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A

REVIEW OF CEREBRO-SPINAL FEVER

BASED ON

PERSONAL OBSERVATIONS AND DEDUCTIONS;

along with

APPENDIX OF CASE-SHEETS AND RECORDS.

PREFACE.

In this Review of Cerebro-spinal Fever I have endeavoured throughout to confine myself as much as possible to my own observations, and deductions therefrom, of cases which came directly or indirectly, under my care during twelve months tour of duty as Pathologist and Bacteriologist for the Ripon Military Hospital and Reserve Training Centre.

With the object in view of writing this treatise at a subsequent date in such a form that it might be helpful to my colleagues, particularly in the diagnosis and treatment of cerebro-spinal fever, I took notes of my various cases as they occurred; but it was not until rather too late that I thought it might be even more interesting to include the case sheets of the actual cases, and so I was unable to collect all of these for copying. I would point out at this stage, that in the first place I have entered up the cases in this volume in the order of their occurrence; and secondly that the cases are in no way chosen.

During the twelve months I was performing the above mentioned duty I came in contact with every case of cerebro-spinal fever that was admitted to the Hospital; but it was not until the February, March, and April of 1917, when we had an epidemic of 49 cases, that I was asked to take full control of the cerebro-spinal wards. Up to that time I came in contact with the cases to do lumbar punctures from a diagnostic point of view, and only occasionally from a treatment point of view, although, through the courtesy of the medical officers in charge, I was given the opportunity of making notes with regard to the clinical features etc. presented. It will therefore be interesting to compare the first few cases in my résumé with the latter ones, because it was from these earlier cases that I made deductions which helped me in the diagnosis and treatment of my subsequent cases; and likewise to compare my own earlier cases with my later ones because from the earlier ones I obtained deductions which provided me

with the necessary indications for observing the clinical features and treatment procedure more closely, with the object in view of improving treatment, and with the result, I am pleased to state, that the death rate very rapidly began to come down. During the first quarter of the above mentioned twelve months, we had 9 cases of cerebro-spinal fever admitted of whom 5 died and four recovered; and of these four, only two were free from sequelae, 1 being blind through optic neuritis and irido-choroiditis, and the other deaf and slightly mentally deranged. I regret that I was unable to obtain the case sheets of all of these cases. During the second quarter (the Summer of 1916) we had no cases. During the following quarter we had ten cases, of whom I obtained several case sheets, and of which cases seven resulted in death. During the followigg quarter, the months of February, March, and April, when I had full charge both clinically and bacteriologically, I had 49 cases of which 37 were bacteriologically proved positive cases of cerebro-spinal fever, and of which only five died. Of the five deaths three were cases of fulminant type, and in one case the fatal result came within two hours after admission; another was a recurrent case; and the fifth died as the result of broncho-pneumonia as a complication. Thus it will be seen that the death rate was considerably reduced in the last quarter which markedly improved state of affairs was due to early diagnosis, early lumbar puncture, close observation of clinical features during treatment, and the religious carrying out of the treatment as laid down in my review, all of which facts I feel sure will be borne out by the subsequent detailed accounts of the cases themselves and my records. I would here include a few lines from the annual report of the cerebro-spinal specialist for the area in which I was stationed:-

> "The mortality rate improvement was most evident among the Ripon cases. The mortality here was over 50% during the first 7 months, whereas during the past 5 months it was reduced to 18.7%. I feel sure that the improved figure is due in a great measure to the energy and determination with which Captain Adams, the Pathologist at the Ripon Military Hospital, tackled the cases. Previous to February the treatment was carried out under conditions of divided responsibility, but later when Captain Adams had sole control treatment became more persistent and continuous."

With reference to this report I would mention that the 18.7% of the 5 months mentioned was improved during the abovementioned three months to an 8.2% death rate.

The only two subsequent cases I have had since, and which are written up in this work, were very severe cases and of great interest. Both of these cases recovered.

In conclusion, it is my ardent desire to explain that, although this work shows difference of opinion on many points, I have not written it with the object in view of its being accepted as a direct contradiction of any one of these points of difference, but merely as my close observation in every section of study of the disease, with the object in view of presenting my findings for comparison with those of others in order that we might ultimately perfect the literature at present in our hands, and thus be of material assistance to the medical world as a whole, and through them to all sufferers from this previously considered almost fatal disease.

INTRODUCTION.

Cerebro-spinal Fever, often termed Epidemic Cerebro-spinal Meningitis, or Spotted Fever, (which latter name is fallacious in as much as only a small percentage of cases develop the typical purpuric rash through which it got this name), is an exceedingly acute specific fever characterised pathologically by an inflammation of the cerebro-spinal meninges, and clinically by a sudden invasion of the healthy state with influenza-like symptoms of cerebral type, and variable features of toxic and nervous origin.

ETIOLOGY.

Bacteriological research of recent years has proved beyond doubt that the disease is due to infection by the Diplococcus Intracellularis Meningitidis of Weichselbaum, now commonly known as the Meningococcus. This organism gains access to the base of the brain through the pharynx or nasopharynx, mainly the latter, in a similar manner to the Influenza Bacillus and the Virus of any other Infectious Diseases; and it can almost invariably be found in this site in early cases and in carriers when it cannot be found elsewhere. Infection by way of the mouth through the common use of feeding utensils, kissing, etc., is less likely, since experiments have shown that the saliva has an inhibitory effect on the growth of the diplococcus in Vitro, whereas the nasopharyngeal secretion favours the growth of the organism. The spread from the nasopharynx to the meninges is probably by lymphatic channels.

The disease occurs epidemically, but fortunately with very considerable limitation. From evidence obtained by recent workers it also appears to be endemic in certain localities, numerous small outbreaks of late having been traced to certain common sources of locality ; but it is much more likely that these apparently endemic outbreaks are really of an epidemic nature, and no conclusive evidence has yet been produced to prove that any country or part thereof is likely to vary the

incidence of the disease; and outbreaks amongst soldiers in camp have generally been proved to have been introduced by a specific case, the resulting outbreak being of limited epidemic form. Sporadic cases have also been recorded, but it is most likely that these cases have been nothing more than individual migratory carriers who have ultimately developed the disease, or those who have become infected by a carrier.

Infection takes place through contact with a positive case, with a carrier, or to a lesser degree with infected clothing or habitat. It is now recognised that the most common source of infection is the proved case, although this is not so dangerous to the community at large as the carrier; here the mode of infection is through the spray from the pharynx in coughing, from the nasopharynx in sneezing; and through the channel of the mouth in coughing, in explosive conversation, in kissing and in common use of feeding utensils. It is a common occurrence for a medical man, nurse or attendant to become infected whilst in attendance on their cases, and repeatedly such persons have given positive results by post-nasal swabbing, and this perhaps intermittently. A considerable amount of work has been done to prove this means of direct infection and cases have been repeatedly traced to known positive cases, a few of which I have recorded in my appendix. Experimentally, by breathing gently on to plates containing suitable cultivating medium, we have not been very successful in producing a growth of the Meningococcus; but with explosive expirations under similar conditions positive results have been presented; by sneezing even more marked results have been obtained, and by coughing likewise. The organisms obtained by these cultures have been thoroughly tested bacteriologically, serologically, and in a few cases by inoculation of the monkey, with results conclusively showing the presence of the Meningococcus.

The most dangerous source of infection however is the carrier, who neither knows that he is harbouring the meningococcus in his nasopharynx nor shows any means of indicating this to others with whom he might be brought into contact. It has been repeatedly shown that the organism lies dormant in the nasopharynx of very many healthy persons, and can be transmitted through them to others who might later develop the disease. In one instance, under my own observation, a batch of 60 men were examined in an area from which no case of Cerebro-spinal Fever had ever been reported, and 7 carriers were found.

A young recruit had become a contact and subsequently developed the disease, and, no evidence being obtained of any case in the District from which he had come, the only traceable source of infection was his contact with one or more of these carriers. Numerous workers have likewise had similar results, some even more marked. In a Bradford Hospital recently a case of Fever was reported, and,although all contacts appeared to have been swabbed (post-nasally) with negative results,no carrier could be located; at a later date another case appeared in the hospital, and still no source could be located; and when, on a third case appearing, the contacts were again swabbed, it was found that a sister, who had been nursing throughout and had been a contact with all three cases, but had missed the previous two nasal swabbings owing to her being on night duty, proved to be a positive carrier; after her removal to isolation no further case was reported there. The conclusion can quite reasonably be drawn, therefore, that the direct source of infection is not necessarily to be sought in the definite case, but in the unmarked carrier. Furthermore it has been found that the Diplococcus can, and will often, remain for weeks and even months in the nasopharynx of one who has not had the disease,without causing any sign or sympton, and in one case which came under my notice, a sister who proved positive on postnasal swabbing after nursing a case remained so for seven months, although she was treated by nasopharyngeal antiseptic sprays and open air life.

Infected clothing, rooms inhabited by infected persons, bedding etc. are not such a serious source of infection as the previous two, particularly since the diplococcus has a very low resistance and is not viable for any length of time away from normal body tissue or in the cold. Nevertheless this source of infection cannot be overlooked since one or two cases are on record where plates of suitable media have been exposed in living rooms occupied by carriers and have given positive cultures; yet no definite results have been obtained from such rooms after being vacated by such infective cases.

Although the above are the main factors in the incidence of Cerebro-spinal Fever, there is no doubt that secondary predisposing factors play an important part in the Etiology of the Disease:-

The most important condition acting as a predisposing feature, in my opinion, is any morbid condition of the nose or nasopharynx. It has been conclusively shown that the nasal mucous encourages the growth of

the Meningococcus; therefore any condition which increases the production of nasal mucous and at the same time lowers the vitality of the part is a most important feature in the causation of the disease; and I feel sure this fact will, as investigation proceeds, prove to be of very great importance. Such conditions as nasal catarrh, hypertrophied turbinates, deflected septa, polypi and adenoids encourage the growth of the Meningococcus in the above manner.

Seasonal incidence has possibly an indirect bearing, the greater proportion of cases occurring during the Winter and very early spring months, fewer during the Autumn, and exceptionally few during the Summer months. About 7% of my cases occurred during the Autumn, the balance after Christmas, my three worst months being the bleak and wet period of February, March and April. However the most likely cause of this increased incidence was the fact that the weather caused the men to crowd indoors and then to indulge in conditions of poor ventilation and overcrowding.

Overcrowding and bad ventilation doubtless will favour the spread of this condition just as in the case of any infectious disease, as also will filthy quarters; overcrowding inasmuch as the persons concerned are brought into closer contact; bad ventilation firstly inasmuch as the atmosphere is warmed and more favourable to the viability of the Meningococcus, and secondly in that there is not such a free interchange of oxygen to keep the respiratory passages and nasopharynx in a healthy condition. Filthy quarters, through their dirt, have not directly shown infectivity, but certainly more cases appear to occur under these conditions, possibly this being a mere coincidence; but the condition of a room is often a direct indication of the carelessness and neglect with which the occupant, or occupants, cares for his own bodily welfare and hygiene, carelessness in which respect predisposes to any disease.

Fatigue, reduced constitution, and age all play a minor part in etiology, all of which, however, possibly do have some influence on predisposition towards the disease, particularly recent illness with its associated reduction in general health. As far as age is concerned, in the past Cerebro-spinal Fever was looked upon as a disease of children and young adults, but this is possibly due to the fact that these classes are more prone to close intermixing than adults; however the numerous cases of recent date, particularly those amongst the

troops, have shown that all ages are liable to infection, although the majority have been between the ages of 18 and 25 years. It is very rare for elderly people to suffer.

INCUBATION PERIOD.

As far as present facts can prove the incubation period appears to be short, between 3 and 5 days, although numerous cases have been recorded of 10 days up to 3 weeks, or even more. However it is quite within the bounds of possibility that some of these latter cases have been those of re-infection, or those who have been acting as carriers for a certain period, only commencing the actual attack through antoinfection by some modification in the virulence of the Meningococcus through subcultivation in a nasopharynx which is so exceptionally adapted through the nature of its secretion for the growth of these organisms. I make this suggestion inasmuch as it can be readily demonstrated that the virulence of any organism can be intensified by repeated subcultivation and particularly so through the medium of the lower animals or human beings.

BACTERIOLOGY.

As before stated, it is now conclusively accepted that the diplococcus Intracellularis Meningitidis of Weichselbaum, commonly known as the Meningococcus, is the actual cause of the disease. Certain workers of recent date have suggested that the Meningococcus is merely a form of pleomorphic organism, or perhaps a late non-infective pleormorphic involution phase of a microbe which has been a filter-passer, growths having been obtained from cerebro-spinal fluid and urine during cerebro-spinal fever, some Gram positive, some Gram negative, others of coccal, and yet others of diptheroid type. These occurrences have in all probability been due to difficulties of a technical nature. One worker reports that in two cases he obtained cultures from the Berkfeld filtrates of cerebro-spinal fluids, of beaded Gram negative bacilli breaking down into coccal-like granules; however on closer investigation of these cases by others, nothing of a definite or

supporting nature could be obtained, and at the autopsies one case proved to be a Pneumococcal Meningitis, and the other a genuine case of cerebro-spinal fever from which cultures of the Meningococcus were subsequently obtained.

The Meningococcus is a gram negative diplococcus, staining readily with ordinary simple laboratory dyes, showing slight variation in size, different strains appearing to vary somewhat in this respect; and at times presenting involution forms. In its appearance and staining reactions it is not unlike the gonococcus, but under high magnification in a well stained slide it shows the opposing side of each diplococcal section flattened, whilst in the gonococcus they are concave. In the cerebro-spinal fluid it is generally found to be intracellular, hence its name, although it does occur, but with very much less frequency, extracellularly. After the examination of a large number of fluids I have been struck with the regularity with which it does occur intracellularly and the rarity with which it occurs extracellularly, and I have noticed in one or two cases that more extracellular organisms occur in a very acute fulminating type, possibly through rapid destruction and disintegration of the polymorphoneuclear cells, thus liberating the previously intracellular organisms, some of course to be immediately taken up by other cells but still a few isolated meningococci being left free in the serum; I have not seen any case present a very large number of extracellular diplococci.

The Meningococcus can be readily cultivated outside the body on suitable media under careful conditions, but it will not stand the exposure of most organisms in vitro, and it cannot be cultivated on the simple everyday laboratory media. In the first place infected nasopharyngeal swabs or cerebro-spinal fluid must be carefully dealt with. In the case of a swab it should be plated at the bedside and the resulting plate conveyed to the laboratory in a heated carrier; in the case of the spinal fluid it should be run into a sterile tube or small flask and conveyed to the laboratory in a similar heated carrier, the heat in both instances being about 37°C. In the absence of standard carriers, an ordinary small leather gladstone bag or suchlike receptacle with a rubber hot-water bottle in the bottom, will serve admirably. It has been found that exposure of either swabs or cerebro-spinal fluid to normal atmospheric temperatures will very frequently kill the Diplococcus, so that it cannot be cultivated and all chance of diagnosis might be lost; by carelessness in this respect in transit I have seen one or

two fluids, showing numerous meningococci in direct smear on arrival at the laboratory, which would not culture on the most suitable of media.

The most satisfactory medium is agar containing human blood or blood serum, and this can readily be obtained for isolated cases by withdrawing a little blood from the finger under absolutely aseptic conditions and mixing it with a tube of agar cooled down to about 45° or 50° C. and then immediately pouring into Petri dish. However, for general work, when a large quantity of medium is required, a substance consisting of legumin or peaflour agar (commonly called trypagar) to which has been added haemoglobin, in the form of sterile defibrinated rabbits blood or defibrinated bullocks blood, is found to be most serviceable and gives the most satisfactory results. Such a medium as "Nasgar" (nutrose-ascitic-agar) can be used just as for the gonococcus, but it is not so satisfactory since some strains fail to grow on it, and those that do grow will not retain their viability for more than about 48 hours. Serum Media; ascitic, pleural, or hydrocele fluid-agar; cerebro-spinal fluid (that which is under examination) and liquid agar mixed at 45° C. and plated, are all useful media.

A very handy medium, and one which is quite efficient for occasional work, and obtainable in every bacteriological laboratory is agar or trypagar smeared with a drop of human blood; and such a medium has many followers even in the routine work of cerebro-spinal fever, and in preference to all other media.

Sterile nasal mucous has been used, and with a variable amount of success, as a means of cultivation, smeared over agar or trypagar plates, or in conjunction with one of the above-mentioned media. Experiments have shown that sterilised nasal mucous if used in conjunction with a suitable medium gives a more prolific growth than without its addition.

Occasionally, even with the most efficient medium, it is difficult to get a growth from the cerebro-spinal fluid, but in many such instances it has been found that by incubating the fluid overnight, or for about 48 hours, and then subculturing a growth can often be obtained. However failure to obtain a culture in what appears to be a definite case and which serologically agglutinates standard cultures, will occasionally fall to the lot of the most careful worker under the most favourable conditions.

After the initial (parent) culture has been obtained, the Meningococcus will be found to subcul- very readily on any of the above media; but it will also grow readily now on trypagar without blood; however to keep the strain going frequent subcultures must be made, particularly where surface growths are being used, at about every 48th hour; although in serum-trypsin-broth or starch-agar-broth it is held that cultures can be kept alive for a period up to 3 or 4 weeks.

The colonies on the above media are whitish with a very faint yellowish tinge, of "painty" consistence, and easily emulsified. Growth takes place at body temperature and only very seldom is there any growth at 23° C.

The Meningococcus ferments glucose and maltose with the production of acidity, but it does not ferment sacchrose; the reaction with mannite is uncertain, but as a general rule in 3 or 4 days there is acidity, becoming alkaline two or three days later.

It is readily killed by heat at 60° C., by weak antiseptics, by moderate degrees of cold, and in fact as before stated it is often impossible to keep it alive at atmospheric temperature much below body heat.

It is readily obtained from the meningeal exudate in the cerebro-spinal fluid withdrawn by lumbar puncture (see later), from the nasopharynx by postnasal swabbing; and also in a very few instances from the blood by culture. It has not been conclusively cultivated from any other situation.

Up to the present four types of Meningococci have been isolated, all showing similar cultural features, perhaps varying a little in size but to no definite degree, but all reacting differently to standard agglutinating sera. Types I and III are most prevalent and almost evenly distributed; type II occurrs to a much less degree, and type IV is comparatively rare.

Experimental inoculations of animals has not been done with any marked degree of satisfaction, Since ordinary laboratory animals are not apparently susceptible; but Flexner, Stuart McDonald and others have recorded cases where the meningeal lesions have been produced in monkeys by injection of the organisms or infective cerebro-spinal fluid, into the spinal canal.

ALLIED ORGANISMS.

There are several diplococci which tend to cause confusion with the Meningococcus, particularly in nasopharyngeal swab cultures, and one who is going to do cerebro-spinal work must firstly make himself conversant with them. Briefly their morphology is as follows:-

a. The Micrococcus Pharyngis Siccus grows very freely as white colonies, which are very adherent to the medium and are not easily emulsified. It grows freely at 23° C. and rapidly ferments glucose and sacchrose.

b. The Micrococcus Flavus I grows freely as yellow colonies which slide about on the medium, and which can be readily picked up with a needle. It does not emulsify readily, grows freely at 23° C., and ferments glucose and sacchrose.

c. The Micrococcus Flavus II. - a rare organism grows as yellow colonies of stıcky consistence. It grows feebly at 23° C. in 48 hours and ferments glucose, and sacchrose in 3 or 4 days.

d. The Micrococcus Flavus III - is not common. It grows as canary yellow colonies of the consistence of paint, and like the meningococcus in some respects. It grows at 23° C., and ferments glucose in 4 days but not sacchrose.

e. Micrococcus Catarrhalis is only occasionally met with, grows as white colonies like paint, and is easily emulsified. It gives a feeble growth at 23° C. and no sugars are fermented.

MORBID ANATOMY.

The Meningococcus tends to irritate the nasal mucosa and to produce, or aggravate, a congestive catarrhal condition of the nasal cavities and nasopharynx; and this catarrhal condition in turn still further favours the growth of the organism. This possibly explains the cause of some cases of prolonged incubation period. Here, on gaining access to a healthy nose, the organism may lie dormant, as it has been conclusively shown that the Meningococcus can do for an indefinite period;

but at some later date it is prone to produce, or help to produce, with other organisms, an inflammatory state which then accentuates the activity of the organism for growth and increased virulence, and there is ultimately an antoinfection causing Meningitis. Once the organism has gained access to the nose or nasopharynx it lodges in the mucosa and eventually probably passes into the lymphatics, and along them to the mininges of the brain and spinal cord and to the peripheral nerves.

The Pia and arachnoid membranes are the chief seat of pathological changes, an acute lepto-meningitis being produced. In the rapidly fatal fulminating cases there may be nothing more than an intense congestion of the meninges with a certain degree of oedema; however in the less fulminating acute cases there is a definite exudation varying from serous to purulent type, which exudation is very often wide spread over the surface of the brain, in the fissures, and along the blood vessels. In less advanced cases the exudate is seen more particularly at the base of the brain, extending over the cerebellar and cerebral hemispheres to a variable extent, and along the cord, more markedly on the posterior surface than the anterior, and particularly well seen in the lumbar region. The ventricles of the brain contain the same type of serous, lymph, or purulent exudate; and occasionally where flakes of lymph are present the aqueduct of sylvius or foramen majendie becomes blocked, with the result that acute distension of the ventricle is caused. There are small patechial haemorrhagic areas on the cerebral and spinal cortex. In the more chronic cases, and following some of the acute cases, the membranes are found to be thickened and numerous adhesions present, which adhesions are the cause of a certain percentage of the cases ending in Hydrocephalus, which condition is directly caused by obstruction of the foramen majendie producing an interruption in the circulation of the cerebro-spinal fluid between the ventricles and the cisterna magna, Similar changes are found in the pia mater and arachnoid of the cord as are found in the brain. At times the inflammation may spread along the cranial and spinal nerves, particularly in those cases where treatment has been withheld or has not been stringent enough, and marked pressure has been sustained in the theca, but in certain of these cases it is doubtless due to inflammatory involvement of the nerves just after leaving the brain, with resulting neuritic changes and all the sequences associated with this complication.

Furthermore a purulent irido-choroiditis might be found, or suppuration in the labyrinth of the middle ear through spread along the cranial nerves. Bacteriological examination of the exudate in all of the above sites, and in the cerebro-spinal fluid of the spine, brain, and ventricles will show the meningococcus in direct smear, and, providing death has not been too long before the autopsy, it will culture with typical features.

Other pathological changes throughout the organs and muscles are those of toxaemia, not unlike those associated with other fevers, such as congestion of the lungs, liver, spleen and kidneys; and granular degeneration of muscle fibre; and, just as with severe pyogenic infection, in the fulminating cases we may have a septicaemic state producing pus in the closed cavities such as the pericardium, pleura or joints.

CLINICAL FEATURES.

In order to facilitate the diagnosis, cases can with advantage be grouped under the following clinical headings:-

(a) Mild acute
(b) Severe acute
(c) Fulminating
(d) Chronic

(a) The mild cases are those which are very liable to be missed, particularly in isolated outbreaks; but by close observation one finds certain features to be fairly constant. The patient, very often a healthy robust individual, suddenly develops malaise and complains of a headache, which at first is nearly always temporal or tempero-frontal but tends to be directed towards the occipital region if anything, and perhaps centralises itself in the occipital region as the disease advances. Generally there is occasional vomiting of which one can nearly always on close enquiry obtain a history of having occurred on one or more occasions. The temperature shows a rise, but this is very frequently a comparatively slight rise for the severity of the disease, perhaps 101° or so; but what pyrexia there is generally shows an irregularly remittant type of continued fever with sudden rises, presenting a

"spiky" chart. In nearly all cases there is a noticeable mental dulness, perhaps in a previously cheery individual, a feature of great importance. Sometimes there is a slightly sore throat, often influenza-like pains, aching or stiffness in the limbs, which latter feature is most likely associated with irritation of the spinal nerves in the lumbar region and is more particularly seen in the more serious cases. Further there is generally a disinclination of the patient to expose the eyes to a bright light. The symptomatology above outlined, is largely nothing more nor less than what might be presented to us in a case of Influenza, some cases being so particularly like influenza that it is advisable always to keep in mind the possibility of cerebro-spinal fever and carefully look for further signs of such being present.

At this stage I would express the opinion that I have not the least doubt that many of these mild cerebro-spinal cases are passed over as Influenza, and perhaps eventually recover through a naturally produced immunity very likely coupled with the fact that the infection is due to an organism of low virulence. However this is the stage for which we should always look very closely, as it is that in which the chances of recovery with early diagnosis are about 100%.

Now on close examination of such a case, there will be found opposition from the patient on lifting his head from the pillow, through a voluntary stiffening of the muscels of the neck to support a tender part, and thus there is evidenced a varying degree of rigidity in the neck. There might be pain in the neck, but in most of these mild cases there has not been any pain complained of; yet on deep pressure over the upper cervical region there is nearly always a varying degree of tenderness. In a few cases there is slight strabismus which is generally internal, but this feature is more fequently present in the more severe types. Very often there is an outbreak of herpes, particularly on the face, but in some cases on the trunk, in fact occasionally along the course of any cranial or spinal nerves. Negatively, in the mild acute cases, there is generally no definite head retraction, no delirium, no rigidity of the trunk, and no rash. One is now encouraged to examine the lower extremities for the presence of the Kernig sign, in one or in both legs, and in no subsequently proved case brought under my notice was this entirely absent. Generally the knee jerk is diminished, although in a few cases I have seen it slightly exaggerated, and

in a few mild cases it might even be absent. With regard to the knee jerk, most literature is inclined to place this reaction as generally being one of exaggeration, but I am inclined to feel that it is the reverse and on questioning other workers I have been informed that the dimished knee jerk is much more frequent than the exaggerated one.

Therefore, to summarise, having found the above features such as headache (irrespective of site) occasional vomiting, mental dulness, variable pyrexia, tenderness in the nape of the neck with perhaps a variable degree of rigidity in the neck, to be present, coupled with a suspicious Kernig sign, a lumbar puncture should be immediately done under a general anaesthetic (for purposes see treatment), when the diagnosis is readily cleared up in a positive case, and should it be negative no harm is done to the patient and most likely several worried minds are set at rest.

(b) If the mild case is neglected there is always the risk of its developing into the more severe type, and this, I am afraid, is only too frequent. In the severe acute case of cerebro-spinal fever we have many or all of the above features of increasing severity, with others superadded; and a picture something like the following is presented:- The headache is generalised, extremely distressing, and with its point of maximum intensity over the occipital region; and patients will often remark that they feel that their skulls will burst. The temperature is increased, and the chart is of continued fever type, or irregularly remittant or intermittent, and with perhaps a rise from 101° to 104° at the outside. The pulse is very often slower than normal rate, perhaps through increased intracranial pressure, although at times of increased rate, being thus a variable factor. Vomiting may be absent, but at times it is a very troublesome feature, although it is not a very constant sign at this stage. Pain and rigidity, in the nape of the neck and extending down the spine, are now becoming more prominent manifestations, and pain is generally present in the lumbar region particularly on pressure. There is a varying degree of retraction of the head, even to the degree of complete opisthotonous. Occasionally there is strabismus, ptosis, inequality of the pupils through involvement of the cranial nerves; and very often there is evidence of irritation of spinal nerves, shown by muscular twitchings, neuralgic pains, or even paresis of groups of muscles. There is marked

mental dulness verging on partial unconsciousness from which it is often difficult to arouse the patient. There may be violent and rowdy delirium, in some cases of which I have seen several men required to hold the patient down on admission to hospital. There is usually a very well marked photophobia. Very frequently there is incontinence of urine and faeces. Herpes is very commonly present, and at times very widespread over the face, and sometimes on the body; this often is a troublesome feature and sometimes appears during the first few days of the disease; in one or two cases which came under treatment there was a typical herpes zoster. These cases usually present diminished or absent knee jerks, although occasionally they may be exaggerated and tend to confuse one, and thus reliance cannot be placed on this sign. Occasionally also there may be a Babinski present. There is always a very well defined Kernig which is generally present in both legs unless paralytic features exist at the same time. Very frequently we have a well defined rash presented in these severe cases, purpuric in type usually, although urticarial and erythematous rashes have also been recorded; the purpuric rash is usually well marked over the lower extremities and the body wall and to a lesser extent on the upper extremities, although it might extend to the face and even conjunctivae in the form of conjunctival haemorrhages. Such a case as the above outlined, if in anything like its entirety, is very readily diagnosed clinically as a case of Meningitis, and having no history or signs of pneumonia, sepsis, or tubercle, as a probable case of Cerebro-spinal Fever. However we can never expect any one case to have the complete set of clinical features laid out as above, so providing we can find sufficient to make us suspicious we should waste no time before Lumbar puncturing when the diagnosis will be clinched and treatment can be proceeded with.

(c) The third type of clinical picture presents an entirely different aspect, having been either a case that has so very rapidly passed from the early acute stage to the fulminating, or has taken the form of an ambulatory type in the early stage (not unlike typhoid fever occasionally does) and through neglect in seeking advice has suddenly became fulminating. Here we have the patient passing very rapidly through the previous stages, when I have not the least doubt he presented transitory features like many of those related above, but on being attended he is comatose, suffers from Cheyne-Stokes respiration and cardiac embarrassment, is delirius, in a state of low muttering delirium, with a complexion varying from flushed to moribund, and very often with nobody

accessible from whom anything like a history can be obtained and no time at one's disposal to permit of investigation. We are now compelled to quickly review the other causes of of coma, and having eliminated many we can be helped in coming to a conclusion by such signs as marked rigidity of the neck or at times of the whole body, the pupils contracted or unequal and reaching sluggishly to light, incontinence of urine and faeces, absence of knee jerks, presence of a positive Kernig sign, but often this is not nearly so well marked as in the other acute forms; most likely a well marked purpuric rash all over the body and limbs and even of the conjunctivae; and perhaps convulsive seizures. By watching the patient, particularly if he is not absolutely unconscious, he will be seen to hide his eyes from the light, to grasp the back of his head with his hands from time to time indicating severe pain in this region, or he will perform some such other movement which will be helpful in spotting features hidden by a partial unconsciousness. Having once got sufficient evidence that he might be a case of cerebro-spinal meningitis lumbar puncture should again be performed when the fluid obtained will perhaps give decisive results.

(d) The chronic type of clinical case is that which is ushered in with an acute attack of variable severity but is comparatively readily got under control by treatment, or that which has passed through a mild acute stage undiagnosed, but recovery from which is exceptionally slow. The patient here lingers on in a dull mental condition, with slight exacerbations from time to time of various features such as headache, helplessness, incontinence of urine or faeces, or both, progressive emaciation, persistent kernig, occasional erratic rises of temperature, mild wandering delirium at times, from which he can be aroused easily. Lack of concentration when in conversation, occasionally strabismus or perhaps ptosis or both, sometimes deafness, failing sight, trigeminal or other neuralgic features through irritation of cranial or spinal nerves, paresis of one or more groupes of muscles, may all show themselves, and one case under my observation even showed paraplegic features. This type of case is one of the most difficult to deal with but one should never despair in its treatment because recovery can take place; and one case (the one mentioned above with paraplegic features) I had, recovered after 7 months, over four months of which were spent on a water bed.

REVIEW OF CLINICAL FEATURES.

Headache is consistently present in every case. It is, when typical, localised or has its maximum intensity in the occipital region, but very frequently it is described by the patient as being temporal, or frontal, or generalised. It is one of the most distressing features from the point of view of symptomatology, very frequently causing the patient to throw himself about violently, to scream out, or to wear an agonising expression and to grasp his head with both hands. A patient will often complain that his skull feels that unless something is done it will absolutely burst. This symptom is due to increased intracranial pressure through congestion of the meninges and cortex, but more particularly through the ever increasing exudation of lymph with overdistension of the cisternae and ventricles of the brain and the theca of the cord, causing pressure on the brain substance itself both from within and from without. The headache of a very acute case of cerebro-spinal fever is one of the most distressing that could be suffered, because unlike that of tumors or of slowly increasing pressure it is of sudden production. It is always relieved by, and sometimes disappears after, lumbar puncture, and it is an important indication for further decompressions by lumbar puncture (see treatment).

Malaise is a feature so constantly present in all acute conditions that it has no definitely specific bearing on this condition, although its sudden development in a person not in the habit of complaining, and particularly its being associated with a headache, at least should indicate that we are dealing with a much more serious condition than a simple idiopathic headache, and thus cause us to investigate the case more closely. In watching cases of cerebro-spinal fever one can almost follow this same malaise passing on into a stage of helplessness. It is possibly of cerebral origin, partly due to the local lesion, and partly due to the effect of a toxaemia on the centres in the brain.

Mental dulness is a most important factor. It will be found to be present, almost without variation, and often to an extreme degree. The patient looks miserable, cannot be encouraged to take any interest in anything, and has no desire to be worried. He is quite conscious but on being asked questions, although he does not interest himself in what is being said, he is slow in answering, does not readily grasp the questions put to him, and

cannot remember even the early stages of his own condition sufficiently to express himself. All of these features of dulness may be present in the more severe cases, but there are always some of them present. In other words the patient is drowsy in appearance and mind although he is far removed from actual sleep, and cannot bear to be worried by those around him... This feature in all probability is due to intracranial pressure and its effect on the frontal lobes.

Temperature is a very variable feature and beyond the fact that it is always raised, and irregularly remittent or intermittent whilst of a somewhat continued type, nothing of a definite nature can be expressed about it. However one must not look for a temperature of 103° or 104° in all cases; my opinion is that, generally speaking, the temperature is remarkably low for the severity of the disease, and a large percentage of the cases show such temperatures as 100°, 101° or such. The temperature in a simple straightforward case shows a sudden rise, and often a sudden fall after lumbar puncture, and in the mildest cases not a rise again. In the slightly more severe cases there is a second and perhaps a third or even further rise of a remittent form according to the persistence of lumbar punctures; however in cases where lumbar puncture is not done repeatedly the temperature is not so regularly remittent but becomes very irregularly remittent.

In other cases we find that the temperature, say after the first lumbar puncture, drops and remains down for two or more days and then perhaps rises again with the same suddenness as before, showing an intermittent chart, which is made somewhat more regularly intermittent by puncturing, but which will become very irregularly intermittent if such treatment is neglected. These irregular sudden rises and falls give the temperature chart a very "spiky" appearance. A fact that I have been impressed with is that the temperature is so much influenced by lumbar puncture that after one or two punctures one might have a normal chart, but in certain instances must be prepared to see it rise again in a few days after the punctures cease. In other words it appears that the pyrexia is largely due to the increased intracranial pressure, and that by under-treatment with punctures and serum in the early stages we are more prone to recrudescence of features including a rise in temperature. Therefore although the temperature chart of every patient varies, if closely observed it will prove to be an exceedingly useful indication for treatment.

Rigors, although at times present, are not constant features. In children, as with most fevers, cerebro-spinal fever is usually ushered in by a rigor; and in adults we find that it also often is; but the severity of the rigor is no indication of the severity of the disease, as some of the mildest cases have very marked rigors, whilst in some of the most severe a history of such cannot be obtained. They are occasionally repeated throughout the course of the disease, and in some cases frequently so.

Stiffness of a varying degree in the muscles of the back of the neck is a fairly constant feature, and it may extend to the muscles of the back, and occasionally to the limbs, which may be the site of tonic spasm. This stiffness in the neck and back is merely natures method of supporting a tender part. In the very earliest stages, or in mild cases, it may be very indefinite, but it can generally be elicited by asking the patient to turn his head sharply from side to side, or to roll over in his bed. However as the disease advances it becomes marked, and may pass into a state of complete rigidity of the neck and back, or still further by excessive contraction of the deep muscles of the neck, dorsal and lumbar regions, into an attitude of opisthotonos of varying degree. When rigidity is present it is readily tested by raising the patients head from the pillow, upon doing which he will be seen to lift his shoulders and body to sustain undisturbed a rigidity of the whole spine.

Pains are very variable in intensity and distribution. With the exception of the mildest cases, pain in the nape of the neck and in the lumbar spinal region is a fairly constant feature, and it might extend throughout the whole length of the spine. The cervical and lumbar regions are singled out for this feature more than the other regions inasmuch as pathologically these appear to be the selective sites for the disease to settle in, and thus we nearly always find a greater amount of exudate here, more changes in the substance of the cord, and greater nerve involvement along with its consequent features. This selection of site, or perhaps apparent selection, is more likely due to the fact that these two regions are the least supported of the whole spine and thus more subjected to movement, irritation, and thus to earlier and greater dissemination of infection. Pains frequently extend

into the muscles of the extremities, due to the inflammatory process involving the nerves as they leave the cord, or the nerve roots; and in fact cutaneous hyperasthesia may likewise be a result.

Tenderness is a fairly constant feature in the cervical and lumbar spinal regions, and it varies from that produced by deep pressure only, to tenderness of such severity that the patient will call out or shrink from one as an attempt is made to elicit the feature. It is localised more particularly in the cervical and lumbar regions owing to the fact that these two regions are more particularly involved. It is also due to the sensory and sympathetic hypersensativeness of the neighbouring parts. The same tenderness may extend throughout the whole length of the spine.

Vomiting, in the early stages of the disease is confined to that of occasional occurrence, one or twice at the outside, and is a feature which should always be enquired for, as such occasional vomiting is a fairly sonsistent feature in the early stage; and on close and repeated enquiries it can generally be elicited. Too many authorities are rather apt to discount this early vomiting as of no great importance and more as a coincidence, since the intracranial pressure at such a stage is not sufficient to precipitate cerebral vomiting; but my observations have convinced me that it is one of the most important features in helping to make a diagnosis; that it is one of the most regularly presented signs; and that it can be accounted for by the sudden variation of intracranial pressure due to such a virulent infection and to such a rapidly developing acute inflammation. A very interesting fact is that it is not a feature which as a rule persists throughout the cause of a mild, or even a large percentage of the severe cases; and this I think can be explained by the fact that the brain recovers somewhat from its first acute shock, and providing the lumbar puncture is done before extreme pressure is produced the vomiting may not recur. However one does come across cases, even in the course of treatment, in which vomiting is a recurrent, persistent, and troublesome factor; here I think it is due to an excessively rapid exudation, because there is, in most of such cases, relief by repeated lumbar punctures and adequate decompression. In some of the advanced or fulminating cases it is present to a very distressing degree, and is not relieved by decompression very often, possibly due to the fact

that in these cases the pressure is in great part due to organising lymph or purulent exudate which has gathered about the base of the brain and cannot be drained away; this latter state of affairs often heralds the death of the patient.

Photophobia is always fairly constantly present, but not necessarily to a marked degree. In the milder cases the patient, even if he does not complain of the brightness of the light, will not overexpose his eyes to the bright light; but in the more serious cases he will often bury his head in the bedclothes until the room is thrown into darkness.

RASH - Various rashes have been recorded including those of urticarial, erythematous, or purpuric type. However I am of the opinion that the only rash which is pathognomonic of cerebro-spinal fever is the latter purpuric type. It occurs only in a certain percentage of cases, far and away below 50%; and the severity of the rash is no direct indication of the severity of the disease, although it is more frequently present in the severe cases than in the mild; nevertheless I have seen a very well marked rash in a very mild case. The rash consists of purpuric spots, not raised above the skin surface, not disappearing on pressure, and like small haemorrhages into the cutis; the individual spots being reddish-purple in colour, and varying in size from minute specs to quite large areas through numerous spots becoming confluent. The distribution is most marked over the lower abdomen buttocks and thighs, to a lesser degree over the legs, upper abdomen, chest and arms, and occasionally on the face; while at times in a severe crop, the conjunctivae may also be the site of small haemorrhagic areas possibly of the same nature.

Herpes is of very common occurrence and develops early in the disease. Like that of pneumonia etc. it is generally facial, but appears to be more extensive and occasionally will cover large areas of the face, generally starting around the nose and mouth, but not necessarily so. Apparently any of the spinal nerves may be picked out and a herpes zoster type develops, of which I have seen only two true cases, one in the cervical region and the other in the intercostal region.

Sore throat is complained of in a few cases, and can be found to be present on

inquiry in many cases, but examination does not show much in the fauces, although there will frequently be found a certain degree of catarrhal pharyngitis. I cannot say that I have been able to place much reliance on this feature, but with close investigation it might be found to be of greater importance than we imagine, particularly since the nasopharynx is so closely associated with the etiology of the disease.

Pulse rate gives us no direct help in diagnosis; in some cases it will be found to be accelerated whilst in others it is slowed. In many of the charts of cases of uncomplicated cerebro-spinal fever I have noticed that the pulse has been a little slower than normal, and that the rate has risen as the temperature has fallen, so that in certain cases when taken in conjunction with the temperature it might with a little further investigation prove to be of assistance particularly in prognosis and treatment.

REFLEXES - Those associated with complications through nerve involvement in severe or advanced cases are more in the form of sequelae. We notice however a variability in such reflexes as the knee jerk, Babniski's extensor toe response, Kernig's sign, and to a lesser degree ankle clonus. The knee jerk is generally diminished or absent, but this is by no means stable, for one might have consecutive cases presenting exaggerated or unchanged knee jerks; but I am convinced that the diminished or absent knee jerk is more common than is usually thought to be the case. Babinski's sign is occasionally present, but is of no importance from a diagnostic point of view and is by no means of regular occurrence, although with prognosis it might have a very important bearing. Ankle clonus is occasionally seen. The most important reflex is Kernig's sign, which is evidenced by the inability to extend the leg when the thigh is flexed on the abdomen, and it is most likely referable to irritation of spinal nerve roots in the lumbar enlargement. If examination is carried out with care this sign will rarely be found to be entirely absent (for details see diagnosis).

Nerve involvement is often seen by the presence peripheral neuralgia or neuritis of varying degree, pains in the ears, tinnitus, deafness, optic neuritis, ptosis, strabismus, or contraction, dilatation, or inequality of the pupils. Any of the cranial or spinal nerves may become involved by direct spread of the inflammatory pro-

cess to the nerve as it leaves the brain or cord, or to the nerve roots, in the cord particularly; or they may become involved by intracranial pressure of the exudate becoming matted around them in their course at the base of the brain or in the spinal canal. The most common earlier features are ptosis and strabismus; whilst pains in the ears, tinnitus, neuralgias, inequality of the pupils are later signs; and peripheral neuritis, optic neuritis, deafness and blindness are very late associates or sequalae.

Delirium is quite a common occurrence, and may be present as a mild wandering type, a wild noisy type, or in the very severe cases as a low muttering type. It may vary in any one case and perhaps from hour to hour, but it is generally relieved by lumbar puncturing and serum treatment, or the former alone; and thus it appears to be more due to intracranial pressure than toxicity.

Unconsciousness is often present, in the less severe acute cases in the form of a partial unconsciousness from which the patient can be aroused, whilst in the more severe cases as a complete unconsciousness; or in the fulminant cases as a complete unconsciousness passing into absolute coma accompanied by Cheyne-Stokes respiration and cardiac embarrassment. There is nothing typical to help one to diagnose this type of unconsciousness or coma except by a process of exclusion, with the aid of other clinical features; but when coma does develop death is usually near.

Incontinence of urine, faeces, or both is a feature which is very often present and in no way indicates a bad prognosis. Occasionally the simpler acute cases will present this state of affairs, it being relieved by lumbar puncture, showing that in all probability it is merely the result of intrathecal pressure. However there are cases in which it persists and perhaps is association with partial paraplegia (evidenced by paresis of the lower limbs with the associated changes of an upper neurone type, or at times of a lower neurone type), where it is due to a myelitis of varying severity in the lumbar region. But even in these cases from a prognostic point of view, if taken alone, its presence does not indicate a black outlook, for it is wonderful with what rapidity incontinence will subside on placing the case under serum control and with repeated lumbar punctures, coupled later with routine medicinal procedures.

Abdominal pain is occasionally complained of but is of a very vague nature, and possibly is due to irritation of nerves supplying the viscera or abdominal wall. It is generally relieved by decompression of the theca.

Cerebro-spinal fluid, and to a lesser degree the blood, provides us with our main points of significance in clinching our diagnosis, and being mostly of diagnostic value they are discussed under that section.

DIAGNOSIS.

A conclusive diagnosis of cerebro-spinal fever can only be made by lumbar puncture and subsequent cytological and bacteriological examination of the cerebro-spinal fluid, at times aided by bacteriological examination of nasopharyngeal swabs, and rarely definitely by cytological and bacteriological examination of the blood.

Everything depends on an early diagnosis firstly in preserving the life of the patient, and secondly in avoiding distressing sequelae; and I am sure that those who have been fortunate enough to have seen a number of cases of cerebro-spinal fever will be agreed that no more distressing prospect could be presented to human nature than the results of an undiagnosed case, or of a case neglected in its early stages. It is therefore essential to be always wide awake to the possibility of the disease, and in all isolated cases presenting influenzal features of the cerebral type to examine carefully for the Kernig sign, stiffness or tenderness in the nape of the neck, and any other of the above outlined clinical features, and finding sufficient of them to be suspicious consider the advisability of a lumbar puncture, for even although no positive evidence may result a negative cerebro-spinal fluid will ease one's mind, will give a chance to prognose more accurately, and will not cause any ill effect to the patient if done carefully under aseptic precautions. I have now done between 3 and 4 hundred lumbar punctures, sometimes as often as 20 or 25 times on the one case, and I can safely say that not one ill effect has shown itself neither at the time nor at any subsequent stage of treatment or convalescence.

Before proceeding to discuss the precedure of lumbar puncture I consider that a few words relative to the Kernig sign will not be amiss.

This sign is elicited by first placing the patient in the supine position in bed, then taking each leg separately in the extended position with the hand under the heel. On lifting the limb from the bed it will be seen to commence to flex at the knee joint, and to confirm this continue to passively raise the leg still further from the bed, and flexion at the knee will be seen to be accentuated, and furthermore by now fixing the thigh with one hand and endeavouring to straighten the limb the muscles inserted into the head of the tibia (particularly the hamstrings) will be felt to be taut, and varying degrees of pain will be shown even up to a sudden scream on just attempting gently to straighten the limb. Now this sign is, in every case examined, definitely absent or present, and what I would like to point out is that there are varying degrees of positiveness. It is not essential, as one only too often sees medical men expecting, to have the limb flexed on the abdomen to almost a right angle to elicit the Kernig sign; one must always remember that the variability of natural stiffness at the knee and the hip under normal conditions is of very wide range, and under these conditions an apparent Kernig might be shown in a normally healthy person; but the true sign will very soon or even immediately begin to show itself on the raising of the foot from the bed, and the sooner it does show itself the more positive is the sign, and very often the more severe is the case. If a doubtful result is obtained by simply raising the foot in this way, confusion arising between a normal stiffness and the Kernig sign, the matter can readily be cleared up by fixing the thigh and examining the muscles inserted into the head of the tibia as above described.

Now at this stage, having assured ourselves that the Kernig sign is present we are justified in proceeding with lumbar puncture ; and failure to do this is nothing more nor less than criminal negligence. Lumbar puncture is therefore of vital importance. It is one of the simplest of all surgical procedures, and can readily be performed by any practitioner; but it calls for absolute asepsis, care in the choice of position of puncture, and absolute care in the passing of the lumbar puncture needle. I shall not take up the subject of the use of anaesthetics in puncturing (fully discussed under treatment), but the first thought must be to get into the theca, and this can be done, failing local or general anaesthetic, quite readily without anything, a course however which is not to be recommended. The needle

chosen should not be too fine, the most satisfactory results being obtained with a lumbar puncture needle 4 or 5 inches long, fairly stout to avoid any chance of breaking, of reasonable bore in case the cerebro-spinal fluid is thick and purulent, and fitted with a close fitting stilette in order to give the needle rigidity and prevent bending, to prevent blocking by the muscle tissue through which it will pass, and to act as a means of clearing the needle in case of blockage through flakes of lymph whilst draining the theca. The next point of importance is the attitude of the patient; our essential object here is to have the back arched so as to widen the intervertebral spaces, and to do this, the patients buttocks should be drawn well over the edge of the bed (or table), the head and shoulders inclined towards the chest, the knees flexed and the thighs drawn up towards the abdomen.

Having now got everything prepared for puncture, take an imaginary line at the level of the iliac crests, and place the finger on a point at either side of the spine just above or below this line and about half an inch from the middle line of the body; take the lumbar puncture needle and with steady and firm pressure insert the needle at this point, pass it in a slightly upward and inward direction towards the mid-line until a slightly increased resistance is felt (the ligamenta flava), when care is required, for on passage through this we are into the theca in the space between the 3rd and 4th or 4th and 5th lumbar vertebrae, according to whether we took our puncture point above or below the above mentioned line. Should the needle in passing strike a bony resistance (the lamina of the neighbouring vertebra) it must not be forced so as to injure the point as well as the bone, but carefully withdrawn a little and passed in a slightly altered direction, less obliquely upwards generally. Having entered the theca, withdraw the stilette, and the fluid should flow, drop by drop in a normal case and as clear as distilled water, but under pressure in an abnormal case even to the extent of a jet, and, if pyogenically or otherwise infected, turbid in appearance. After a few lumbar punctures one becomes so adept with the needle that it is possible to become exceedingly sensitive to the passage into the theca, and nowadays, when so much of diagnostic importance depends thereon, medical men should make themselves absolutely conversant with its procedures and the very minor difficulties that occasionally present themselves.

If the fluid flows normally in drops and is perfectly clear, having been collected in a sterile glass tube, the needle should at once be withdrawn and the point of puncture painted over with iodine and sealed with a little collodion. However if one's suspicions of cerebro-spinal fever are supported, the fluid will be found to flow with a varying degree of increased pressure from a quick drop up to a strong jet intensified by the respirations, and of varying degree of opacity. This fluid should be collected in a sterile glass tube or flask, and to the naked eye it will present various features. Firstly one should never omit to measure, approximately is sufficient, the amount of fluid drained away, since it is to be our desire in treatment to drain away at least as much as the volume of serum thatis to be injected, and which is usually between 20 and 30c.c.; but further because the gradual diminution in volume on repeated puncture is an indication of the progress in treatment. Therefore, having noted this, one of the following grades of fluid will be found to have been collected, and all may support cerebro-spinal fever as the cause:-

(a) Perfectly clear fluid under varying degrees of increased pressure.

(b) Clear fluid with a few flakes of lymph under very slight to markedly increased pressure.

(c) Slightly turbid fluid with or without increased pressure.

(d) Turbid fluid containing large flakes of lymph, which flakes are apt to block the needle and necessitate the passage of the sti-lette frequently.

(e) Very turbid fluid under increased pressure perhaps, but very often so thick that it cannot readily flow, though insufficient pressure in this region of the cord or difficulty in passing through the needle. This type fortunately is very rare and only present in a few fulminant cases.

The next step is to have this fluid transferred to the nearest laboratory for cytological and bacteriological examination, and, to avoid any mistakes through contamination, the most careful technique with regards to sterility must be observed; and

since the meningococcus is so readily killed, the specimen must be kept in transit at about body heat. This latter necessity is easily overcome, i.e. failing proper apparatus, by placing the tube or flask in a fairly large vessel of warm water at about 37° C. and hurrying it in transit.

EXAMINATION OF THE CEREBRO-SPINAL FLUID.

If to the naked eye the fluid is apparently clear, it might microscopically still present a few polymorpho-nuclear cells but no meningococci in direct smear or culture, and yet support a diagnosis of cerebro-spinal fever. Such fluid should be incubated over night at 37° C. and again plated, and over the next night and again plated, and in a certain small percentage of such cases a culture will be obtained on one of the latter plates. However it may still remain negative, and if the case is still undiagnosed, a second lumbar puncture should be done, and often this second specimen of the fluid will be more turbid, or, if not, may give a culture if treated as above. Yet in some cases, perhaps very mild infections and not widespread, it may happen that a culture cannot be obtained at all, and the case may pass undiagnosed, although in a few of such the diagnosis is at times cleared up by finding the meningococcus in the post-nasal swab.

When the cerebro-spinal fluid is apparently clear but with a few flakes of lymph in it, we might be presented with exactly the same results as obtained above after proceeding in the same manner bacteriologically; but it does occasionally happen in this type of specimen that on centrifuging the fluid the flakes are found to consist of a fibrinous exudate containing polymorphonuclear cells and with a few meningococci. However before giving a negative result the technique must be carried out as above outlined.

When we are presented with a slightly turbid fluid, a little should be decanted, centrifuged and examined cytologically and bacteriologically, and we generally find, if the cerebro-spinal fluid is of cerebro-spinal fever type, numerous polymorphonuclear cells, fewer lymphocytes, and perhaps a few meningococci in the direct smear. However even in slightly turbid fluid it is by no means a regular thing to find the meningococci in direct smear, and I am

afraid if one expected such he would suffer many disappointments. Culture methods should be persisted in, and very often a positive result is obtained. Nevertheless a few of these cases will even fail to present a culture, but in such instances a second lumbar puncture generally clears things up.

When the fluid obtained is very turbid or purulent it is generally very easy to find the meningococcus present in the direct smear, sometimes very numerous, and confirmatory cultures are readily obtained.

With reference to the isolation of the meningococcus from the cerebro-spinal fluid our diagnosis should not stop with the mere finding of the organism; at this stage we should proceed to distinguish the type of meningococcus present by serological tests, because the treatment by serum is particularly influenced by this knowledge; and as our knowledge increases the prognosis also might be found to have a direct or indirect bearing on the type of organism found.

Before leaving the subject of examination of the cerebro-spinal fluid, a few words about the chemical and cytological changes found in cerebro-spinal fever might be included. Abnormality supporting or negativing this fever can be found in the cellular element, coagulability, volume, specific gravity, globulin, and sugar content. Firstly a normal cerebro-spinal fluid is clear, free from morphological elements, specific gravity of 1002 to 1008, alkaline, contains about 0.1% of dextrose, and less than 0.1% of albumen. The specific gravity, globulin and sugar content do not help us much in diagnosis since any acute meningeal condition,as well as syphilitic and parasyphilitic lesions,will present these to an abnormal degree; but when in difficulty with a very low type of chronic case,with other features in the fluid not definitely supporting cerebro-spinal fever,we might be led by these abnormalities to have a Wassermann reaction of the fluid done for syphilis and thus eliminate cerebro-spinal fever. We have already discussed turbid fluids containing polymorphonenclear cells, but clear or turbid fluid containing lymphocytes in excess of polymorphs rather tends to support tubercular meningitis. The volume of cerebro-spinal fluid in excess, when taken along with the cytology, is often helpful but is not conclusive; the largest amounts of fluid being found in cases of serous or tubercular meningitis, so that a large volume of clear or very

slightly turbid fluid,in which no organism can be found and no culture obtained, irrespective of cells in the slight cellular deposit although it is usually lymphocytic in type,rather points to tubercular meningitis. However the volume being in excess, without a bacteriological examination,is not conclusive, because I have frequently seen 70 to 80 c.c. drained away in a cerebro-spinal case, but in these cases the organism was found either in smear or culture or both. A feature which is of value along with other examinations of the fluid is the fact that a fairly firm coagulum can generally be obtained from the cerebro-spinal fluid whilst with tubercular fluid only a very slight coagulum is usually observed.

A further procedure of diagnostic importance in those cases with suspicious clinical features, and cerebro-spinal fluid under pressure, either clear or turbid, but from which a culture cannot be obtained, is the use of the post-nasal swab. A positive culture by this means in a suspected mild case is quite sufficient to warrant our diagnosing it as a mild cerebro-spinal fever. However where the use of the post-nasal (naso-pharyngeal) swab is of greatest diagnostic importance is in detecting the carrier, or in declaring a cured case free from infection. The most frequently used post nasal swab is a piece of glass tubing about 9 inches long, slightly curved at once end, and containing a flexible spring wire with a cotton wool swab at one end and a loop at the other end by which it can be held in manipulation; the wire when free from the tube takes up a curve, similar to that of its glass tube [illegible]-retainer, so as to permit of its being introduced behind the soft palate in order to reach the mucosa of the nasopharynx. Great care must be exercised in the use of these swabs, firstly because one does not desire to have the cotton wool soaked with saliva which tends to inhibit the growth of the meningococcus, and secondly to make absolutely sure that the cotton wool has actually reached the mucosa of the nasopharynx. This can readily be done by sitting the patient down in a chair, instructing him to open the mouth widely, and then, passing the glass tube containing the wire and swab into the open mouth, guiding it backwards until the curved end of the tube is behind the level of the soft palate, at the same time gently pressing on the tongue with the glass tube, by asking the patient to say Ah-h-h--,quickly but gently press the handle of the wire forwards through the tube so that the swab is directed upwards behind the soft palate on

to the mucosa of the nasopharynx, after which the wire is rapidly drawn back again so as to have the cotton wool swab back into the glass tube again before the tube itself is withdrawn. After a little experience this can be done with absolute satisfaction and with no inconvenience whatever, the only difficulty being, in a nervous individual, to get his confidence in order to overcome his timidity. Now the most important factor about this post-nasal swab is that it should be promptly plated, or, in other words, the surface of a plate of suitable medium should be inoculated at the bedside, the plate being conveyed to the nearest laboratory in a heated chamber in a similar manner to a specimen of spinal fluid at 37° C. From this plate typical colonies are isolated and the type of organism identified by the usual serological procedures.

A still further diagnostic procedure, not truly diagnostic by itself, but yet giving interesting and supporting features, is the examination of the blood, bacteriologically, cytologically and serologically. Cytologically the blood shows a marked increase in its leucocytes, which increase varies from 10,000 per c.m.m. to 50,000 per c.m.m., and by differential count this will be shown to consist of polymorphoneuclear cells mainly, the total lymphocytes not being materially affected, although in infants an increase in lymphocytes has occasionally been reported. Serologically, agglutination of the four types of meningococcus should be tested for with the serum of these patients, and the reaction will usually be found to be positive about the fourth day in dilutions of 1 in 50 up to 1 in several hundreds, varying of course with the case. Where the serological test fails in its usefulness is in the fact that before the necessary time is allowed for the production of agglutinins in the blood the case has been either diagnosed by previously discussed measures or has died; but one is from time to time puzzled with a mild or a chronic case and then it proves of considerable service. In testing the agglutination reaction the fact must not be forgotten that we have four types of organism and thus the four sets of agglutinations must be done. Bacteriologically a considerable amount of work has been done with regard to the blood stream as a site for finding the meningococcus, and on the whole the results have been very unsatisfactory. I myself have on only one occasion obtained the organism from the blood; neverthe less the fact remains that the organism has been found, and by some more frequently than by others, but perhaps these cases have been of a fulminat type associated with a meningococcal septicaemia which it is well known

can occur. Since nearly all of my cases occurred in an isolated outbreak when we were wide awake to the possibility of such cases presenting themselves, and we thus had the opportunity of getting the cases under early treatment by lumbar puncture and serum, my failure to obtain cultures from the blood in only one case can easily be explained by the probability that a passively produced immunity was established before the meningococcus had a chance to circulate; or in other words that the meningococcus does not usually pass into the blood stream for three or four days at least, and by this time with treatment the patient is somewhat immunised against its growth in the blood. However I am of opinion, considering the very little trouble it is to the physician or inconvenience to the patient, that in every likely case the blood should be cultured, because it serves as an aid to prognosis, and as time goes on might present some valuable information. The procedure here is to withdraw from 2 to 5 c.c. of blood from one of the superficial veins of the arm by means of an absolutely sterile syringe fitted with a fine needle, and after withdrawing the needle from the vein, to inject the blood immediately into a flask or tube containing a little sterile broth, and then place the flask in a bacteriological incubator for further investigation.

DIFFERENTIAL DIAGNOSIS.

The milder cases of cerebro-spinal fever, those cases which from a treatment point of view are the most important, are the most difficult to diagnose; but if one continually keeps in mind the possibility of such cases cropping up, or in other words looks upon cerebro-spinal fever as a condition of common occurrence instead of a rarity, there is very little chance of these milder cases being passed over. They have to be differentiated from such conditions as Influenza of Cerebral type, early tubercular meningitis, early pneumonia, early rheumatic fever, toxaemic or pyaemic conditions, mild septicaemia, and perhaps such simple ailments as megrim or even idiopathic headaches. This is generally readily and definitely done by reviewing the clinical features systematically by looking for the kernig sign, and finding sufficient evidence here to indicate meningeal involvement, by doing a lumbar puncture. Should the cerebro-spinal fluid return under pressure and turbid, even although slightly so, one is justified in making a provisional diagnosis of cerebro-spinal fever, to the exclusion of such conditions as influenza, rheumatic fever,

idiopathic headaches etc.; and generally, on account of the suddenness of the onset, the mildness of the clinical features, and no presence of a tubercular or of a septic focus, to the exclusion also of tubercular or pyogenic meningitis. Examination of the fluid withdrawn of course will clear the diagnosis up still more decisively. The condition which is likely to give us most trouble in differentiation, particularly when we are handling apparently clear fluid withdrawn under pressure, is that type of tubercular meningitis which has been lying somewhat dormant for a considerable time, only producing isolated features such as headache and malaise at repeated intervals spread over many months, and which features have not been of sufficient severity to attract attention or to cause the patient to seek medical advice, but which condition has suddenly fired up producing a meningeal clinical picture not unlike cerebro-spinal fever. Here the cerebro-spinal fluid will prove of value if systematically examined (as outlined under diagnosis), supported by tuberculin reactions, serological examination of the blood, and perhaps a very carefully taken history of the case. If features still persist and no definite diagnosis has been come to, a second lumbar puncture is quite justified, when bacteriologically more success might be obtained, and cytologically an increase in the polomorphoneuclear or lymphocyte elements might prove helpful in deciding, the former supporting cerebro-spinal fever, and the latter supporting tubercular meningitis. A nasopharyngeal swab might clear up the diagnosis here by presenting a positive growth. No reliance can be placed on the cytology of the blood in differentiating between cerebro-spinal fever and tubercular meningitis (whether early or advanced), because we are here handling one of the tubercular conditions which frequently causes a rise in total leucocytes, the increase being of the polymorphoneuclear type. I saw this feature particularly well marked in a very recent case, which was provisionally diagnosed as a case of cerebro-spinal fever, with a leucocyte count of 25,000 per c.m.m. of which 89% were polymorphoneuclear, a fact which rather tended to confound the diagnosis; but at the subsequent post mortem it proved to be a case of acute hydrocephalus resulting from a comparatively localised tubercular meningitis in the region of the foramen of majendie causing obstruction of this foramen.

The more severe acute cases are not so difficult to differentiate because the severity of the clinical features in nearly every instance points to a cranial condition, and very often directly to a meningeal condition. However as one does not always

have typical or uncomplicated cases it is as well to be prepared to have to differentiate from gross cerebral lesions, meningeal or cerebral haemorrhage, tubercular meningitis, pyogenic meningitis, pneumococcal meningitis, severe cases of influenza of cerebral type, syphilis of the brain and meninges, etc. Here the Kernig is not of much use beyond confining the condition to the meninges more particularly, but, wherever in doubt, a lumbar puncture along with an examination of the blood will generally give us the wherewithal to come to a definite conclusion.

In gross cerebral lesions there will generally be the associated headache not localised necessarily to the occipital region, persisting vomiting of increasing severity and of cerebral type, slow pulse and subnormal temperature, vertigo, optic neuritis and localising features due to interference with the motor or sensory areas or tracts through the brain; furthermore the progress in the above conditions will give a much longer history than the sudden one presented by cerebro-spinal fever. Meningeal or cerebral haemorrhages will generally give a history of injury, or arterial changes associated with an age somewhat above that at which it is usual to get cerebro-spinal fever. These cases will furthermore, as time progresses, generally produce localising features. However in a rarely doubtful case, particularly of meningeal haemorrhage, the condition is usually cleared up by lumbar puncture presenting a fluid under pressure and blood stained, and further by examination of the blood no septic leucocytosis.

Tubercular meningitis again presents the most difficult problem for exclusion, although generally the spinal fluid will go a long way to clear up most cases. In those cases in which no organism can be isolated from the cerebro-spinal fluid or nasopharynx however, and the fluid is only moderately turbid, we are handling a subject of difficult differentiation; nevertheless by taking a careful history of the case, making a careful general examination, the use of tuberculin tests, examination of the cerebro-spinal fluid on repeated occasions to note whether there is an increase in polymorphoneuclear or lymphocyte cells (the latter supporting tubercle), the volume and congulalibility of the spinal fluid, and the repeated negative investigations for cerebro-spinal fever, one can generally come to the conclusion that the case is one of tubercular meningitis. I have not included in the differentiation of these tubercular cases cultural or inoculation procedures

because the acute cases are not of long enough course to allow of these being completed in order to assist in diagnosis for use in treatment; nevertheless they should always be carried out; and in any of these suspicious cases one should not neglect to use Dorset's egg medium, Lubenau's glycerine egg medium etc. for culture of the tubercle bacillus from the cerebro-spinal fluid, and inoculation of the guinea-pig with the centrifuged deposit, since our knowledge, to be of subsequent assistance, can only be advanced in this way, and a definite diagnosis reached, even perhaps after death.

Another difficult series of cases to differentiate are the pyogenic and pneumococcal types of meningitis; but in these there is generally a history of a septic focus somewhere, or a patch of pneumonia in one or other lung. Even here, however, cases do occasionally crop up where no septic focus can be located, or where there is neither history nor clinical evidence of a pneumonic patch; in these cases the infection has possibly taken place through septic absorption from the respiratory tract, alimentary tract, or some accumulation of pus in a deepseated pocket-such as a perinephritic abscess. These cases do not very long puzzle one, because on lumbar puncture the organism can generally be very readily found in the fluid both on direct smear and culture; and furthermore these types of case generally produce a more rapid and widespread infection and are of a fulminant nature, very soon ending fatally, particularly in the pneumonic form.

Several cases of influenza of cerebral type, and syphilis of the brain and meninges are very readily cleared up by lumbar puncture and examination of the cerebro-spinal fluid, and in the latter case by the Wassermann reaction of the cerebro-spinal fluid or blood serum.

I have seen one case of tetanus (early) admitted to hospital as a cerebro-spinal fever suspect, but failing sufficient features to warrant a lumbar puncture he was kept under observation for several hours, when he began to develop twitchings in one leg (the site of a shrapnel wound), and in doing lumbar puncture for curative purposes the cerebro-spinal fluid was under next to no pressure and perfectly clear.

Acute encephalitis, or polioencephalitis, is a condition which might confuse one very materially, because there is very frequently, if not always, some degree of meningeal involvement in an acute

state; but one generally finds groups of cortical cells involved with their associated regional or sensory signs; and moreover lumbar puncture will produce negative results for cerebro-spinal fever.

Fulminating cases of this condition, which are comatose when they come under one's notice, or very rapidly become so, have firstly to be differentiated from the various other types of coma such as:-

1. Uraemia with its history of urinary complications, convulsive seizures of epileptiform type, uraemic odour of the breath etc.

2. Alcohol poisoning with its less profound unconsciousness, from which the patient can usually be aroused, equal and dilated pupils, strong alcoholic odour of the breath, etc., and absence of features of acute fever.

3. Diabetes with its history of the condition, sweet odour of the breath, presence of sugar or derivatives in the urine, etc., and absence of features of acute fever.

4. Opium poisoning in which the pupils are equal and extremely contracted, pulse and respirations slow; and there is a gradually deepening coma, with no evidence of acute fever.

5. Hepatic disease, in the later stages of cirrhosis or acute yellow atrophy, where we have a history to assist us, and the presence of jaundice.

6. Head injury, apoplexy, heatstroke, and gross cerebral lesions which can generally be suspected by their histories or associated motor or sensory phenomena.

Having examined for the possibility of the presence of one of these conditions, and still feeling suspicious that the case is one of meningeal involvement of cerebro-spinal type, lumbar puncture is the procedure to be adopted, and this under a local anaesthetic or without anaesthetic at all, when we will be able to come to a definite conclusion by examination of the cerebro-spinal fluid as above outlined, after eliminating the possibility of septic or of pneumococcal meningitis.

Chronic forms of cerebro-spinal fever are not nearly so common as the previously mentioned forms, and are very often ushered in by a mild acute

attack in which we might have a chance of making our diagnosis as previously outlined; but an occasional chronic case will present itself with no such obtainable history, when our main sources of confusion will arise from chronic tubercular meningitis of a serous type, or syphilitic meningitis. The former type is cleaned up as previously outlined, and the latter by the Wassermann reaction of cerebro-spinal fluid and blood serum, and in both by the predominance of lymphocytes in the cerebro-spinal fluid rather than polymorphoneuclears.

PROGNOSIS.

The prognosis of a fulminant case is hopeless. I have not seen a truly fulminating case recover, but on the other hand I have seen a case with a history of only 36 hours from the development of the first sign up to death, the end coming only two hours after admission to hospital. Another such case under my notice lasted three days and died without regaining consciousness.

In the sever acute cases, with energetic treatment and frequently repeated lumbar punctures, the prognosis is very much more hopeful, but at all times throughout the early stages we must be very guarded. If these cases show marked improvement after their first two lumbar punctures, unconsciousness and delirium disappearing, there is a very good chance of recovering, but the prognosis must be withheld until the patient has absolutely regained consciousness and can assist you with indications of improvement of other clinical features, because these cases sometimes, after a brief temporary partial recovery, will relapse into the original state, and often very quickly succumb after the manner of a fulminating case.

In the mild acute cases I think I can safely say that, with energetic treatment on the lines laid down in this treatise, the exception is to meet with a death. However if these cases are not treated with a keen determination and exceptionally close observation they will be as troublesome as the previous two groups.

In the chronic cases the prognosis is very good with regards to the life of the patient, but unfortunately is very much the reverse with regards to complications and sequelae.

In all varieties where recovery has taken

place we are liable to get sequelae, but with the energetic treatment of recent date these are now reduced absolutely to a minimum. Deafness is the most common result of cerebro-spinal fever through infection spreading possibly directly along the auditory nerve and thus producing suppuration of the inner or middle ear. Vision is very often impaired as a result of the complication of optic neuritis, purulent choroiditis, iritis, keratitis, or even ulcerative conjunctivitis during the course of a severe acute case. Chronic hydrocephalus might also result through adhesions forming in the region of the foramen of majendie obstructing the circulation of cerebro-spinal fluid between the ventricles and the cisterna magna of the brain. Hemiplegia, aphasia, and paraplegia have also resulted in very severe acute cases, but with persistent treatment such cases generally recover for the most part if not completely; one such case of mine had a definite paraplegia but after seven months in bed he recovered completely with the exception of a certain degree of weakness. Such other sequelae as epilepsy, idiocy, and cranial nerve paralysis, have also been reported. In the majority of these cases, after recovery, certain mild features appear to remain for an indefinite period, such as a slightly dull disposition, heaviness of head verging on dull headache, neuralgia of facial type, neuralgic pains of the limbs particularly the lower extremities, weakness even to dull aching in the lumbar region ; but generally speaking none of these prove sufficient to cause serious worry, and perhaps will subside entirely as time elapses after recovery.

TREATMENT.

Just as with all infectious diseases our first aim is to prevent the occurrence of the disease as far as possible, and thus with this object in view and the knowledge of the epidemic nature of the disease our aim should be directed to the minimising or prevention of overcrowding, the encouragement of general cleanliness, the attention of throat and nasopharyngeal abnormalities, the encouragement of ventilation of living rooms and workshops etc, the encouragement of outdoor sports, and in fact anything which will keep the general health at a high standard and avoid disease generally.

However a case having occurred, the next important preventative step is the isolation of all contacts, the nasopharyngeal swabbing of such contacts, and the further isolation of those who are positive, i.e. carriers. Whenever a case of cerebro-spinal fever is diagnosed, or even suspected the local or military authority (as the case may be) should immediately leave no stone unturned in collecting and isolating all persons who have been in contact with that case during the previous few days (up to 10 days). These contacts should be postnasally swabbed and all of those found positive removed into the nearest isolation hospital; the negative cases should then be re-swabbed 7 or 8 days later and any carrier likewise dealt with, and so on until one swabbing results in entirely negative results in the whole set of remaining contacts. This procedure avoids the risk of a person developing into a positive carrier after the first swabbing and infecting one of those already declared free. The positive carriers should be treated energetically since it has almost exclusively been shown that as a rule these cases clean up extremely slowly if left alone; but on the other hand it has also been proved that the meningococcus is very poorly resistant to antibactericidal reagents even when applied locally to the nasopharynx. Those cases which appear to have resisted being due to the difficulty in getting the antiseptic into the recesses of the nose and nasopharynx. For the purpose of treating such carriers chloramine as a direct application in a 1% solution should be used, or perhaps less efficaciously the inhalation of a steam spray charged with zinc sulphate. Combined with this treatment plenty of fresh air day and night is essential. The nasopharynx should be re-swabbed periodically and the carriers as they become negative removed from their fellows, and upon producing three negative swabs taken weekly, permitted to return to their homes.

The treatment of the disease itself is in the main part by means of repeated lumbar punctures coupled with the use of one or other standard type, or polyvalent, antimeningococcal serum. Any outstanding symptom such as hyperpyrexia, severe headache or pains elsewhere, threatened collapse, etc., is treated on the same lines as any other fever.

Since no two cases are exactly alike no hard and fast lines can be laid down with regard to the number of lumbar punctures necessary, or with

regard to the persistent use or otherwise of anti-meningococcal serum; but there is a certain routine treatment which can be applied in all cases, the variation only being the degree to which any or all of the procedures are carried out. Therefore in order to facilitate the description of, and at the same time review, these procedures I propose to take them up under certain headings, and in each case to include my own personal observations and conclusions:-

1. Frequency and number of lumbar punctures.

2. Use of anaesthetics in puncturing.

3. Time of day most suitable for puncturing.

4. Amount of cerebro-spinal fluid to be drawn off.

5. Use of antimeningococcal serum.

6. Sedative treatment.

7. Conservative treatment.

8. Convalescence.

1. Frequency and number of lumbar punctures:- There is no dogmatic rule as to the number of punctures to be done in any one case, but as soon as a case presents any of the clinical features previously outlined not a moment should be lost before lumbar puncturing, which procedure should be continued daily until such clinical features subside. One must be guided in this continuance by individual features and not necessarily by a group of features, for to wait for developments is to ask for disaster, and delay at such a time, when the patient's resistance and strength are at such a low ebb, is fatal in many cases. Therefore the following important features must be carefully studied in each case:-

(a) Pain such as headache, neckache, and backache.

(b) General condition of the patient.

(c) Temperature variations.

(d) Pressure of the cerebro-spinal fluid at the last puncture.

(a) In the greatest number of cases that I have had the opportunity of observing and treating

I have found my greatest asset as an indicater is pain in the form of headache, backache, or pains in the nape of the neck; and I have always found that when the patient does complain of his headache or pain he is sorely tried by it, and in very many cases he will plead to have another puncture done. This is to my mind a positive indication that he has been relieved very materially on previous occasions; and hence for relief of symptoms alone I am convinced that it is warranted. I have never punctured in such a case without finding increased intrathecal pressure. Although in the early stages of treatment it must not be expected to entirely rid the patient of his headache, as it will be found in the majority of cases that after the patient has settled down from the effects of the actual puncture there is almost invariably very considerable subsidence of head and spinal pain, which perhaps will gradually increase again in intensity during the subsequent 24 hours with the gradual reaccumulation of cerebro-spinal fluid, this being again relieved by the next puncture, and so on, the headache diminishing in its maximum intensity daily until it is permanently relieved after the second, third or subsequent puncture according to the severity of the infection. Therefore punctures should continue daily until there is absolute relief from headache or above mentioned pains. I have found in a very fair proportion of cases that with the disappearance of headache there is disappearance of all other clinical features, a fall of temperature, a brightening of the mental condition and increase in the pulse rate and cure of the case.

(b) The second indication for persisting with lumbar punctures is where the patient has not complained so much of headache after his first one or two punctures, where the temperature has perhaps subsided, but yet where the patient has continued to look ill, has complained of feeling weak, has been exceedingly dull mentally, and perhaps has had some rigidity remaining. This state in itself is an indication that the process is still active and is strongly in favour of the necessity for continuance of punctures. In some of my cases I have had the feeling that the patient has been sufficiently relieved for nature to continue the treatment, and that a great part of the condition just outlined has been due to the depression of sedatives used, and to my regret after a few days there has been a recurrence of other clinical features, and in one or two cases a recurrence of the original symptoms in their entirety, necessitating the recommencement of all treatment. In one subsequent case, particularly

where I had ceased puncturing on the disappearance of headache and pyrexia etc., but where the patient complained of nothing but that he was very "heavy" and dull, and certainly looked so, I repunctured and found the cerebro-spinal fluid under increased pressure and got decided improvement in the patients condition afterwards. In another case the only complaint was that of sleeplessness and restlessness, and the mental condition was not bright but there was no headache; I treated this case likewise and found increased intrathecal pressure, and subsequently got cessation of symptoms complained of. In both of these cases although headache and temperature gave no indication the patients were distinctly on the downhill grade before resuming punctures.

(c) The third indication is the temperature variation. In a great proportion of straightforward cases where the temperature subsides coincidently with the other features we have no concernment with regards to repeating lumbar puncture, beyond the fact that as a routine procedure I am of the opinion that it is advisable, and have made it a practice, to do at least one lumbar puncture after the subsidence of symptoms. However there is always occurring a class of case in which the temperature continues up, somewhat intermittently, and I have here found that to refrain from puncturing generally means a recrudescence of head and other features in a day or two, and the necessity for the recommencement of treatment again at a stage further back than that at which I left off. In other cases I have found that there has been a subsidence of temperature to normal for a few days and then arise perhaps only to 99.5° or 100° without any alarming associated features; and by returning to lumbar puncture treatment immediately the temperature has subsided and only a slight or no recurrence of other clinical features has been evident. At the most by accepting this timely warning only one or two further punctures have been required, whereas as many as six or seven may have been required by waiting for further indications. In one or two cases where I have waited headache etc. has returned, and putting aside the retrograde step, recurrence of clinical features after their disappearance is very depressing to a patient who is already in extreme depression.

(d) The fourth indication for repeated lumbar puncture, which I have seen presented on one or two occasions, but which I feel in itself is somewhat rare is the continuance of a considerable intrathecal

pressure with perhaps a very slight turbidity after other main clinical features have subsided. Although some such cases will doubtlessly subside, I am inclined to think it is only with considerable delay, because in the one or two such cases in which there was subsequently developed a tendency towards recurrence of clinical features, by lumbar puncturing without the injection of serum I got disappearance of suggested developments, and I am sure a quicker convalescence. I am of the opinion therefore that this factor should not be entirely overlooked as an indicator, and record should always be kept of the approximate pressure and amount of fluid drained away each time a puncture is done, and this should help one in deciding how many punctures are required after the cessation of symptoms and signs in a certain number of cases.

Of course there are numerous other features which one might be guided by from time to time, viz. stiffness in the neck, lumbar or abdominal pain, incontinence of faeces or urine, strabismus, deafness, etc., but I cannot say in my experience that they have alone been presented without one of the four previous features to indicate the necessity for continuance in puncturing; but I would have no hesitancy in puncturing were any of these features present alone and in my opinion part of the progress of the disease. I have often noticed pain complained of in the lower limbs, and in one instance in the upper limbs, but in these cases I paid no attention whatever to the complaint, just continuing puncturing or otherwise in accordance with the necessity indicated by the previously mentioned features, the neuralgic pains subsiding in due couse.

There is one feature which must, in my opinion, never interfere with continued punctures if otherwise indicated, unless perhaps it be presented to an alarming degree or associated with an early feature of anaphylaxis (neither of which I have ever experienced in these cases), i.e. an urticarial type of serum rash. I have often seen it present in a fairly marked degree, and occasionally fairly early in treatment, but I have noticed that it is not regular in appearance with every puncture in those cases in which it occurrs; and I have not seen any ill effect by continuing punctures with administration of serum if other features necessitated.

2. Use of anaesthetics in lumbar puncture for the treatment of cerebro-spinal fever:- I have not the least hesitancy in the first place of stating

that in no case whatever should a lumbar puncture in the treatment of this disease be done without an anaesthetic, and at that a general anaesthetic, and for preference chloroform, for the following reasons:-

a. In these cases it should be one's desire to endeavour to obtain the confidence of the patient in what is being done for him, and to encourage him to display his exact symptoms if possible in degree of severity as compared with previous days, in order that we may judge of the necessity for further puncturing. I am sure that by abstaining from the use of an anaesthetic, the pain and distress caused by the simple operation in almost every case will cause the patient to hide his symptoms in order to avoid further similar treatment; and experiencing no distress at the actual operation, will withhold nothing, and in fact will often ask for further puncture to be done.

b. There is at the very least a slight shock to the patient's nervous system at a time when he is carrying as big a load as his nervous system can carry.

c. These patients are all more restless than one in normal health and there is added risk of the needle being broken, and more difficulty in the performance of the operation through voluntary muscle contraction and movement.

d. The sedative effect of the anaesthetic is lost. By the use of an anaesthetic such as chloroform, inasmuch as the effect of the anaesthetic does not pass off for some considerable time, the patient gets some rest after the operation and remains analgesic during that period, thus giving any untoward feature time to subside before the normal is regained. This is in my opinion a very important factor, and if carried out it is very rare to have complaints from patients concerning neuralgic pains etc. There is nearly always distress or even very severe neuralgic pain along the nerves of the lumbar plexus when serum is injected, particularly where repeated injections are being carried out without the use of a general anaesthetic.

e. The following advantages are lost - the free and safe manipulation of the patient, avoidance of shock, and freedom with regards to the time taken in draining the theca and the subsequent slow injection of the serum.

I am not aware of any definite contraindica-

cation in the general run of cases, as these patients take chloroform exceptionally well, are very easily got under its influence, and very rarely require sufficient to precipitate vomiting even although it be given late in the day or after meals.

I do not advocate the use of local anaesthetics, although I have been driven to use them in certain cases where a general anaesthetic has been refused, or where it is contraindicated, viz in a fulminant case in a state of coma. However in the former case we should always use our best endeavours to persuade the patient to give his consent to general anaesthesia. I feel that there is nothing beyond these two conditions to support the use of a local anaesthetic in preference to a general, beyond, possibly, where a puncture is being done in a very indefinite case for diagnostic purposes, or where assistance is not available, and the facility with which it can be administered is a consideration. The patient is not much better off with a local anaesthetic than with no anaesthetic, and its use leaves the patient with practically similar disadvantages as those outlined above.

3. Time of day most suitable for puncturing:- With the early cases under my charge I invariably did lumbar puncture in the mornings, but unavoidably I had cause to do one or two in the evenings, and I found that there was apparently more satisfaction with these latter cases from the point of view of restfulness of the patient. Therefore I observed my subsequent cases more closely, and I found generally that when I did a puncture in the morning the patient had a fairly good or at least an improved day although he bacame increasingly restless and sleepless as the night set in, with the result that the following day he was more exhausted than on previous days in many instances. At the same time I punctured other cases at night, and foun d with them that they had more restful nights, and that their symptoms did not develop sufficiently to sorely aggravate them until during the following day; and furthermore that as is always the case, the patients bore these inconveniences better during the day than at night, and that throughout the period of treatment there tended to be less exhaustion, and there was certainly less complaint on the part of the patient, and decidedly less call for sedative treatment. Guided by these results I was induced invariably to puncture in the evening, and I am still of the opinion that this is the best time of the day for

the procedure, except of course with the initial puncture which must never be delayed a moment. With one or two observations, I feel that to leave the punctures until too late at night on the other hand is almost as bad as, if not worse than, doing them in the mornings for the patient does not seem to have the same advantages, and he appears to overstep his hours of slumber, a fact which even in health in many people produces a certain degree of sleeplessness. The best time I feel is between 5 and 7 p.m., an hour which allows the patient time to settle down after his operation, and make himself comfortable for the night at his usual time.

4. Amount of cerebro-spinal fluid to be drawn off:- There are still many followers of the old routine, who drain away about the same volume as they are going to inject, but I myself have diverted from this routine throughout; however I have always adhered to the generally accepted view of draining away the fluid, when under excessive pressure, slowly. With my earlier cases I only drained away 30 or 40 c.c. and was satisfied, before injecting serum; but with my later cases I invariably drained the theca until the pressure became normal, and in so doing have drained off as much as 70 c.c. or even more in some instances (when I have not measured carefully), and I must say that the only results I have seen have been entirely satisfactory. I am of the opinion that it is no more nor less than the draining of an abscess cavity, in which case it is our one desire to remove as much foreign material as is possible, and as long as the natural water-bed of the brain and cord is not drained off, which state of affairs is indicated by a return to normal pressure, we can quite easily and with safety remove the surplus with nothing but an appreciable advantage. I have certainly had more success by coupling this routine with my other treatments than I had prior to coming to this decision.

5. Use of antimeningococcal serum:- Antimeningococcal serum is used with two specific objects in view, firstly that of producing a passive immunity, and secondly by its injection into the spinal canal of directly neutralising the virus at its site of production. From our general knowledge of immunity this is quite in accordance with scientific treatment, and I feel sure that the satisfactory results we have obtained by its use have quite borne this out. However there are apparently two schools of opinion with regard to this procedure, one

favouring the use of serum intrathecally after decompression, and the other favouring simple decompression without the use of serum. Since I have followed religiously throughout the view that every possible available means of treatment should be used during the active stages, I cannot very well support the no serum school. In fact I must admit that I am strongly in favour of serum, but not its indiscriminate use, for there are times when one must discontinue temporarily or even permanently the use of serum. I have noticed on more than one occasion that in the later stages of the disease, where I have been continuing punctures after the disappearance of the major features, with alternating procedures of decompression one day, and decompression plus serum the next, that I have had a greater intrathecal pressure on the occasion following the latter procedure, and I have seen in one or two cases a much aggravated condition follow. Therefore I have formed the opinion that if any serum is not having the desired effect, or where it is apparently producing the previously mentioned aggravation, unless another type of serum can be obtained it should be discontinued and simple decompression done. Of course another attempt can be made a few days later, but I feel sure that if a serum is going to act at all it will show some signs of doing so very quickly, at least after two or three punctures, and perhaps after the first. I have noticed furthermore in some cases that, when all symptoms are under control and the treatment is less stringent, the patients have started to develop a headache again, and on puncturing I have found increased intrathecal pressure with clear fluid, and I have here satisfied myself with decompression only, and in some cases this has proved sufficient, whilst in others symptoms have continued to develop and serum has been again given with satisfactory results. In two or three cases with very definite clinical features I have alternately decompressed one day, and decompressed with injection of serum subsequently the next day, and my only conclusion has been that I have had more satisfaction with the latter procedure than with the former. I have noticed that in those cases in which the cerebro-spinal fluid presented very few or no polymorphs in the later stages of treatment, decompression alone has sufficed, the increased pressure in these cases being most likely due to the exudation of healthy serum so often seen in the reparative process of inflammation. On the other hand cases will present themselves in which decompression and serum are both required in the later stages of

treatment, the morbid process still being active. Therefore from present deductions I am of the opinion that it would be unwise to refrain from the use of antimeningococcal serum as long as the disease is still active and we see the least benefit resulting from its use. With regard to the dose of antimeningococcal serum to be used, I have never used more than 30 c.c. at a time, and never less than 20 c.c., and almost invariably I use somewhere about 25 c.c.

As for the kind of serum to use, scientifically one should use that type of serum which is antibactericidal for its own type of meningococcus; but since this is not always procurable, or perhaps it is not definitely known what type of meningococcus is active in the particular case, it is advisable to use one of the standard makes of polyvalent antimeningococcal serum such as that put up by the Pasteur Institute, Burroughs Wellcome & Co., Rockfeller's Institute, Flexner, or the Lister Institute. Most of my work was done with one or other of the polyvalent sera mentioned above, with the exception of the Flexner serum, each of which was used from time to time; but I am of the opinion that whenever cerebro-spinal fever is being treated on anything like a large scale it is wrong to confine oneself to any one maker of serum, and that several varieties should be kept in stock, including those for the No. I, II, III, and IV type meningococci. Excluding the univalent sera for Nos. I, II, III and IV organisms, I cannot say that I have found definitely that any one polyvalent variety is specific for any one type of organism, or that any one is specific for all types; but I have found that after repeated punctures and use of one serum with no truly satisfactory result, I have changed my serum and have had good results with the change, and in two or three cases immediately satisfactory results. I feel therefore that first importance should be attached to watching one's case with regard to the careful selection of the make of serum to be used, and particularly when working with polyvalent sera, which selection can only be made during treatment, and must be made with an unbiassed mind.

6. Sedative treatment:- In my early cases I depended on sedative effect through the use of:- (a) general anasthesia when puncturing; (b) ¼ grain hypodermic injections of morphia for the relief of acute pain or distress (other than cardiac or respiratory); and (c) Bromides in moderate and repeated doses.

However during the treatment of my later cases I varied this treatment a little as follows:- (a) General anaesthesia as before when puncturing; (b) Chloral and Bromide continued for the relief of acute pain; and of these I have given from gr.V-XX of chloral with gr.X-30 of potassium bromide four hourly throughout the day during the acute stage of the disease, varying the dose according to the severity of the symptoms, and as necessity required. I found that by this method I appeared to obtain a much more continuous sedative effect, and more satisfaction than just giving morphine when required. (c) However in exceptional circumstances ¼ grain hypodermic injections of morphia were given when there was very severe pain; but since using the chloral and bromide I have very rarely had cause to resort to morphia at all, and in fact when lumbar puncture was done in the evening it could be almost entirely eliminated from the routine treatment.

7. Conservative treatment:- In the simple and slight cases this does not enter much into treatment, but in the severe and prolonged cases, and in those cases where there is incontinence of urine and faeces or any complication, it plays a very important part; so, with such cases in view, and the lack of knowledge as to how any one individual case is going to end, it should be started from the very beginning of treatment. The patient should be placed in a quiet, shaded, well-ventilated ward; quietness should be absolutely assured, as most of these cases are fairly light sleepers, and every possible encouragement for rest should be secured. The ward should be shaded firstly to encourage the patient to rest and sleep, but more particularly to relieve the photophobia, and to help to minimise the intensity of the headache. Good ventilation is required just as for fever. The diet should be light just as for all fevers. Great care must be taken of the skin, because in prolonged cases there is apt to be formation of bedsores. It must always be borne in mind that any apparently simple case may by prolonged illness develop these, or any case may at any time become incontinent, and where care has not been taken of the skin previously we may readily have trouble in this respect. The patient should be kept in the recumbent position for a considerable time after the disappearance of all symptoms and signs, and most of my cases have had recumbent treatment for at least three or four weeks after disappearance of their active trouble.

After the patient has ceased active treatment and all acute features have subsided, he requires feeding up, and should be put on tonic treatment including nux vomica or strychnine, potassium iodide, cod liver oil, etc., which can be coupled with a little bromide, as there is often a tendency to morning headaches and mental excitement on the least provocation after a severe attack.

Before discharge from hospital every patient should be swabbed postnasally, and be proved negative on three consecutive occasions at weekly intervals.

8. Convalescence:- The convalescence of these cases is prolonged and on no account should be hurried. Immediately after leaving Hospital, wherever it is possible, the patient should be sent to a quiet seaside resort or to a healthy country district, where reasonable quietness, avoidance of over excitement, and plenty of quiet healthy outdoor pleasure can be readily obtained. Life should not be too strenuous, early hours for bed should be strictly adhered to, abolition of all vices such as alcohol and tobacco etc. enforced, good wholesome dietary indulged in, with or without the use of tonic medicinal treatment as above mentioned and as each individual case will call for; and the patient will be seen to rapidly lose the little sequelae so frequently left, and will put on weight and take a new lease of life.

APPENDIX

of

CASE - SHEETS and RECORDS

including

Temperature Charts

and

Bacteriological and

Cytological findings.

CASE 1.

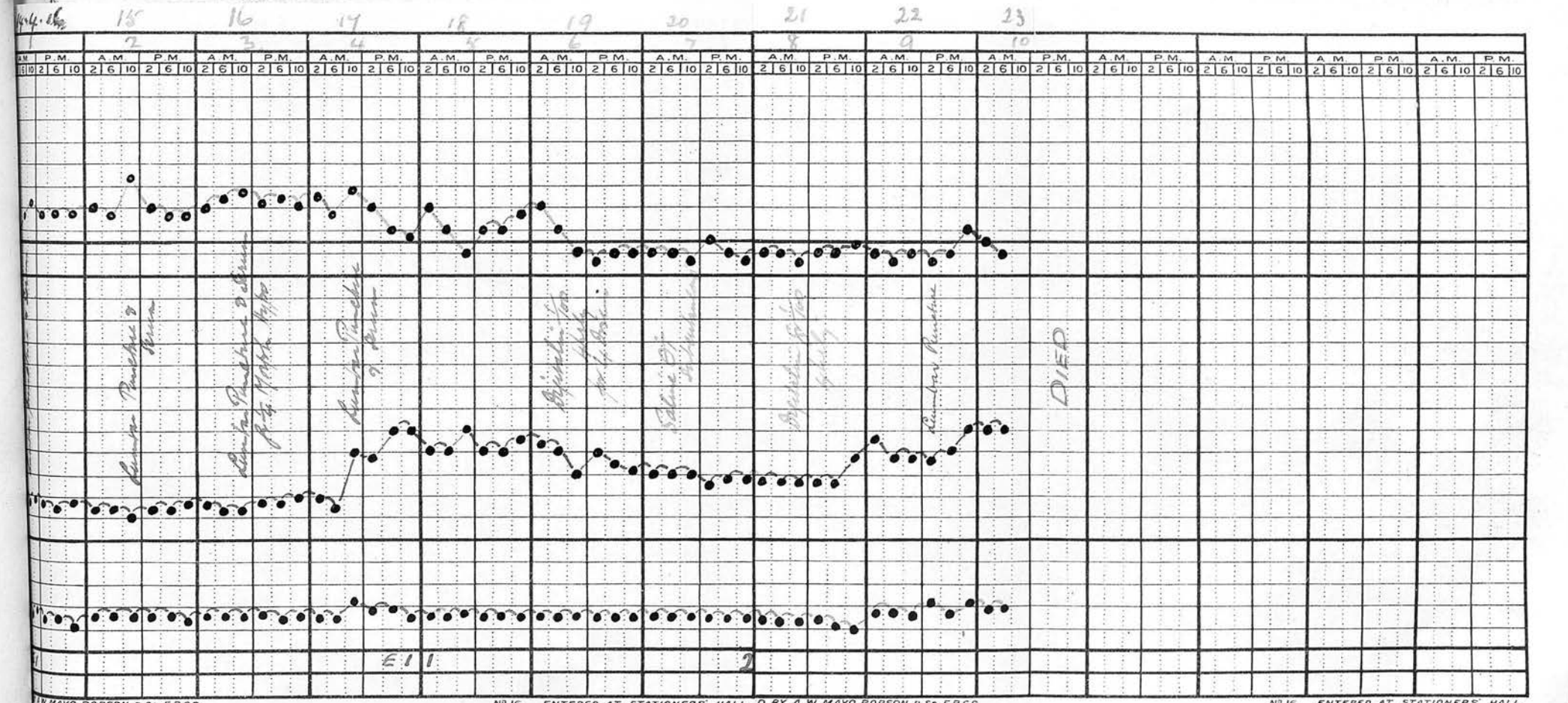
Pte E. P -------, aet. 19½ years was admitted to hospital at about 6 p.m. on 13-4-16 with a provisional diagnosis of Meningitis, and was sent to one of the medical wards. When he was seen at about midnight he was lying with his eyes shut, throwing himself about in bed, and judging from his expression was suffering a great deal of pain; he was continually grasping his head with his hands. He was semi-unconscious and took no notice of anybody, nor could he be completely aroused. There was no history procurable. His whole attitude was suggestive of Cerebro-spinal Fever. He had slight head retraction, a well defined Kernig was present, and his knee jerks were absent. He suffered from incontinence of urine. Lumbar puncture was done, and 60 cc. of turbid fluid was withdrawn under increased pressure. No serum was at hand to inject. He was still restless and semi-unconscious after coming from under the chloroform.

14-4-16. Patient's condition was much the same; he was still semi-unconscious and was that restless that it was impossible to examine him with any exactitude. Lumbar puncture was again done, and 60 c.c. of turbid fluid was withdrawn under pressure. 30 c.c. A.M. Serum was injected.

15-4-16. Condition had not changed during the previous three days. He had taken nothing by the mouth until the previous evening, and, as he was now both incontinent of faeces as well as of urine, his nutrient enema were being returned. He was the previous evening, however, fed, through the manipulations of the sister in charge, with small quantities of fluid diet at short intervals. He appeared considerably quieter and apparently suffered from less headache. Kernig sign was still well marked; there was no planter or knee reflex. Lumbar puncture was again done at 7 p.m. under a general anaesthetic, and about 30 c.c. of fluid drawn off, much more turbid than before but not so marked in pressure. 30 c.c. of A.M. polyvalent serum was injected.

16-4-16. Patient was more sensible and could answer questions a little. He was very restless, had marked headache, but really there was no general improvement of consequence. Lumbar puncture was again done with very similar results to the previous day, and serum was injected.

17-4-16. There was slight improvement although the patient was exceptionally dull, and he was



A. W. MAYO ROBSON, D.Sc. F.R.C.S. No 16 ENTERED AT STATIONERS' HALL. D BY A. W. MAYO ROBSON, D.Sc. F.R.C.S. No 16 ENTERED AT STATIONERS' HALL

rapidly becoming weak and emaciated. His features were still present, including pain and tenderness in the neck and along the spine, marked stiffness in the neck, tense headache in the occipital region, and a certain degree of ptosis and internal strabismus were beginning to show themselves. Lumbar puncture was again done, 30 c.c. of very thick fluid was drained away under very little pressure, and 30 c.c. A.M. serum was injected.

18-4-16. The patient was much worse during the previous night. He developed muscle twitchings down the right side of the body as a whole at intervals. He later became very exhausted and somewhat cyanosed. In the morning however he rallied a little, and became restless, but very weak. His reflexes were examined and found to be increased throughout. His temperature was normal. Lumbar puncture was done but no serum was injected.

19-4-16. Condition was much improved. He was more sensible, could understand what one said and would answer fairly freely. He was still incontinent of both urine and faeces; his headache and other features were present but apparently slightly less marked. Two pints of saline was given subcutaneously because his pulse became feeble; also 1/120th gr. of digitalin with strychnine was given four hourly hypodermically.

21-4-16. Condition was unchanged the previous day as well as on this day. His pulse had improved considerably on the above treatment, which was stopped at this stage. The patient was now looking very toxic, had developed a herpes on his lips; his respiration was rapid and shallow; rigidity of his neck and spine was very marked. His temperature was 97.8°, pulse 106, and respirations 34.

22-4-16. Rigidity and pain were still present, and in fact there was no change in his condition. At nine-thirty p.m. his pulse became weak and he became unconscious. Lumbar puncture was done under ethyl-chloride, and very little cerebro-spinal could be drained off, but what did come was very purulent and thick. However the patient died at 7-30 a.m. the following morning.

Post-mortem examination revealed the base of the brain and cerebellum, and to a lesser degree the cerebral hemispheres, covered with a very thick pus-like exudate, which extended down the cord. The ventricles were very slightly distended, and contained a turbid fluid, but nothing like as thick as that on the surface of the brain.

Remarks:-

As I was in full charge of this case throughout I made several notes. He was certainly admitted as a mildly fulminant type of case, very much like a few cases I handled later. He showed some relief under his first lumbar puncture, but never made any advancement beyond this. His clinical condition remained unimproved but stead for a few days, although he was persistently punctured and given serum, whilst his pathological condition was progressing rapidly with the formation of more organised lymph at the base of the brain, in the fissures, and along the cord. At this stage decompression was worthless because the fluid could not be drained away from the site of the trouble, and in fact when lumbar puncture was done it was not under increased pressure. Furthermore the anti-meningococcal serum injected could not pass freely along the cord and thus had lost one of, if not its most important factor viz: its neutralising effect on the causal factor. Therefore, in consultation with the cerebro-spinal specialist for the area, having had no result with five lumbar punctures combined with serum, we decided to cease giving the serum; and since no result was produced by a further lumbar puncture without serum to stop that procedure also. We came to the conclusion in this case that we were handling inferior serum, and with my subsequent experience, I feel sure that the serum supplied for this case was of exceedingly poor quality, - in fact was useless; and at a subsequent date the stock, from which it was taken, was withdrawn.

Bacteriology:- A gram negative intracellular diplococcus was found frequently in direct smears from the case, and produced typical cultural characters of the meningococcus. Its type was not investigated. Nasopharyngeal swab also gave markedly positive results. On two occasions the blood failed to produce a culture.

Case 2.

Pte. W. R. C------aet. 20 years was admitted to Hospital on the 20-4-17 with a temperature of 101° and complaining of a very severe headache, and pains and stiffness in his neck and along his spine. He had a history of having felt somewhat out of sorts for a few days, that he had been somewhat feverish at times, and that he had vomited once or twice. He was markedly malaised, and of very dull disposition. On examination he showed a slight retraction of the head, stiffness in the neck, tenderness along the spine particularly in the cervical region, and a definite but not exceedingly well marked Kernig. There was no rash, no eye sign, and no delirium or unconsciousness. His knee jerks were less active than normal. Lumbar puncture was done at 5 p.m. under chloroform, and only 10 c.c. of cerebro-spinal fluid was drained off under very slightly increased pressure just at first, but it was very cloudy in appearance. 20 c.c. of A.M. serum was injected intrathecally.

21-4-17. Condition was very markedly improved; headache was improved, stiffness and pain along the spine was diminished, and generally speaking all features were subsiding. Lumbar puncture was again done under chloroform,and 25 c.c. of fairly clear fluid was drained away under slightly above normal pressure; 25 c.c. of A.M. serum was injected.

23-4-17. Patient felt considerably better after his last puncture, his headache had entirely disappeared, and he had no complaint; his temperature was normal.

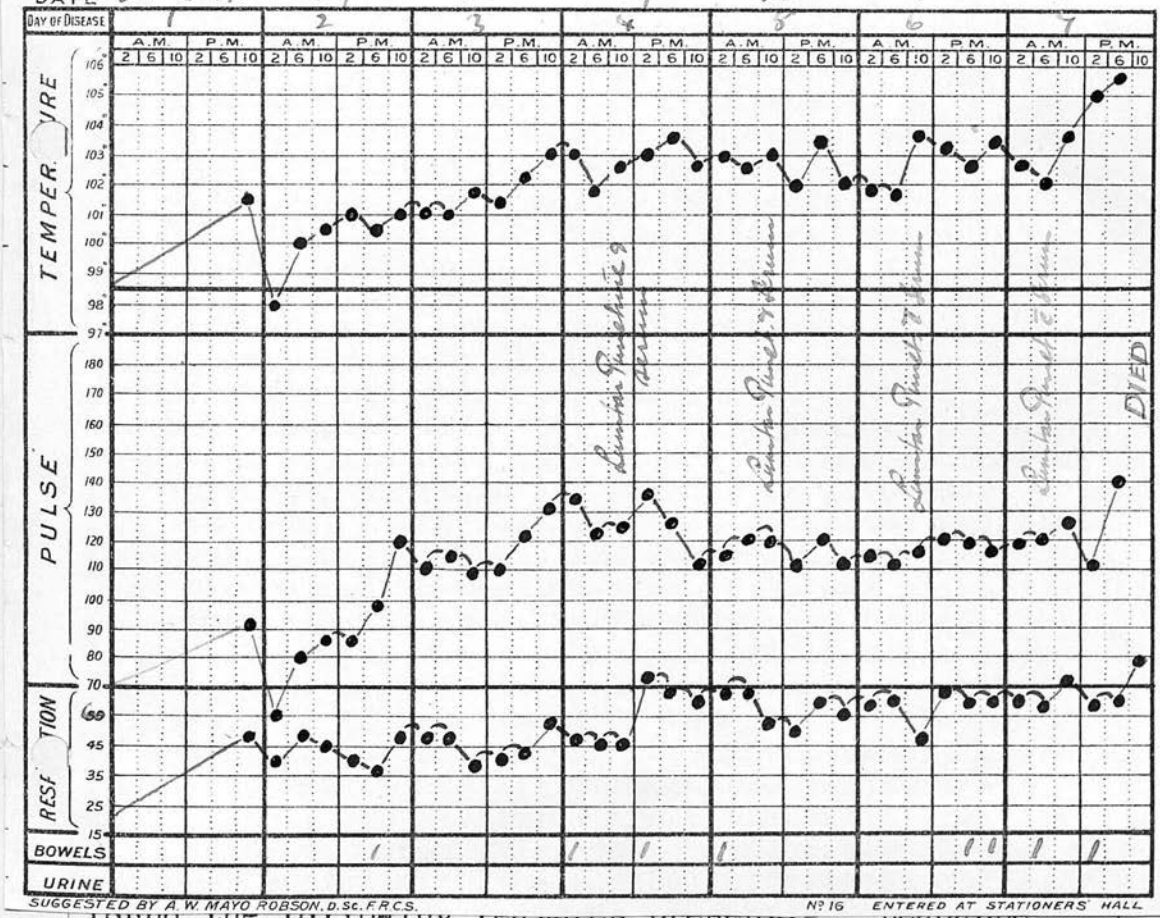
29-4-17. Progress was maintained throughout the previous few days. All features had by this time entirely subsided and, beyond weakness, he was convalescent.

25-6-17. No complaints whatever. He was sent home for his convalescence.

Remarks:-

A mild acute case, diagnosed early, and very quickly reacting to treatment.

Bacteriology:- A gram negative intracellular diplococcus was obtained from the fluid in direct smear, but unfortunately the fluid was overlooked for a few hours and a culture could not be obtained. A second lumbar puncture was done but a culture could not be obtained from this fluid either. Nasopharyngeal swabs were taken several times, the first two presenting positive cultures. Type of coccus was not investigated.



found the following features present: headache was very severe and centralised in the occipital region; there was marked photophobia, pain tenderness and rigidity in the neck, and slight head retraction. All of the features previously outlined were noted, including the typical rash; knee jerks were absent, kernig sign was definite but not very well marked, and planter reflexes were absent. Lumbar puncture

Case 3.

Q.M.S. D.D.L----- aet 40 years was admitted to Hospital at 5 p.m. on the 26-6-16 in an unconscious state and undiagnosed.

27-6-16. Temperature was 101°; he was comatose and could not be aroused at all, and thus no history was procurable. He was delirious, in a low-muttering form of delirium, although during the previous night the delirium had been of a more active type. His face was flushed, skin fairly moist, and tongue furred. There was a well marked purpuric rash present, distributed chiefly on the legs, body and arms, some of the spots having become confluent forming large bluish patches that could not be covered by a sixpence, especially well seen about the elbows and knees. There had been no vomiting since admission. There was incontinence of urine and faeces. The pupils were contracted and reacted to light, but sluggishly. Knee jerks were present and diminished. Kernig sign was tested for but was indefinite. There was no head retraction; stiffness and tenderness were present in the cervical region. He partially regained consciousness once or twice, and then complained of headache, pains throughout the whole muscular system, and severe pains in all his joints. On account of this latter feature, coupled with the rash, the medical officer in charge of the case diagnosed it as one of fulminant Purpura Rheumatica and treated it likewise.

28-6-16. The rash was more extensive over the buttocks, flanks, limbs, and lower chest. The body was bathed in perspiration. He was still delirious and muttered incessantly, but he had lucid intervals during which he complained of headache, thirst, considerable pain, and stiffness in his joints; pain and stiffness in his neck and back. He was still incontinent of faeces and urine, his pulse was weaker and his temperature remained at about 101°. He was still under rheumatic treatment.

29-6-16. Condition was considerably worse. In consultation with the medical officer in charge I found the following features present:- Headache was very severe and centralised in the occipital region; there was marked photophobia, pain tenderness and rigidity in the neck, and slight head retraction. All of the features previously outlined were noted, including the typical rash; knee jerks were absent, kernig sign was definite but not very well marked, and planter reflexes were absent. Lumbar puncture

was done, and very turbid fluid was drained off under markedly increased pressure. Polyvalent Serum was injected. During the afternoon the patient brightened up very markedly, spoke fairly freely, lost his unconsciousness, complained of only slight headache, and stated that the pains in his limbs were subsiding markedly; he was however still incontinent of urine and faeces.

30-6-16. He had a fairly quiet night although he rambled incoherently in his speech when awake. In the morning he was perfectly conscious and stated that he felt better and that he had no complaint to make. He lay prostrate in his bed. There were no clinical developments but his signs were still all present, the rash still the same, and his general appearance was very dull. Lumbar puncture was again done and a large amount was removed, very turbid and under great pressure; and A.M. polyvalent serum was injected. This was done in the morning. He continued throughout the day in much the same condition, at times in a state of low muttering delirium from which he could easily be aroused, when he would converse quite rationally. He had no complaint in the evening.

1-7-16. Condition was still unchanged, respirations were shallow and fast (48 per minute), yet there were no fresh developments beyond that he was considerably weaker. Lumbar puncture was again done, and a large quantity (about 70 c.c.) of fluid drained away, very turbid and under greatly increased pressure. 30 c.c. of A.M. polyvalent serum was injected. During the evening, after his puncture, he appeared very much brighter and conversed very rationally.

2-7-16. Condition was still unchanged; respirations were increasing (now 66), and pulse was 126. However he appeared a little brighter, conversed freely although at times he tended to ramble in his speech. He again complained of vague joint pains, similar to what he had had a few days previously. Lumbar puncture was again done, and a considerable (unmeasured) quantity of turbid fluid was removed under greatly increased pressure. Serum was injected. As the evening came on, the patient began to show signs of collapse, his respirations ran up to 120, pulse 120, and temperature 105°. Pituitrin was injected and he rallied a little, when he complained of pain in his arms and legs, and on examination his legs were found to be spastic. He died at 7-45 p.m.

Remarks:-

An interesting case showing how necessary it is to keep the possibility of the occurrence of the disease before one, and not to be deceived by features such as the medical officer in charge of the case was. Doubtless with the difficulty of obtaining a history, the prominence of the patient's pains, and the rash, which might excusably have been mistaken for that purpura rheumatica, it was easier than usual to make a mistake here; but nevertheless there were quite sufficient features present, even in the unconscious state to convince one of the possibility of meningeal involvement, and to lead to the performance of lumbar punctures. Certainly the case was a very severe acute one, perhaps of fulminant nature, but it is difficult to say what satisfaction might have been obtained if one had been able to start lumbar punctures and serum three days earlier; I am rather inclined to feel, with my subsequent experience that the case might have been cured.

Bacteriology and cytology:- Abundance of polymorphoneuclear and very lymphocyte cells were present in the fluid. Numerous gram negative diplococci, all intracellurlar, were found in direct smears from the fluids of several punctures. Culturally, typical growths of the meningococcus were obtained, although the type of coccus was never got out. The patient's blood serum agglutinated a stock culture; but the blood would not culture anything. Nasopharyngeal swabs were not taken, on account of the patient's unconscious state.

Post-mortem examination revealed a typical picture of the pathological changes usually met with in this disease. There was a considerable amount of organising purulent lymph at the base of the brain, around the cerebellar lobes, pons, and medulla. The lumbar cord was also matted with organising purulent lymph.

Case 4.

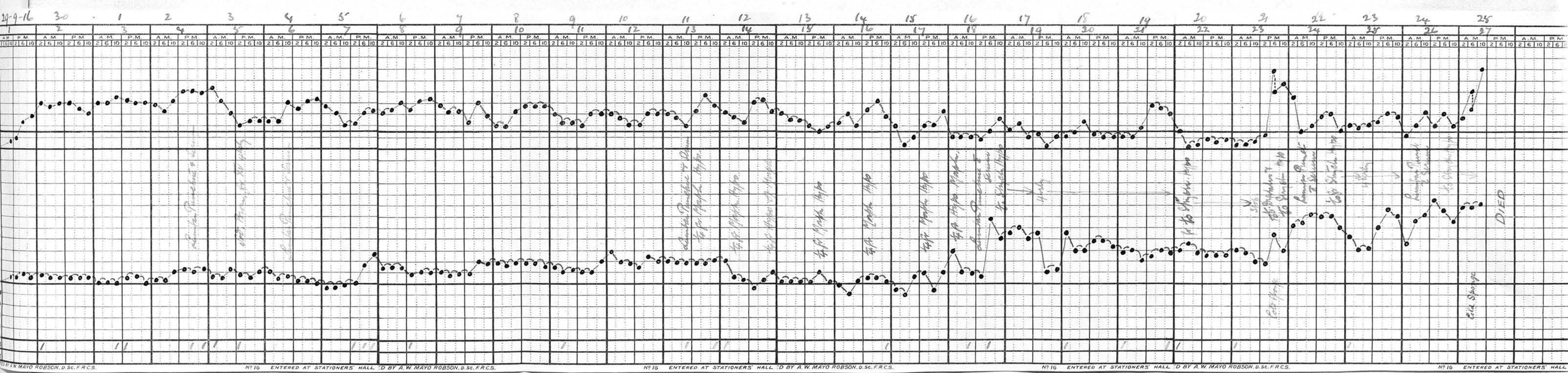
Dvr. T. C-----, aet.17 years was admitted to hospital on 29-9-16 undiagnosed, and in an unconscious condition. During the course of the evening he passed large quantities of urine at irregular intervals. Temperature was 98.2°, pulse 78, respirations 21. His heart presented nothing to note except an accentuated second Aortic. Respiration was shallow. He was not suspected as a case of cerebro-spinal fever, and was admitted to the general medical ward. No history was obtainable. During the night he became violent.

30-9-16. He was conscious for a very short time at about 10 a.m. and complained of a severe headache. He gave a history of generalised headache extending over four days previous, accompanied by pain in the lumbar region, and occasional vomiting. His ankles were slightly oedematous. His temperature was 101°. He became violent again throughout the day, and had moments of consciousness, although generally speaking he was unconscious most of the time. Incontinence of urine and faeces were present.

1-10-16. Temperature was 101°, pulse 70, respirations 31. Knee jerks were feeble. Pain in the head and neck became very pronounced and extended along the spine. Patient was still violent at intervals.

2-10-16. Temperature 101°, pulse 80, respirations 28. General condition was a little brighter. Headache was generalised, muscles of the neck were painful on movement, and there were complaints of pain throughout the vertebral column; pupils were equal and reacting to light; herpes labialis was observed; and the patient was very drowsy most of the day.

At this stage I was asked to see the case in consultation with the medical officer in charge, and the patient was then in too unconscious a state to obtain a history, but on reviewing the notes taken above I made a close examination and made the following observations:- There was marked rigidity of the neck and whole vertebral column; evidence of great tenderness in the cervical and lumbar regions, and of pain in the neck on being moved; his head was causing him considerable pain by the way he occasionally grasped it and threw himself about; he had a well-marked herpes around his mouth and nares; ptosis and strabismus were present; there was no rash; there was incontinence of urine and faeces; a well defined Kernig was present in both legs; knee jerks were both



absent; and there was a Babinski. Lumbar puncture was recommended and done under chloroform with the result that very turbid cerebro-spinal fluid was obtained, and under very great pressure, about 60 c.c. being drained away. Polyvalent A.M. serum was injected intrathecally.

3-10-16. Condition much improved. Temperature 99°.

4-10-16. Patient complained greatly of headache and backache, but this was relieved somewhat by potassium bromide. He slept at intervals during the previous night. He was slightly improved in the morning in general appearance, and felt better and talked a little more freely. However as the day went on he became ill again, and I was again asked to lumbar puncture him, upon doing which 50 c.c. of turbid fluid was drained away under markedly increased pressure. Polyvalent A.M. serum was injected. Later on at night he was very restless, and had a very severe headache and back-ache. Polyuria was still present.

5-10-16. He was considerably easier during the forenoon; and during the afternoon, beyond complaining of his severe headache, he appeared to show improvement and gave no concernment.

6-10-16. He had a fairly good night, but still had pain in the neck and headache. 120 oz. of urine was passed in 12 hours, of low specific gravity (1002), and containing albumen.

7 & 8-10-16. His condition was much the same. He complained considerably of occipital headache and pain in the nape of the neck, he still had polyuria, with urine of a specific gravity of 1010 and containing a trace of albumen. Incontinence of urine and faeces were still present.

9-10-16. Patient generally speaking felt better; headache was not quite so severe. He had a restless night owing to headache and cervical pains, and pains between his shoulders.

10-10-16. Condition was just the same, headache and spinal pain was still complained of as also was tenderness in the same regions. There was less polyuria. As the day passed his headache got worse.

11-1016. Condition was similar to that of the previous day but symptoms were of increased severity if anything. I was again asked to see the case, and again did lumbar puncture under chloroform, but could only drain off 15 c.c. of very turbid fluid. Polyvalent A.M. serum was injected. His Kernig sign on this day was very much more marked, and his neck and spine were very much more rigid than when I previously saw the case.

12-10-16. He complained greatly of pain in the neck and back. Morphine gr. $\frac{1}{4}$ was given hypodermically at 4 p.m. and at midnight.

13-10-16. Condition was similar and gr. $\frac{1}{4}$ of Morphine with 1/200th of atropine was given hypodermically.

14-10-16. Patient was very apathetic and his pulse was very feeble.

16-10-18. The patient seemed better. His left pupil was very slightly dilated. Later in the day he became worse, was restless, and had pain in his back and marked headache. Lumbar puncture was again done and only 20 c.c. of fluid could be drained away, and it was very thick and purulent. Polyvalent A.M. serum was injected. Atropine and Adrenaline was given hypodermically.

17-10-16. Condition somewhat improved.

18-10-16. Just as of previous day in general condition. Strychnine was given hypodermically every six hours.

21-10-16. No change in condition during the past three days. Towards evening the patient became much worse. His pulse became very feeble, he had several rigors, and became unconscious passing into a state of low muttering delirium. Temperature was 103.8°. Morphine hypodermically was administered and ice-cap was used for his distressing headache.

22-10-16. His condition was very low; all features were accentuated particularly his headache and spinal pain and stiffness. Lumbar puncture was again done and fluid was obtained in considerable volume (not measured), and under great pressure, and very turbid. Polyvalent A.M. serum was used intrathecally.

24-10-16. Patient was a little better after his last lumbar puncture but the following day he became very restless and semi-unconscious. Lumbar puncture was done with similar results to that of the previous time; polyvalent A.M. serum was injected.

25-10-16. Patient had an extremely restless night and was very delirious. He had no sleep. At 8 a,m. he had a rigor, his temperature rose to 104°, pulse 138, and respirations 48. Hypodermic injection of strychnine did not improve his condition, and he died at 1-20 p.m.

Remarks:-

I have included this case for many points of interest. In the first place I might state that the case sheet in general was not mine, but was copied from the original, and with my notes in one or two places only; my interest in the case professionally being that of bacteriologist and otherwise just when requested by the medical officer

in charge to lumbar puncture. However since the case ventilated many of the points I have brought up in my review I could not let it pass.

I think after reading my review of cerebro-spinal fever it will be manifest in the first place that cerebro-spinal fever was not here anticipated. The mere fact that there were urinary features - polyuria with albumen - and no fever temperature, mislead the medical officer in charge of the case. In the second place, at this stage if awake to the possibility of the disease, there were sufficient symptoms and signs present by which to at least be suspicious of, if not to almost diagnose the condition. In the third place when lumbar puncture was done and the case definitely diagnosed energetic treatment by lumbar puncture and antimeningococcal serum was not carried out. In the fourth place the closer observation of clinical features, so necessary from a treatment and prognostic point of view, was not carried out as is shown by the brief uninteresting notes taken from day to day. In the fifth place a lack of knowledge of the condition was shown generally in, once having diagnosed it, placing any importance on the vague features that have been recorded here and there throughout. In the sixth place the possibility of urinary features being a complication of any other disease was overlooked.

I am of the opinion that this was nothing more nor less than an average severe acute case, which, if diagnosed early and treated energetically, might have been cured in a few days; or which if only diagnosed on the doing of the first lumbar puncture several days after the start of the disease, could have been readily saved by energetic treatment. I consider that I am reasonably correct in this opinion because it is obvious, by the way the case lingered on with next to no treatment, that he had exceptional resistance, and that with reasonable assistance he could have pulled through satisfactory. Further, pathologically, it is interesting to note how, in the later stages, the fluid became much thicker, when there appeared to be less serous exudate and more organised lymph formation, as was shown by the fact that the intrathecal pressure fell and the fluid could only be drawn off with very great difficulty at times, and then was of a very purulent nature.

Bacteriology and Cytology:- The cerebro-spinal fluid contained an excessive number of polymorphoneuclear cells and very few lymphocytes. Gram negative diplococci were found in direct smears, although scanty, and all intracellular. However no growth was obtained on plating the fresh fluid. After incubation of the fluid with broth for 24 hours,

and then plating, a very good growth was obtained. The coccus obtained from the fluid of 2-10-16 showed marked agglutination with all types of serum, and even with normal serum. The coccus obtained on 22-10-16 only agglutinated with types I and III sera. The patient's blood agglutinated types I & III cocci. The nasopharynx was swabbed for the first time on October 2nd and was negative, as also it was on all subsequent occasions. Blood culture was negative on two occasions. The later specimens of cerebro-spinal fluid showed numerous extracellular diplococci.

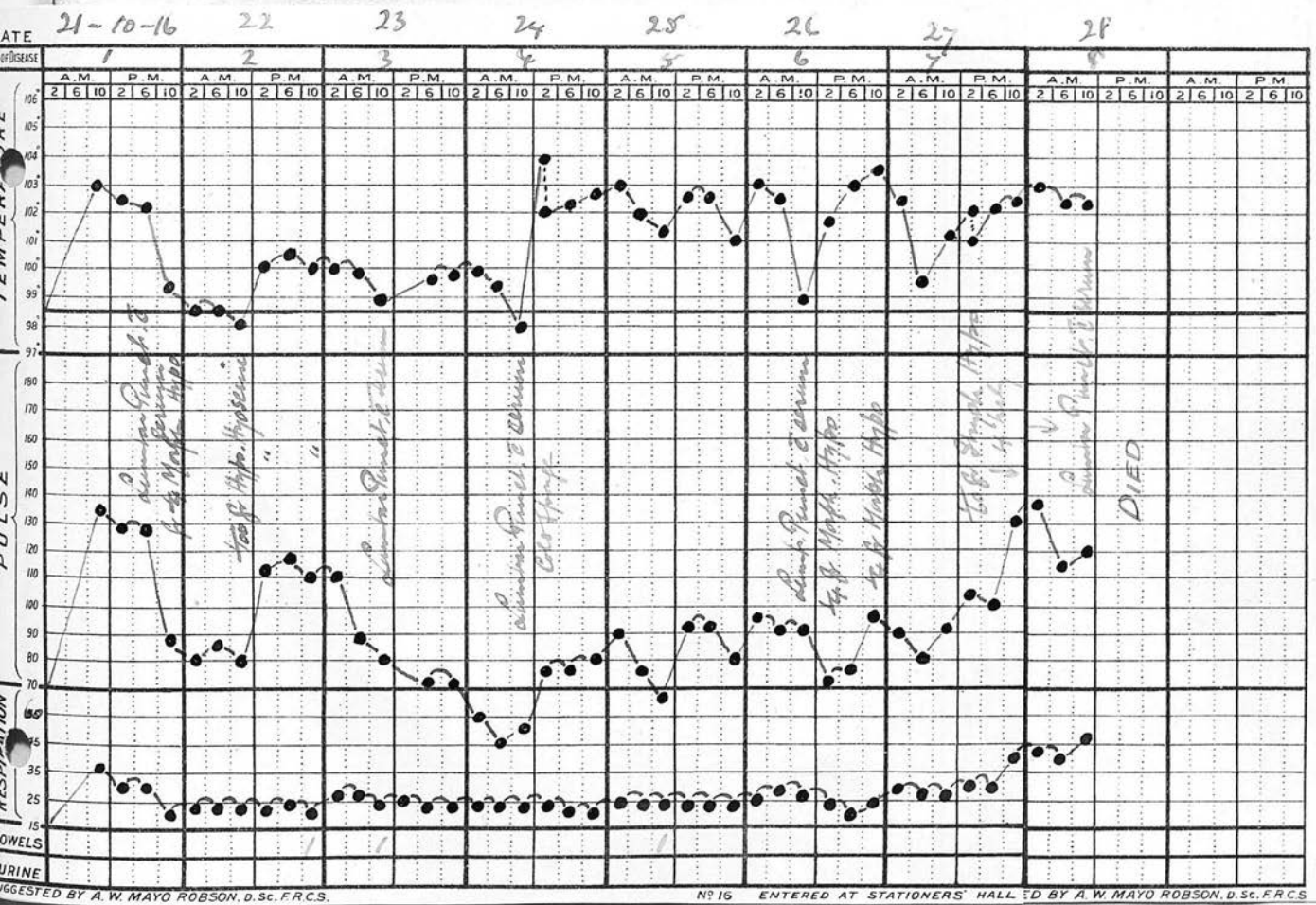
Post-mortem examination presented the typical picture of this type of meningitis, but purulent exudate extended throughout the whole surface of the brain, in a thick layer and was adherent at the base and more organised.

Case 5

Pte. H. S------ aet. 17 years was admitted to hospital on 21-10-16 suffering from headache and with a temperature of 103°. He was diagnosed as cerebral influenza. He had a furred tongue, no sore throat, a peculiar odour of the body, and vomited a little on one occasion. His history was that he took ill the previous night with headache, vague pains about the body. On admission he was dull mentally, complained sorely of his headache, and within an hour afterwards he became semi-comatose, struggled as if in serere pain, and placed his hands to the back of his head; his pupils were widely dilated, and his head was retracted. On further examination there was marked cervical rigidity, Kernig sign was present, knee jerks were absent, and there was a well marked Babinski. Lumbar puncture was done under chloroform and about 50 c.c. of turbid fluid was drained away under increased pressure. 25 c.c. of A.M. Polyvalent serum was injected.

22-10-16. He had a very restless and noisy night, and in the morning appeared exhausted. A haemorrhagic discharge had appeared from the ear. He continued restless and semi delirius all day.

23-10-16. He was still restless and noisy and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URINE
DIED
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complained sorely about his headache. Lumbar puncture was again done, and 40 c.c. of turbid fluid was drained away under increased pressure. 25 c.c. of A.M. polyvalent serum was injected intrathecally. The patient quietened down very considerably three hours later.

24-10-16. He had a good night and was very quiet in the morning. His clinical features were greatly improved. During the afternoon however he had a rigor and his temperature rose to 103.8°. Lumbar puncture was again done and considerable fluid was removed, turbid and under markedly increased pressure. 25 c.c. A.M. Polyvalent serum was injected.

25-10-16. Patient had a fairly quiet day, bu t complained of his headache, and showed head retraction still.

26-10-16. He still complained of his headache and also of backache; the retraction of the head became marked. Lumbar puncture was again done, and turbid fluid was drained away under increased pressure. A.M. Polyvalent serum was again injected. After this puncture there was a sudden transitory drop of temperature from 102.5° to 98.6 degrees, but within three hours it had again risen to 101.6°. The patient was much about the same in the evening as before the puncture in the morning. Gr. $\frac{1}{4}$ of morphine was given hypodermically.

27-10-16. Patient was restless and groaning with severe headache. Lumbar puncture was again done and yielded yellowish turbid fluid under high tension at first, but it suddenly stopped. 20 c.c. of A.M. serum was injected. The patient showed considerable collapse with irregular pulse sometime after the puncture, however with strychnine and saline per rectum he recovered satisfactorily. At night he became unconscious, his pulse was very bad, and he was bathed in perspiration.

28-10-16. His condition was much the same as on the previous day; he was semi-unconscious, developed a rigidity in the arms and legs; and the temperature was 102.6°, pulse 120, respirations 48. Lumbar puncture was again done at 3 p.m. and considerable turbid fluid withdrawn under slightly increased pressure. No serum was injected.

The patient died that night.

Remarks:-

This case apparently failed in the face of the fact that he was diagnosed early, and was liberally punctured. In fact one might even have been led to feel that the punctures with serum tended to make him worse. However from my subsequent experience, I am of the opinion that his pathological condition continued to progress more than the drainage by lumbar puncture compensated

for, and that the serum being used was not as satisfactory as it might have been. Similar cases, under similar treatment, but with a different type of serum have recovered readily, and with the time at our disposal in this case I have the feeling that had I not been confined to the one particular brand of serum here used, I might have had m ore satisfactory results - a fact I saw confirmed in some of my subsequent cases.

Bacteriology and Cytology:- The fluid was abundant in polymorphoneuclears. No cocci were found in direct smears on the 21st and 23rd; no growth was obtained on first culture but on plating the fluid after 24 hours incubation with broth, a profuse growth of type II coccus was obtained. Nasopharyngeal swabs were taken and were proved negative on the 21st but positive on the 23rd, culturing type II coccus. Blood cultures on both days were negative.

A post-mortem was not granted.

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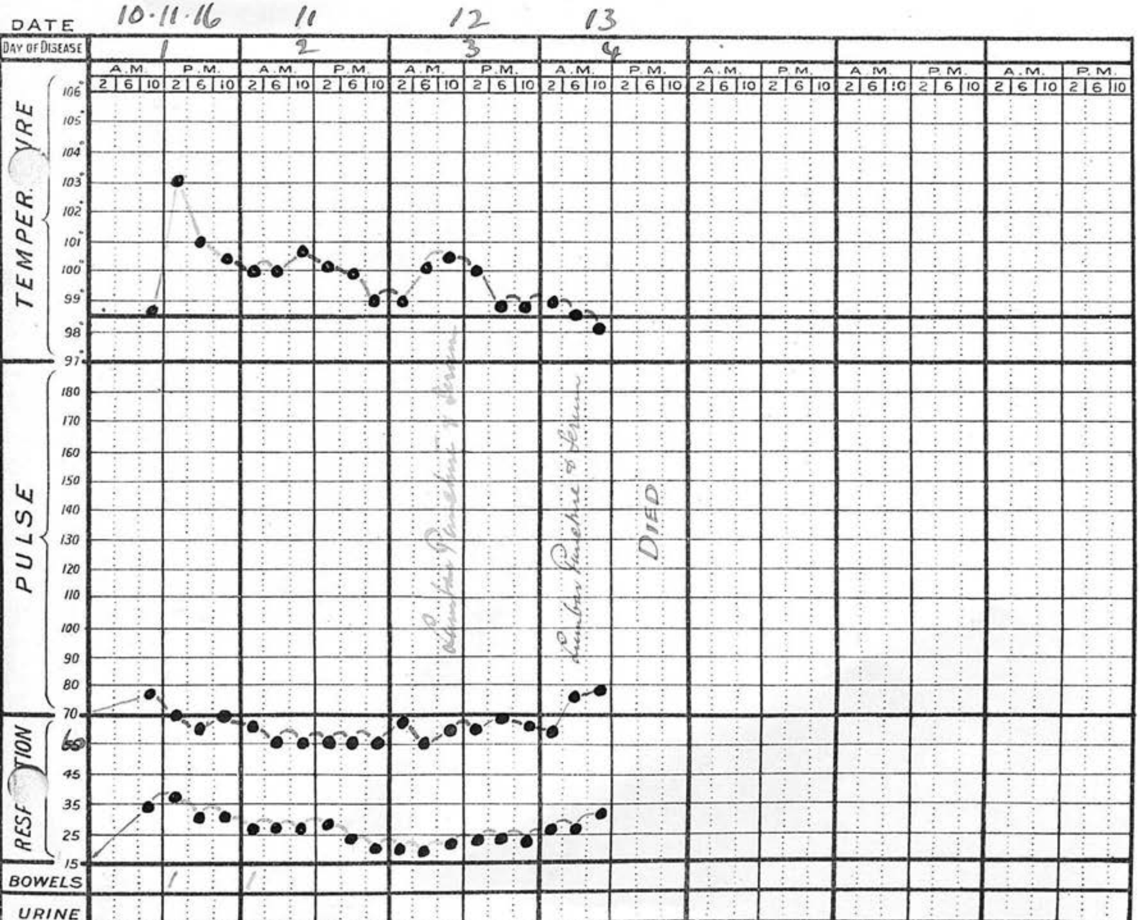
Case 6.

Gnr. J. H. B-------aet. 18 years was admitted to hospital on the 11-11-16 diagnosed as a case of influenza. He complained of a headache, photophobia, pain in the nape of the neck and pains in the loins. His history was that he was perfectly well up to 5-11-16 when he developed a headache which continued until the 8-11-16, when he reported sick with a headache, pyrexia, stiffness in the neck, and pain in the same region on movement. He was then looked upon as a case of influenza.

On examination he was found to be very drowsy, mentally dull, and to have tenderness and rigidity in the nape of the neck; his left pupil was smaller than his right, and he complained of more sensitiveness of this eye than the right. There was no evidence of lung or abdominal conditions being present. He had a very indefinite Kernig, but on gently forced extension of the leg pain was present in the adductor muscles. Knee jerks were absent; there was no Babinski; and no sore throat was present.



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12-11-16. Condition generally speaking was unchanged, but he had been somewhat delirious the previous night; tenderness in the neck and along the spine had increased slightly, and the headache if anything was a little worse. No further developments. On being asked to see the case, and on reviewing the above features I decided that it was essential to lumbar puncture, and upon doing so under a general anaesthetic, slightly turbid fluid was withdrawn under considerably increased pressure. 20 c.c. of Polyvalent A.M. serum was injected.

13-11-16. Although the patient was somewhat relieved after his puncture of the previous day, he became very restless during the night. In the morning his features were accentuated, and as the day passed he became unconscious and could not be aroused. Lumbar puncture was again done under a local anaesthetic (ethyl-chloride), and about 30 c.c. of very turbid fluid under marked pressure was drained away. 25 c.c. of A.M. Polyvalent serum was injected. Towards evening his condition became much worse, his pulse became very weak and rapid, and his respirations were of Cheyne-Stokes type. Incontinence of urine and faeces had been present throughout the day.

14-11-16. Patient had a very restless night, and in the early morning his pulse could not be counted with accuracy, he was still unconscious, and he had typical Cheyne-Stokes respiration. He died at 9-15 a.m.

Remarks:-

In reviewing this case I am sure that he was nothing more nor less than a mild acute case, which, through failure in early diagnosis, delayed lumbar puncture, and perhaps to a lesser degree poor quality antimeningococcal serum (for it was not of exceptionally good quality at this time), he became a very severe acute case, and ended in fulminant form. I feel that if the disease had been anticipated, and close observation had been made between the dates 5th and 8th, or at the latest between the 8th and 11th, some features suggestive of mild cerebro-spinal fever might have been found, to induce early treatment. By delaying in this way lumbar puncture was not given a chance either alone or with the assistance of serum. This case shows one how a mild case can be overlooked and result in very serious consequences.

Bacteriology and Cytology:- The fluid obtained on the 12th showed polymorphoneuclear cells and lymphocytes in the ratio of 3 to 1. No organism was found in direct smear, and no growth could be obtained from the cerebro-spinal fluid on plating. The fluid obtained on the 13th showed the polymorphoneuclear cells increased above the ratio of the previous day's examination; no organism was found in

direct smear, but the plating of the fluid gave a typical agglutinable culture of types I and III cocci. Blood was negative on culture on both days. Naso-pharyngeal swabbing was not done owing to the severity of his symptoms.

A Post-mortem was not done on account of the inability to obtain the consent of his parents.

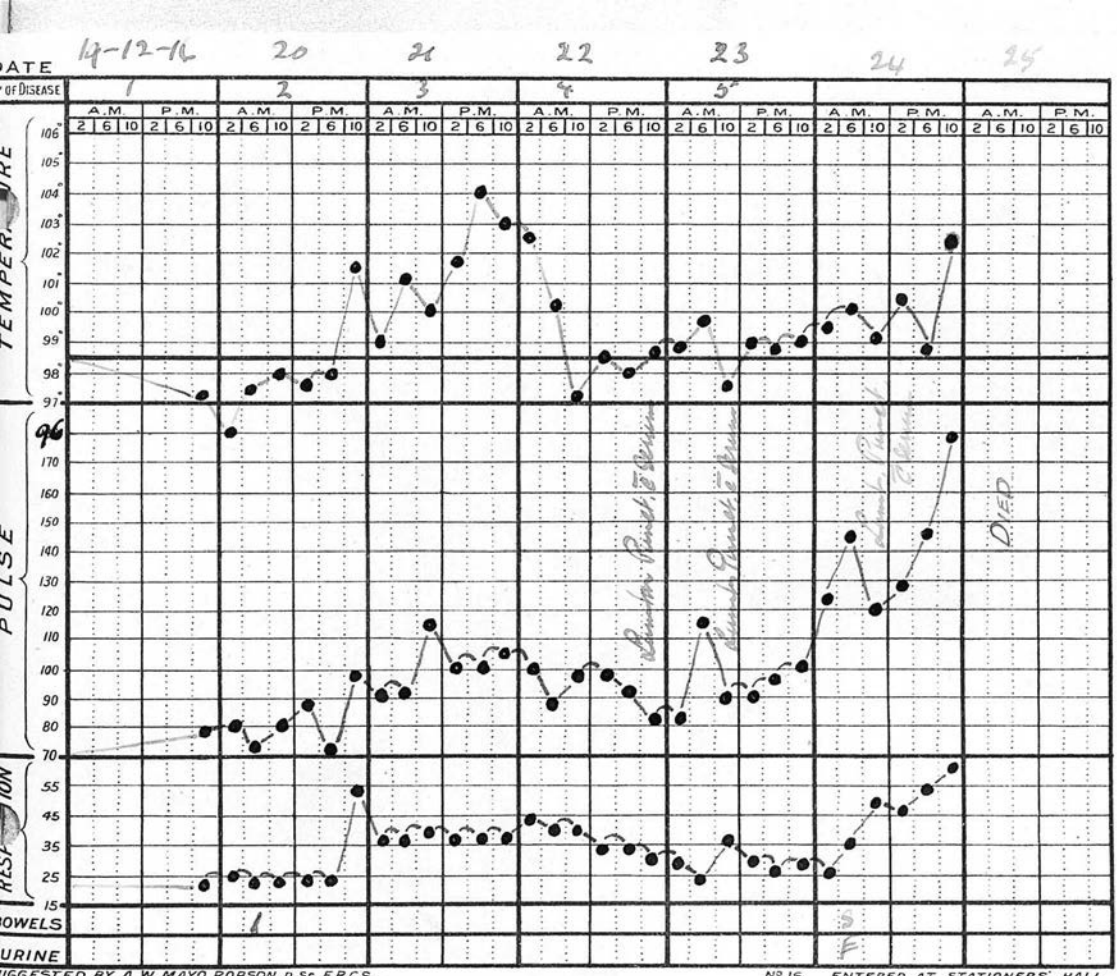
———— " ————

Case 7.

Pte. K. S-------, aet. 25 years, was admitted to hospital on the night of 19-12-16, with headache, pyrexia, pains about the limbs and body generally, and with a diagnosis of influenza.

20-12-16. He became delirious as the night passed on. He had no history (or could give none), beyond that he had a headache and what he termed a "cold". On examination of the chest, his right lung apex showed increased vocal resonance and vocal fremitus, tubular breathing, and comparative dulness, and his diagnosis was questioned as phthisis. He stated that he was stiff, could not sit up in bed, and could not bend his legs; however on examination his legs could be readily bent. There was no Kernig. Knee and planter reflexes were absent. Temperature was 98°, pulse 88, respiration 24. He still continued semi-delirious throughout the day. His temperature rose to 101.6° at 7 p.m.

21-12-16. He was markedly dull mentally, semi-delirious, rambling in his conversation, but would answer questions put to him. His only complaint was that he had a "cold", and that his cough was troublesome. As the day passed he became incontinent of urine. Temperature was 101.5° and pulse 92. On examination of the posterior thorax, he held his body very rigid, but this appeared more like an "intentional" rigidity rather than a pathological one. There was no definite Kernig, although the muscles inserted around the knee became very taut and were the site of considerable pain on extending the leg beyond a certain degree. Knee jerks were absent;



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no planter response and no ankle clonus could be obtained. There was no headache complained of. On examination of the neck a certain degree of stiffness was present, but not markedly so; and on forcing his head forward a little he complained of pain in this region, as well as tenderness on pressure. His heart valves were all incompetent, possibly the result of an old Rheumatic Endocarditis, since he gave a history of having had Rheumatic Fever some time previously.

22-12-16. He had a restless night, and was still incontinent and delirious; the rigidity of his body was considerably reduced. In the morning however he appeared a little better, appreciated things more, and was far less delirious. No change in his lung and heart condition was manifest. Feeling that his lung and heart condition could not readily explain his state, and as he was as yet undiagnosed, inasmuch as he had a few features of cerebro-spinal fever I decided to lumbar puncture under a local anaesthetic, since he objected to chloroform (and his heart and lung complications did not particularly recommend it). Puncture yielded slightly turbid cerebro-spinal fluid under slightly increased pressure. Polyvalent A.M. serum was injected.

23-12-16. He had a considerably more restful night, and slept for five hours after gr. 10 of chloral. In the morning he was slightly delirious but was more peaceful than on the previous days. There were no developments. Lumbar puncture was again done and fairly clear fluid was removed under less increased pressure than on the previous day; polyvalent A.M. serum was again injected.

24-12-16. He slept peacefully throughout the night from nine p.m. until 5 a.m., and he was perfectly restful after this, except that at times he rambled in his conversation a little; however he entered into rational conversation on every occasion that he was spoken to. He stated that he felt better and certainly he was much brighter, and he interested himself in his surroundings. He was quite happy and enjoyed some of the jokes of those about him. His Kernig was still absent, and no Babinski was present. There was a hypertonicity of the dorsal muscles. He was still incontinent of urine but not of faeces. No rash had developed. Lumbar puncture was again done and comparatively clear fluid was obtained under very little above normal pressure. A.M. polyvalent serum was injected.

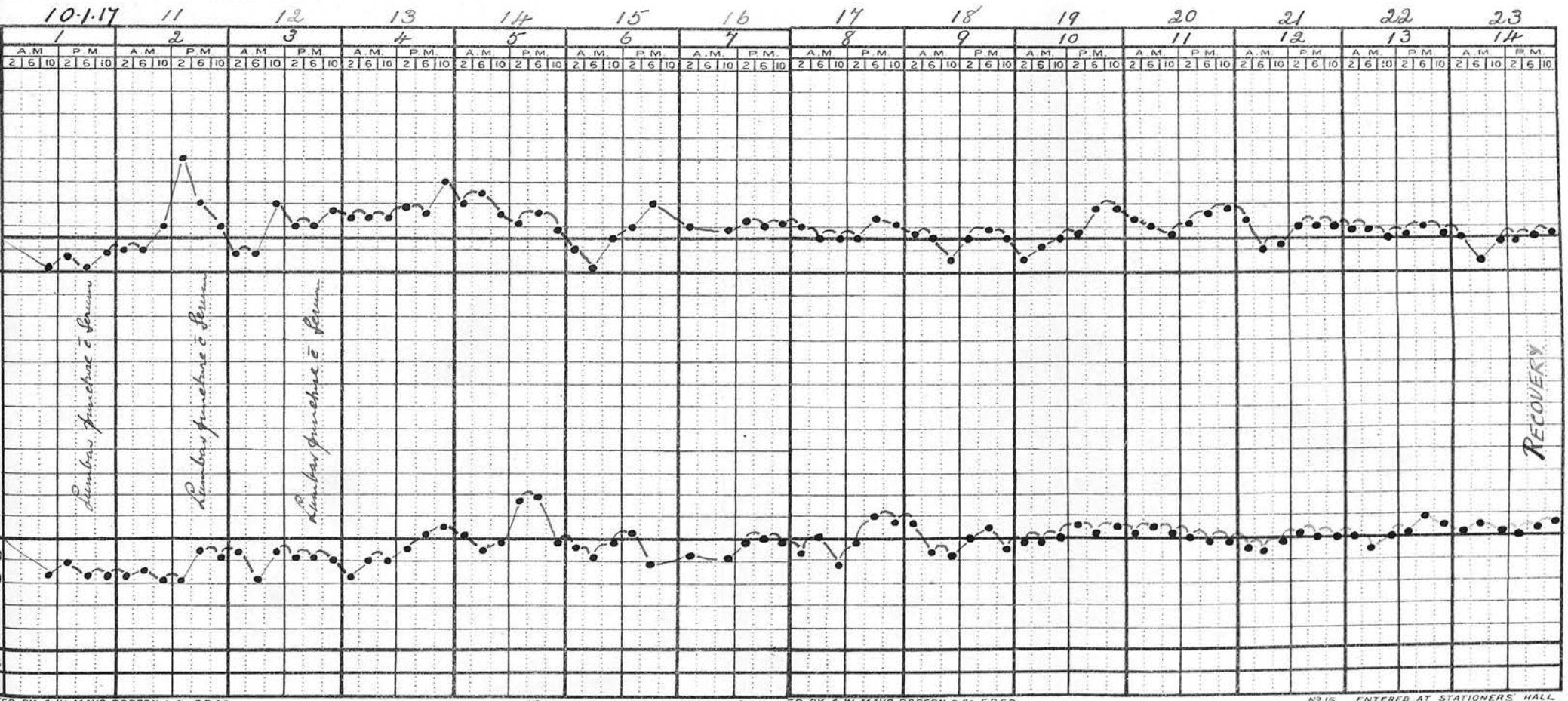
During the afternoon, up to which time he had been showing marvellous improvement, he began to show signs of cardiac embarrassment, his pulse becoming weak, and his heart's action irregular and feeble. Stimulants were administered in the form of strychnine and digitalin hypodermically, and he improved slightly, but this could not be maintained well. Salines and Pituitrin were tried also without avail.

His condition that night became very precarious, and failing a satisfactory result with stimulants, he died at 5-10 a.m. on 25-12-16, as the result of his cardiac condition.

Remarks:-

A very unfortunate case, but yet somewhat instructive. This was my case throughout and I am anxious to show where I failed in diagnosing the case earlier than I did. This was another case presenting other clinical features than those of cerebro-spinal fever to blind one at first; his lung and his heart condition, with the history that he had developed influenza, which was somewhat epidemic at the time, rather foiled me. There were certainly quite sufficient features although each in itself was not well marked, to make one suspicious of cerebro-spinal fever, and I feel sure that had this case occurred after my subsequent experiences I should have had no hesitation in making my provisional diagnosis of cerebro-spinal fever a day or two earlier. However when diagnosed he was religiously punctured and given serum, with the most markedly successful results, and I think I am correct in saying that, had he not had such a markedly weakened heart, he would have very readily recovered, and with remarkably little treatment.

Bacteriology and Cytology:- The Cerebro-spinal fluid was prolific in polymorphoneuclear cells, and had very few lymphocytes in proportion. The fluid of the 22nd gave no cocci in direct smear or on culture. The fluid of the 23rd gave no cocci in direct smear, but cultures produced a scanty growth of typical meningococci, which agglutinated with Type II serum. Nasopharyngeal swabs produced a prolific culture of Type II organism. Blood culture was negative.



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Case 8.

Pte. A. F-------. aet. 39 years, was admitted to hospital on 10-1-17 undiagnosed, and complaining of pain in the occipital region and neck, with stiffness in the cervical region. He was generally speaking hyper-asthetic; there were nervous twitchings of the muscles of the face, about the eyes and mouth, and marked hyperasthesia along the dorsal and lumbar regions generally. He suffered from photophobia; knee jerks were slightly increased; and an indefinite Kernig was present. No definite history was obtainable of his previous condition. Lumbar puncture was done under chloroform, and fairly clear fluid was drained away which contained flakes of lymph, and which was under slightly increased pressure. Polyvalent A.M. serum was injected.

11-1-17. Condition was much the same; he was very slow in answering questions, and appeared slightly dazed. When moving himself in bed, he complained of pains in the neck. Headache in the occipital region was still a prominent feature. Lumbar puncture was again done, and with similar results as on the previous day. Serum was again injected.

12-1-17. Considerable improvement was manifest; he still had a certain amount of pain in the neck, and headache; he had not slept well the previous night. Lumbar puncture was again done, and clear fluid was obtained under normal pressure. Serum was injected.

23-1-17. Condition continued to improve after his last lumbar puncture; he still had a trace of headache, and perhaps very slight cervical stiffness. He had slept soundly during the previous nights. Generally speaking there were no complaints of any consequence.

13-2-17. Headache although very slight continued for a few days after the 23rd but had now disappeared.

24-2-17. Discharged to convalescent hospital feeling perfectly fit.

Remarks:-

A mild case which I feel, through persistence of headache and neck features might have resulted in a much more severe infection had it not been for early and persistent treatment.

Bacteriology and Cytology:- Very little cellular element was found in the centrifuged deposit from the fluid, Lymphocytes and polymorphoneuclear being evenly distributed. No organism was obtainable in direct smears or cultures from any fluid. Nasopharyngeal swab gave a typical growth of meningococcus which agglutinated with type III serum. Blood examination showed an increase in polymorphs and total leucocytes, but gave no culture.

Case 9.

Gnr. H--------, aet. 20 years, was admitted to hospital on 6-2-17 with pains in the occipital regions and neck. He had a history of not feeling well for two days, of having been a little feverish, and of vomiting once or twice. He had slight rigidity of the neck; knee jerks were present; there was no Kernig; he appeared very dull and was reluctant in speaking; and slight head retraction was present. He was kept under observation during the night.

9-2-17. Owing to my absence on leave during his admission and the past two days, I cannot record his progress, but I note the following from his case-sheet:- "His condition was unchanged".

On the 9th however I was informed that he was becoming worse, and I found all of the above features accentuated; and that his knee jerks were absent, a definite Kernig was present, and in fact that he was a typical picture of cerebro-spinal fever. Lumbar puncture was done, and 35 c.c. of slightly turbid fluid was removed under increased pressure. 20 c.c. of Polyvalent serum was injected. His condition at night necessitated gr. $\frac{1}{4}$ morphine being given hypodermically.

10-2-17. His condition was much the same, he had a distressing headache, was markedly restless, and exceedingly dull mentally. He became very weak during the day and was somewhat collapsed; however he picked up under pituitrin. Lumbar puncture was done under local anaesthesia and with similar results to the previous day. Serum was again injected.

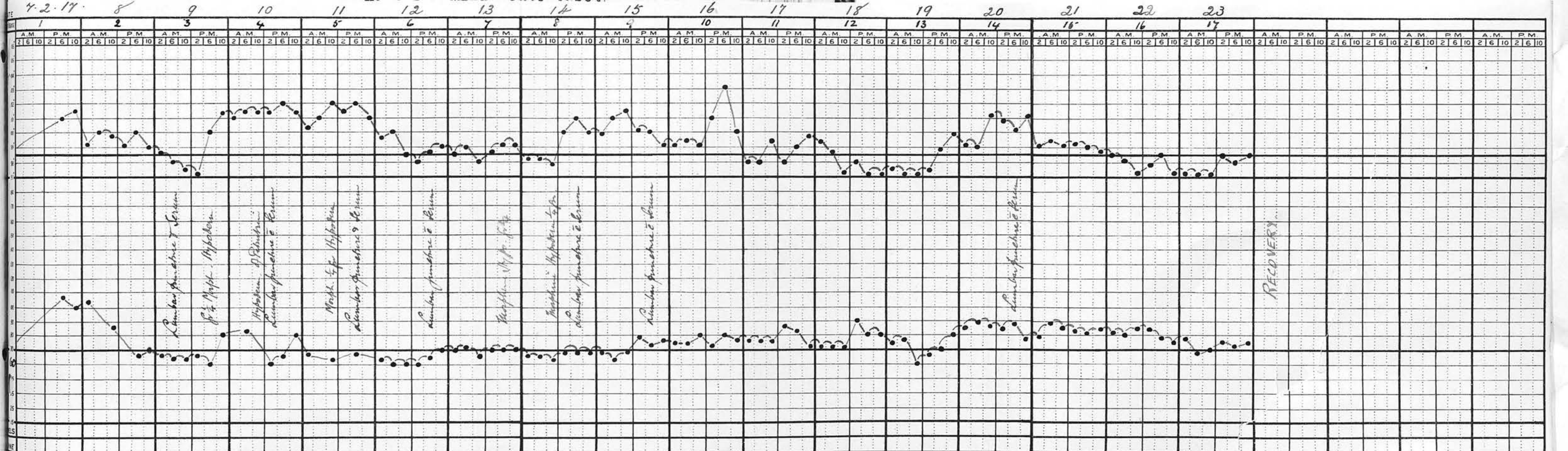
11-2-17. His condition was still much the same, but with no developments. Lumbar puncture was again done, and about 30 c.c. of fluid was removed under increased pressure and slightly turbid. Serum was again injected. After this puncture he appeared greatly relieved and slept quietly.

12-2-17. Great improvement had taken place; his headache was still present but much better. Lumbar puncture was again done with similar results to the previous day and serum was injected.

13-2-17. Progress was satisfactory.

14-2-17. Temperature rose during the afternoon with increased headache and general uneasiness. His features tending to get worse, lumbar puncture was again done with similar results to those of previous days and serum was injected.

15-2-17. Improvement was again marked, but still the headache was somewhat severe. Lumbar puncture was again done with similar results and serum was injected.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Lumbar puncture & Serum
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Lumbar puncture c̄ Serum
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Lumbar puncture c̄ Serum
RECOVERY.

19-2-17. During the past four days he was much better.

20-2-17. Temperature again rose to 101°, accompanied by headache and mental dulness, pain in the limbs, and stiffness in the neck. Lumbar puncture was again done, and comparatively clear fluid was drained away, but under very considerable pressure.

After this his condition rapidly improved and was well maintained. On the 10-4-17 he was perfectly well except for occasional headaches, and was sent to convalescent hospital..

Remarks:-

He was a mild acute case, who might have required much less treatment had his punctures been commenced a few days earlier. From this case I was helped in my decision not to stop puncturing too soon as it will be seen that his clinical features kept returning, and necessitated repeating puncture procedure. It is quite possible that had I done another puncture with administration of serum on 13-2-17 or 15-2-17, there may have been no necessity for further procedure in this respect.

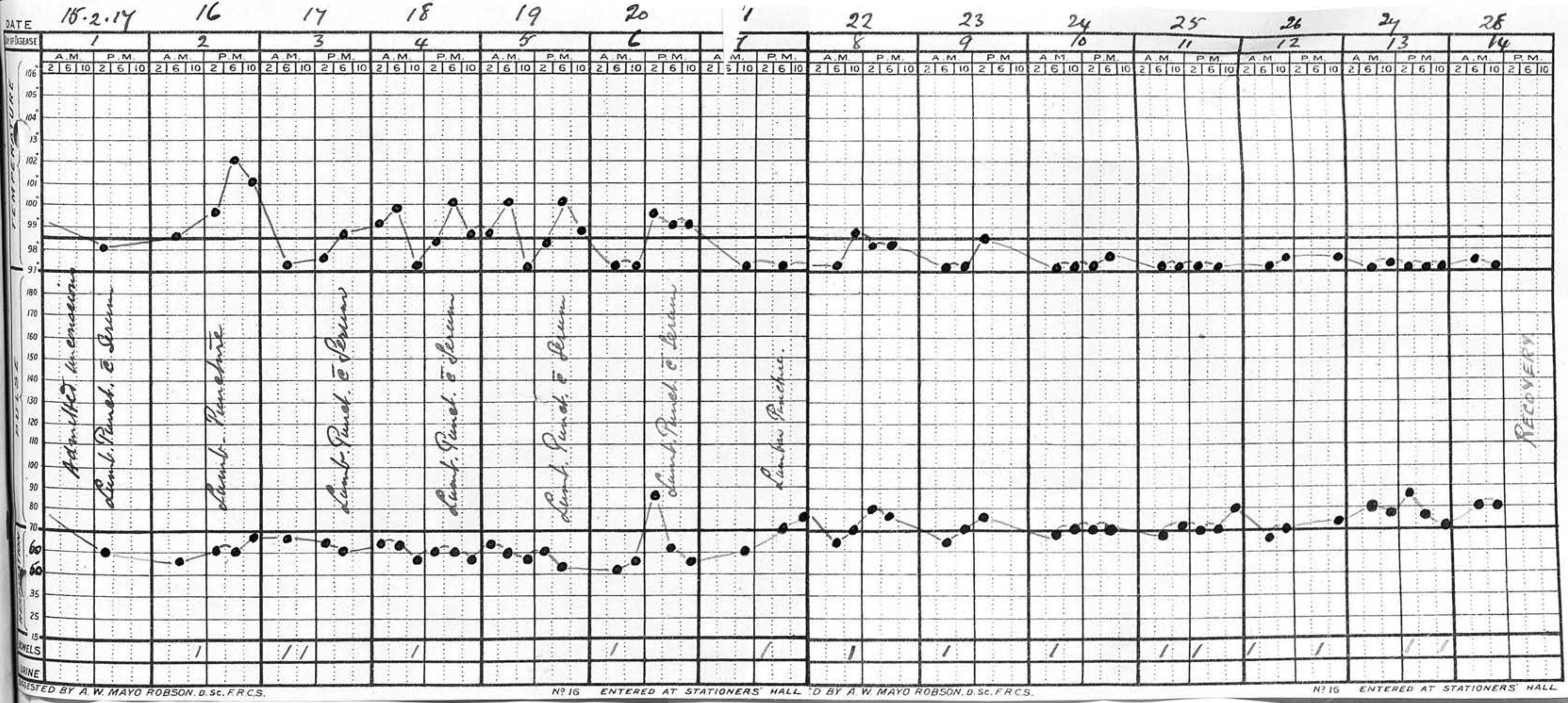
Bacteriology and Cytology:-

Direct smears showed polymorphoneuclears to be profuse and lymphocytes few, but no cocci. The first plates of the fluid gave no culture, but after 24 hours primary incubation of the fluid with broth a good growth was obtained of meningococci, agglutinating with type I serum in dilutions up to 1 in 200, with type II serum in dilutions up to 1 in 200, and with type IV serum in dilutions up to 1 in 400. As the organism died quickly and no further growth could be obtained further conclusions as to the type of organism present could not be obtained. Nasopharyngeal swabs proved negative on three occasions, but these were not taken until late in the course of the disease. The blood was negative on culture; but presented a leucocytosis of 18,000 with the main increase in polymorphoneuclears.

Case 10.

Bomb. A. H. R-----, aet 22 years, was admitted to hospital undiagnosed on 15-2-17 in a semi-unconscious state, and in a condition of wild delirium necessitating 4 or 5 men to hold him down. Physically he was a very robust fellow. I was unable to get any history on admission, being unable to get as much as an attempt to answer from him. He threw himself about as though suffering great pain, and was continuously grasping his head as though the pain were localised there. His body was held very rigid particularly in the cervical and lumbar regions. On careful examination there was some slight degree of head retraction, marked rigidity in the cervical regions and lumbar region, and in fact throughout the whole spine. There was evidence of tenderness on deep pressure along the whole spine. There was no rash; no incontinence; and no history of his having been seen to vomit. The Kernig sign was present, but not exceedingly well marked; the knee jerks were present and about normal; and there was a very definite Babinski. His temperature was 98° and his pulse 56, when taken at 2 p.m. just after admission. Lumbar puncture was immediately done under chloroform and 50 c.c. of very turbid cerebro-spinal fluid was drained away under increased pressure, the drainage being continued until normal pressure was presented.

16-2-17. Owing to marked restlessness in the early part of the night, he had to be given gr. $\frac{1}{4}$ of morphine hypodermically, after which he had a fairly quiet and restful night. He was watched by an orderly continuously, but never required to have his movements restrained. In the morning he was quite conscious, and was able to converse freely, and gave the following history:- "On the morning of the "14-2-17 when he awoke he had a headache accompanied "by aching in the small of the back, in fact he felt "stiff all over; he had slept fairly well during the "early part of the previous night and retured to bed "feeling perfectly well; he reported sick but was "looked upon as a case of influenza; the night of "that day (14th) he became more feverish and felt a "great deal worse and could not sleep for the sever-"ity of his headache and backache. On the morning "of the 15th he felt very ill, was very feverish, "and vomited some greenish fluid, was very thirsty, "and had a distressing headache. He was then looked "upon as an acutely bilious case. His vomiting con-tinued throughout the early morning and then ceased. "at about dinner time he became unconscious and "remembered nothing until he awoke in hospital on the "morning of the 16th after regaining consciousness."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Lumbar Puncture
RECOVERY
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His complaints this particular morning were as follows:- A very severe headache of particular intensity in the occipitalregion, trobbing in nature and with the distressing feeling that his skull must burst if not relieved. There was intense pain at the back of the eyes and very marked photophobia. There was pain in the nape of the neck and along the spine, and considerable hypersensitiveness along the spine with marked tenderness on slight pressure throughout the whole length of the spine. He had slight abdominal pains more of the nature of discomfort. He was very quiet and mentally dull. He was developing a very extensive herpes around the mouth and mares. By this time a very well marked Kernig was presented; and he had entirely lost his knee jerks. Head retraction was less marked than on the previous day. His temperature was 102.2°, and his pulse 60 at 6 p.m. He still had strabismus, slight ptosis, and his left pupil was somewhat more contracted than his right. Lumbar puncture was done in the evening under chloroform, and about 70 c.c. of very turbid yellowish green fluid was drained off under exceedingly increased pressure, at first pumping out and accentuated by respirations; he was decompressed down to normal pressure and very slowly; and 30 c.c. of polyvalent A.M. serum was injected intrathecally. Late at night gr. $\frac{1}{4}$ of morphine was given but, failing in its result, chloral and potass. bromide was given.

17-2-17. Condition was markedly improved; he was feeling very much more comfortable; his head was still aching but the distressing acuteness was away; all clinical features were improved,and his eye features were not so marked. There were no new developments. His temperature was normal, and his pulse 66. In the evening the intensity of his headache increased, so lumbar puncture was again done, and 40 c.c. of much clearer fluid was removed under increased pressure, but not so much so as the previous day. 20 c.c. of polyvalent A.M. serum was injected intrathecally. Chloral and bromide mixture was continued throughout the day.

18-2-17. General condition had slightly improved, but no symptom nor sign had entirely disappeared. He complained of slightly more headache, still had considerable pain in his back, and considerable neuralgic pain was developing along the nerves of both lower extremities. His temperature was 100° and his pulse 60. Lumbar puncture was done in the evening a t 6 p.m. under chloroform, and 50 c.c. of turbid fluid was removed under increased pressure. 20 c.c. of polyvalent A.M. serum was injected intrathecally.

19-2-17. Condition was much improved, headache was less, mpvement in bed was with more freedom, head retraction had absolutely gone, and stiffness in the neck and dorsal regions was subsiding. Lumbar puncture was again done at 6 p.m. and about 30 c.c. of fairly clear cerebro-spinal fluid was drained away under very slightly increased pressure. 20 c.c. of the same polyvalent serum was injected. As the patient objected to have a further general anaesthetic this puncture was done under local anaesthesia (ethyl-chloride spray), with the result that although the serum was injected slowly and was previously warmed, he complained of considerably lumbar inconvenience. There was not the same relief of headache as with previous lumbar punctures and he complained for an hour or two of shooting pains down into his thighs; and moreover he did not get to sleep so readily as on previous occasions.

20-2-17. Patient did not have such a good night; however his condition was still improving and he was much more comfortable than he had been, generally speaking although his headache was if anything worse. He was quite bright; the pains in his limbs had disappeared, as also had the stiffness in his neck. Lumbar puncture was again done under local anaesthetic as before, and 30 c.c. of clear fluid was drained off under little above normal pressure. 20 c.c. of polyvalent A.M. serum was injected.

21-2-17. Condition continued to improve. Headache was a little better, and other features were subsiding. Temperature was still up the previous night, and although it was not rising this evening, another lumbar puncture was done with similar results to that of the previous nights. No serum was injected.

The patients condition then steadily improved with steady disappearance of practically all symptoms and signs. On 6-5-17 all clinical features had entirely disappeared; he had put on considerable weight, was up and about, and the only remnant was the slightest headache on exertion, and sluggish knee jerks. He was thrice swabbed negative post-nasally and was transferred to convalescent hospital.

Remarks:-

A very severe case verging on the fulminant type. The guiding features for treatment in this case were headache and temperature. He was a very critical case. Pasteur polyvalent serum was used throughout.

Bacteriology and Cytology:- Gram negative diplococci were found in direct smears, and on culture typical colonies of meningococci were found to be present, and agglutinated with types I and

III sera. No growth could be obtained from his blood, but his blood serum agglutinated types I and III cocci. Nasopharyngeal swabs presented good growths of types I and III cocci and these were persistent for several weeks.

I saw this patient six months later, looking well and feeling well, his only sequelae being a slight weakness in the lumbar region.

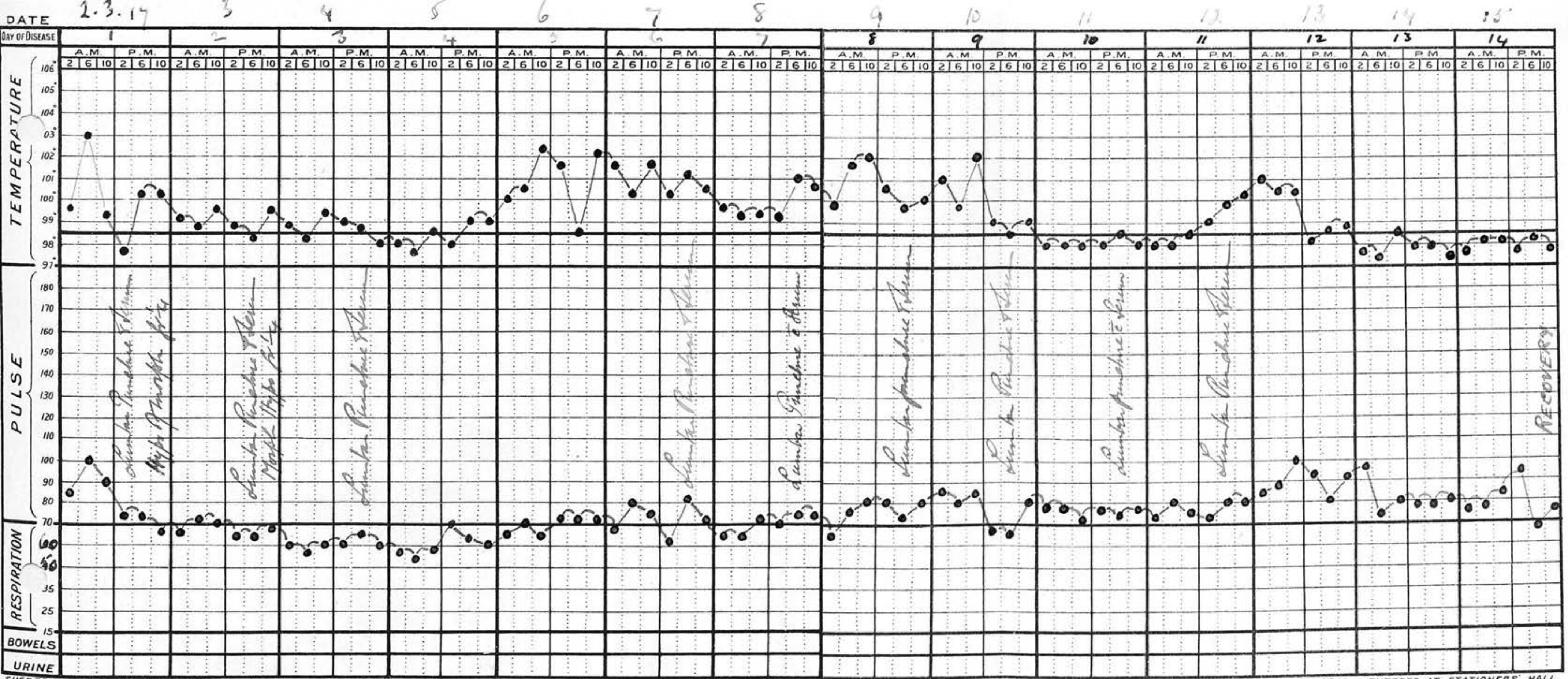
Case 11.

Pte. R. M--------, aet 27 years, was admitted to hospital on 2-3-17 complaining of a marked headache, pain in the nape of the neck accompanied by stiffness, and occasional vomiting. On examination he presented a very definite and typical rash, consisting of purpuric spots about the abdomen, buttocks, and thighs. He had a well developed Kernig and his knee jerks were absent; he was mentally dull, and he showed marked photophobia. Lumbar puncture was immediately done and 30 c.c. of turbid cerebro-spinal fluid was removed under slight pressure. 20 c.c. polyvalent A.M. serum was injected.

3-3-17. Severe headache was still present, but his general appearance was greatly improved, and he stated that he was considerably better. His photophobia was considerably diminished. Lumbar puncture was again done, and 50 c.c. of turbid fluid was drained off under increased pressure. 20 c.c. of polyvalent A.M. serum was injected.

4-3-17. General condition was much improved; he still had a headache and pains in his legs; he had very little sleep during the night; he still had slight photophobia, particularly marked in his right eye. Lumbar puncture was done under local anaesthesia because he objected to chloroform. 30 c.c. of turbid fluid was removed under slight pressure and serum was injected.

5-3-17. Headache was still present but general condition was improving.



DATE
2.3.17
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11
12
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DAY OF DISEASE
1
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A.M.
P.M.
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TEMPERATURE
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104°
103°
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101°
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PULSE
180
170
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130
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90
80
70
RESPIRATION
60
50
40
35
25
15
BOWELS
URINE
Lumbar Puncture & Serum
Hypo Morphia gr 1/4
Lumbar Puncture c̄ Serum
RECOVERY

6-3-17. Improvement was maintained; slight pyrexia was still present, but pain in the head, neck, and limbs was much reduced, and photophobia was completely away.

7-3-17. He complained of returning pain in his neck and around the shoulders. His general appearance was good, he felt a little weaker, had tinnitus, and his temperature was 102°. Lumbar puncture was done and 25 c.c. of fairly clear fluid was drained away at about normal pressure. 25 c.c. of polyvalent A.M. serum was injected.

8-3-17. General condition was slightly improved, but there was still pain in the nape of the neck, and pyrexia continued. Lumbar puncture was done and serum injected. The fluid obtained was the same as on the previous day.

9-3-17. General features were improved, but he complained of weakness and tiredness and was very dull. Lumbar puncture was done, and 20 c.c. of somewhat turbid fluid was drained away under slightly increased pressure. 20 c.c. of polyvalent A.M. serum was injected.

10-3-17. There was steady improvement, but features as before mentioned were still present. Lumbar puncture was done and fairly clear fluid was drained away under increased pressure. 20 c.c. of A.M. polyvalent serum was injected, but owing to the features hanging fire somewhat I decided to change the brand of serum in this instance.

11-3-17. There was manifest general improvement; but I cannot state any more markedly so than with the previous type of fluid. Lumbar puncture was again done and 30 c.c. of clear fluid was drained away under nearly normal pressure. 20 c.c. of the same brand of polyvalent A.M. serum was injected as on the previous day.

12-3-17. Condition showed extremely well-marked improvement, with marked subsidence of most features.

13-3-17. Condition was well maintained.

22-3-17. Since the last lumbar puncture the improvement had gone ahead with leaps and bounds and there was practically a total disappearance of all signs and symptoms.

11-5-17. Patient was perfectly well and had no sequelae whatever. He was sent to convalescent hospital.

Remarks:-

This case was certainly of severe acute type, but presented typical straightforward features. He had a typical rash, which, as one or two of my cases showed, was not present in the fulminant cases only.

In the treatment he certainly showed more rapid progress under a change of brand of serum; but this result alone was not conclusive enough to make any

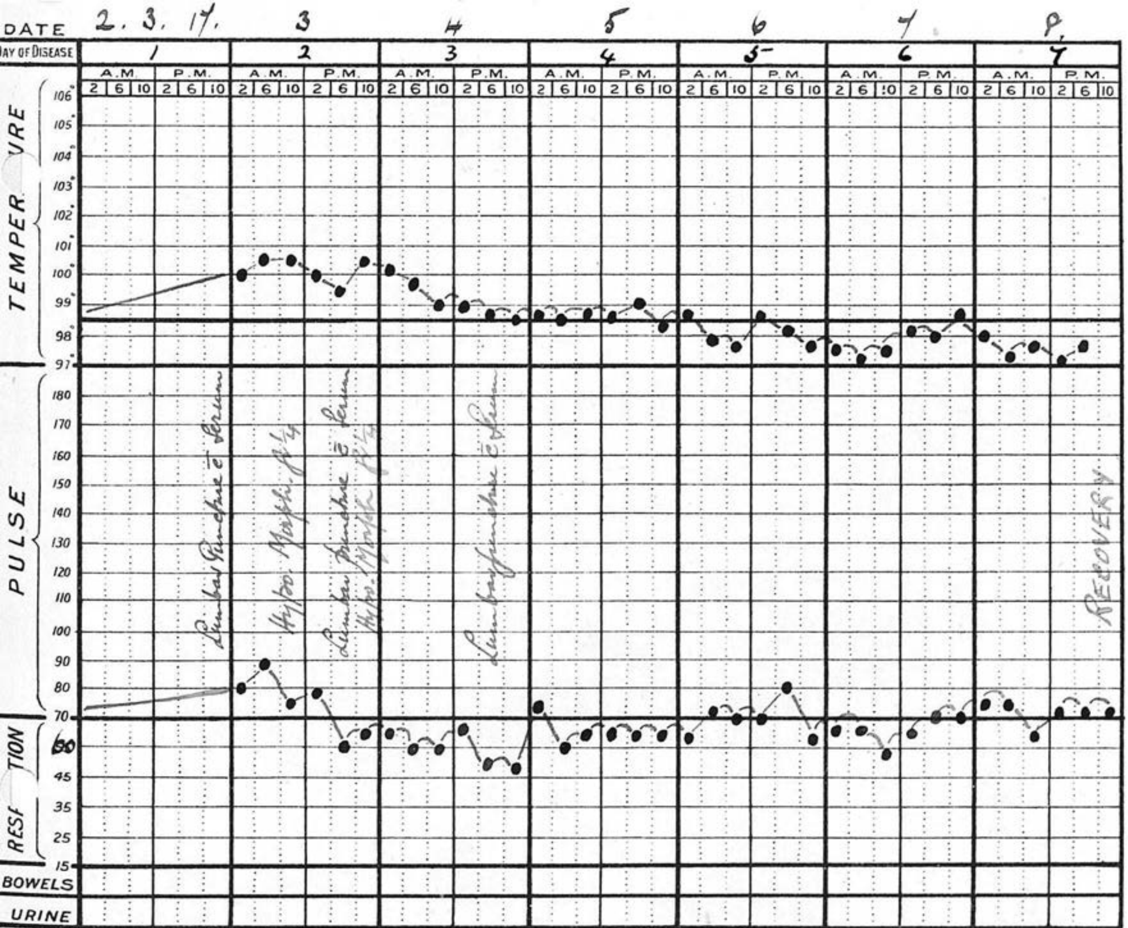
definite remark about, although I am inclined to think it was more than a coincidence from the experience I had in other cases.

Bacteriology and Cytology:- Direct smears showed meningococci on several occasions although no culture could be obtained, perhaps explained by exposure of the first sample of fluid in its transit to the Laboratory, and in later samples through the action of the antimeningococcal serum. In the cellular element of the fluid there was a marked preponderance of polymorphoneuclears. The nasopharyngeal swab cultured Type I coccus. Blood was negative on culture. Blood count showed a marked leucocytosis with the increase entirely in polymorphoneuclears.

Case 12.

Pte. L. S-----, aet. 27 years, was admitted to hospital at 11 p.m. on 2-3-17 with only one complaint viz: a distressing headache. It was impossible to get any further details from him. The history obtained from a companion was that he took ill suddenly on parade that afternoon, vomited once only, and complained of a severe headache. On examination it was impossible to definitely decipher his reflexes, although his knee jerks appeared to be present. He had a very definite Kernig sign in both extremities, and considerable rigidity in the cervical region. He evidenced pain on lifting his head from the pillow. Still his only symptom complained of was severe headache. There was no evidence of acute Thoracic or abdominal trouble, no history or sign of an accident; and no rash was present. Lumbar puncture was done under chloroform and 70 c.c. of very turbid fluid was removed under very great pressure. 25 c.c. polyvalent A.M. serum was injected.

3-3-17. He was completely conscious, had a very severe headache, pains along the spine, stiffness in the legs, and pains throughout his body on movement. Lumbar puncture was done and 40 c.c. of very turbid fluid was drained away under great pressure. 25 c.c. polyvalent A.M. serum was injected.



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4-3-17. He was very restless during the night; his headache was still very severe, pains in the spine were still present, and generally speaking there was nodisappearance of any feature, although all features were somewhat improved. Lumbar puncture was again done and 30 c.c. of slightly turbid fluid was removed under pressure. 20 c.c. polyvalent serum was injected.

5-3-17. General condition was markedly improved. All features were rapidly subsiding.

6-3-17. Marked improvement was maintained.

2-5-17. Patient was convalescent and had no sequelae beyond slight headaches occasionally.

Remarks:-

A very severe acute case which acted very readily to routine treatment.

Bacteriology and Cytology:- Direct smears from the fluid showed gram negative intracellular diplococci, which on plating cultured Type I meningococci. Nasopharyngeal swab was not taken until late in the course of the disease, when it proved to be negative. The cellular element of the spinal fluid consisted mainly of polymorphoneuclears, although there was a small proportion of lymphocytes present. Blood gave a negative culture. Cytology of blood :- leucocytes of 24,000 with increase mainly in polymorphoneuclears.

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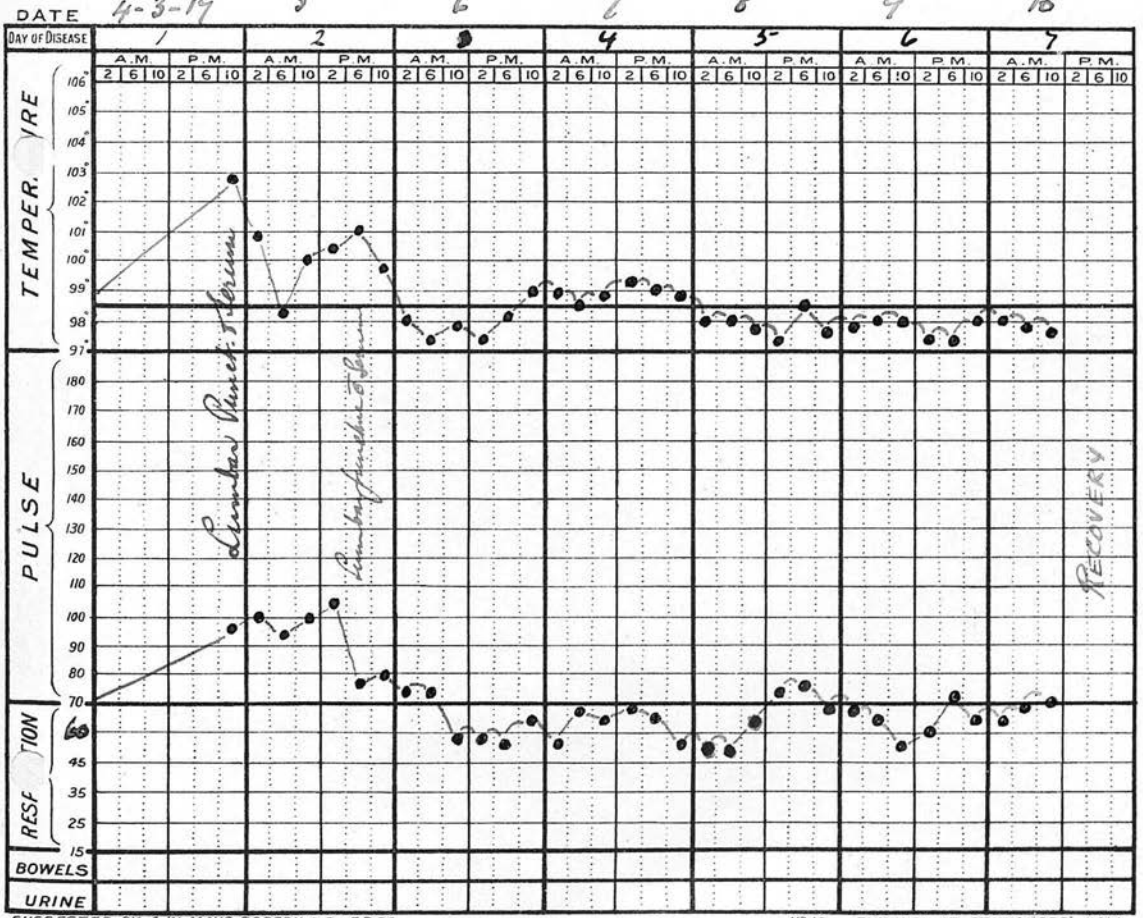
Case 13.

Dvr. T. P------, aet. 18 years, was admitted to hospital at 9 p.m. on 4-3-17 with the following history:- That he first felt ill on 1-3-17 with a sore throat, cough and headache, but with no vomiting. This state continued until his admission, when his headache was rapidly becoming worse, and he was developing pain in the small of his back. He was of dull disposition, had a distinct photophobia, and had pain and stiffness in the nape of the neck. Kernig's sign was positive and well shown, and the knee jerks were absent. He had a well marked purpuric rash scattered throughout the whole surface of his body, and even haemorrhages into the conjunctivæ. Lumbar puncture was done, and about 45 c.c. of turbid fluid was drained away



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under very greatly increased pressure. 25 c.c. of polyvalent A.M. serum was injected.

5-3-17. General condition was very markedly improved, although he still had a headache, and pain in the neck with stiffness. Lumbar puncture was done and 30 c.c. of slightly turbid fluid was removed under very little above normal pressure. A.M. serum was injected.

6-3-17. Patient appeared and felt better. Temperature was normal, stiffness and pain were greatly reduced, and he appeared well on the way for recovery.

2-5-17. Progress after the last lumbar puncture was rapid and uninterrupted. He still had slight recurrent headaches occasionally but otherwise was quite well when he was transferred to a convalescent hospital.

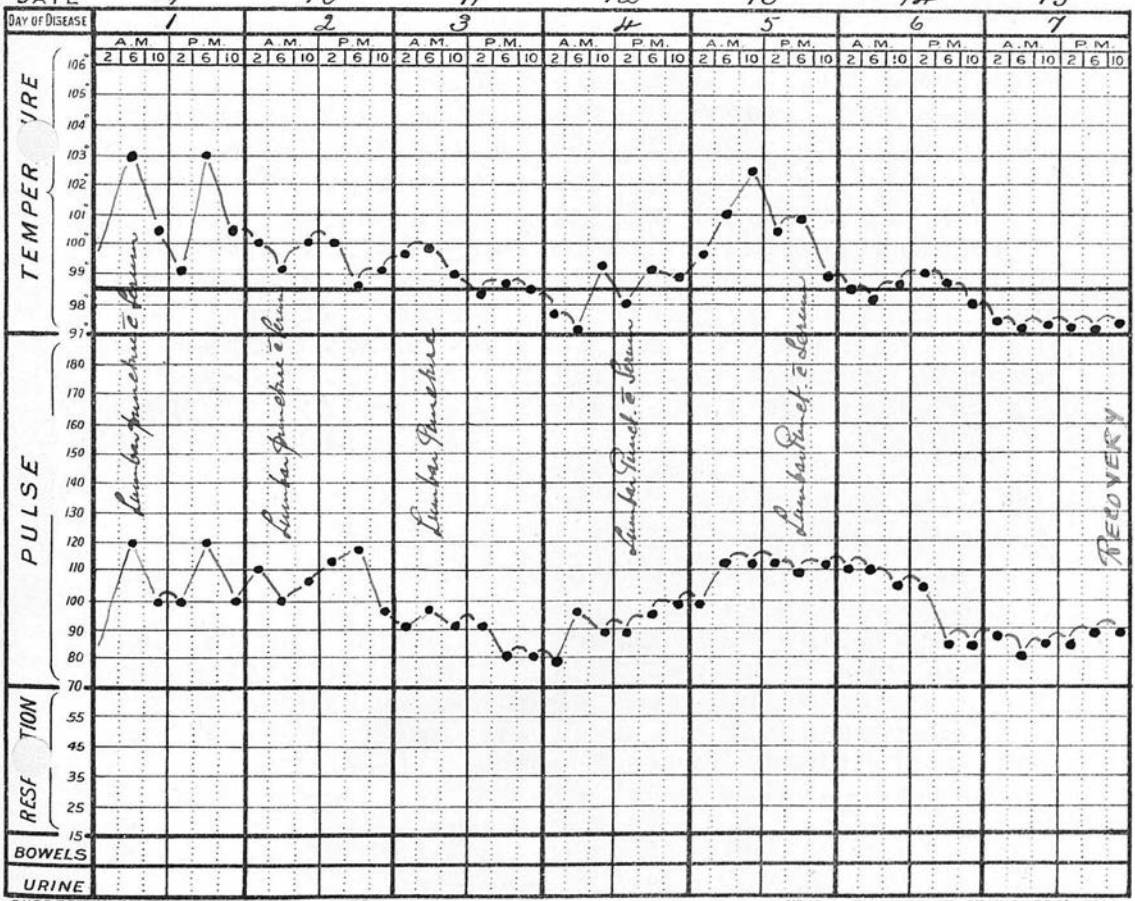
Remarks:-

Although this case was only of moderately mild severe type, he had the most widespread purpuric rash so typical in a certain percentage of cerebro-spinal cases that I have ever seen. The extent and severity of the rash was therefore no indication of the severity of the disease.

Bacteriology and Cytology:- Direct smears of the fluid showed gram negative intracellular diplococci which on culture proved to be Type II cocci. Nasopharyngeal swab produced an agglutinable culture of Type II coccus. Blood culture was negative.

Case 14.

Gnr. T. N. G-----, aet. 18 years, was admitted to hospital on the 9-3-17 suffering from influenza. He was complaining of headache, and general pains throughout the body and limbs. He had a history of having vomited on the previous day. On examination he was seen to have slight photophobia; there was a very typical purpuric rash over the lower part of the trunk, buttocks, and thighs. His knee jerks were absent, Kernig's sign was definitely present; there was a slight rigidity in the neck, but no pain nor tenderness; he had a slightly sore throat. His further history was that he took ill the previous day, felt a stiffness in the back and limbs, vomited in the morning, and that a headache developed and increased in intensity as the day passed on. Lumbar puncture was done immediately, and 40 c.c. of turbid fluid was removed under considerably increased pressure. 25 c.c. polyvalent A.M. serum was injected.



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10-3-17. General condition was improved but he still complained of stiffness in the lower extremity and neck. Headache was still present. Lumbar puncture was again done and 40 c.c. of very turbid fluid was removed under greatly increased pressure. 25 c.c. polyvalent A.M. serum was injected.

11-3-17. General condition, including stiffness and headache, were much better and no lumbar puncture was done.

12-3-17. Headache became much worse than on the previous day and he began to be mentally dull again; so lumbar puncture was again performed, and 45 c.c. of much less turbid fluid was drained away under greatly increased pressure. 25 c.c. of the same serum was injected.

13-3-17. General condition was improved markedly, although he had considerable pyrexia. In view of this fact, and the increased intrathecal pressure of the previous day, another lumbar puncture was done, and about 30 c.c. of very slightly turbid fluid was removed under very little above normal pressure. 25 c.c. polyvalent A.M. serum was injected.

14-3-17. Marked improvement. The only pain now present was on movement of the head.

11-5-17. His condition continued to improve rapidly. He was now convalescent and suffered from no ill effects.

Remarks:-

A typical mild case showing the fact that the typical rash may present itself in other cases than the fulminant type.

Bacteriology and Cytology:- No organism was found in direct smears but polymorphoneuclears were present in large numbers. Culturally a typical growth of meningococcus was obtained and was agglutinated by Type II serum. Nasopharyngeal swabs cultivated colonies which agglutinated to both types II and III sera. Blood culture was negative.

Case 15.

L/Cpl. G. McN------, aet 24 years, was admittedto hospital on 14-3-17 as a suspicious case of cerebro-spinal fever. He gave the following history:- That on 12-3-17 he developed soreness in the neck on movement, faintness, and malaise generally, with only a slight headache; he had a restless night and next morning he could not stand upright, and felt ill, and was thus confined to his bed. On the following day 13-3-17 he developed a more severe type of headache, becoming accentuated as the day passed on, and centralising itself in the occipital region; he had acute pain in the neck on the least movement. He had vomited a few times.

On admission he vomited once, had some slight twitching of face muscles, was mentally dull, had marked stiffness in the nape of the neck with slight head retraction, had marked occipital headache, and had pains in the nape of the neck with tenderness in the same region. His knee jerks were absent and he had a well marked Kernig's sign. Lumbar puncture was done, and 40 c.c. of very turbid fluid was drained away under excessive pressure. 25 c.c. of polyvalent A.M. serum was injected.

15-3-17. Temperature was 103°. He felt much better and clinical features were slightly improved, but were all still present. Lumbar puncture was again done, and 40 c.c. of turbid fluid was removed under increased pressure. Serum was used as before.

16-3-17. He appeared better and stated that he felt better. Pyrexia, headache and other features were still present. Lumbar puncture and serum were resorted to as on the previous day.

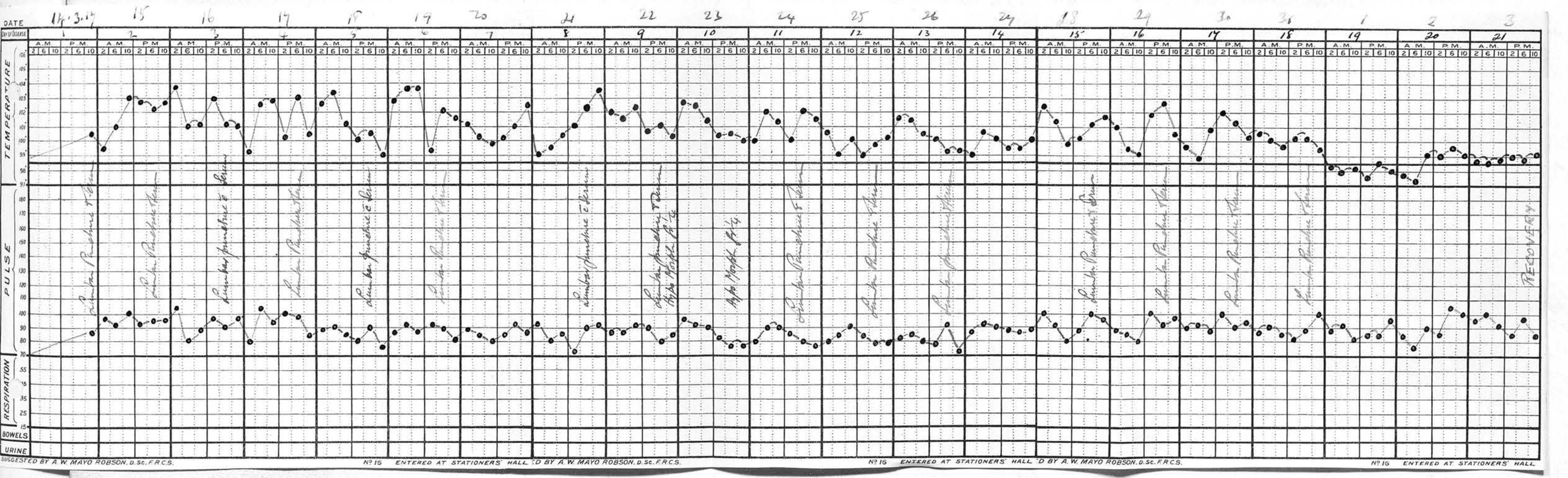
17-3-17. Pyrexia continued, features appeared to become accentuated, headache was much worse, and he was generally worse. Lumbar puncture was again done, and 50 c.c. of turbid fluid was drained away under markedly increased pressure. Polyvalent A.M. serum was injected but the brand was changed.

18-3-17. Very manifest improvement was noticed after the change of brand of serum. He still had pyrexia, but was very cheerful and obviously better. Lumbar puncture was again done and turbid fluid drained off under increased pressure, and the same serum given as on the previous day.

19-3-17. Condition was much the same as on the previous day, but improvement was maintained. Lumbar puncture was again done with similar results to the previous day, and the same serum used.

20-3-17. Improvement was maintained but slowly; he asked for more substantial food, was quite cheery; had slight headacheand slight stiffness in the neck. No puncture was done.

21-3-17 & 22-3-17. Condition was now at a standstill, no improvement was evident, but if anything



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a tendency to go backward. I decided to puncture again and drained away 30 c.c. of fairly clear fluid under increased pressure. Having had such success with my change of brand of serum I here decided to go back onto the previously used serum to endeavour to decide whether it was a mere coincidence or otherwise.

23-3-17. Condition still at a standstill. No puncture was done.

24-3-17. Condition here convinced me, by refraining from puncture on the previous day, that I was right in my conclusion that he was "hanging fire" and that all I was doing was to keep abreast of the pathological process. He now presented a very marked retrograde step, complained of a markedly increased headache, of increased cervical stiffness, had a high swinging temperature, and in fact showed an aggravation of nearly all features. I punctured again and obtained slightly turbid fluid under very considerable pressure. I decided again to try the first lot of serum used with the object in view of confirming my suspicions that one serum could act more efficiently than another in any one case, and thus I injected 25 c.c. of the same serum as at his last and first punctures.

25-3-17. Condition was a little better than the previous day, but nothing near as good as he had been at his best, and he was complaining of his headache, stiffness in the nape of his neck, and pains along his spine. Lumbar puncture was again done, and 35 c.c. of fairly clear fluid was drained off under greatly increased pressure. This time I returned to the serum which I had used with advantage on the 17th, 18th and 19th.

26-3-17. Patient appeared much brighter, and features appeared much easier; but still he had headache and spinal pains although much more bearable. Lumbar puncture was again done with similar results to those of the previous day, and the same make of polyvalent serum was injected.

27-3-17. Very marked improvement. He was considerably easier in every respect, although his features were still present in a modified form. No puncture was done.

28-3-17. He was not quite so bright as on the previous day, but was not seriously worse in any one individual respect. Lumbar puncture was done again, and fairly clear fluid removed under great pressure, and the same serum injected as at his last puncture.

29-3-17. He stated that he did not feel quite so well, but on inquiry into, and examination of, his individual features there appeared to be a steady improvement, not quite so manifest though as on the previous two days. Lumbar puncture was again done, and 50 c.c. of clear yellowish fluid was removed under excessive pressure. 20 c.c. of the same serum was injected as at his last few punctures.

30-3-17. Condition was better again. Lumbar puncture however was again done with similar results to those of the previous day, and the same serum was again injected.

31-3-17. General condition was markedly improved; he both felt and appeared better, and all features were subsiding rapidly.

23-5-17. Improvement was steadily maintained after 31-3-17 with the disappearance of all features except a little giddiness on exertion or on bending.

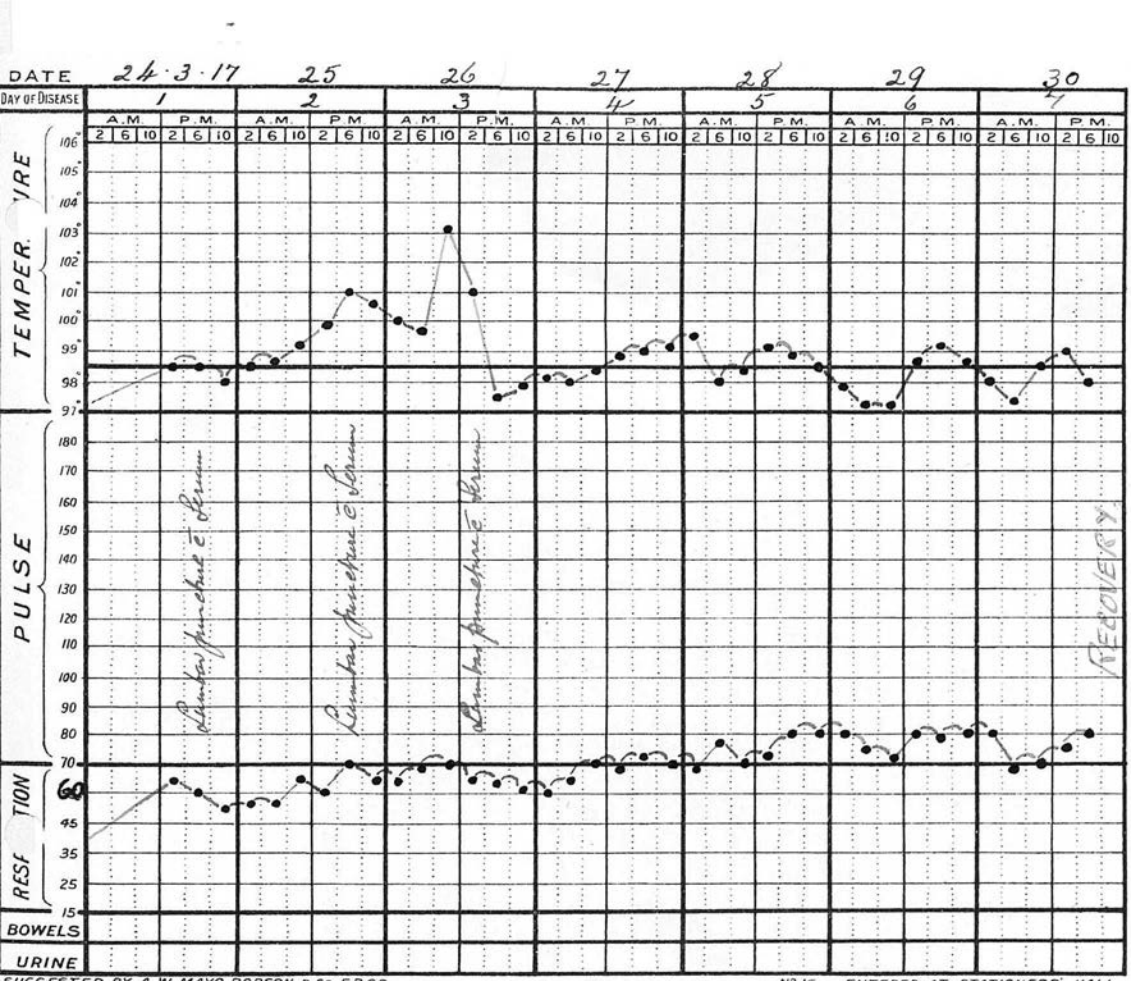
1-10-17. Quite fit although somewhat debilitated. He was discharged from hospital with no sequelae.

Remarks:-

This was certainly a severe acute case, and very clearly showed the necessity for:- Firstly - not stopping punctures too hurriedly. Secondly - not confining oneself to any one brand of polyvalent A.M. serum when working with such. I think on observing the daily condition of this case it will be manifest that it was much more than a coincidence that he should have improved so very markedly after a change of serum on the 17-3-17, with no such continued improvement after returning to the previously used brand of serum, a feature still further accentuated by the fact that improvement again advanced after subsequently returning to the same serum as used on the 17th, which improvement was maintained by the continued use of this same serum.

I have not the least hesitation in expressing the opinion that if this knowledge had been in my possession earlier some of the cases of the previous year (some of which are included in this treatise) would have been cured. I feel sure in my own mind, that there is a great deal more in this alternation of brands of serum in treatment than I have been able to show. I am satisfied however that it has given me one of my most valuable assets in the treatment of my cases.

Bacteriology and Cytology:- In direct smears of the cerebro-spinal fluid no cocci were found, but there was a preponderance of polymorphoneuclears in the cellular deposit. A very good growth was obtained on plating the fluid after a preliminary incubation in broth for 24 hours. The coccus here obtained agglutinated as follows:-



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	Type I Serum	Type II Serum	Type III Serum	Type IV Serum	Normal Serum
Mar.21st.	+++	+	+	—	—
Mar.22nd.	++	+	+	—	—
Mar.23rd.	+	—	—	—	—

Nasopharyngeal swab and blood both gave nil results on culture.

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Case 16.

Dvr. B-------, aet. 21 years, was admitted to hospital on 24-3-17 with the following history:- He had been perfectly well until the previous day when he felt giddy and had a headache; he vomited once or twice, and had to parade sick. He was sent to bed but he gradually got worse, his headache became more intense, pain and stiffness developed in the nape of the neck, he developed marked weakness in his legs, and he vomited again at night. His condition on admission was:- Intense headache, stiffness in the nape of the neck, occasional vomiting, photophobia, dull disposition, pain in the neck and lumbar spine; he had lost the use of his legs although there was no evidence of paralysis; he moved about in bed with difficulty; there was a very well defined Kernig sign and his knee jerks were absent. There was no rash. Lumbar puncture was done at once, and very turbid fluid was drained away under markedly increased pressure, about 50 c.c. being measured; 25 c.c. of A.M. polyvalent serum was injected.

25-3-17. His condition showed slight improvement, although all features were present, but in a marked degree. Lumbar puncture was again done, and turbid fluid was drained away under slightly increased pressure. 25 c.c. of A.M. serum was injected.

26-3-17. Condition was markedly improved in every respect. Lumbar puncture was again done, and slightly turbid fluid was drained away under slightly increased pressure. 20 c.c. of A.M. serum was injected.

2-5-17. His condition steadily maintained improvement after the last two lumbar punctures. Patient had no complaint at this stage beyond an occasional headache. His knee jerks were present but sluggish. He was discharged to a convalescent hospital with no sequelae.

Remarks:-

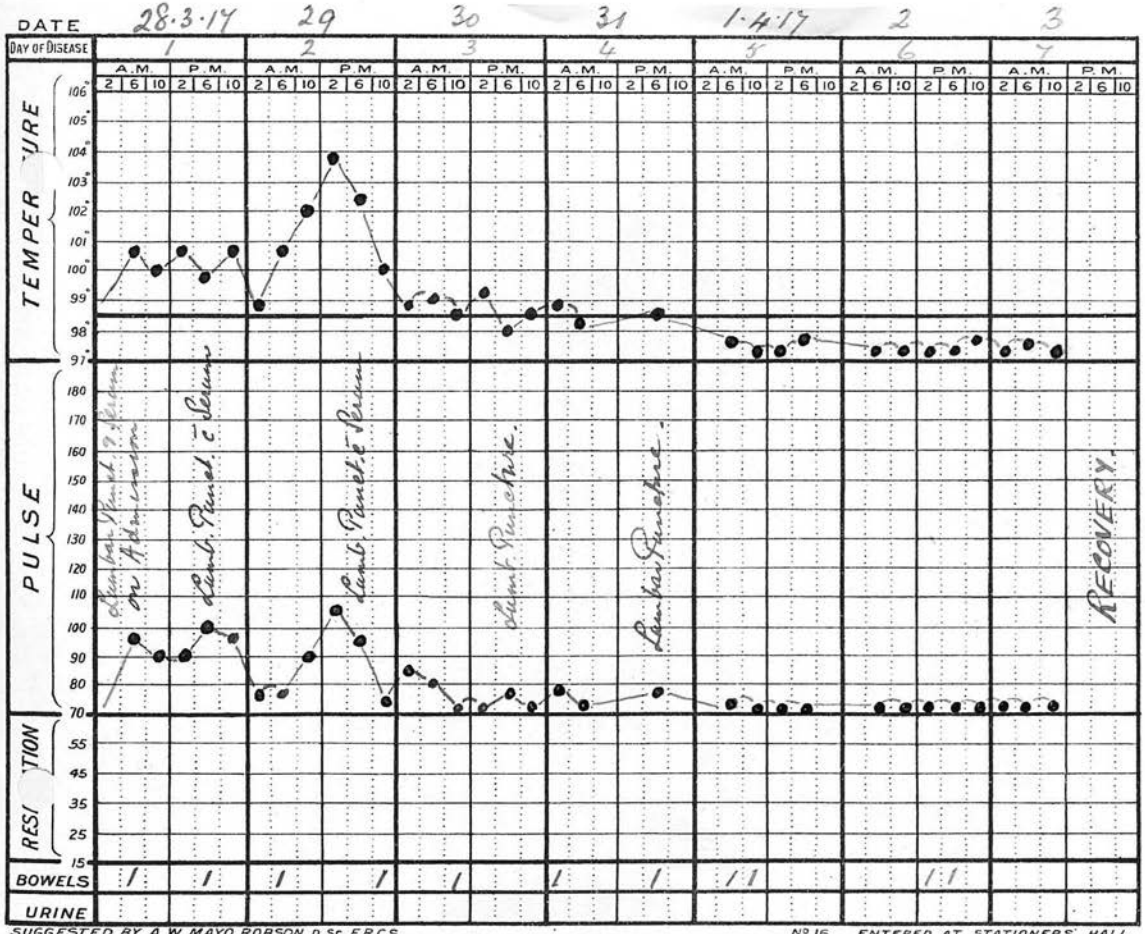
A straightforward mild acute case diagnosed early and adequately punctured.

Bacteriology and Cytology:- Direct smears showed meningococci present, all intracellular. The cellular element was almost entirely polymorphoneuclear. Primary culture presented a prolific growth of Type I and Type III cocci. Nasopharyngeal swab cultured Type III coccus. Blood culture was negative.

Case 17.

Gnr. R------, aet. 20 2/12 years, was admitted to hospital on the morning of 27-3-17 with the history that he had not been feeling well for a week, that during this period he had suffered from a more or less continuous headache which had gradually increased in intensity; and that on the morning of admission he had vomited once, was overcome by a marked feeling of weakness, and that his headache was rapidly getting worse. He was sent into hospital with a provisional diagnosis of Influenza. After admission, he stated he began to develop a feeling of pain and stiffness in the cervical region, had a slightly sore throat, and suffered from considerable feeling of malaise. He was somewhat delirious when first seen by me, but he could converse more or less rationally. He had no history of having been feverish until the night before admission.

On examination I found distinct rigidity in the cervical region, pain and tenderness in the nape of the neck, a generalised headache but particularly well marked in the occipital region, and a very distinct photophobia. His knee jerks were present but considerably reduced; Kernig's sign was present although not exceddingly well marked. There was a slight



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internal Strabismus. There was tenderness on deep pressure along the spine. There was no rash. He was very typically dull mentally, temperature was 100.8°, and pulse 96. Lumbar puncture was immediately done under chloroform, and 70 c.c. of very slightly turbid fluid was drained away under very markedly increased pressure; and on the pressure becoming normal 25 c.c. of polyvalent A.M. serum was injected intrathecally.

28-3-17. Patient had a restless night, gr. ¼ of morphia being given hypodermically with only a transitory effect; 15 gr. Chloral with 20 gr. Potass. Bromide was given 4 hours later, and this was followed by a few hours of fairly sound sleep. In the morning his condition was not markedly improved, his clinical features were unchanged and he was still delirious. He was now developing marked herpes around the mouth and nares. Temperature and pulse were not materially changed. Lumbar puncture was again done under chloroform, and a large amount (not measured) of fluid was drained away under very considerably increased pressure, but less so than on the previous day; and it was still slightly turbid. Polyvalent A.M. serum was again injected.

29-3-17. His condition was unchanged except that delirium had subsided considerably under repeated doses of chloral and bromide. Temperature had steadily risen to 103.9° and pulse to 104. Lumbar puncture was again done and 40 c.c. of somewhat turbid fluid, much more than on previous days, was removed under increased pressure. 25 c.c. of polyvalent A.M. serum was again injected. The intrathecal pressure was still further reduced than the previous day and contained numerous flakes of lymph.

30-3-17. A marvellous improvement had taken place. There was no delirium, he was much brighter, and generally speaking he appeared better. His headache had subsided very considerably, his strabismus had disappeared, and his neck features were very greatly improved. The herpes had extended over his face and chin almost to an alarming degree, but was beginning to show evidence of drying up. Lumbar puncture was again done under a general anaesthetic, and 30 c.c. of fairly clear fluid was removed under just above normal pressure. No serum was injected.

31-3-17. Improvement was maintained although headache and stiffness were still present, and the patient thought these were a little more accentuated than on the previous day. However he was much brighter, and chatted with his fellow patients, and was certainly generally speaking better. However lumbar puncture was done under chloroform, and clear fluid was removed under very slightly increased pressure. No serum was given.

1-4-17. Next to no headache was present, stiffness in neck and back was subsiding, herpes was well under control, and generally speaking he was on the way to recovery. No puncture was made.

His subsequent progress was extremely satisfactory, on the 6-5-17 he was out of bed, and had had no return of any symptom or sign, his strength was being regained, and there was no evidence of any ill effect being left. He was getting about freely without any headache even. He was transferred to convalescent hospital feeling, and looking perfectly well.

Remarks:- This case was certainly a moderately severe one presenting almost typical features, and treated on the lines laid down in my review. B.W. & Co. serum was used throughout.

Bacteriologically direct smears of centrifuged deposit showed gram negative diplococci, intracellularly arranged. On culture the cerebro-spinal fluid presented a typical culture of the meningococcus which agglutinated with No. 2 serum. A culture of an agglutinable diplococcus could not be obtained from his nasopharynx. Blood culture was negative.

Case 18.

Pte. J. V---------, aet. 18 8/12 years, was admitted to Hospital on 28th March, 17. as a suspected case of cerebro-spinal fever. He complained of generalised headache, stiffness in the neck, and malaise. His history was that he took ill on 27-3-17 with headache, occasional vomiting, feeling of weakness and slight feverishness. These features increased, and marked stiffness in the nape of the neck developed. He had photophobia, his knee jerks were almost absent, he had a very well marked Kernig sign, was still vomiting, and he suffered from marked mental dulness. There was no evidence of a rash.. Lumbar puncture was done, and about 50 c.c. of turbid fluid was drained away under very much increased pressure. 25 c.c. of polyvalent A.M. serum was injected.

30-3-17. Condition was steady, neither improvement or retrograde change taking place. Lumbar puncture was done with similar results to those of the previous day, and serum was injected.

TE 28-3-17 29 30 31 12 13 14 15 16 17

DISEASE

	28-3-17	29	30	31	12	13	14	15	16	17
	8	2	3	4						

A.M. 2 6 10 P.M. 2 6 10

106° 105° 104° 103° 102° 101° 100° 99° 98° 97°

180 170 160 150 140 130 120 110 100 90 80 70

55 45 35 25 15

PULSE

URINE

Lumbar Puncture Given

Lumbar Puncture Given

Lumbar Puncture Given

Lumbar Puncture Given

RECOVERY

SUGGESTED BY A. W. MAYO ROBSON, D.Sc. F.R.C.S.

ROBSON, D.Sc. F.R.C.S.

No 16 ENTERED AT STATIONERS' HALL

DATE 28-3-17 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

Day of Disease 1 2 3 4 5 6 7

TEMPERATURE

PULSE

RESPIRATION

BOWELS

URINE

Lumbar Puncture & Serum

RECOVERY

SUGGESTED BY A. W. MAYO ROBSON, D.Sc. F.R.C.S. — No 16 ENTERED AT STATIONERS' HALL. ED BY A. W. MAYO ROBSON, D.Sc. F.R.C.S. — No 16 ENTERED AT STATIONERS' HALL. ED BY A. W. MAYO ROBSON, D.Sc. F.R.C.S. — No 16 ENTERED AT STATIONERS' HALL.

31-3-17 to 3-4-17. Condition during this period had not materially changed, although he had become somewhat quieter. He was still in a state of muttering delirium, complained of considerable headache, and of pain and stiffness in the neck, and he was exceedingly restless. Lumbar puncture was done on the 31st, 1st, 2nd, and this day. The cerebro-spinal fluid tending to become clearer every day, but still remaining under excessive pressure. The same type of serum was given every day, no change of serum being possible owing to my being confined to the one brand, new supplied of this not having arrived.

4-4-17 to 6-4-17. His condition was improving, but very slowly, from day to day. Lumbar puncture was done every day, the resulting fluid showing improvement in its opacity and in its volume. Serum of th e same make as above given was used at every puncture.

7-4-17 to 13-4-17. Condition continued to improve but exceedingly slowly. He still complained of pain in the nape of the neck although it was only slight. He certainly looked much better. Lumbar puncture was done on alternate days and the same type of serum given.

14-4-17. He was much brighter and generally speaking there was a big improvement.

2-5-17. After the 13th his progress was rapid and he had no symptoms or signs remaining on this date.

Remarks:-

A very obstinate case of severe type, and recovery was due I am sure to repeated lumbar puncturing with complete drainage of the theca. The serum did not seem to have a material effect, although one might have had a retrograde change had it been stopped. Had it been possible to change the make of serum,more satisfactory results might have been obtained.

Bacteriology and Cytology:- Direct smears showed no cocci to be present; the cellular element consisted mainly of polymorphoneuclears. After preliminary incubation with broth the fluid presented a plate culture of typical meningococci agglutinating with Type I serum. Blood and nasopharyngeal swabs were persistently negative.

DATE

DAY OF DISEASE

TEMPERATURE

PULSE

RESPIRATION

BOWELS

URINE

A.M. P.M.

2 6 10 2 6 10

106° 105° 104° 103° 102° 101° 100° 99° 98° 97°

180 170 160 150 140 130 120 110 100 90 80 70

55 45 35 25 15

RECOVERY.

SUGGESTED BY A. W. MAYO ROBSON, D.Sc. F.R.C.S.

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Case 19.

Gnr. G----, aet. 2o years, was admitted to hospital on 31-3-17 as a mild case of influenza, but more particularly because he had developed a headache and slight pyrexia, and had been a contact with a positive case of cerebro-spinal fever. His history was that he had felt slightly out of sorts for about 48 hours, during which time he had a slight headache which tended to increase in intensity. On close inquiry it was found that he had vomited once on the previous day. He had no manifest pain or stiffness in his neck, although there was slight tenderness on deep pressure. His knee jerks were present, but if anything sluggish, and there was a suggestive Kernig's sign. Lumbar puncture was done and clear cerebro-spinal fluid was drained away under considerable pressure. No serum was given.

1-4-17. Condition was improved, but still he had a slight headache. No new developments had shown themselves.

3-4-17. His headache had disappeared and his general condition was improved.

11-5-17. Patient was well and was transferred to convalescent hospital.

Remarks:-

A developing case, nipped in the bud and aborted by very early diagnosis. Fortunately in this case the patient was already in isolation as a contact and developments were being looked for.

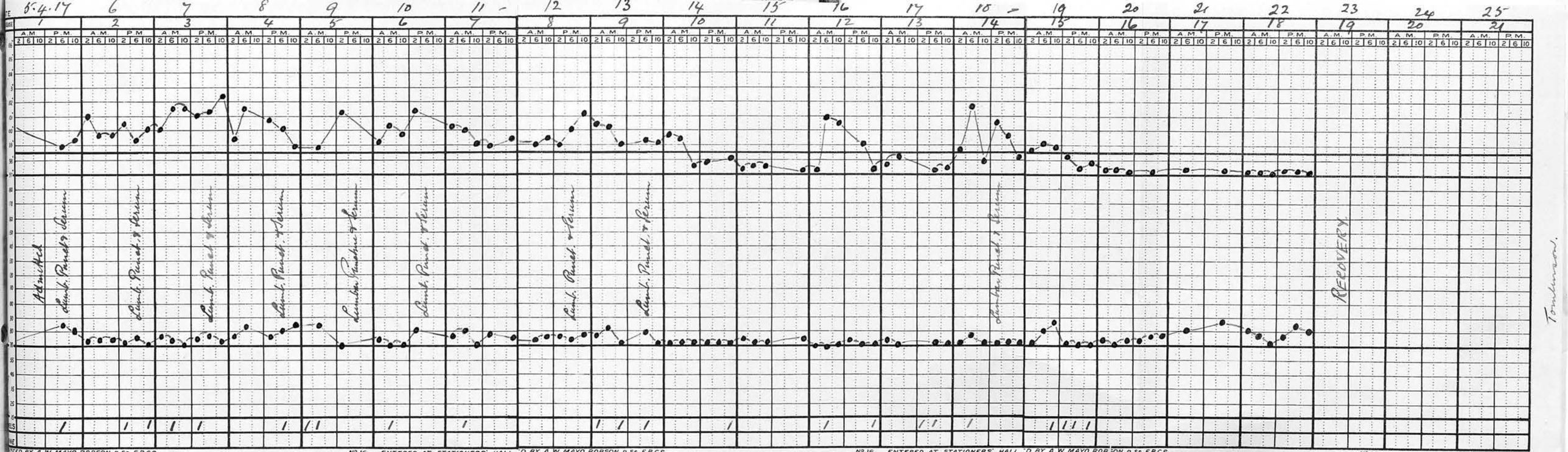
Bacteriology and Cytology:- No organism was found on smear or culture of the cerebro-spinal fluid. Cytology of the fluid - although very little cellular element was present it was practically entirely polymorphoneuclear. Nasopharyngeal swab produced a typical culture of No. I and No. III Types of meningococci , agglutinable with their respective sera. Blood culture was negative.

Case 20.

Pte. E. T-----, aet. 18 years, was admitted to Hospital at 11-45 a,m. 5-4-17 with a provisional diagnosis of acute Tonsillitis. He had a history of sore throat, headache, pains in the abdomen, marked malaise, and that he had vomited once or twice. His temperature was 100° and his pulse 60. On admission he was immediately put to bed and very soon became semi-unconscious, and could only be made to answer questions with difficulty.

At 7 p.m. the same day I was called in consultation, and found the patient semi-comatose, only aroused with difficulty, and appearing to suffer from photophobia, evidenced by the way he buried his head in the bedclothes and screwed up his eyes. I could obtain no history of his initial symptoms beyond from a companion of his, in that he had only taken ill the previous day, with the features mentioned above. On examination I found that his temperature was 102°, and his pulse was 60. He had a positive Kernig although not well marked, his knee jerks were absent, there was no evidence of a rash of any kind, and no incontinence. He had a slight rigidity of the neck but no head retraction, and he resented being moved about. There was no evidence of acute abdominal trouble or lung involvement. Lumbar puncture was performed at 8-30 p.m. under chloroform, and about 40 c.c. of turbid cerebro-spinal fluid was drained away, under slightly increased pressure, until normal pressure was established. 25 c.c. of polyvalent antimeningococcal serum was injected intrathecally.

6-4-17. Patient had a fairly restless night, but in the morning was perfectly conscious, his general appearance was greatly improved, although he was still mentally dull. He still complained of severe headache, mainly in the temporal and occipital regions, but of greatest intensity in the occipital region. He had considerable pain, stiffness, and tenderness in the nape of the neck, was tender along the spine, and particularly so in the lumbar region, and he felt bruised about the abdomen. He had no evidence of a rash, and no incontinence of urine or faeces had developed. Lumbar puncture was again performed at about 10 a,m. under chloroform, and about 30 c.c. of turbid cerebro-spinal fluid was removed, commencing under great pressure but finishing under normal pressure. 25 c.c. of polyvalent A.M. serum was injected. During the evening the patient began to get restless again, and that increased as the night progressed. A mixture of Chloral gr. X and Potass, Bromide gr. XX to



8-4-17 He complained of distressing headache

the half oz. was given with the result that the patient had a few hours rest in the very early morning.

7-4-17. Patient had a headache, pain in the nape of the neck, but his general appearance was brighter, and he was not so dull mentally, and stated that he felt a good deal better. There was no development of any fresh sign or symptoms. Lumbar puncture was again done under chloroform, but this time at 5 p.m., and 40 c.c. of fairly clear cerebro-spinal fluid drained away under increased pressure. 25 c.c. of polyvalent A.M. serum injected.

8-4-17. Headache and pain in the nape of the neck were the only features complained of. He had a good night and was a great deal better and brighter. A considerable herpes, around the mouth and nose and extending over the face, had broken out. Lumbar puncture was again done in the evening and fairly clear fluid was removed under increased pressure, and 25 c.c. of polyvalent serum injected intrathecally.

9-4-17. Patient was much the same as on the previous day, but the headache and pain in the nape of the neck still persisted. Lumbar puncture was again done with similar results to the day previous, and serum was injected.

10-4-17. Patient was much the same, with perhaps very slight improvement. Lumbar puncture was again done with similar results, and serum was injected.

12-4-17.& 13-4-17. Progress was still good, but headache persisted along with slight pain and stiffness in the neck. Herpes was clearing up. Lumbar puncture was done on both days; on the latter day however the fluid was almost clear and under normal pressure. Serum was injected on both days.

Progress was very steady, although headache and slight neck stiffness and tenderness were present until the 16th. The patient was not disturbed by lumbar puncture during this period. However on the 16th he became restless, and that night he was very sleepless. As the next day (17th) progressed he complained that headache and stiffness in the nape of the neck were increasing. His temperature rose to 100.8° on the 16th, but his pulse was normal, and the temperature fell again the subsequent day and night.

18-4-17. He complained of distressing headache, increasing stiffness in the neck, but his general appearance did not show any retrograde change. Lumbar puncture was done in the evening under chloroform, and 55 c.c. of clear fluid was drained off under very greatly increased pressure. 20 c.c. of polyvalent serum was injected.

19-4-17. All signs of troublesome headache had gone, pain and stiffness in the nape of the neck was dispersed, he had an excellent night's sleep, and was feeling perfectly well but a little weak.

Subsequent progress was quite satisfactory,

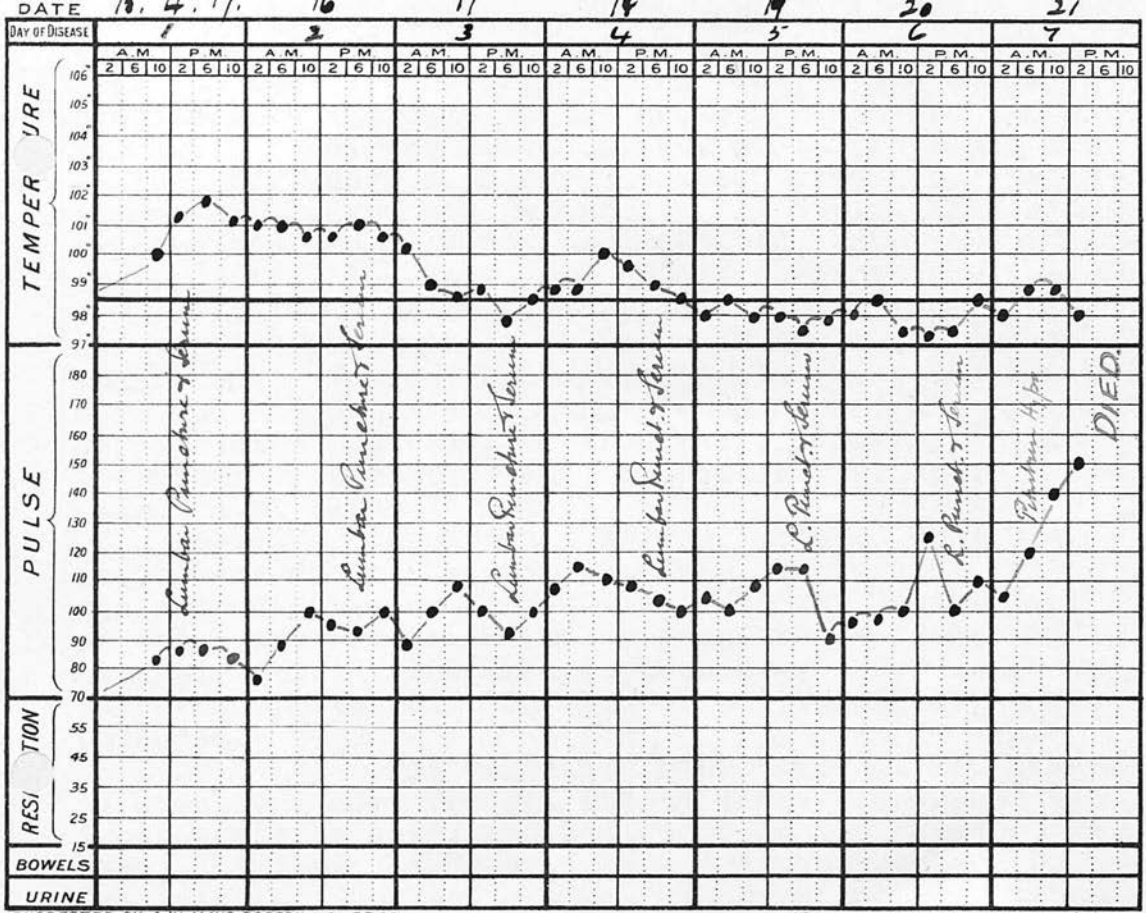
there being no recurrence of any disturbing feature. On the 12-5-17 the patient was able to get out of bed into an easy chair, he had a very slight headache in the mornings, but his only other complaint was that he could not bear the bright sunlight in his eyes. On the 21-5-17 he was transferred to convalescent hospital feeling quite well and with no ill effects.

Remarks:-

This was certainly a severe acute case presenting very typical features similar to those laid out in my review. The treatment was based mainly on the headache and neck features, and showed a perfect result of repeated lumbar punctures associated with antimeningococcal serum. B.W.& Co. serum was here used throughout.

Bacteriologically he showed gram negative diplococci on direct smear from the cerebrospinal fluid, and culturally these proved to be the number III type cocci. His blood serum further agglutinated No. III coccus. His nasopharyngeal swabs cultured a prolific growth of No. III coccus on several occasions during the earlier stages of his disease; but on the 28-4-17 he was negative, and never again presented a positive swab.

I further had the pleasure of seeing this case a few months later when he expressed to me that he had never felt better and had no ill effect left whatever.



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Case 21.

Pte. T. E. L-------, aet. 30 years, was admitted to the infectious disease Hospital as Diphtheria (clinical) on 15-4-17, with a temperature of 100°, dull and heavy in appearance, complaining of pain in the neck and back. He had a frontal headache. There had been no vomiting since admission. His fauces were very congested and his tonsils enlarged. There was stiffness in the neck; knee jerks were present; Kernig's sign was present. Lumbar puncture was done and considerable turbid fluid was drained off under increased pressure. Polyvalent A.M. serum was injected.

16-4-17. He was mentally very dull, his face was very flushed, and he complained of very severe headache and pain in the nape of the neck. There was considerable rigidity in the neck. Lumbar puncture was again done, and about 50 c.c. of turbid fluid was drained off under markedly increased pressure. Polyvalent A.M. serum was injected. At 9 p.m. this same evening his respirations became rapid, short and shallow, and his pulse fast. He became somewhat unconscious.

17-4-17. He had a very toxic appearance, still had very severe pain in the nape of the neck, and was incontinent of urine and faeces. Otherwise the features were unchanged. Lumbar puncture was done, and 50 c.c. of yellowish fluid was drained away, slightly turbid and under very considerably increased pressure. Polyvalent A.M. serum injected.

18-4-17. Apparently he was improved, but his speech was not clear, his headache was severe, and he was now not unconscious at all. He was incontinent of urine and faeces. Lumbar puncture was done, and slightly turbid fluid was drained away under slightly increased pressure. 20 c.c. of polyvalent serum was injected.

19-4-17. His condition had improved. He answered questions more freely, but at times his speech was incoherent; he still had stiffness in the nape of the neck, still had headache, and was incontinent of urine and faeces. Lumbar puncture was done and very slightly turbid fluid was drained away under increased pressure. 20 c.c. polyvalent serum was injected.

20-4-17. General condition was lower; he became delirious, would reply to questions but with incoherent statements at times, was still incontinent both of faeces and of urine, pulse was rapid and thready, and stiffness in the nape of the neck was not improved. Lumbar puncture was again done under a local anaesthetic, and fairly clear fluid was drained away, yellowish in colour, and under slightly increased pressure. Polyvalent A.M. serum was injected.

21-4-17. General condition was very much worse, his pulse was very feeble, and generally his condition was failing.

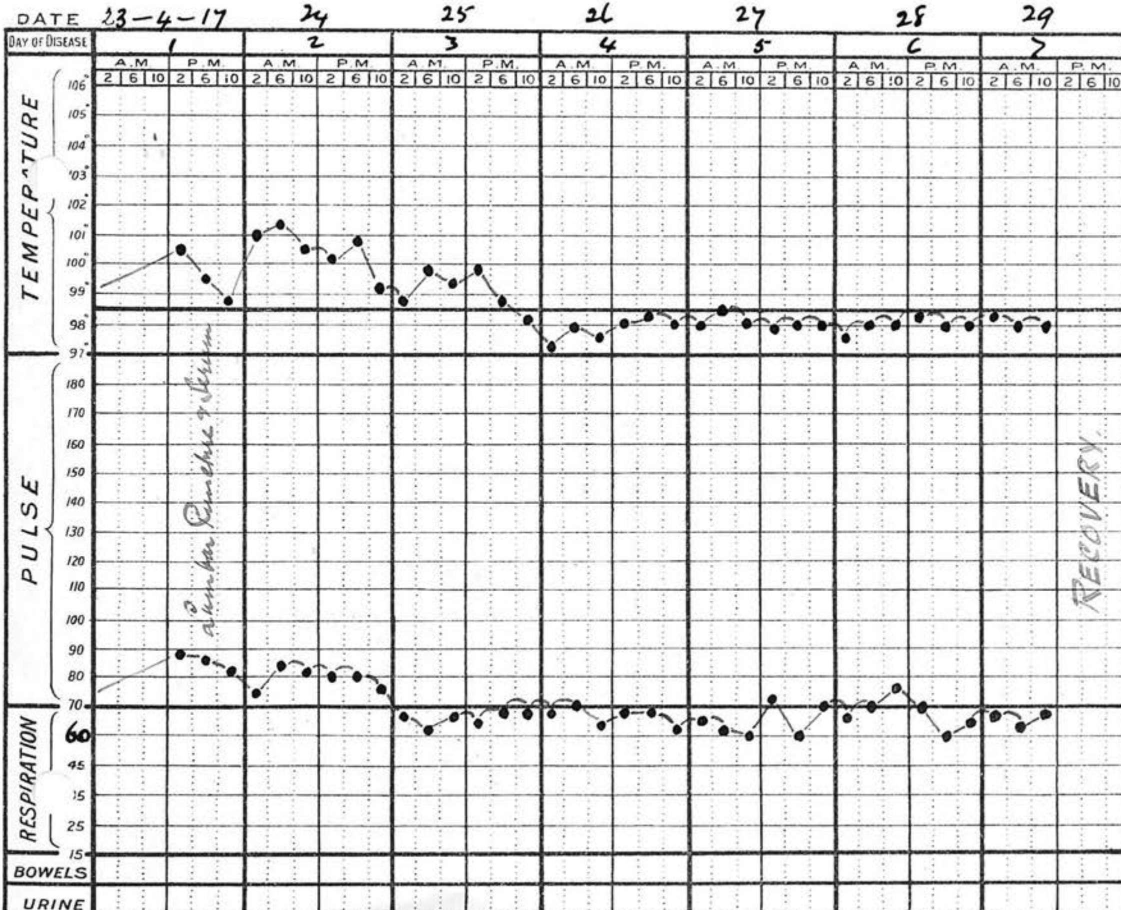
Patient died at 5-45 p.m.

Remarks:-

I am of opinion that this case was nothing more nor less than of severe acute type, where the morbid condition appeared to progress in spite of lumbar puncture and serum; but in this case I was confined to the one brand of serum, and I have the feeling that, had I been able to try other sera, there might have been a successful result similar to that which I obtained in a few other similar cases where progress was at a standstill, or even retrograde changes were taking place. The necessity of having several makes of polyvalent serum handy might not appear scientifically correct, but nevertheless I am convinced that the clinical results do show an advantage. This can be partly explained by the fact that certain "lots" of sera are prepared by the use of organisms of low virulence, or that the units are measured by organisms of low virulence, and thereby indicating that the serum contains more immune bodies than it actually does contain. Or it may readily be explained by the possibility that one serum may contain immune bodies more like those which would be produced by the type of organism causing the infection, more so than another serum; or in other words the serum which would act most successfully would be the one nearest in nature of immune body to that of an autogenously prepared serum.

Bacteriology and Cytology:-

Direct smears showed polymorphoneuclears in excess, and gram negative diplococci which on culture proved to be meningococci agglutinating type I serum. nasopharyngeal swabbing was only done with difficulty and a negative result was obtained, but this was inconclusive.



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Case 22.

Pte. J. K. C-----, aet. 21 years, was admitted to Hospital on 23-4-17 with a diagnosis of influenza, and presenting a temperature of 101.8°, pulse 89, and respiration 22. He had a history of mild malaise of two or three days standing accompanied by a headache and giddiness. He was now complaining of a headache temporal in nature but "shooting" backwards to the occipital regions; he had vomited once; and he had slight pain and stiffness in the neck. No other complaint could be obtained even by putting leading questions to the patient. On examination he certainly had rigidity in the neck and suffered pain when turning to one or other side; his knee jerks were not altered; he had the merest suspicion of a Kernig; and he was tender on pressure in the lumbar spinal region. There was nothing further to assist one. However I decided to lumbar puncture under chloroform and obtained fluid with the slightest degree of turbidity, and under slightly increased pressure; 20 c.c. of polyvalent A.M. serum was injected.

24-4-17. His condition was markedly improved although his temperature was up. Inasmuch as his general condition was so improved, and his fluid the previous day was so near normal I decided to wait until the evening to lumbar puncture, but then his temperature was so satisfactory as well as his general features that I decided to wait until the following day.

25-417. Condition absolutely satisfactory.

From this date he made a rapid and satisfactory recovery.

Remarks:-

I am of the opinion that this was one of the mildest cases I saw, one of that type so readily apt to be missed in diagnosis, but which if untreated might end seriously. In this case there was nothing more than a slight meningeal irritation which I feel one can accept as possibly being the result of the threatened meningococcal invasion.

Bacteriology and Cytology:-

Polymorphoneuclear cells were found in the centrifuged deposit of the fluid obtained, but no meningococci were found either in direct smear or on repeated culture as outlined under the bacteriological precedures of my review. Postnasal swabbing however presented the meningococcus in prolific growth on culture.

Case 23.

Gnr. W----, aet. 32 years, was admitted to hospital on 21-7-17 with the following history:- He came to the district two weeks ago from Ripley in Derbyshire and was feeling perfectly well. On 19-7-17 he developed a headache, pain in the lumbar spinal region, and a certain degree of feverishness; the headache continued and increased in severity until his admission.

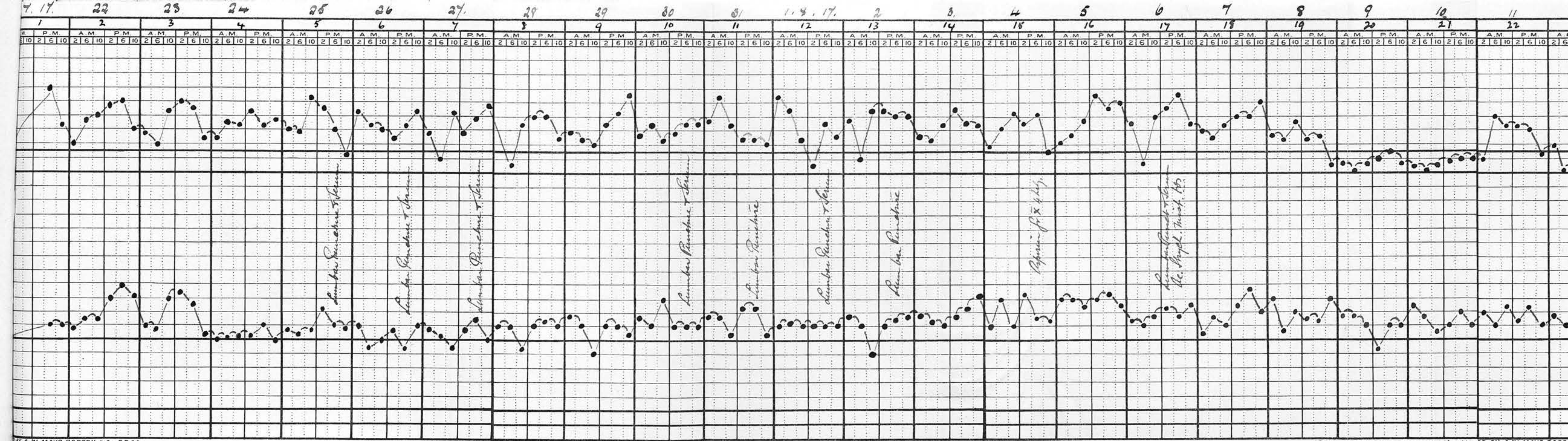
His condition on admission was as above outlined, but on account of the pains that he had in his lumbar regions, and his comparatively low temperature, and the mildness of his features, he was placed in the medical ward as a case of lumbago. As his condition did not improve under salicylates and he was, generally speaking, going downhill I was asked to see him in consultation when his condition was as follows:-

25-7-17. His headache was not so bad as it had been, but he complained acutely of pain and stiffness in his neck, and of great pain in his lumbar spinal region on movement. He had vomited occasionally after admission. On examination there was marked rigidity in the neck and marked herpes around the mouth and nares; on moving his head he evidenced great pain and there was acute tenderness on pressure. He had a very well defined Kernig sign. His knee jerks were absent, and there was a Babinski present. He was incontinent of urine but not of faeces. He had no rash, and no Strabismus. He was markedly dull mentally and looked seriously ill. Lumbar puncture was done under chloroform and 40 c.c. of turbid fluid was drained away under considerably increased pressure. 20 c.c. of polyvalent A.M. serum was injected intrathecally.

26-7-17. The condition was improved, the herpes was drying up, and he looked and felt much better; but he still complained of headache and lumbar pain. There was no incontinence. Lumbar puncture was again done and 30 c.c. of less turbid fluid was obtained, and 25 c.c. of A.M. serum was injected intrathecally.

27-7-17. Condition was still improving, although headache and lumbar pain were complained of still. He stated that he had considerable scalding in the urethra on micturition. No vomiting was now reported. Lumbar puncture was done, and 50 c.c. of less turbid fluid was obtained than that of the previous days. 20 c.c. of A.M. serum was injected.

28-7-17. Improvement was maintained, and there was no headache or pains in the neck; very slight lumbar pain was present, and the temperature was subsiding. His only complaint was that he felt weak. No puncture was done.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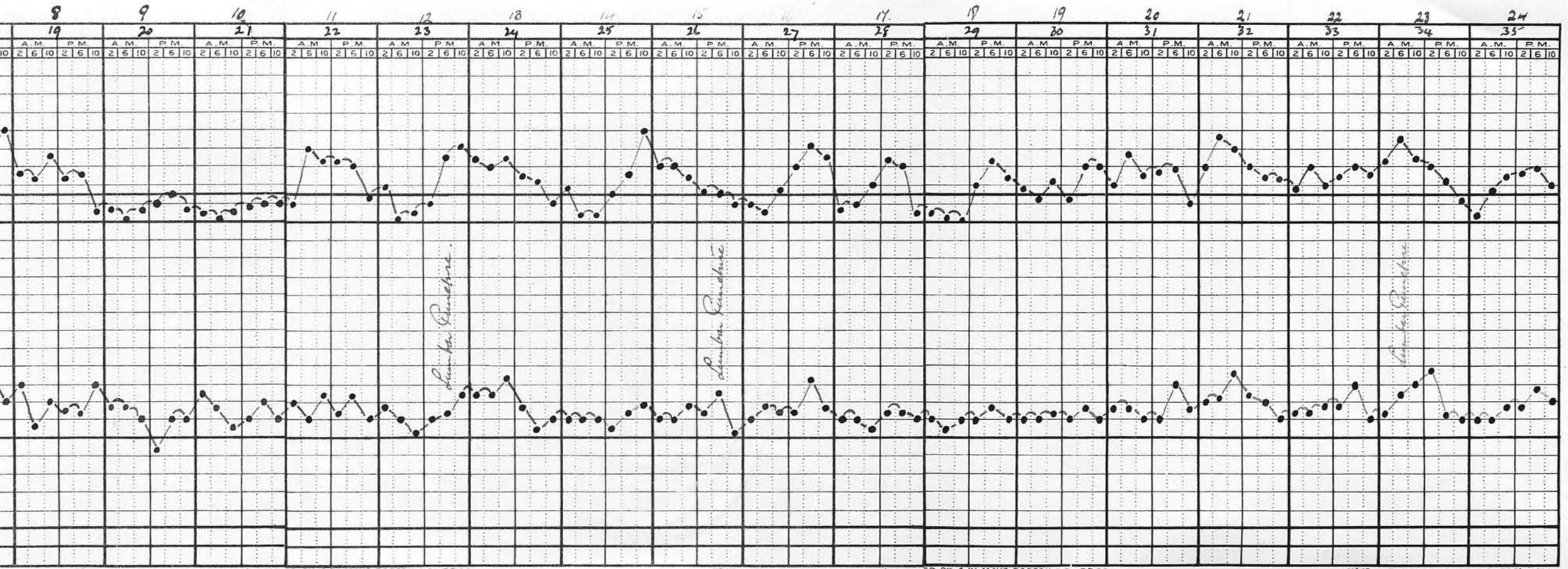

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30-7-17. During the previous day he was quite well. However slight headache was again showing itself, his temperature was showing a tendency to rise, and he appeared to have had a retrograde change. Lumbar puncture was done, and considerable (unmeasured) clear fluid was drained away under slightly increased pressure. 20 c.c. of polyvalent A.M. serum was injected.

31-7-17. Patient was feeling brighter, although slight headache persisted; he was not so weak; his temperature showed a slight rise again; and generally speaking he had not advanced in progress. Lumbar puncture was done, and as only clear fluid was drained away under very slightly increased pressure, no serum was injected.

1-8-17. He was markedly improved, looked well, had no headache, felt stronger, but his temperature was 102°. Lumbar puncture was again done, and clear fluid under slightly increased pressure was drained away. 20 c.c. of polyvalent serum was injected.

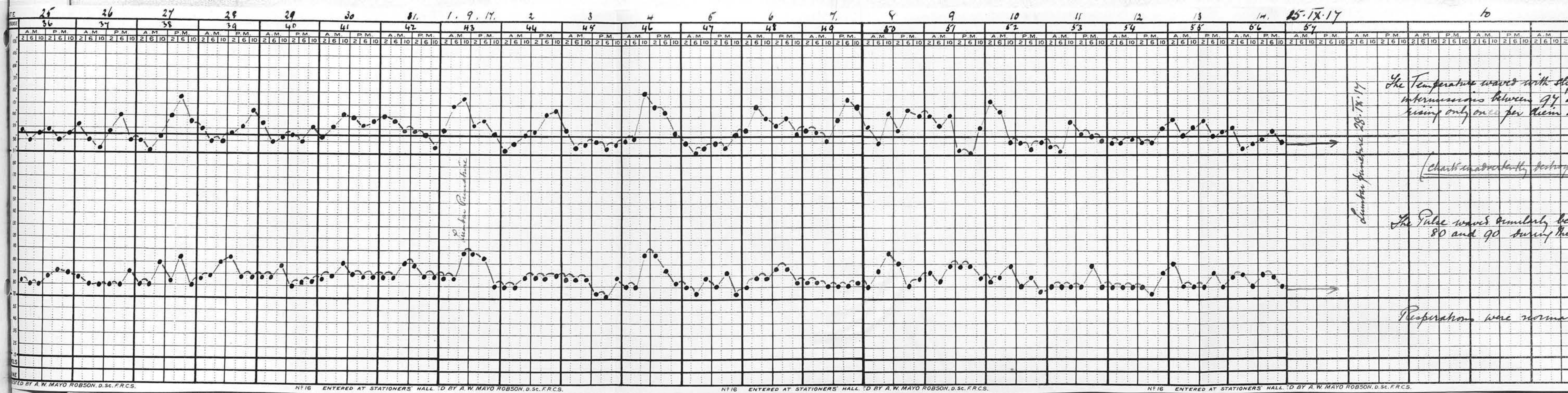
2-8-17. He was feeling if anything a little better, but there was no material apparent clinical change. He still had a very slight headache. He looked bright and well. Temperature was still up. Lumbar puncture was done, and 40 c.c. of clear fluid was drained away under great pressure. No serum was injected.

3-8-17. He was feeling well and was certainly looking well; he had hardly any headache; stiffness in the neck was still present but was improving slightly. He had considerable photophobia. Temperature was still slightly raised. No lumbar puncture was done.

4-8-17. Headache had disappeared, he was much stronger, was attempting a little to read from the paper, and generally speaking he was a great deal better.

5-8-17. Condition was very satisfactory although the temperature still continued slightly raised. Towards evening he developed a slight headache again, so aspirin gr. X in repeated doses was administered.

6-8-17. He had no complaint beyond that of weakness; no headache; all features of an acute nature appeared to have completely subsided. Temperature was normal, pulse 80, and respirations 20. Acid Strychnine mixture was given t.i.d.
As the day progressed and particularly towards evening he complained of much more weakness, of a feeling of heaviness in his head, but not of actual headache, and he did not look nearly so well. Lumbar puncture was again done under chloroform, and 60 c.c. of clear fluid was removed under excessive pressure pumping out at the commencement of the decompression.
20 c.c. of polyvalent A.M. serum was injected.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Lumbar Puncture 28·IX·17
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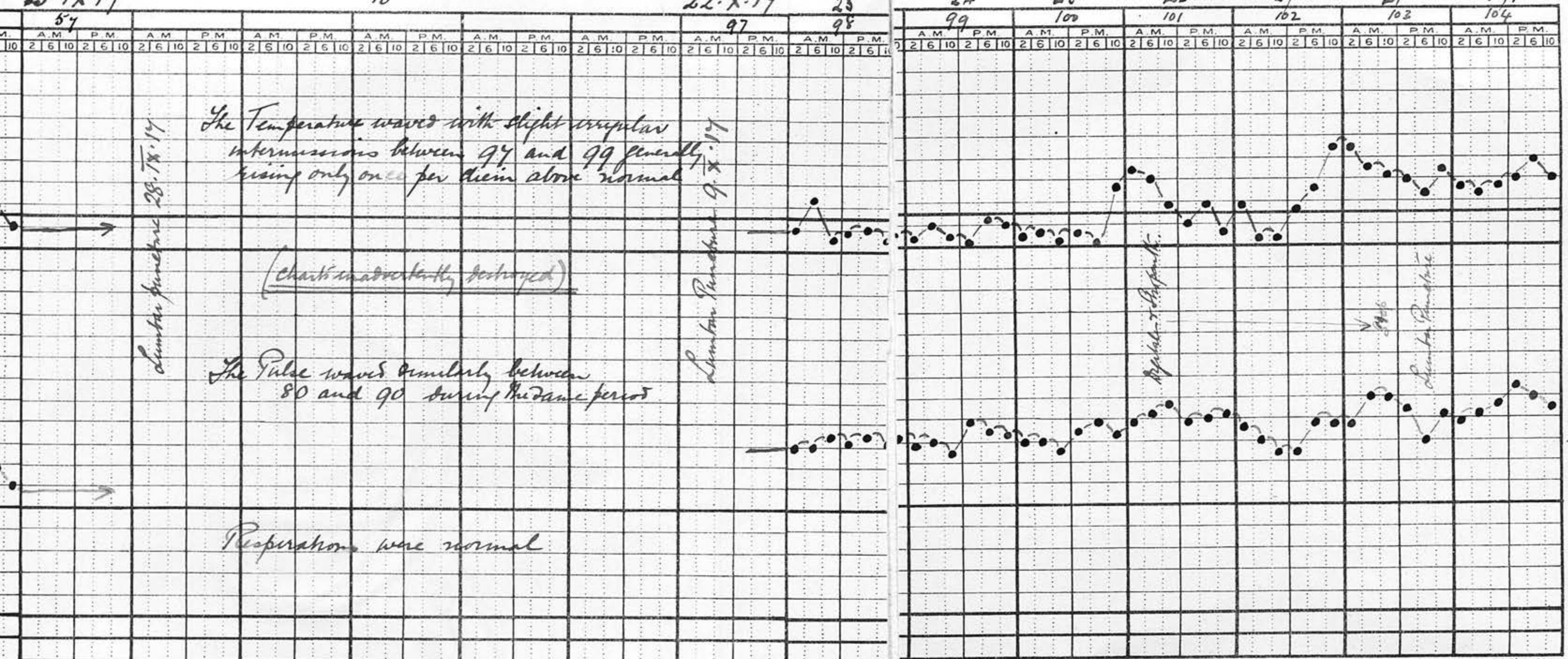
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Lumbar Puncture 28.IX.17
Lumbar Puncture 9.X.17
(chart inadvertently destroyed)
The Pulse waved similarly between 80 and 90 during the same period
Respirations were normal
Lumbar Puncture

7-8-17. Condition was much improved, all feeling of distressing weakness had disappeared, as also had the feeling of heaviness in the head. He interested himself in everything around him and endeavoured to write a letter. Progress was maintained throughout the day and at night he slept peacefully and soundly.

12-8-17. Progress was maintained and was satisfactory up to this date; but on this evening the temperature rose again, although he had no other feature present beyond that his head had threatened to ache all the afternoon. Lumbar puncture was again done, and 30 c.c. of clear fluid was drained away under slight pressure. No serum was given.

15-8-17. Condition was good during the previous three days although he did not appear to make any progress. He felt well, but complained of increasing weakness, and his temperature rose to 102° during the previous night. He had no further complaint however. The weakness became more distressing as the day progreassed, so lumbar puncture was again done, and about 30 c.c. of clear fluid was drained away under pressure. No serum was injected.

23-8-17. Condition was steady during the previous few days but he did not appear to go ahead much; he was somewhat duller than usual on this day, and had a tendency to worry about little matters. He had no headache, and no pain anywhere, although he had a little stiffness in his neck still. He became incontinent of urine again. He also complained that the light hurt his eyes; and he worried about himself, frequently stating that he was not so well again. Occasionally he had a temporal throbbing verging on a headache. Lumbar puncture was again done, and with a similar result to that obtained on the previous 2 or 3 occasions. No serum was injected.

26-8-17. His condition seemed to improve again slightly during the previous three days. He was however occasionally incontinent of urine. He slept well and had no complaint except rheumatic pains in his tempero-maxillary joints. He did not seem to make any satisfactory step towards recovery.

1-9-17. His condition was at a standstill during the previous few days. He had displayed marked irritability of manner, had occasionally passed his urine in bed (the nurse stating through carelessness and want of interest in himself). He had transient headaches which tended to get worse as the previous two or three days progressed, but these headaches had never been persistent He slept well every night. He had no feeling of weakness. His headaches generally came on towards evening. Otherwise he stated that he felt perfectly

alright. His temperature, although it was low and more steady seemed to swing somewhat. Lumbar puncture was again done, and clear fluid was drainedaway under exceedingly increased pressure. No serum was injected.

2-9-17. He was somewhat improved, was much brighter in disposition, stated that he felt better, his temperature had subsided and remained down throughout the day; and his head was clearer. At night his temperature showed a tendency to rise again.

5-9-17. His condition was steady but not really satisfactory. His temperature was again swinging. No developments were noticed.

8-9-17. Temperature was still swinging. He complained of pains about his limbs, neuralgic in type and particularly in his right hip; and also he had pains in the nape of the neck. His tongue was very dirty.

9-9-17. His temperature was high all the previous day. At night all of his joints ached, as also did his head, but not severely. He suffered from incontinence of urine again. His general disposition was bright, his eyes clear, and his expression animated. He took his food well, Kernig was still present; knee jerks were exaggerated; and planter reflexes were normal.

15-9-17. There was no material alteration in his condition. All features seemed to be subsiding a little, but not to a satisfactory degree. He did not appear to regain strength.

27-9-17. He had occasional relapses of dulness, but otherwise his condition was steady. He complained of stiffness in the neck and slight headache, his temperature was normal, and he was still incontinent.

28-9-17. His neck was considerably stiffer, incontinence was still present, he had a slight headache, but his temperature and pulse were normal. He was considerably more dull than on recent days. No further complaints nor signs were manifest. Lumbar puncture was again done, and 50 c.c. of clear fluid was drained away under greatly increased pressure. No serum was injected.

29-917. He was considerably brighter during the morning, but still complained of stiffness in the neck although he could move his neck more freely and with much less pain. He slept better during the previous night, and had no incontinence. Aspirin gr. X was given 4 hourly during the day.

30-9-17. His neck was very stiff during the morning; there was slight headache; incontinence was again present; but he was still bright and conversed freely.

2-10-17. He was feeling much better and certainly looked better. There was still evident stiffness in the neck but not so marked as it had

been; and also there was still pain in the neck on movement.

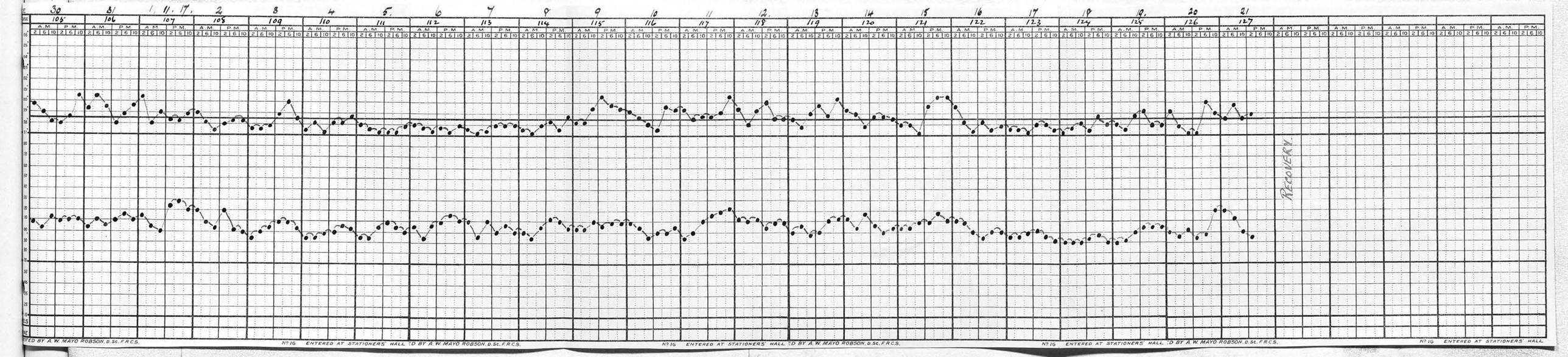
9-10-17. His condition had improved during the past week very slightly. Stiffness in the neck was gradually subsiding, his general demeanour was brighter, and there was less complaining. However on this date he was developing mental dulness, he did not answer questions readily, was rather more stiff in the neck, and took no interest in anything around him; his pulse was rather thready; there was a slight discharge from the left ear but no acute pain or tenderness in that region which on close enquiry proved to be a recrudescence of an old trouble. He was still incontinent. Lumbar puncture was done and 35 c.c. of clear fluid was drained away under very greatly increased pressure at first. He was markedly relieved after this puncture. He was placed on a water bed, as he had become so very emaciated and a few pressure points were beginning to show slight evidence of reaction.

16-10-17. His condition was not markedly improved although he moved his head and neck a little more freely. He had no complaint. No bedsores were developing and stringent preventative measures were being adopted to prevent such.

25-10-17. He was much brighter and moved his head a neck more freely. He was very weak, but if anything, was beginning to gain strength. He was still incontinent of urine and faeces. He had no complaint. His knee jerks were sluggish although present. He was inclined to wander in his conversation at times, and his memory was not very good. Cod liver oil and acid strychnine tonic were being pressed in administration.

26-10-17. Generally speaking he was much brighter, and the stiffness in his neck had almost disappeared. His pulse was rather feeble andthready. Cod liver oil was still continued,but a mixture containing digitalis, stropanthus and nuxvomica, replaced his acid strychnine mixture. Towards night his pulse had improved and was 90 in rate and very much fuller.

28-10-17. He had a pseudo-rigor in the evening when his temperature mounted to 101.4°; his pulse 108 and weak; and his respirations 22. He had no complaint but he was less lively, somewhat lethargic, and appeared slightly stiffer in the neck; there was no headache. He had taken his food well throughout. He was still incontinent. Digitalis and stropanthus mixture was still continued. Vitality was generally speaking very low, and bedsores were being avoided with the greatest of difficulty. Lumbar puncture was again done with the same result.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105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127
A.M. P.M.
2 6 10 2 6 10
RECOVERY.
ENTERED BY A.W. MAYO ROBSON, D.Sc. F.R.C.S.
No 16 ENTERED AT STATIONERS' HALL. D BY A.W. MAYO ROBSON, D.Sc. F.R.C.S.
No 16 ENTERED AT STATIONERS' HALL. D BY A.W. MAYO ROBSON, D.Sc. F.R.C.S.
No 16 ENTERED AT STATIONERS' HALL. D BY A.W. MAYO ROBSON, D.Sc. F.R.C.S.
No 16 ENTERED AT STATIONERS' HALL.

29-10-17. He was considerably better; pulse was improving, but other individual features were not materially improved.

15-11-17. Incontinence still persisted; he was fairly helpless, and had to be moved about in bed by his nurse. He developed small sores on his heels through rubbing his feet together. He slept well and took his nutrition well. Cod liver oil was being pressed and was well tolerated.

22-11-17. The most marked improvement was now showing itself; he was moving himself about more freely in his bed; he had lost his cervical stiffness; and the sores on his heel were nearly healed. He was still incontinent of urine however.

15-12-17. Improvement was being well maintained, All features were now rapidly subsiding, he was beginning to put on weight, and his face was filling out. He could move himself about much more freely in bed, and in fact appeared to be well on the way towards recovery.

After I was transferred from this hospital I followed his progress through the kindness of the medical officer who took charge of the case; the same tonic treatment with cod liver oil was continued, no further lumbar punctures were required, and his progress was very well maintained throughout the subsequent weeks. I received a letter from the patient about three months later, when he had been discharged from hospital convalescent, and although feeling weak he was suffering from no serious inconvenience or sequelae, and was making rapid strides to regain his normal health.

Remarks:-

This was the most atypical case I have ever seen, but which, I am of the opinion can be looked upon as a severe acute case which reacted readily to lumbar puncture and serum, but which subsequently developed a chronic cerebro-spinal condition. During the greater part of his chronic course he was suffering from a partial paraplegia, possibly due to the pathological process in the lumbar spinal region. Further he was threatened by a hydrocephalic state which was only controlled by the occasional lumbar punctures with decompression. From this latter point of view it is interesting to note that the cerebro-spinal fluid during the punctures after the acute attack had passed off presented the following features:-

a. No culture of meningococci was obtainable;
b. It was perfectly clear throughout;
c. It was under very greatly increased volume and pressure which both diminished as treatment progressed;
d. The cellular element, although very small in amount consisted of a few polymorphoneuclears and lymphocytes but a fair number of endothelial cells.

I must remark that in the treatment of this case, I was tied down to the use of one serum and at that a serum which I was not very greatly in favour of, and with which I had failed to obtain good results in the treatment of many of my other cases. Therefore, perhaps with the above explained bias, I might here state that I feel that the sequence of events might have been changed somewhat had I had two or three brands of polyvalent serum to work with. However the main result was obtained, viz: that of recovery, and without any manifest sequelae as far as I could hear. The case shows how essential it is not to lose heart in the treatment of a chronic case, and that by persistence of a given routine treatment a satisfactory result can be well obtained.

Bacteriology and Cytology:- Direct smears of the cerebro-spinal fluid in the earlier lumbar punctures presented gram negative diplococci, intracellular, and a preponderance of polymorphoneuclear cells. Culture of the fluid ofrom the first two lumbar punctures produced a typical growth of meningococci agglutinating with Types I and III sera.

Nasopharyngeal swabs were unsatisfactory; no growth being obtained; but this was probably due to the fact that one could not be assured of getting the swabs on to the mucosa of the nasopharynx, as the patient fought so much that they generally became contaminated with saliva.

Examination of the aural discharge showed no meningococci to be present.

Cerebro-spinal fluid obtained by lumbar punctures on later dates during the course of the disease produced no culture.

Blood was negative on culture throughout; but in the early stage showed marked leucocytosis with the increase mainly in polymorphoneuclears.

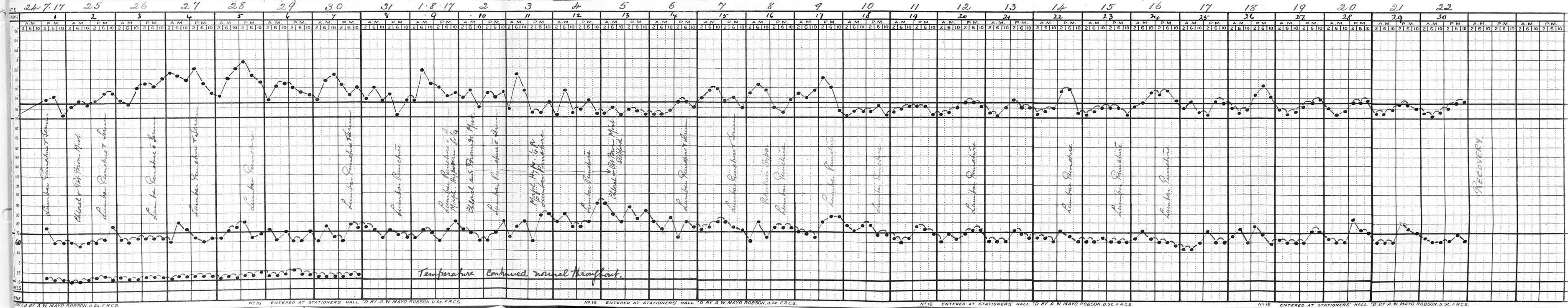
Case 24.

Cpl. L. C-----, aet. 28 years, was admitted to Hospital undiagnosed on 24-7-17 complaining of pains in the nape of the neck, intense occipital headache, and vomiting during the three previous days. He stated that he felt quite well until the 22-7-17, when he awoke with a shivering, had to get up to vomit, felt nausea[ted] throughout the day, had a frontal headache, and had pains in the nape of the neck. On examination after admission his head was found to be retracted, his neck was rigid, and pain was present in the neck on the least movement; his spine was rigid throughout, and there was pain on movement and tenderness on pressure in the lumbar region; his mental state was exceedingly dull; photophobia was present; he had a slight purpuric rash on the lower abdominal wall only. His Kernig sign was well marked, his knee jerks were present, and he had a Babinski. He was slightly incontinent of urine and faeces. Lumbar puncture was done under chloroform, and 50 c.c. of very turbid fluid was drained away under considerably increased pressure. 20 c.c. of polyvalent serum was injected.

25-7-17. Patient had a restless night in its early part, but on the administration of chloral and potass. bromide he became more restfull and slept a little. In the morning he was comfortable and drowsy; he had no incontinence, asked for food, stated that his back and neck were not so stiff, and that his headache was improved. Lumbar puncture was again done and 55 c.c. of fluid was drained away under increased pressure, but not so turbid as on the previous day. 20 c.c. of A.M. serum was injected.

26-7-17. His general condition had improved, he was much brighter and mentally clearer; he did not complain of his headache,had no vomiting, was not incontinent, and was not anything near as rigid in his neck or spine. His only complaint was that he was not getting enough to eat. Lumbar puncture was again done, and clearer fluid was removed, not in such great volume or under such increased pressure as on the previous day. 30 c.c. A.M. serum was again injected.

27-7-17. Improvement was maintained, there were no complaints,and individual features were subsiding. Lumbar puncture was again done on account of the volume and turbidity of the cerebro-spinal fluid of the previous day. The fluid obtained was clear and practically under normal pressure. 20 c.c. of A.M. polyvalent serum was injected.


24.7.17
1.8.17
A.M. P.M.
Lumbar Puncture
RECOVERY
Temperature continued normal throughout.
No 16 ENTERED AT STATIONERS' HALL
BY A.W. MAYO ROBSON, D.Sc. F.R.C.S.

28-7-17. His condition was steady but he was a little dull in disposition. Lumbar puncture was done with similar results to the previous day. No serum was injected.

29-7-17. Patient was bright, had no complaints, his headache was rapidly disappearing, and very little was present in his neck. No puncture was done.

30-7-17. General condition was good but he complained of a distressing headache during the evening. Lumbar puncture was done and clear fluid was drained away under markedly increased pressure. 20 c.c. A.M. serum was injected.

31-7-17. His condition was much brighter, his headache was slight, he had a good night, and he was, generally speaking, very comfortable. His temperature was still high. Lumbar puncture was again done but no serum was injected.

1-8-17. Patient had a bad night, disturbed by an increasing headache. In the morning his headache had subsided a little. He was developing a little deafness. Lumbar puncture was done and very slightly turbid fluid was drained off under greatly increased pressure. 20 c.c. of A.M. polyvalent serum was again injected. His temperature rose sharply t o 102° at night.

2-8-17. He complained considerably of headache and restlessness during the previous night, necessitating gr. $\frac{1}{4}$ morphine. His headache continued during the morning, but was reduced as the day passed on, under the influence of chloral and bromide. Pain and stiffness in the neck and back, from which he had had a recrudescence, were subsiding. Mentally he was bright. Lumbar puncture was again done, and 40 c.c. of almost clear fluid was drained away under increased pressure. 25 c.c. of polyvalent serum was injected.

3-8-17. Patient was not nearly so well again, and during the morning he was inclined to become slightly delirious and to throw himself about in his bed. He stated that he had no headache or pain anywhere, but reliance could not be placed in his answers. Gr. $\frac{1}{4}$ morphine was given Hypodermically. His condition improved during the day, he spoke rationally during the afternoon, and remarked that his headache was a little better; however his speech was not so clear as on the previous days. Temperature had subsided. He was again incontinent of urine. Lumbar puncture was done, and 40 c.c. of very turbid fluid was drained away under increased pressure. No serum was given.

4-8-17. His headache was better but he remarked that he was "very thick in the head" and had a feeling of weight and fullness in the occipital region.

He had a very much improved day. There was no report of incontinence. His temperature was normal, he looked better, and he could move about with more freedom. Lumbar puncture was done, and about 50 c.c. of clear fluid was drained off under excessive pressure. He was getting steadily more deaf, and one had to shout for him to make him hear at all.

5-8-17. He was much improved, generally speaking, in the morning; but still he was mentally dull and heavy in appearance, and complained of a feeling of "heaviness". Chloral and bromide mixture was stopped. He had no headache of consequence; his temperature was normal; and there was no incontinence. In the evening he had a very slight headache, for which aspirin was given. He brightened up mentally towards evening.

6-8-17. He was very drowsy, but felt better otherwise. Individual features were either absent or on the wane. Early in the afternoon however his head began to ache, and he became somewhat more restless; in the evening these features became more manifest, his temperature began to rise, his headache became distressing, and he obviously had taken a retrograde change. Lumbar puncture was done, and fairly clear fluid was drained away from him, 70 c.c. in volume and under excessive pressure. 20 c.c. of polyvalent A. M. Serum was injected.

7-8-17. He vomited three times during the morning, bilious looking vomit; his head was "heavy"; he had a restless night. However he stated that he was better generally speaking except for his vomiting. This vomiting ceased under sedative treatment at 11 a.m., but he vomited once again at 7 p.m. His headache got much worse as the day progressed. Lumbar puncture was done, and a large volume of fluid was drained away under excessive pressure. 20 c.c. of polyvalent A.M. serum was injected. His deafness was, if anything, becoming more marked.

8-8-17. His condition was much lower, there was no headache of consequence but there was marked depression and dulness. He had the general aspect of a failing condition; he was vomiting in the morning and was restless during the day; he was always incontinent of urine and faeces. Lumbar puncture was done, and 40 c.c. of yellowish-green clear fluid was drained off. As I had a feeling that, at the very least, the serum being used was not having the desired effect, or that it might be, as it appeared

to be, having an injurious effect, and was acting as an irritant (and not as an anaphalyctic), I decided to inject no serum.

9-8-17. He had a very good night and his condition was on the whole better. He was tak n a greater interest in life, had no incontinence, talked more freely, but his temperature however swung up to 102° in the afternoon. As the day advanced he again began to complain about headache which was intensifying. Lumbar puncture was again done, and clear colourless fluid was drained off under increased pressure and in a smaller volume than on previous days. He had not vomited throughout the day, had taken his food well, and, if anything, was not quite so deaf; no serum was injected on this day.

10-8-17. There was a marked improvement; he was very bright, even to the extent of laughing. There was a marvellous recovery from his condition o f a day or two back. He had very little headache or stiffness in the neck, and his temperature was normal.. He slept well during the previous night, and had no incontinence or vomiting. Lumbar puncturing was done and only 30 c.c. of fluid could be drained off under the very slightest decrease in pressure, and it was clear and colourless.

11-8-17. Condition was greatly improved. There was no headache, he was of quite bright demeanour, and was reading the newspaper. He had a very good night and his temperature was normal.

12-8-17. Progress was satisfactory until the evening, when headache was again threatening. Lumbar puncture was done, and 50 c.c. of clear fluid was drained off under excessive pressure. No serum was injected.

13-8-17. and 14-8-17. Progress was very satisfactory. Towards evening on the latter date his head began to ache, his temperature threatened to rise so lumbar puncture was done, and 35 c.c. of clear fluid was drained off under slightly increased pressure.

15-8-17. Condition was much improved, there was no complaint whatever, deafness was diminished very perceptibly. Towards evening again his headache threatened to return. His temperature remained normal. Lumbar puncture was again done, and 40 c.c. of clear fluid was drained away under increased pressure.

16-8-17. General condition was improved although he vomited a little once or twice. There was no further developments. As this vomiting, I felt, may be the result of a rapid accumulation of fluid, especially with its being accompanied by a dull heavy headache, I again punctured, but found only clear fluid under very little above normal pressure.

20-8-17 Progress was satisfactory and well maintained.

23-8-18. Progress was maintained. His only complaint was that he felt giddiness on moving about in bed. He could read and write with no inconveneince.

1-9-17. Condition steadily progressed towards complete recovery.

He made a perfect recovery and in the course of six weeks was transferred to a convalescent hospital with no sequelae, not even a headache.

Remarks:-

This was a severe acute attack which, although religiously punctured with free administration of serum, ran a prolonged acute course. He presented several interesting clinical features including tinnitus, deafness, incontinence etc., all, I am sure, being the result of pressure with resultant nerve irritation. The most instructive factor, in the treatment of the case, was the fact that it was doubtless that the A.M. serum caused irritation and was doing him harm. As before remarked I had not a good opinion of this "lot of serum" that was supplied to me since both cases in which I used it presented prolonged courses, although they started in a similar manner to many of my other cases. They were relieved, with similar results, by their lumbar punctures, which were really drainage punctures more than anything. Furthermore, in the fact that after the improvement of the first day or two when we were beginning to expect, and scientifically to rely on, results from the use of the serum, we were faced with disappointment. It is obvious on reading through this case sheet that no definite improvement was resulting from the serum; and by the results by lumbar punctures on the 7th, 8th 9th and 10th days of the month respectively, that it was having deleterious, if not injurious effects on the patients. Another important factor enunciated was that lumbar punctures had to be continued for decompression only, after the acute stage of the disease was past.

Bacteriology and Cytology:-

Direct smears showed no organism, but cultures presented a very fair growth of Type II meningococcus. The patient's blood also agglutinated Type II coccus. No blood culture was obtainable. The cellular element was almost entirely polymorphoneuclear in the centrifuged deposit of the cerebro-spinal fluid. A naso-pharyngeal swab cultivated Type II coccus.

Owing to my inability to procure the case sheets of my remainingcases I can only include the laboratory notes of these, which are as follows:-

Case 25.

Sap. D-----, aet. 45 years, was a mild case which reacted very readily to one or two lumbar punctures with serum. Direct smears of the cerebro-spinal fluid showed gram negative intracellular diplococci, but no growth could be obtained from cultures. There was no agglutination of standard cocci with the patient's blood serum. No blood culture was obtained. Nasopharyngeal swabs produced typical colonies of meningococci.

Case 26.

Pte. J. C. I----, aet. 21 years. This was a most interesting and a most complicated case. In November 1916 he was admitted to hospital with a history of a previous fracture of the skull associated with paralysis of the third nerve which fact led to considerable confusion in diagnosis at the time. It was not until the 7th day after admission when features of an acute nature continued, that it was considered advisable to puncture, when turbid cerebro-spinal fluid was obtained. The result of treatment was satisfactory.

Bacteriology and Cytology:- No organism was found in direct smear but a good growth was obtained on direct plating of the fluid. Type II coccus being isolated. In no subsequent specimen of fluid could a culture be obtained. The cellular element was nearly entirely polomorphoneuclear. The nasopharyngeal swabs were negative throughout, having been taken too late to start with.

In March, 1917, after having had a satisfactory convalescence and complete recovery, he was again admitted to hospital suffering from definite clinical features of cerebro-spinal fever. Lumbar punctures were persistently done and the serum was administered intrathecally. Various makes of polyvalent serum were tried; but he proved a most disappointing case in as much as Broncho-pneumonia was superadded as a complication and resulted in the death of the patient.

Bacteriology and Cytology:- Direct smears of the fluid failed to show diplococci, but showed abundance of polymorphoneuclear cells. Direct plates of the fluid failed to produce a culture, but a good growth was obtained after preliminary incubation of the fluid with broth for 24 hours. No agglutination of the cultures so obtained was seen even after 48 hours incubation; but subcultures agglutinated with Types I and III sera. Nasopharyngeal swabs produced a typical culture, but agglutination was negative to all types of sera. On April 10th the cerebro-spinal fluid was practically clear, and the pressure was only very slightly increased. A culture was obtained and was agglutinable with Types I and III sera. Further nasopharyngeal swabs were unsatisfactory, and failed to produce a typical culture. The blood failed to produce a culture.

Case 27

Dvr. K--------, aet. 20 years was admitted to hospital 7-2-17. He was a very severe acute case, which almost entirely cleared up after the first five lumbar punctures with administration of serum. However two days later, he developed almost a complete return of all features, although of reduced severity, and lumbar puncture with the use of sera had to again be resorted to; and after several such procedures he recovered completely.

Bacteriology and Cytology:- Direct smears showed a few gram negative diplococci which were all intracellular. Direct plates of the fluid gave a good growth of Type III coccus. Nasopharyngeal swabs were positive on the 7th and 11th days respectively, culturing Type III coccus; but on the 19th day a negative result was obtained, and this persisted afterwards. Blood culture was negative. Cytology showed a preponderance of polymorphoneuclears.

Case 28.

Dvr. H-------, aet. 18 years, was admitted to Hospital on 29-1-17, and was a mild acute case running a straightforward course. He showed no very marked improvement on his first two lumbar punctures with serum injection, but after two further lumbar punctures, and a change of the brand of serum used, he had recovered from his acute stage, and only two further punctures were required before complete recovery.

Bacteriology and Cytology:- No organism was found in direct smears at any date; of the cellular element polymorpho-neuclears were in abundance, and lymphocytes few. No culture was obtained either on direct plating of the fluid, or after primary incubation of the fluid with both for 24 and 48 hours respectively. The blood prouced no culture. Nasopharyngeal swabs on the 29th. and 30th. days respectively, produced typical colonies of meningococci, which were definitely agglutinated by type I and III sera. The patient's blood serum also agglutinated Type I and III cocci.

Case 29.

Dvr. S------, aet. 33 years, was admitted to Hospital on 4.1.17, as a very severe acute case in a man markedly debilitated previously. No specific treatment was carried out until five days after admission. He had a very definite improvement after his first three punctures with the use of serum, but this procedure was then stopped. On the 15th. he had a recrudescence of all clinical features and lumbar puncture with serum was resorted to again but with no improvement, but with ultimate death on 24.1.17. In my opinion this case illustrates two features, firstly the necessity of getting cases under treatment early, and secondly the desirability of continuing lumbar punctures after the cessation of troublesome features such as pain and headache whilst the temperature is still up; because in this case the temperature was fairly high, and continued high after his initial improvement.

Bacteriology and Cytology:- His intra-thecal pressure was very greatly increased. Direct smears showed an abundance of meningococci both intracellular and extracellular. This is in my opinion an interesting factor, because, although I have just suggested that with more persistent treatment the case might have had a more satisfactory

result, it is quite within the bounds of possibility that the presence of extracellular cocci might have indicated a bad progrosis. Unfortunately my experience has not been wide enough to form a conclusive opinion on this point, but what I have seen has rather tended to convince me that the presence of extracellular cocci at least indicates the necessity for very stringent and persistent treatment by liberal use of lumbar puncture and serum, or possibility that the prognosis is to be grave, or in fact hopeless. I certainly have noticed that extracellular cocci most frequently occur in the most severe or fulminant types of case.

Good growths of meningococci were obtained on direct plates, and these agglutinated with Type II serum very definitely.

Blood culture of the 4-1-17 produced a growth of gram negative diplococci with typical meningococcal colonies etc., but unfortunately it was not agglutinated.

Nasopharyngeal swabs produced typical cultures of meningococci, agglutinable with Type II serum.

Case 30.

Dvr. K------, aet. 20 years, was admitted to hospital on 10-1-17 in an exceedingly toxic state, and suffering from very much circulatory depression. He was undoubtedly a fulminating case. He was not diagnosed as a case of cerebro-spinal fever until the fourth day of his illness and by this time he was dying. There was only time for one lumbar puncture before death.

Bacteriology and Cytology:- Direct smears showed many intracellular as well as extracellular diplococci. Cellular element was profuse in polymorphoneuclears. Typical colonies were obtained on direct plating of the cerebro-spinal fluid, of Type III coccus. Nasopharungeal swabs produced a typical meningococcal growth, and very copious, agglutinating typically with Type II serum.

Blood culture of 11th inst. grew a gram negative diplococcus, but agglutination was not clear; on the 14th inst. another blood culture produced a similar growth which agglutinated with normal serum and Type II and III sera; on 17th inst. another similar growth which agglutinated with all types of sera as wellas normal serum was obtained.

Case 31.

Gnr. W------, aet. 19 years, was admitted to hospital during February, 1917 with severe symptoms and signs of cerebro-spinal fever verging on fulminant type. The most remarkable feature of this case was that his cerebro-spinal fluid was perfectly clear throughout, and with very little cellular deposit (polymorph in type), and not under very increased pressure. He was a very atypical case.

The diagnosis was made by nasopharyngeal swab which produced a typical plate, the subcultured colonies agglutinating with Type I and III sera.

Case 32.

Pte. C------, aet. 18 years, was admitted to hospital during February, 1917. He was a mild uncomplicated case resulting in absolute recovery.

Bacteriology and Cytology:- Direct smears showed intracellular diplococci but scanty; cellular element was almost entirely polymorphoneuclear. Direct plates presented a good growth of typical meningococcal colonies which however agglutinated with all types of sera. Owing to the rapid recovery of the patient no further cultures were obtained for further investigation. Blood culture was negative.

Case 33.

Pte F--------, aet. 18 years, was admitted to hospital during April, 1917, suffering from an exceedingly acute infection. He made a marvellously satisfactory recovery considering the initial severity of his attack.

Bacteriology and Cytology:- Direct smears showed intracellular diplococci, and preponderance of polymorphoneuclear cells. Culture of the cerebro-spinal fluid on direct plates presented Type III coccus. Nasopharyngeal swabs cultured typical colonies of Type I and III cocci. Blood culture was negative.

Case 34.

Pte. H. L-----, aet. 27 years, was admitted during March, 1917, as a fairly severe case; but improvement was not satisfactory under treatment. Four days elapsed between his third and fourth lumbar puncture, but his second series of punctures following the interval, did not appear to produce such a marked improvement although they gave relief. The last lumbar puncture was done without serum,and following this, very satisfactory and uninterrupted improvement was the result.

Bacteriology and Cytology:- Direct smears showed numerous intracellular gram negative diplococci, which cultured typical colonies of meningococci, which agglutinated with Type I and III sera. Nasopharyngeal swab cultured Types I and III cocci. Blood culture was negative.

———— A ————

Case 35.

Pte. A------, aet. 27 years, was admitted during March, 1917, as a mild case and ran an unterrupted course to wards rapid recovery.

Bacteriology and Cytology:- Direct smears were negative, but showed considerable polymorphoneuclear cellular element. Cultures of the fluid produced a typical growth after a preliminary incubation with broth for 24 hours; direct plates produced no growth. Coccus obtained agglutinated with Type III serum. Nasopharyngeal swab produced a positive culture agglutinating with Type III serum. Blood culture was negative.

———— B ————

All of these latter cases, outlined in brief only, were treated on exactly the same outlines as laid down in my review, and as shown in my detailed accounts of the progress of the previously described cases.

Of the balance of my cases I have no more notes than are included in the tabulated record which follows. I regret to state that all notes of a few other cases have been entirely lost through accident

or carelessness on my part.

However I have included the detailed case-sheets of two cases:-

1. Cerebral Syphilis involving the Meninges;
2. Tubercular Meningitis;

both of which cases were admitted to hospital as suspected cases of cerebro-spinal fever, but which were cleared up in diagnosis by cytological, bacteriological, and serological examinations; and the second case further confirmed by subsequent post-mortem examination.

Case 36.

Cyclist A. K-----, aet. 19 years, was admitted to hospital on 20-5-16 with a temperature of 100° and complaining of a very severe headache, marked drowsiness, pains in the nape of the neck, and stiffness in the limbs. On examination he appeared to be suffering from severe headache by the way he threw himself about. He had an internal strabismus of both eyes, considerable head retraction, tenderness in the neck and along the spine. He was very dull and of sleepy disposition, and would only speak reluctantly on being spoken to. There was no rash. Kernig sign was present but not exceedingly well marked. He moaned a great deal obviously from pain. Lumbar punctures was immediately done under chloroform, and 40 c.c. of slightly blood-stained cerebro-spinal fluid was obtained, and under considerably increased pressure. 30 c.c. of polyvalent A.M. serum was injected.

21-5-16. Condition was much the same although a little less headache was present since his lumbar puncture was done. There were no new developments.

22-5-16. There was no change whatever in his condition. Lumbar puncture was again done and much less intrathecal pressure was found, and the fluid was slightly blood stained again. The patient was still mentally dull. No rash had appeared. The temperature was irregular. Questions were answered but very slowly. On being questioned he stated that he was certain that he had not met with even the slightest injury to his head. Kernig sign was more marked than on previous days.

23-5-16. No change was evidenced, although he stated that he felt a little better. His temperature was the same, he was still moaning a great deal, and he still had marked headache and internal strabismus.

25-5-16. His general condition was unchanged on the 24th. He slept well during the night, but in the morning he became incontinent of urine and faeces. He continued to be dull, was nonconversational, and had a distinct squint with his left eye,although not manifest in his right. This strabismus feature I noticed to be interestingly variable,as during the same day his squint was transferred to the other eye. The pupils were even,and reacted to light. His tongue was very dirty; he complained of great pain in the muscles inserted about the knee on testing his Kernig; he did not answer questions readily; there was no head retraction; his knee jerks were absent, and a Babinski was present, being more marked on the left than on the right side. There was a developing paresis of the right side of the body, but there appeared to be no involvement of the seventh nerve. The paresis was apparently taking the flaccid type.

26-5-16. Symptoms and signs were unchanged beyond that he was a little brighter and would answer questions somewhat more freely, for the first time giving his christian name. He stated that his head ached a little, but that he felt better. He attempted to grasp with his right hand, but he had a very poor grip. His pupils were equal and reacted to light. There were no muscular spasms, and no convulsive seizures. He moved his left arm and leg freely, but made no endeavour to move his right arm or leg. Sensation was diminished on the right side to pain, heat and cold; in fact there appeared to be an entire loss of sensation. Having completed bacteriological examination of the cerebro-spinal fluid and obtained no culture, and having found a preponderance of lymphocytes in the very small amount of cellular deposit , I was led to suspect tubercular or syphilitic meningitis, and thus did a Wassermann of the cerebro-spinal fluid and blood,with the result that a positive reaction was obtained. Koch's test dose of Tuberculin was also given without result. Thus the case was diagnosed as syphilitic meningitis and immediately put on to a course of potassium Iodide.

29-5-16. His condition was unchanged, although if anything he was better and would converse more freely. He still retained a little power in his right hand on gripping, although he could not raise his right arm. He still had incontinence of urine, but his bowels had not moved for two or three days. An enema was given,and its return was satisfactorily controlled by the patient, thus convincing me that he was not incompetent of faeces.

31-5-16. His condition was unchanged, his grip was still weak in the right hand. The fundi of his eyes were examined by the ophthalmologist with the

following result:- Optic neuritis was present in both eyes with considerable oedema of the retina; the left eye showed several minute haemorrhages in the neighbourhood of the larger vessels as they entered the disc.

1-6-16. The first evidence of the seventh nerve becoming involved was seen in his face being drawn to the left on smiling. He was inclined to converse more freely, smile on being saluted, took more notice of things around him, and was not nearly so drowsy. Incontinence of urine was still present. Doses of potassium iodide were increased.

5-6-16. He had a good night. His condition was steady during the preceding few days. His condition now was that of perfect consciousness, internal strabismus of the right eye, paresis of the right arm, complete paralysis of the right lower extremity, and also paresis of the right side of the face. Incontinence of urine was still present.

27-6-17. His condition was from steady to slight improvement during the preceding days. The paresis of the face had now largely passed off, and he had lost his strabismus. He could raise his right arm slightly, moved his fingers freely, and with difficulty could pull his right leg up to the position of flexion at the knee, but could not lift it clear of the bed. He had no incontinence and had recovered a good deal of his power of speech, and was quicker in appreciating things said to him and in answering questions.

30-9-16. Progress was steady and very satisfactory during the previous weeks on potassium iodide in gr.XV doses t.i.d., p.c. He was now up and moving about; his pupils were still unequal but were reacting to light; there was no trace of involvement of the seventh nerve, or of paresis of the upper or lower extremities; the power in both arms was about equal, but his right leg was weaker than the left.

20-10-16. His condition was practically normal, his only complaint being that he was very easily tired. He was sent to convalescent hospital.

Remarks:-

This was a very interesting case since it proved to be so very like cerebro-spinal fever in its initial stages. However this was cleared up by two examinations of the cerebro-spinal fluid negativing this fever, but still leaving us with a necessary differentiation between Tubercular and Syphilitic Meningitis. This was readily done by positive Wassermann tests,and was supported by a negative Koch's Tuberculin Reaction, and still further by the fact that the conditions subsided under potassium iodide in continued doses.

Bacteriology and Cytology:-
Cerebro-spinal fluid neither showed any organism in direct smears nor cultured anything after even primary incubation with broth for 24 and 48 hours respectively. The patients blood serum gave no agglutination with a stock culture of meningococcus. The cellular element of the cerebro-spinal fluid was confined almost entirely to lymphocytes. The two lumbar punctures done showed a little blood in the fluid but not sufficient to be of any significant indication, most likely having originated through the puncture of some small blood vessel. Wassermann reaction of the cerebro-spinal fluid gave a positive result. Chemical examination of the cerebro-spinal fluid was not done.

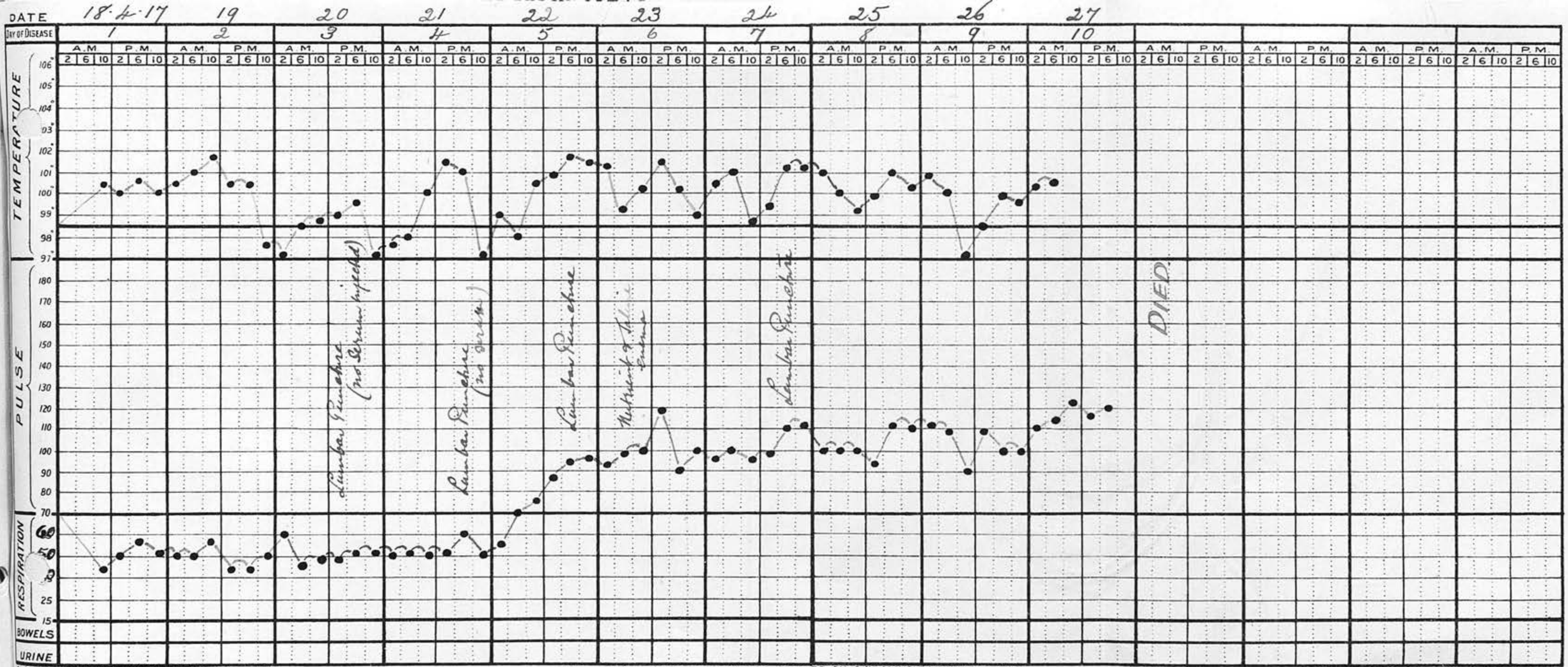
Case 37.

Pte. H-------, aet. 26 years, was admitted to hospital on 18-4-17 with a temperature of 100.4°, pulse 44, and complaining of a very intense headache. No abnormalities could be found throughout any of the systems, with the exception of some type of cranial involvement. Pupils were equal and were reacting to accommodation and light. There was no Babinski or Kernig present.

19-4-17. His condition was much the same, he was sleeping badly, and occasionally he rambled in his conversation.

20-4-17. No change had taken place in his general condition. It was decided to lumbar puncture; this was done under chloroform, and perfectly clear cerebro-spinal fluid was obtained, but under very excessive pressure, absolutely pumping out at first, 80 c.c. being drained off. No serum was injected. Later in the day the patient stated that his headache was very markedly relieved, and he was more restful, and tended to sleep quietly.

21-4-17. Patient still complained of headache, pains in the nape of the neck, but had no vomiting; he had stiffness along the spine; and on examination had a pulse of 50, a suspicious kernig sign and diminished knee jerks. He was somewhat delirious, his temperature towards evening went up to 102.4°, and pulse to 64. Lumbar puncture was again done for decompression and diagnostic purposes, and again clear fluid was drained away under very high pressure, no serum was used.



SUGGESTED BY A. W. MAYO ROBSON, D.Sc. F.R.C.S. No 16 ENTERED AT STATIONERS' HALL

taken; and no tuberculin reaction was looked for.

Post-mortem examination revealed the following facts:-

a. Considerable distention of the ventricles with clear fluid,

b. Numerous tubercular nodules scattered over the base of the cerebral hemispheres.

The deduction was that of acute hydrocephalus following tubercular leptomeningitis.

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TABULATED RECORDS.

I. Cases with their Etiological, Clinical, and Curative data.

II. Cases with their numbers of contacts and carriers, and their relationship to Infective areas.

III. The persistence of the Meningococcus in carriers.

IV. The relationship of the Meningococcus to the Nasopharynx, Cerebro-spinal fluid, and Contacts.

These tabulated records are here included with the object in view of summarising the etiological, clinical, and curative deductions; and will, in a certain measure, permit one to see at a glance the data from which many of my conclusions were drawn. In order to facilitate ready reference the case numbers are the same throughout the case sheets and tabulated records.

The first series of records of various cases with their etiological, clinical, and curative data, clearly show:-

a. The relationship age and seasonal incidence have to the eitology of cerebro-spinal fever; firstly in particularly supporting the fact that it is most predominant in the younger adult or adolescent than in the older adult; and secondly that it is much more widespread in the cold and wet months of February, March, and April than at any other time of the year.

b. The intimate association of the meningococcus with the nasopharynx in cerebro-spinal fever, so fully discussed in my review, and generally accepted by all workers on the subject of cerebro-spinal fever.

c. The regularity with which the meningococcus is obtained from the cerebro-spinal fluid either by direct smear or culture in cases of this disease.

d. The frequency with which the Type I and Type III meningococci occur; the smaller proportion of times that the Type II coccus was found; and particularly the rarity with which the Type IV coccus occurs.

e. The number of lumbar punctures and serum injections required in treatment. However, although these might be interesting, they do not provide us with conclusive deductions without referring to the individual case sheets, because one has to take into consideration several other features at the same time, such as the severity of the attack, the date of commencing treatment, the regularity with which these procedures were carried out, and the general condition of the patient etc.

f. That early diagnosis and early treatment were prominent factors in a big proportion of my later cases, thereby reducing the number of lumbar punctures in severe cases whilst at the same time adhering to the principle of persistence with this procedure until the case was absolutely under control.

g. That the percentage of recoveries was very markedly increased in my later cases, in which close observation and treatment as laid down in my review were carried out in detail.

h. That it is quite possible that the Type of Coccus (or Cocci) found might, with further investigation, prove to be of great assistance in prognosis, since my investigations show that death was rare in infections with Type I, III, or IV Cocci, whilst it was much more frequent with Type II Coccus, and still more so with the dual infection with Types I and III Cocci combined. These data can be summarised from my first records as follows:-

	Type I.	Type II	Type III.	Type IV	Type I & III
Recovery	6	8	6	1	8
Death	1	5	1	0	6

k. That the Meningococcus can only be cultivated from the blood on very rare occasions.

Patient	Age	Month of onset	Post-nasal swab.	Blood culture	Spinal fluid.	Type of Coccus	Number of puncts.	Number of injects.	Treat. started	Type of Case	Result
Case 1	19½	April 1916.	pos.	neg.	pos. smear culture	-	7	4	-	Very severe	Death
Case 2	20	April 1916.	pos.	-	pos. smear	-	2	2	4?	Mild	Recovery
Case 3	40	June 1916	-	neg.	pos. smear culture	-	4	4	-	Very severe	Death
Case 25	45	Augt. 1916.	-	neg.	pos. smear	-	2	2	8th	Mild	Recovery
Case 4	17	Sept. 1916.	neg.	neg.	pos. smear culture	I & III	6	6	5th	Severe	Death
Case 5	17	Octr. 1916.	pos.	neg.	pos. culture	II	6	5	2nd	Severe	Death
Case 26	20	Octr. 1916.	neg.	neg.	pos. culture	II	6	6	7th	Severe	Recovery
Case 6	18	Novr. 1916.	-	neg.	pos. culture	I & III	2	2	4th	Severe	Death

Patient	Age	Month of onset	Post-nasal swab.	Blood culture	Spinal fluid.	Type of Coccus	Number of punct s.	Number of injects.	Treat. started	Type of Case	Result
Case 7	25	Decr. 1916.	pos.	neg.	pos culture (scanty)	II	3	3	5th	Severe	Death
Case 36	30	Decr. 1916.	-	-	pos. smear culture	I & III	5	4	18th	Severe	Death
Case 8	39	Jan. 1917.	pos.	neg.	neg.	III	3	3	7th	Mild	Recovery
Case 37	18	Jan. 1917.	pos.	-	pos. culture	II	7	7	3rd	Severe	Recovery
Case 30	20	Jan. 1917.	pos.	pos.	pos. smear culture	I & III	1	nil	4th	Very Severe	Death
Case 38	24	Jan. 1917.	-	neg.	pos. smear culture	III	2	1	2nd	Very Severe	Death
Case 28	18	Jan. 1917.	pos.	neg.	neg.	I & III	4	4	2nd	Severe	Recovery
Case 29	33	Jan. 1917.	pos.	pos. not agglut	pos. smear culture	II	5	5	5th	Very Severe	Death

Patient	Age	Month of onset	Post-nasal swab.	Blood culture	Spinal fluid.	Type of Coccus	Number of punct.	Number of injects.	Treat. started	Type of Case	Result
Case 27	20	Feb. 1917.	pos.	neg.	pos. smear culture	III	9	9	3rd	Severe	Recovery
Case 9	20	Feb. 1917.	neg.	neg.	pos. culture	III	7	6	3rd	Mild	Recovery
Case 32	18	Feb. 1917.	-	neg.	pos. smear culture	-	2	2	4th	Mild	Recovery
Case 31	19	Feb. 1917.	pos.	-	neg.	I & III	3	3	3rd	Severe	Death
Case 10	22	Feb. 1917.	pos.	neg.	pos. smear culture	I & III	7	6	2nd	Very Severe	Recovery
Case 11	26	Mar. 1917.	pos.	neg.	pos. smear	I	8	8	2nd	Severe	Recovery
Case 13	18	Mar. 1917.	pos.	neg.	pos. smear culture	II	2	2	4th	Severe	Recovery
Case 12	26	Mar. 1917.	neg.	neg.	pos. smear culture	I	3	3	1st	Severe	Recovery

Patient	Age	Month of onset	Post-nasal swab.	Blood culture	Spinal fluid.	Type of Coccus	Number of puncts.	Number of injects.	Treat. started	Type of Case	Result
Case 14	19	Mar. 1917.	pos.	-	pos. culture	II	4	4	2nd	Very Severe	Recovery
Case 39	29	Mar. 1917	-	-	pos. smear culture	II	1	1	2nd	Fulminant	Death
Case 15	24	Mar. 1917.	neg.	neg.	pos. culture	I?	13	13	3rd	Very Severe	Recovery
Case 40	31	Mar. 1917.	pos.	neg.	pos. culture	II	4	4	6th	Very Severe	Recovery
Case 41	33	Mar. 1917.	-	-	pos. smear culture	II	1	1	1st	Fulminant	Death
Case 42	18	Mar. 1917.	pos.	neg.	pos. smear culture	I & III	6	4	2nd	Very Severe	Recovery
Case 26	21	Mar. 1917	pos.	neg.	pos. culture	I & III	5	5	4th	Very Severe	Death
Case 16	21	Mar. 1917.	pos.	neg.	pos. smear culture	III	3	3	2nd	Severe	Recovery

Patient	Age	Month of onset	Post-nasal swab.	Blood culture	Spinal fluid.	Type of Coccus	Number of puncts.	Number of injects.	Treat. started	Type of Case	Result
Case 43	21	Mar. 1917.	pos.	neg.	pos. culture	II	7	7	2nd	Severe	Recovery
Case 17	20	Mar. 1917.	neg.	neg.	pos. smear culture	II	5	5	7th	Severe	Recovery
Case 18	18	Mar. 1917.	neg.	neg.	pos. culture	I	11	11	2nd	Very Severe	Recovery
Case 19	20	Mar. 1917.	pos.	-	neg.	I & III	1	nil	2nd	Mild	Recovery
Case 44	18	Apr. 1917.	pos.	-	pos. culture	IV	3	3	2nd	Mild	Recovery
Case 20	18	Apr. 1917.	pos.	-	pos. smear culture	III	10	10	2nd	Severe	Recovery
Case 33	18	Apr. 1917.	pos.	neg.	pos. smear culture	I & III	10	8	2nd	Severe	Recovery
Case 34	27	Apr. 1917.	pos.	neg.	pos. smear culture	I & III	7	6	3rd	Severe	Recovery

Patient	Age	Month of onset	Post-nasal swab.	Blood culture	Spinal fluid.	Type of Coccus	Number of Puncts.	Number of injects.	Treat. started	Type of Case	Result
Case 35	27	Apr. 1917.	neg.	neg.	pos. culture	III	2	2	2nd	Mild	Recovery
Case 21	30	Apr. 1917.	neg.	-	pos. smear culture	I	6	6	2nd	Very Severe	Death
Case 45	34	Apr. 1917.	pos.	neg.	pos. smear culture	I & III	6	6	?	Severe	Recovery
Case 46	31	Apr. 1917.	pos.	neg.	pos. culture	I	5	5	2nd	Severe	Recov ery
Case 47	29	May 1917.	neg.	neg.	pos. smear culture	I	10	8	2nd	Severe	Recovery
Case 24	28	July 1917.	pos.	neg.	pos. smear culture	II	20	9	3rd	Very Severe	Recovery
Case 23	32	July 1917.	neg.	neg.	pos. smear culture	I & III	16	6	7th	Severe	Recovery

The second series of records of cases with their numbers of contacts and carriers, and their relationship to various infected areas, help us to appreciate the following facts:-

a. That the greater number of the cases occurred in two regimental areas viz:- R.F.A. and Lancashire and Manchester Regiments. It will here be noticed that I have included two Gordon Highlander cases in with those of the Lancs. and Manchesters because these two cases occurred in the sam e section of the Camp, the Lancs. and Manchesters taking over from the Gordons. Furthermore the R.F.A. and Lancs. & Manchesters areas were adjoining one another. I would here intimate that one half of the entire camp area (Southern Section), accommodating about 15,000 troops was free from cases. By further glances at my fourth series of records at this stage it will be seen that there was, with only few exceptions, the same type of meningococcus present in both of these areas.
Therefore it is suggested, in support of the limited epidemicity of the disease, that not only can an outbreak occur in a large isolated area, since there were more cases in the Ripon Reserve Area than all the rest of the Northern Command put together, but that isolated sections of that area can show a greater case incidence than other areas.

b. That cases and carriers do occur through infection from a definite source.

c. That carriers can be found in areas which are considered free from the disease, and amongst apparently healthy persons.

Patient	Month	Unit	No. of Contacts	No. pos.	Percentage.
Case 6	Nov. 16	R.F.A.	31	5	16
" 28	Jan. 17	"	75	6	8
" 31	" "	"	29	4	13.5
" 10	" "	"	16	0	-
" 27	Feb. "	"	30	3	10

Patient	Month	Unit	No. of Contacts	No. pos.	Percentage
Case 9	Feb. 17	R.F.A.	44	1	2
" 13	Mar. 17	"	27	1	3.5
"" 14	" "	"	26	0	-
" 39	" "	"	22	1	4.5
" 16	" "	"	27	3	11
" 17	" "	"	32	11	37
" 35	Apr. "	"	17	2	11.5
" 23	Jul. "	"	34	3	9
" 26	Oct. 16	Lancs. and Manchesters.	30	3	10
" 26	Jan. 17	"	31	0	-
" 8	" "	"	46	3	6
" 12	Mar. "	"	26	5	19.5
" 18	" "	"	25	4	16
" 21	Apr. "	"	37	0	-
" 33	" "	"	25	2	8
" 20	" "	"	36	2	5.5
" 34	" 16	Gordon Hdrs.	23	0	-
" 4	Sep.16	"	48	4	8.5
" 5	Oct.16	T.R.B.	30	6	20
" 11	Mar.17	"	46	1	2
" 25	Aug.16	R.E.	30	6	30
" 7	Dec.16	R.A.M.C.	58	3	5
" 24	Jul.17	Yorks.	51	1	-
" 15	Mar.17	A.& S.H.	27	3	11

CONTROLS FOR PREVIOUS CASES.

No. of Controls	Month	Unit.	Case Controlled	No. pos.	percent.
25	Nov. 16	R.F.A.	-	4	16
20 (1st)	" "	"	Case 6	0	-
20 (2nd)	" "	"	" 6	3	15
29	Jan. 17	"	" 28	0	-
25	Mar. "	"	" 12	0	-
15	" "	"	" 16	1	7
10	" "	"	" 17	2	20
25	" "	"	" 39	1	4
14	Apr. 17	"	" -	3	21
24	" "	"	" -	6	25
60	" "	Highlanders	" -	7	12
29	Mar. "	Hosp. Ward	" -	0	-
41	Apr. "	"	" -	0	-

The third series of records of cases with their numbers of carriers and periods of isolation, shows the persistence of the meningococcus in the nasopharynx of carriers when under treatment with Chloramine or Sulphate of Zinc sprays or douches, coupled with open air treatment:-

Patient	No. of Contacts	No. Positive	Longest Positive	Shortest Positive	Average
Case 25	20	6	8½ wks.	2½ wks.	5 wks.
" 4	48	4	12 "	3½ "	6 "
" 5	40	6	11½ "	1½ "	4 "
" 26	31	3	8½ "	3 "	4½ "
" 6	31	5	8½ "	2½ "	5 "
" 7	58	3	3½ "	2½ "	9 "
" 36	39	1	2 "	-	2 "
" 8	48	3	3½ "	1½ "	2 "
" 37	34	4	2 "	2 "	2 "
" 30	72	6	8 "	2 "	3 "
" 28	75	6	12½ "	2½ "	5 "
" 29	64	3	9½ "	1½ "	5½ "
" 27	30	3	5 "	3 "	3½ "
" 9	44	1	1½ "	-	1½ "
" 32	128	12	10½ "	1½ "	3½ "
" 31	29	4	4½ "	3 "	3½ "
" 11	22	1	2 "	-	2 "
" 13	27	1	3 "	-	3 "
" 12	26	5	16 "	2 "	5½ "
" 39	22	1	2 "	-	2 "

Patient	No. of Contacts	No. Positive	Longest Positive	Shortest Positive	Average
Case 15	27	3	6 wks.	5½ wks.	5½ wks.
" 40	37	8	12½ "	1½ "	5 "
" 41	190	6	15 "	1½ "	5½ "
" 42	33	9	17½ "	3 "	7 "
" 16	27	3	3½ "	1½ "	2½ "
" 43	9	1	1½ "	-	1½ "
" 17	32	12	13 "	2 "	5 "
" 18	25	4	2½ "	1½ "	2 "
" 20	36	2	6 "	4 "	5 "
" 33	25	2	15 "	4½ "	10 "
" 35	17	2	2 "	2 "	2 "
" 45	25	2	8½ "	2½ "	4½ "

The fourth series of records of cases with the types of meningococci found in each patient's nasopharynx and cerebro-spinal fluid, and each carrier's nasopharynx shows firstly that there is a marked relationship between the nasopharyngeal infection and the subsequent development of the disease; secondly, that there is also a relationship, but not quite so definite, between the case and the carrier or vice versa; thirdly, that there are dormant carriers amongst healthy people who have perhaps become unconsciously infected elsewhere; and fourthly, arouses the suspicious that the various types of meningococci may be varying degrees of virulence of the same organism, or in other words, that the meningococcus is a form of pleomorphic organism of several types, any one type being convertible into another type through some local environment not yet understood.

However putting these considerations aside the data here presented is instructively interesting from two points of view:-

a. The finding of the same type of meningococcus in the nasopharynx as in the cerebro-spinal fluid presents us with an important supporting factor for the hypothesis that the infection arises in the nasopharynx. In opposition to this, it might be argued that the nasopharynx is infected through the cerebro-spinal fluid, which has previously been infected through some other channel; but the fact that cannot be readily explained here is how it occurs that so many cases appear where neither in smear nor culture can the meningococcus be obtained from the cerebro-spinal fluid, whilst it can readily be cultured from the nasopharynx. These cases we know do occur, and not infrequently, and are readily explained by the suggestion that under very early observation and treatment the organism is not permitted to establish itself in the meninges after infection through the nasopharynx.

b. The frequent finding of the same type of meningococcus in the contact as in the case strongly supports the generally accepted view that direct infection is the main source of infection, either the case having infected all of the contacts, or the presence of an undiagnosed carrier having infected the case as well as the rest of the contacts. This does not explain the fact that other types of meningococci are found in a batch of contacts, but since it is possible to have positive carriers in healthy areas it is just as possible to have them intermixed in an infected area and perhaps included in a batch of contacts. This latter feature also supports the hypothesis that the types of meningococci might upon further investigation prove to be some unknown variation of the one type.

c. The comparative frequency with which the one type of coccus was found in the one area (with few exceptions) supports the fact that the disease is infectious and of limited epidemicity.

Patient	Unit.	C.S. Fluid	naso-pharynx	Contacts.
Case 6	R.F.A.	- - -	I & III	II(4) III(1)
" 21	"	III	III	III
" 31	"	-	I & III	I (1) II (3)
" 10	"	I & III	I & III	-
" 13	"	-	II	II
" 14	"	II	?	-
" 39	"	I	-	I
" 16	"	I & III	III	III(2) IV(1)
" 19	"	-	I & III	-
" 17	"	II	-	II
" 35	"	III	III	I (1) III(1)
" 8	Lancs. & Manch.	-	III	III
" 26	"	I & III	-	-
" 18	"	I	-	I(1) II(3)
" 20	"	III	III	I & III
" 33	"	III	I & III	I & III
" 3 4	Gord. Hdrs.	I & III	I & III	-
" 4	"	I	-	I(2) II(2)
" 11	T.R.B.	-	I	-
" 5	"	II	II	II
" 7	R.A.M.C.	II	II	II
" 15	A.& S.H.	I	-	I(1) II(2)