention of urine, when present, is an important symptom, especially in association with other signs; it sometimes appears within twenty-four hours of the onset.

The state of the deep and superficial reflexes is of little or no value in the diagnosis of meningitis, while a "tache cerebrale," stressed by older writers, is present in too many other conditions to be of assistance.

The provisional diagnosis of cerebrospinal fever is finally confirmed by an examination of the cerebrospinal fluid obtained by lumbar puncture. The fluid withdrawn during the pre-meningitic stage of the disease is quite clear to the naked eye and may reveal no meningococci. At a slightly later stage, when muscular rigidity is just beginning, the fluid may still be clear to the naked eye, but gram-negative diplococci may be found on microscopical examination of the centrifuged deposit; after the elapse of a period varying between twelve and twenty-four hours of the onset, the cerebrospinal fluid becomes turbid and microscopical examination shows a vast predominance of polymorphonuclear cells with some mononuclears; gram-negative diplococci, intracellular, extracellular, or both can usually be made out, although sometimes only after prolonged search. For all practical purposes, such diplococci can be taken as diagnostic of cerebrospinal fever. Further and absolute confirmation is obtained on cultivation of the organism.

II. DIFFERENTIAL DIAGNOSIS

In this discussion on differential diagnosis, the various diseases mentioned are those which in the writer's experience have at some time given rise to erroneous diagnosis, and comprise (a) examples of true cerebrospinal fever which, prior to investigation, were regarded as one or other of the disorders mentioned below, or (b) examples of these other diseases received into hospital as cases of cerebrospinal fever.

The various pathological conditions from which it is necessary to distinguish cerebrospinal fever may be conveniently classified under the following headings: (1) acute infective processes, (2) diseases of the central nervous system other than meningitis, (3) miscellaneous conditions, and (4) other forms of meningitis.

(1) Acute Infective Processes

Influenza.

The clinical differentiation of cerebrospinal fever and influenza sometimes presents considerable difficulty, particularly as the diagnosis of the latter is arrived at chiefly by a process of exclusion. Both influenza and cerebrospinal fever in their early stages show many features in common—a sudden onset, headache, pyrexia and pain and stiffness in the muscles. On the first day accurate diagnosis may be impossible; points of difference, however, are as follows: vomiting is more frequent in cerebrospinal fever; a relatively slow pulse in proportion to the temperature towards the end of the first day favours cerebrospinal fever; by this time some neck rigidity may be present; on the second day Kernig's sign may be positive. With influenza, there may be some slight rigidity of the hamstring muscles but it seldom amounts to a definite Kernig's sign, nor does it increase as rapidly as in meningitis. If there remains any doubt after attention to the above points, lumbar puncture is indicated rather than the opportunity of early treatment being missed.

Pneumonia.

In the early stages this disease may be mistaken for cerebrospinal fever and conversely, more particularly if vomiting has occurred and if it is too early for pulmonary signs to have developed. In pneumonia, however, neck rigidity is absent or extremely slight, and Kernig's sign is not present; the pulse rate is raised in proportion to the temperature, this ratio being more or less continuous. A blood culture, taken early in cases of suspected pneumonia without definite physical signs, will frequently yield pneumococci. Should pulmonary signs fail to develop within a day or two and the diagnosis still remain in doubt, the cerebrospinal fluid should be examined.

Typhoid fever.

At first not easy to diagnose as such, typhoid fever during the early stages has been mistaken for cerebrospinal fever. The two conditions during the first week may resemble each other in the drowsy, sometimes delirious mental state; the headache; relatively slow pulse as compared with the temperature; and the occurrence of vomiting. A leucocyte count may be of assistance, as in cerebrospinal fever leucocytosis is the rule, but in typhoid fever a leucopenia is usual. The absence of neck rigidity and of Kernig's sign after the second or third day is fairly conclusive in excluding meningitis, excepting in the so-called cerebrospinal form of typhoid (see "meningism"), in which lumbar puncture is necessary.

Typhus fever.

The onset in both cerebrospinal fever and typhus is similar, consisting of rigors, headache and vomiting; the latter symptoms, however, are less common in typhus. Delirium and retention of urine also occur, but are later than in meningitis. Further, the purpuric rash of cerebrospinal fever, if present at all, appears on the first or second day, while in typhus it does not develop before the fourth or fifth day of illness. As a rule the typhus eruption is maculoroseolar, and petechial rashes are seen in only 10 per cent of cases. It is evident, therefore, that differential symptoms appear more rapidly in cerebrospinal fever, and by the second, or at the latest the third, day meningitis should be revealed by the characteristic signs.

Septicaemia.

The pyrexia, rigors and various cutaneous eruptions—erythematous, petechial or purpuric—may well lead to confusion with cerebrospinal fever. In septicaemia, however, the onset is more insidious, endocarditis is more frequent, and the spleen may be enlarged. Further, the absence of neck rigidity and Kernig's sign after the first twenty-four hours would tend to exclude meningitis. Blood culture should be carried out, as it must be borne in mind that the meningococcus is capable of giving rise to meningococcal septicaemia with or without endocarditis, and in the absence of meningitis.

Measles.

Acute forms of this disease, occurring in children, may simulate cerebrospinal fever, especially if a condition of "meningism" be present. In doubtful cases it will be necessary to examine the cerebrospinal fluid.

Malignant smallpox.

According to Milligan this condition may closely simulate cerebrospinal fever, chiefly on account of the sudden onset, headache, vomiting, and pain in the back. The muscular rigidities of meningitis, however, are absent, and on the third or fourth day the characteristic eruption appears.

Acute rheumatism.

Owing to the pain in the limbs and relative muscular rigidity subacute cerebrospinal fever is occasionally mistaken for acute rheumatism. If an early arthropathy be present the resemblance is further enhanced. Careful clinical examination and the involvement of other joints may serve to distinguish the two conditions, but in some cases one may have to resort to lumbar puncture.

Acute tonsillitis.

This condition may at first give rise to a suspicion of cerebrospinal fever, particularly as a "sore throat" sometimes precedes the development of meningitis. The onset of tonsillitis may occur with headache, rigors, and even vomiting, while the soreness of the throat and tenderness of the cervical glands may give rise to apparent neck rigidity, the patient being reluctant to permit flexion of the head owing to the pain produced in the throat. Kernig's sign, however,

is absent, and consciousness usually normal; the tonsils are inflamed, and the submaxillary or cervical glands enlarged and tender, the latter being unusual in cerebrospinal fever.

A true meningitis, due to the causative organism in each case, may occur in pneumonia, typhoid fever, and, associated with Pfeiffer's bacillus, in apparent influenza. Meningitis has also been described as a complication of measles, mumps, and typhus fever.

Meningism.

In acute infections the toxic process not infrequently gives rise to a clinical state suggesting meningitis, and to which Dupré originally applied the term "meningism." In the so-called cerebrospinal form of typhoid, for instance, intense nervous symptoms—photophobia, head retraction, muscular rigidity, and sometimes convulsions—may develop even at an early stage of the disease. The cerebrospinal fluid, however, reveals no abnormality, and if the case proves fatal no meningitis is apparent on post-mortem examination.

If meningism is at all pronounced during the course of an acute infective process, especially in children, it is advisable to perform lumbar puncture in order to exclude meningitis. A rise in the intrathecal pressure may be found and the amount of fluid obtainable may be more than usual, but the cerebrospinal fluid itself is normal. Some authors have described a slight increase in the total protein, and even a slight lymphocytosis, the latter finding, however, constitutes meningitis; the term "meningism" should be confined to those cases showing a normal cell count and a normal protein-content in the cerebrospinal fluid.

The question as to whether meningism is entirely due to toxæmia or whether it is dependent upon definite though slight changes in the pia-arachnoid without visible exudate has not been satisfactorily determined. In most instances of meningism associated with infectious disease, in which post-mortem examination has been possible, the meninges have been found free from anatomical change beyond the occasional presence of oedema and slight opacity of the membranes. On microscopical examination, however, acute inflammatory changes have been described, especially about the smaller blood vessels and associated with leucocytic infiltration in the meninges, and even in the brain substance. It is probable that many cases of "meningism" are examples of a mild meningo-encephalitis.

(2) Diseases of the Central Nervous System Other than Meningitis

Spontaneous subarachnoid hæmorrhage.

This condition, especially in young subjects, is often clinically indistinguishable from meningitis until lumbar puncture has been performed. The hæmorrhage, in the young, occurs as a result of leakage from or rupture of a congenital "berry" aneurism, situated at the bifurcation of one or other of the cerebral arteries, particularly those at the base of the brain. Such aneurisms may be multiple. In older individuals, subarachnoid hæmorrhage may result from an aneurism produced by atheromatous softening or associated with hyperpiesis. The onset of symptoms is sudden, consisting of acute pain in the head or neck, and sometimes in the back, vomiting, collapse, and frequently loss of consciousness and coma. Both neck rigidity and Kernig's sign are present and there may be a slight irregular pyrexia. On fundus oculi examination, the presence of subhyaloid hæmorrhages may indicate the diagnosis, but lumbar puncture is almost invariably necessary to exclude meningitis. The cerebrospinal fluid is found uniformly and intimately mixed with blood, and microscopical examination confirms the absence of inflammatory reaction.

Cerebral abscess.

This condition may simulate meningitis, and particularly when the abscess is situated in the cerebellum. The abscesses may be either single or multiple, the former usually being secondary to otitis media. Features that the condition has in common with cerebrospinal fever are persistent headache, drowsiness and lethargy, a relatively slow pulse rate, and occasional vomiting. The onset, however, is not usually sudden or abrupt as in cerebrospinal fever, and although the temperature may be raised in the earlier stages, it not infrequently becomes subnormal. In doubtful cases the history or presence of an ear discharge favours cerebral abscess. Some cervical rigidity may also be present, but Kernig's sign is usually negative.

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In any case, however, lumbar puncture will be necessary to determine the diagnosis. The cerebrospinal fluid of abscess shows a relatively slight increase in cells as compared with meningitis, some of which may be polymorphs, and a raised protein content.

Cerebral or cerebellar abscess may give rise to a secondary meningitis, the causative organism of which will be revealed on microscopical and bacteriological examination of the cerebrospinal fluid.

Encephalitis.

Epidemic encephalitis, especially of the lethargic type, may simulate meningitis in the relatively sudden onset and the occurrence of stupor or coma. There is, however, no neck rigidity, and Kernig's sign is usually absent. Bilateral ptosis is more frequent in encephalitis, and the mental state more likely to be that of somnolence and lethargy than the irritable stupor of meningitis. In most cases, however, a final diagnosis will be made only on lumbar puncture. The cerebrospinal fluid in encephalitis is clear to the naked eye, and on microscopical examination the cells usually found to be normal; in the earlier stages of the disease, however, there may be a slight increase in the total lymphocytes. The total protein is only slightly raised and glucose and chlorides are normal; finally the fluid is sterile on culture.

Encephalo-myelitis.

Encephalo-myelitis in children following vaccination, or complicating one of the exanthemata (measles, varicella, etc.), and occasionally arising spontaneously may exhibit itself in a "meningeal" form. In these cases, the onset is acute with headache, vomiting and pyrexia; neck rigidity and Kernig's sign may also be present. More usually, however, choreo-athetoid movements or signs of cerebellar disturbance are present, and evidence of spinal cord involvement may also be observed—extensor plantar reflexes, exaggerated deep reflexes and ankle clonus. Pupillary abnormalities and oculo-motor palsies are not infrequent. The cerebrospinal fluid is clear to the naked eye and is frequently normal; occasionally the lymphocytes and total protein are increased.

Poliomyelitis and polioencephalitis.

Poliomyelitis and polioencephalitis sometimes present meningitic symptoms during the earlier stages. The onset may be acute, with headache, vomiting, general pains, and a high temperature. Polioencephalitis in children, in whom these symptoms are most frequently seen, is often ushered in by a convulsion, also a not infrequent event in young children with cerebrospinal fever. Further, the patient may be irritable and restless, and complain of pain in the neck and spine; stupor may be present, but as a rule questions are answered fairly well. In the so-called meningitic type of the disease, described by Wickham, added to these symptoms, the neck and spine may show considerable rigidity, and even a certain degree of opisthotonus may be present.

In polioencephalitis, strabismus and other cranial nerve palsies may be observed comparatively early in the disease, but in acute anterior poliomyelitis, paralyses affecting the extremities are not usually apparent before the fourth day, or even later. Muscular rigidity, if present at all, shows no tendency to increase as in cerebrospinal fever; Kernig's sign is not definite, and in the initial stages the pulse is raised in proportion to the temperature.

On lumbar puncture, even in the meningitic form of acute polioencephalitis or poliomyelitis, the cerebrospinal fluid, although under pressure, is clear to the naked eye, but sometimes a fine central coagulum may develop on standing. On cytological examination, some increase in cells may be found during the first two or three days of disease; the cells are mainly lymphocytes, but a few polymorphs may be present. Total protein is slightly raised, while chlorides and glucose are normal. On culture the fluid is sterile.

Cerebral thrombosis.

This condition rarely simulates cerebrospinal fever. Apart from the syphilitic form, which is usually accompanied by monoplegia or hemiplegia, cerebral thrombosis occurs in patients of an age at which cerebrospinal fever is comparatively rare, viz., past middle age. Further, although headache and drowsiness or stupor may be present in cerebral thrombosis, neck

rigidity and Kernig's sign are absent, and not infrequently signs of a focal lesion develop, such as hemiplegia.

Cerebral tumour.

Cerebral tumour is rarely mistaken for cerebrospinal fever. The more or less gradual onset, absence of pyrexia, and often the development of papilloedema, epileptiform attacks and focal signs serve to establish a diagnosis. Further, the cerebrospinal fluid is clear to the naked eye, although the total protein is often increased (most gliomata). If the tumour be a meningioma or astrocytoma, the protein content may be normal. Cells are usually not increased, but in the presence of some gliomata there may be a mild lymphocytosis, while in spongioblastoma a few of the cells may be polymorphs.

Lateral sinus thrombosis.

Lateral sinus thrombosis often gives rise to acute cerebral symptoms. The presence of an ear discharge, rigors, and possible local evidence of mastoiditis, together with absence of any pronounced rigidity of the neck muscles and Kernig's sign will usually serve to differentiate the condition from meningitis.

Generalised tetanus.

Generalised tetanus may sometimes be mistaken for cerebrospinal meningitis and vice versa. Features in common are the spinal and general muscular rigidity; stiffness of the neck and occasional photophobia. In tetanus, however, the mind remains quite clear, and trismus usually develops prior to cervical rigidity; also the muscular stiffness is at first confined to the neck and jaws. Further, the frequent spasms and the history or presence of a wound are significant. Trismus does occur, but indeed rarely in meningitis, while frequent spasms have also been described. In tetanus the cerebrospinal fluid, although sometimes under increased pressure, is quite normal as regards cellular and chemical content.

Infantile convulsions.

As the onset of cerebrospinal fever in young children is often accompanied by a convulsion, care must be taken not to mistake such a seizure for a convulsion due to dietetic or other causes. Conversely, the appearance of such a symptom may give rise to a suspicion of early meningitis, especially if the convulsion is followed by a sharp rise in temperature. Bulging of the anterior fontanelle, present during the seizures, disappears during the intervals; in meningitis the bulging persists, and the more usual signs are also present.

Tetany.

In infants the diagnosis between tetany and acute meningitis may sometimes present difficulty. The anterior fontanelle, however, is not affected in tetany, and neck rigidity is usually absent. In some cases, however, it is necessary to perform lumbar puncture.

Epilepsy.

The convulsive seizure and resulting stupor may occasionally give rise to doubt, especially in children. Cases have even been described in which it was not possible to exclude meningitis without examination of the cerebrospinal fluid. Epileptiform seizures may occur in adults as well as in children during the early stage of cerebrospinal fever; the usual signs of meningitis, however, should serve to distinguish between the two conditions.

Acute mania.

Acute mania is not often mistaken for cerebrospinal fever, but I have known the reverse occur in cases who were extremely delirious. If the fact be borne in mind that an apparently maniacal patient may be suffering from meningitis and appropriate examination be instituted the mistake should not occur.

Delirium tremens.

During a stage of excitement cerebrospinal fever has been mistaken for delirium tremens. Careful physical examination, however, should eliminate meningitis.

Migraine.

A patient seen during the acute crisis of migraine with intense headache and vomiting may arouse the suspicion that the condition is one of early meningitis, and more particularly if it is the variety of migraine with occasional strabismus (migraine ophthalmoplégique). The history of recurrent attacks, absence of mental symptoms, neck rigidity, and Kernig's sign will give the true diagnosis.

Hysteria.

Gowers, in his classical *Manual of Diseases of the Nervous System* (1888), refers to the occurrence of symptoms of meningitis in hysterical individuals during epidemics of cerebrospinal fever; he regarded fear of contracting the disease as the exciting cause, and consequently termed the condition "meningitophobia." It is certainly true that hysteria may occasionally give rise to a suspicion of meningitis, and particularly if it complicates an attack of influenza or tonsillitis. The patient may lie completely apathetic, almost cataleptic, and take no notice of questions or of any attempts at rousing. Response to painful stimuli may be shown by the facial expression, but anaesthesia suggested by the examination may be present, even the corneal reflex being abolished. The case may show apparent neck rigidity, that is, firm resistance to any effort made at bringing the head forwards; similarly, resistance will be offered to extension of the leg on the thigh, giving rise to an apparent Kernig's sign. The difficulties are frequently increased owing to the fact that a history of onset is unobtainable from the patient. Perseverance, however, will usually show that there is no true Kernig's sign and no real neck rigidity. Further, the patient seldom looks ill, and will usually take food fairly readily. I have met with several cases of hysteria simulating meningitis, some of which have complicated influenza; a few of these latter the signs were so suspicious that lumbar puncture had to be performed in order to establish a positive diagnosis.

(3) Miscellaneous Conditions

Other diseases with which, in my experience, cerebrospinal fever has occasionally been confused are the following:—

Gastro-enteritis.

The initial vomiting and prostration of cerebrospinal fever may be mistaken for that of acute gastro-enteritis. Also, in infants convulsions are by no means unknown in disorders of the alimentary tract, and "meningism" is occasionally met with. The anterior fontanelle, however, is depressed in gastro-enteritis, while in cerebrospinal fever, although diarrhoea may occur at the onset, the fontanelle remains bulging and tense. In older children, the rapid development of neck rigidity and Kernig's sign should serve to differentiate the two conditions.

Muscular fibrositis.

When this condition co-exists with pyrexia, the differential diagnosis is the same as that for influenza. Subacute cases of cerebrospinal fever with a gradual onset have at first been mistaken for cases of "muscular rheumatism," but the true diagnosis cannot remain long in doubt, as even if the temperature is normal when first taken, it will probably have risen a few hours later. Kernig's sign may appear to be positive in muscular fibrosis, but if passive extension and flexion at the knee be continued, it will usually prove to be absent, which is not the case in meningitis. Cervical rigidity may also appear to be present, but perseverance will show that such stiffness is often voluntary, the patient being unwilling to relax the muscles owing to the stretching producing pain. Further, in muscular fibrositis affecting the neck, passive movement continued for a short time, brings about considerable reduction in stiffness, while the reverse takes place in meningitis.

Uraemia.

Chronic nephritis with uraemic symptoms may occasionally give rise to a suspicion of meningitis. In uraemia the patient may be admitted comatose; there may also be a history of headache and vomiting. Albuminuria is not infrequent in the early stage of cerebrospinal fever, but epithelial casts are rare. Kernig's sign may be positive in uraemia, but neck rigidity is usually absent. In some cases differential diagnosis may only be possible on lumbar puncture, but as this procedure is quite appropriate for uraemia, doubt need not long be entertained.

Acute osteomyelitis of the spine.

This condition may sometimes be associated with meningitis symptoms. The fact that on lumbar puncture pus may be withdrawn from the extra-dural space, occasionally renders the diagnosis from meningitis very difficult. In spinal osteomyelitis, the first symptom is often acute localised pain in some particular region of the spine in association with pyrexia. Flexion at the neck may be painful, but unless the lesion is situated in the cervical region of the spine, definite rigidity is absent; in some cases signs indicating involvement of the cauda equina may be found. Acute tenderness is usually present over the affected area, and within a day or two swelling may appear.

Diabetes.

The differential diagnosis from diabetic coma may have to be considered, especially as glycosuria occasionally occurs in association with cerebrospinal fever. The differential diagnosis is made by attention to the characteristic signs of meningitis, which are absent in diabetic coma.

(4) Other Forms of Meningitis

Meningitis due to various causative organisms produces symptoms clinically identical with those of cerebrospinal fever, and differential diagnosis is impossible apart from examination of the cerebrospinal fluid. The most important forms of meningitis to be considered are the following:—

Tuberculous meningitis.

This condition in many cases can be diagnosed clinically. In contrast to that of cerebrospinal fever, the onset is gradual and insidious, often lasting over a period of two weeks or longer, and being characterised with gradual failure in health and headache developing slowly in intensity. The meningitis may be secondary to a known tuberculous lesion elsewhere, but such cases would seldom be suspected of meningococcal meningitis. The temperature at first may be only slightly raised, and vomiting is less frequent than in cerebrospinal fever. Photophobia, unequal pupils, and papilloedema are more frequently seen in tuberculous meningitis. On lumbar puncture, whereas the fluid withdrawn in cerebrospinal fever with meningitis is definitely turbid, in tuberculous meningitis it is often clear to the naked eye, or at least only very slightly turbid; also, in the latter disease the cerebrospinal fluid cells are relatively fewer, lymphocytes predominating often up to 90 per cent, and the chlorides are greatly reduced. In all forms of acute meningitis, the chlorides of the cerebrospinal fluid are somewhat diminished from the normal figure of 720 to 750 mgm. per cent; in meningococcal meningitis they seldom, if ever, fall below 650 mgm., while in tuberculous meningitis they are reduced below this level, and may be as low as 500 mgm. per cent. Finally, after long and patient search, tubercle bacilli may often be found in films of the centrifuged deposit (stained by the Ziehl-Neelsen method) of the cerebrospinal fluid of tuberculous meningitis.

Acute lymphocytic meningitis (Chorio-meningitis).

The onset resembles cerebrospinal fever in the headache, nausea, vomiting, and generalised pains, and the presence of neck rigidity and Kernig's sign. Papilloedema, strabismus, and retention of urine may all occur. Final diagnosis is only possible on examination of the cerebrospinal fluid. As a rule the fluid is clear although under increased pressure, but microscopical examination shows an excess of cells, almost exclusively lymphocytes. The total protein is

also considerably increased. The chloride content (normally 720 to 750 mgm. per cent) of the cerebrospinal fluid, however, is very little if at all reduced, a point which serves to distinguish the condition from tuberculous meningitis in which the chlorides are low (500 to 650 mgm. per cent); also, the sugar content is normal.

Pneumococcal meningitis.

This form of meningitis frequently occurs as a primary condition, but is sometimes secondary to a focus of pneumococcal infection elsewhere—the middle ear, the accessory sinuses of the nose, the lungs—or complicates of a pneumococcal septicaemia. It is not nearly so commonly seen secondary to pneumonia as is generally supposed, the number of cases probably being under 2 per cent. In the primary form, a nasal catarrh frequently precedes the onset of meningitis, which, as a rule, is somewhat sudden; in that secondary to disease of the accessory sinuses of the nose and middle ear, the onset may be rather more gradual. On lumbar puncture a distinctly purulent fluid is almost invariably obtained in which lanceolate gram-positive cocci are identified.

Streptococcal meningitis.

Streptococcal meningitis is almost invariably secondary to infection elsewhere, such as purulent infection of the nasal sinuses, otitis media, penetrating wounds of the cranium, etc. Meningitic symptoms occurring during the course of a known pyogenic infection will not usually be considered as possibly due to the meningococcus, but only if the infection is in an obscure situation. Lumbar puncture yields a definitely purulent fluid, in which gram-positive streptococci are easily identified. Occasionally, as in a case reported by the writer, the streptococci are associated with *B. fusiformis*.

Acute syphilitic meningitis.

Acute meningovascular syphilis occurring during the secondary stage of the disease and developing with or soon after the cutaneous eruption may be mistaken for cerebrospinal fever. The condition is comparatively rare, but cases are met with in which, one to three months after the initial syphilitic lesion, the patient develops all the signs of acute meningitis—pyrexia, vomiting, neck rigidity, Kernig's sign and even strabismus. On lumbar puncture the cerebrospinal fluid is usually clear to the naked eye, but microscopical examination shows a well-marked lymphocytosis with occasionally a few polymorphs. Both the blood and cerebrospinal fluid yield a positive Wassermann reaction, and the latter a positive Lange curve usually of paretic type.

Meningitis due to various other organisms.

Of other forms of meningitis, those due to Pfeiffer's bacillus, the anthrax bacillus and bacillus coli communis may also be met with. Meningitis due to Friedländer's bacillus, Gaertner's bacillus and micrococcus flavus also occur. Meningitis from infection by the spirochaete icterohaemorrhagiae, without the symptom of jaundice, has also been reported. Such conditions can only be identified bacteriologically. The occurrence of true gonococcal meningitis is doubtful, especially as the organism is easily confused with the meningococcus.