Remarks

ON AN

OUTBREAK OF EPIDEMIC CEREBRO-SPINAL MENINGITIS.

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I SHALL not attempt to give a detailed historical survey of epidemic cerebro-spinal meningitis, but the recapitulation of one or two facts of outstanding interest may not be amiss.

The first written account of the disease in its epidemic form was given by Vieusseaux, who described the Geneva outbreak of 1805. During this epidemic there were 33 deaths. In the following year, Danielson and Mann called attention to the existence of the disease in Massachusetts. From that centre the disease spread throughout New England, and continued to make its presence felt for the ten subsequent years. The epidemic occurrence of this disease has been grouped into the following periods: 1805-30, 1837-50, 1854-75, 1876 onwards. In the first period, America was seriously involved, only isolated epidemics appearing on the Continent. During the second period, widespread epidemics occurred in France, Italy, Algeria, America, and Denmark. The third period found the disease established in Europe, Asia, Africa, North and South America. In the fourth period, Germany, Italy, and the United States were attacked.

It will be thus observed that nearly every European country has been involved. It is surprising, therefore, that Great Britain has escaped an epidemic visitation so long. Ireland suffered in the Forties and Sixties, but England, Wales, and Scotland have not, within recent times at least, been seriously affected. Sunderland was invaded in the year 1830.

In Creighton's *History of the Epidemics of Britain*, one finds reference to spotted-fever epidemics, but it is impossible to say definitely that the spotted fever there described is the same as that now known as epidemic cerebro-spinal meningitis. The only clue we have in favour of the similarity of the two diseases is the fact mentioned by the earliest observers, about the seventeenth century, that the mortality, in London especially, was amongst children, though adults did not escape. And in view of the present ambiguity with regard to the method of spread of the disease, it is highly interesting to note that Sir Joseph Mayerne, the King's physician, in 1624, wrote that the disease was "not so much contagious as common through an universal disposing cause." Also at that time the idea prevailed that cucumbers contaminated by water from foul ditches and polluted watercourses had promoted the spread of the disease. Sporadic cases of cerebro-spinal meningitis have been recognized by many physicians and pathologists, but, as I have said, the epidemic form of the disease has not been well known. I shall therefore now attempt to offer a possible explanation for the present involvement of Scotland.

In the first place it falls to be observed that the towns which have principally suffered from attack in Scotland have been Glasgow, Edinburgh, Leith, Grangemouth, and Falkirk. Leith is really the seaport of Edinburgh, Grangemouth standing in the same relation to Falkirk. In Ireland, Belfast and Cork have been attacked, and, later, Dublin became involved. Passing over to America, one finds that New York, New Orleans, Boston, and Massachusetts and San Francisco have suffered severely from the ravages of the malady. The foregoing enumeration shows that the chief centres of attack in this country and America have been seaport towns.

When attention is directed to the Continent, one is able to point to Hamburg, Copenhagen, Naples, and Gibraltar as other seaport towns that have suffered. Since the intimate connexion of these ports with one another is actual, the opportunities for oversea conveyance of infection are many. Further, thousands of immigrants and transmigrants annually arrive in Leith from infected European countries. This naturally prompts the pertinent question: Why should Glasgow have been involved before Leith, when one knows that the latter is the port of debarkation? The answer can,

I think, be supplied by the following explanation. Coming, as they do, from Antwerp, Hamburg, Rotterdam, Copenhagen, and other Continental ports, these foreigners—in many instances most undesirable subjects—have been collected from Russia, Poland, Germany, Austria, Italy, Bulgaria, and other countries. As soon as they reach Leith they are, without delay, entrained for Glasgow, their sojourn in Leith being measured by minutes. On arriving in Glasgow, a residence of a few days there is often necessary until a steamer is ready to sail for America, consequently the opportunities afforded for sowing the seeds of infection in Glasgow were considerably greater than in the case of Leith. When one learns how infection may be spread, the force of my contention will be strengthened. It is generally believed that the infection of Hamburg and other cities in Northern Germany as well as Copenhagen, was conveyed from America, where the disease had become endemic. That this method of conveying infection between Europe and America is likely, is borne out by the fact that many passenger steamers sail direct between the two continents. Had the infection of Scotland been traceable to America, then Liverpool and Southampton ought to have shared in the present attack, since the oversea connexion (between Liverpool, Southampton, and America is much more intimate than it is with Glasgow. We know that the meningococci can be recovered from the upper air passages of what I shall call "intermediaries" for a period of three weeks. The voyage between the Continent and America can be completed within that period, and it is reasonable to suggest that the final settling place of "infection carrying" transmigrants will receive the chief brunt of attack. That the constant conveying of infection carriers to Leith resulted in converting the ships themselves into infected places will be presently proved.

Lanarkshire shared in the first epidemic of cerebro-spinal meningitis, that is, the epidemic which occurred in Glasgow last year. But whether the outbreak occurring in Lanarkshire preceded that of Glasgow I am not in a position to state. It is highly significant, however, that Polish miners are employed in large numbers in the Lanarkshire coalpits. Epidemic cerebro-spinal meningitis had been very prevalent among the coal-mining population of certain Continental countries. It is not, I think, improbable, therefore, that miners coming to this country may have played an important part in conveying infection with them. The Leith outbreak may be said to have begun late in December of 1906, when several sudden deaths of a suspiciously obscure nature occurred among children. In one or two instances death was certified as having been due to convulsions, accompanied in one or two cases by gastro-intestinal disturbance. Such sudden and obscure deaths among young children continued to occur at intervals. Early in January, however, several cases of peculiar illness were admitted to the Leith General Hospital, where suspicions became centred upon epidemic cerebro-spinal meningitis. Lumbar puncture verified the worst fears. The cases were notified to me, and I became aware of the fact for the first time that Leith was involved in the outbreak which had been raging in Glasgow and Belfast for a considerable time. It is interesting to observe at this point that some weeks before the above cases were verified a boy was admitted to the scarlet fever ward of the Fever Hospital with all the symptoms of that disease—a rash, with throat injection—the symptoms of onset consisting of acute headache, rigors, and vomiting. Subsequent investigation proved that the onset of illness had been peculiarly sudden. The boy afterwards developed head retraction of an exaggerated form, and lumbar puncture verified the diagnosis of epidemic cerebro-spinal meningitis. This patient lay for five months, growing progressively worse, until he became, like all other chronic types of this disease, a mere skeleton. I have digressed to mention this case in order to point to the occasional association of scarlatiniform-like rashes and throat symptoms with this disease. At first the cases coming under notice were separated by wide intervals, but as time went on the victims were notified with greater frequency, though up to the end of May there were lapses of several days between notifications. Now and again an entire week would pass without the notification of new cases, but the hopes that the outbreak had begun to decline were rudely shattered by the occurrence of as many as 9 or 10 cases within twenty-four hours, such cases occurring

in different parts of the community and apparently having no connexion with one another. This, to my mind, is one of the inexplicable features underlying the spread of the disease.

TYPES OF CASES ENCOUNTERED.

The first cases of epidemic cerebro-spinal meningitis when encountered by the practitioner are most puzzling. The usual experience is somewhat as follows: The medical man is called in to see a patient who has been seized with sudden illness. The onset is always sudden. In the case of children and young persons convulsions may herald the attack, and these may begin and terminate the illness; in other words, only a few hours may separate the onset of attack from the moment of death. Shivering and vomiting are fairly constant accompaniments. Extreme restlessness may and often does ensue. This in adults becomes occasionally violent. Headache is often frontal and acute. Occasionally the pain is referred to the nape of the neck. A characteristic stiffness of the neck invariably manifests itself, and when attempt is made to lift the head from the pillow great pain is complained of. Even should the sufferer be in a comatose condition, this pain is evidenced by the distortion of the face or perhaps the crying of the patient. In fact, children invariably cry when the least movement of the head is made. Another very constant feature in acute cases is hypersensitiveness. Yet when left alone the patient may lie as still as a log, with eyes shut and with apparent freedom from suffering. Temperature readings have not much significance, for the simple reason that fever is far from being a constant feature. To illustrate the various phases of the disease that may be encountered, let me briefly quote the following types:

1. A woman, aged 60, was well when she went to bed at night. About 3 next morning a daughter was roused by her mother's restlessness. The restlessness became exaggerated until ultimately the patient fell on the floor and grovelled under the bed. About 10 a.m., when I saw the patient, she was lying perfectly still, her eyes closed and her temperature subnormal. There was no rash of any kind on her body. It was difficult to elicit a clear history of the mode of onset. Pain in the neck had been complained of, and the patient had twice attempted to vomit. The absence of temperature and the peculiar nature of the symptoms rendered the diagnosis very difficult, but the sudden onset suggested epidemic cerebro-spinal meningitis, the existence of which was verified by lumbar puncture, the syringe withdrawing turbid fluid. The patient died at the expiry of sixteen hours. There was no head retraction, but herpes subsequently developed about the mouth and alae of the nose.

2. A boy, aged 10, was admitted to hospital showing exaggerated head retraction, acute cyanosis, the finger tips being livid and his body perfectly cold. In this case, too, the onset was quite sudden, the boy having been in the best of health the day before. His legs were tightly flexed, as were his arms and fingers. When his head was raised from the pillow the whole body moved with it, and intense suffering accompanied the movement. The boy's chest and abdomen were marked by a distinct purpuric eruption. This may be taken as a typical picture of acute epidemic cerebro-spinal meningitis, as seen especially among children. The boy died within twenty-four hours. His temperature on admission was 102° F.

3. A little girl, aged 6, was bright and happy about 6 at night. In fact, her parents remarked that their daughter had seldom been in better spirits. She went to bed apparently perfectly well. At 1 a.m. an elder sister was roused by the vomiting of the little girl, who afterwards lapsed into a condition of drowsiness. During the forenoon the patient could be roused to whisper her name and to show her tongue. She lay on her back in a comatose condition, her eyelids being shut. There appeared to be pain when the head was moved. The surface of her body was perfectly cold, and there was no fever. There was not the least evidence of head retraction. About 4 p.m. purpuric spots appeared on different parts of the trunk, and at 6 the patient died, restlessness having supervened.

4. A woman, aged 56, took suddenly ill during the night. She was very restless, had a great deal of pain at the nape of her neck, and early during the ensuing forenoon herpes appeared on the lips and cheek. She gradually became more restless, and died at the end of twenty-four hours. She had a temperature of 101° F.

5. A girl, aged 16, suddenly became violently ill, vomited repeatedly, and complained of severe frontal headache. Urine was suppressed, and that drawn off was loaded with albumen. She grew gradually worse, and died next day. Everything pointed to uraemia, but the sudden onset and lumbar puncture proved the existence of epidemic cerebro-spinal meningitis.

A peculiar feature of attack is its almost invariable onset at night.

Though the vast majority of cases, especially among children, are typical in respect of head retraction with the manifestation of Kernig's sign, the above have been quoted to indicate how extremely difficult it is to diagnose the disease in its varying phases. It is true that typical clinical features, especially among children, predominate, but such puzzling and aberrant types as some of those quoted are not uncommon. Among children one encounters instances of illness of fairly sudden onset. The cheeks are flushed, the tongue is furred, and other evidences are suggestive of gastro intestinal disturbance. The patient is perfectly conscious, is very fretful, and eats sparingly. There is no head retraction, but attempts to move the head are accompanied by manifestations of pain. In these cases the duration of illness is not infrequently prolonged, death resulting after the patient has become extremely emaciated. During the course of such an illness as that instanced there may be bright periods in the patient's condition when the medical attendant may be buoyed with the hope of recovery. But in all such cases it will be found wise to be guarded in the prognosis. One or two of our patients who appeared to have no chance of recovery, and in whom the manifestations of the disease were of a most pronounced kind, ultimately got well without any sequelae. They were reduced to mere skin and bone, and their convalescence was very protracted. That the difficulty in prognosis is extremely great will be best borne out if I quote one or two examples.

A young man, between 20 and 30 years of age, had been under treatment for a month, and was apparently on the fair way to recovery. He was feeling perfectly well, was very intelligent, his condition being considered eminently satisfactory. He was being regularly treated by lumbar puncture and the injection of lysol. Ten minutes after injection of lysol he complained of sudden faintness, and fell back dead.

Two patients suffering from slight attacks of epidemic cerebro-spinal meningitis were sent home from hospital after a brief residence there. The patients felt and looked perfectly well, and in each case the diagnosis had been verified by lumbar puncture. One of them died suddenly a fortnight after leaving hospital; the other on being remonstrated with by his mother, put his hand to his head, complained of acute pain there, and fell back dead. These two cases convey a very far-reaching lesson and point to the necessity for prolonged rest and convalescence. It is well to note, however, that the second boy had been playing football two days before he died, and had sustained head injuries whilst at play.

The influence of shock or sudden emotion has been commented upon by writers upon this subject. Another noteworthy feature, which has also been observed, was the onset of illness immediately following head injuries. In six different Leith cases the parents ridiculed the diagnosis of epidemic cerebro-spinal meningitis, pointing to the fact that the sudden onset must have been due to head injuries recently inflicted. For example, in the case of a man attacked, the history given was injury sustained during a Saturday night brawl. On the Monday he was seized with illness verified to be cerebro-spinal meningitis, death resulting.

In only a small proportion of the cases were purpuric or other rashes encountered. In only one adult were purpuric spots seen. I have cited the case of a boy with a scarlatiniform rash. In a few instances the rash was of a measles character. Herpetic eruptions were never present in any of our patients under 16 years of age. In most of our adult patients herpes appeared on the lips, chin, cheek, and alae of the nose. These eruptions appeared soon after the onset of acute manifestations. A highly suggestive feature was the injected appearance of the fauces of most of the patients attacked. During the later periods of the epidemic some of the patients suffered from illness which closely simulated typhus fever. The temperature was fairly high, occasionally rising to 104° F., the pupils contracted, conjunctivae injected, and the tongue furred. The patients were dazed, and only lumbar puncture established the diagnosis. This type of the disease deserves notice, since the earliest writings on the subject of epidemic cerebro-spinal meningitis indicate that spotted fever was believed to be no other than a new form of typhus fever. From many of the patients a peculiar odour was detected, a fact mentioned by the earlier writers. This odour, however, may have been due to the fact that the vast majority of the patients suffering from epidemic cerebro-spinal meningitis were affected by incontinence of urine and faeces. No more arduous task can be

allotted to nurses than the attendance upon patients suffering from this terrible malady. The suffering of the patients is constant, their wants are many, and in numerous instances nasal feeding has to be resorted to. Should treatment by hot-water baths be called for, the nurse's labours become most exacting and exhausting.

IS THE DISEASE INFECTIOUS?

On this point there can be no possible doubt. The disease is infectious, but, contradictory as it may sound, it is not the sufferer who is the source of danger to others but an "intermediary." That a sufferer from epidemic cerebro-spinal meningitis is comparatively harmless as an agent in spreading infection is borne out by the fact that many patients have been treated in the medical wards of general hospitals without harm resulting to others. One of our patients was treated in the scarlet-fever ward among highly susceptible subjects for a period of three weeks, and no other case developed. The peculiar feature of this disease, then, lies in the fact that it is an "intermediary" who is the carrier of infection. Dr. Jehle, of Vienna, was, as far as I am aware, one of the first to point to this feature. A parent or visitor harbours the meningococci about his throat or nostrils, and, as I have said, may retain them there for a period of three weeks. During that time he blows his nose, coughs, or sneezes, or spits about his house or its precincts, or in some public place, thus causing infection to be blown in all directions. While, then, in the case of scarlet fever or other epidemic disease we trace infection to its original source, the actual sufferer, in the case of epidemic cerebro-spinal meningitis we look for the source in some person who is not actually suffering from the disease. It has been the experience on the Continent, as well as in this country, that the disease followed the example of typhus fever by invading, in the first instance at least, the houses not only of the poorer classes, but also selected its victims from among the dirty and dissolute. When, however, infection lays thorough hold of a community, the infecting agent becomes widely distributed, and the disease no longer confines its attentions to the slums. This was the experience of Boston during its second epidemic. The first epidemic found the poorer classes chiefly attacked; the second claimed its victims from among rich and poor alike.

With one or two exceptions, our first twenty cases had links connecting them with one another. Let the following be taken as instances:

Ellen D. became ill on January 10th, and died on the 15th. Infection was traceable to a child called Davie. This child's aunt, the "intermediary," frequently saw Ellen D. during her illness. Child F. died on January 17th after three days' illness. Mrs. F. removed Ellen D. from one house to another. Mrs. I. washed clothes for Mrs. D. and dressed the dead body of Ellen D. Mrs. I. also took clothes to Mrs. F. On January 24th the granddaughter of Mrs. I. sickened and died; the child had been constantly about the D.'s house. A girl called H., aged 7, took ill on January 21st and died next day. She was frequently playing in the D.'s house. During the first weeks of the epidemic repeated instances like the foregoing came to light, thus proving that infection could be conveyed from one house to another.

Continental authorities have remarked upon this feature, and have advised medical men when attending cases of cerebro-spinal meningitis to make their last visits to those cases lest infection might be conveyed from house to house. As has already been said, it became more and more difficult to trace connexion between cases when the infection became widespread.

Another feature, however, which manifested itself, and one of peculiar interest, was the grouping of cases in particular districts. These groupings were made very manifest on the spot map used to indicate the course of the epidemic. This aggregation of cases recalls to the mind of the medical officer of health the manner of the spread in the case of scarlet fever, and to a lesser degree, perhaps, diphtheria. An unrecognized case of scarlet fever is often the nucleus of a group of other cases, especially if the district involved be a densely-populated one, and tenement properties common.

Two factors must, therefore, be taken into account for the spread of the disease in the manner just detailed—namely: (1) The diffusion of meningococci by the sputum on the one hand; and (2) the contact of those from infected houses on the other. A person living in an

infected house may convey the meningococci about, and may himself escape the disease.

HOW IS INFECTION CONVEYED?

When the outbreak was in its infancy in Leith, I was struck with the fact that the victims of epidemic cerebro-spinal meningitis were to be found solely among families of the casual or regular dock labourers. This feature was gradually lost when the epidemic became widespread. The case in favour of oversea conveyance of infection was made strong by this involvement of dock labourers. The selection of the families of dock labourers for attack suggested to Drs. Fraser and Comrie of Edinburgh a closer study of the subject, with the result that the meningococci were recovered from the posterior nares of several of those in whose households there had been recent cases of epidemic cerebro-spinal meningitis. Further, a very striking lesson was afforded by the fact that Petri dishes exposed in the engine-room of a steamer plying between Leith and the Continent were found, on incubation, to yield unmistakable meningococci. Still another interesting feature, which afforded a very good index to the method of spread of infection, was manifested by the occurrence of cases of epidemic cerebro-spinal meningitis among the families of five different fathers who had worked in a gang in the hold of this particular steamer. The steamer had been laid up in dry dock for some time, and no doubt the men's spitting habits had permitted the meningococci to be diffused about the hold. The meningococci may have been spread about the hold by Continental "intermediaries" in the first instance. No more convincing proof of oversea conveyance of infection could be adduced than the recovery of meningococci from the engine room.

That foreigners coming to this country, either to stay there or on their way to America, had conveyed infection with them, was brought into striking prominence by the fact that a ship steward whose work brought him into intimate contact with these aliens developed epidemic cerebro-spinal meningitis and died; that a railway clerk whose duties consisted in looking after transmigrants at one of the Leith Railway Stations also took ill and died; finally, that a 6-year-old daughter of a Customs officer was seized with illness and succumbed. The employment of labourers at the docks is not regular, consequently groups of them stand about the quays or dock entrances waiting for work. Inside the docks smoking is strictly prohibited, chewing is accordingly resorted to, and spitting accompanies chewing. Should the sputum contain meningococci, they are readily blown about the extensive sheds which adjoin the quays. At the dock gates the idlers, or those looking for work, collect in more compact groups. Smoking and chewing are indulged in, and spitting is constant. Here also diffusion of meningococci becomes easy.

Now it is the case that during the period when epidemic cerebro-spinal meningitis was at its height in Leith, cold, dry, and dusty weather prevailed. Consequently the elements all favoured the spread of infection by the blowing about of dust. Continental authorities have remarked upon the prevalence of epidemic cerebro-spinal meningitis during dry and dusty weather. The distribution of houses in the municipality in which cases of the disease occurred clearly indicates that there was a preference for congested areas and imperfect sanitary environment. One might, however, be inclined to assume that, owing to the greatest incidence of the cases being within close proximity to the docks, these had a decided influence in spreading the disease within their immediate vicinity. But the fact that the poorest localities are situated nearest the docks prevents one from dogmatizing upon the point. I am strongly of opinion, however, that the germs of epidemic cerebro-spinal meningitis can be airborne in the manner suggested. Dr. Jehle has, in a most convincing manner, demonstrated the association of dust in coal mines with the spread of infection. For instance, he has cited the case of a mine having four separate shafts. In shaft No. 4 infection was scattered about by the coughing and spitting of those men harbouring meningococci about their upper air passages. Only the families of the men working in shaft No. 4 were attacked by epidemic cerebro-spinal meningitis. The families of the men working in the other three shafts escaped.

While the aggregation of cases in particular streets may

have been due to the scattering of infection by sputum, one must also take into consideration the possible danger lurking in the ashbucket. These receptacles invariably contain the floor sweepings, which, when collected from a house in which an "intermediary" has lived, facilitate the blowing about of meningococci. The working man is not always careful as to the use of a spittoon, consequently the housewife, when sweeping about the fireplace, may gather up with the household dust dried meningococci. The sweeping of the floor has also to be taken into consideration as a means of swirling meningococci about an apartment, and thus exposing susceptible subjects, such as children, to the risk of infection.

What is the Portal of Infection?

This question is not readily answered. Though the meningococci are to be found in the nose and throat, it does not necessarily follow that the organisms pass into the interior of the skull by the route which appears to be obviously the shortest—namely, through the bony structures. In fact, I have the assurance of my respected teacher of anatomy, Professor Cleland of Glasgow, that it is extremely unlikely that the meningococci can pass readily, if at all, by the nasal route—that is, through bony structures. Moreover, *post-mortem* appearances do not lend weight to the theory that meningococci pass first to the brain cavity from the naso-pharynx. For the present, therefore, the idea that infection reaches the meninges through the cribriform plate may be departed from in favour of some other more feasible route. Drs. Fowler and Stuart-Macdonald of Edinburgh have advanced the theory that the disease is carried by food. In support of this, they put forward the following strong arguments:

1. The cord lesion is of longer standing, and therefore antecedent to that in the brain.
2. The abolition of the abdominal reflex suggests spinal involvement.
3. The retention of the mental faculties is, in many cases, characteristic, thus freeing the brain of early involvement at least.
4. They state that no exclusively breast-fed infant has been attacked by the disease.

This latter contention has been contradicted because breast-fed infants have been attacked. Arguing from the standpoint of Drs. Fowler and Stuart-Macdonald, I might supplement their theory by offering the opinion that many an infant may be breast-fed yet may be readily infected by an "intermediary" who harbours meningococci in the naso-pharynx. This especially will apply among the poorer classes. Many mothers wet their nipples with saliva before applying the infant to them. It is also a common practice to soften a biscuit or rusk in the mouth to feed the infant. The food-infection theory has much to be said in its favour when Leith, for instance, is cited as an example. The following table indicates the class of houses in which cases of epidemic cerebro-spinal meningitis occurred:

TABLE I.				
Number of 1-roomed houses involved				
"	2	"	"	15
"	3	"	"	44
"	4	"	"	11
"	5	"	"	3
"	6	"	"	2
"	7	"	"	1

From these figures it is seen that the greatest number of cases occurred in the houses of one or two rooms. The inmates of these houses are not always careful in their methods, nor have they the necessary accommodation for the proper storage of food. In fact, bread, butter, and other foodstuffs are allowed to lie about uncovered, and often on a very filthy table, from beginning to end of the day. Dishes are carelessly washed, and cloths used for drying are not over-clean. In small, badly-kept houses the surroundings favour the food-infection theory. Further, since children are most commonly attacked amongst the poorer classes in the first instance, it is easy to understand why food may be blamed in their case. Among the working classes children are fed by occasional pieces of bread, and if they do receive milk it has been exposed to varieties of contamination. It is well to explain that Dr. Jehle suggested that children were most frequently attacked because they played about floors, and were thus much more liable to be infected by the meningococci spread by the promiscuous spitting of the infection-carrying "intermediary," such as the father.

Whilst food infection must appeal to us very forcibly as a probable mode of infection, one cannot overlook the possibility of the entrance of meningococci through the tonsils or abraded buccal surfaces. I have mentioned the feature of throat infection observed in many of the cases treated at the Infectious Diseases Hospital. This feature suggests the possibility that infection may be by the tonsillar path. We know that the meningococci lodge about the back of the throat and nose. One can readily understand, therefore, that a ready entrance is afforded to the germs under favourable conditions—the favourable conditions being impaired mucous surfaces. In two consecutive cases attack followed teeth extraction, both victims being adults. No matter what path the meningococci mark out for themselves—intestinal, buccal, or tonsillar—it is obvious that the route to the meninges cannot be by the lymphatics to the spinal cord and brain, because the current in the lymphatics is in the opposite direction. Accordingly to reach their destination, the meninges, the meningococci must pass into the blood stream. Premonitory symptoms, especially among children, are conspicuous by their absence. This may be accounted for by the fact that it is only upon reaching the meninges that the virulence of the meningococci manifests itself. The incubation period of the disease, as far as one can gather, is extremely short. In fact, it may be measured by the length of time which elapses between the entrance of the meningococci into the blood stream and their lodgement on the meninges. Intravenous injection of such a drug as ether manifests itself in the odour of the breath of the patient in a space of time which is incredibly short. The analogy between such a volatile substance as ether and meningococci may not be strictly accurate, but the illustration serves to show that organisms possessing such marked affinity for the meninges will not be long delayed in their journey once they reach the blood current.

Another method of infection may be by inhalation. The occasional existence of pulmonary complication lends strength to that view. Pneumococcal infection must not, however, tempt me into a digression at present.

Experience has taught that school epidemics do not occur. This has been remarked upon by Continental observers. Fourteen different Leith schools were involved, but investigation proved that the schools which suffered most were attended by children drawn from among the very poorest classes. The need to discuss school closure does not, therefore, exist.

Age-Distribution and Fatality Rates.

Table II provides a very striking commentary upon these features. The figures speak for themselves, and I need not dwell upon them.

TABLE II.

No. of Cases.	Age.	Deaths.	Death-rate per Cent.	Under Treatment.	Discharged.
10	Under 1 year	10	100.0	—	—
24	1-5 years	20	83.3	3	1
32	5-15 "	21	65.6	8	3
7	15-25 "	4	57.1	2	1
9	25-60 "	7	77.7	2	—
1	over 60 "	1	100.0	—	—
Totals...83	—	62	74.7	15	5

Duration of Illness.

Table III indicates more clearly than words can that there are two types of cases—the acute and chronic. I

TABLE III.—Periods of Illness (Deaths).

6 under 1 day.		1 between		60-70 days.
23	between 1-2 days.	—	"	70-80 "
9	" 2-5 "	—	"	80-90 "
5	" 5-10 "	—	"	90-100 "
6	" 10-20 "	—	"	100-150 "
6	" 20-30 "	1	"	150-200 "
2	" 30-40 "	—	"	
—	" 40-50 "	Total 62		
3	" 50-60 "			

have already alluded to the trying task imposed upon those who are called to nurse chronic cases. In one or two instances our patients appeared, after four months' residence, to be progressing favourably, yet relapses took place and death resulted. In one instance, so great was the deformity of a boy in death that his coffin took the shape of a square box.

TREATMENT.

Serumtherapy has as yet given no promise of success, either as a preventive or curative. Specifics in the form of drugs are not yet known. One must rest content with combating acute symptoms, more especially pain, by the exhibition of such sedatives as morphine. Lumbar puncture and the repeated withdrawal of fluid appear to afford temporary relief, and much was hoped from the injection of such antiseptics as lysol. The results have been far from encouraging. The best palliative has so far been treatment by means of hot baths at frequent intervals. The sufferings of the patient are greatly relieved, and when the immersion comes to an end the patient grumbles. Systematic immersion in hot water demands a greatly increased staff, and entails almost perpetual labour. Cupping is now suggested as another mode of treatment, the cupping being applied along the course of the spine.

Administrative Control.

To control the spread of epidemic cerebro-spinal meningitis is a most difficult problem. The "intermediary" must be discovered and properly dealt with if any hope of arresting the spread of infection is to be entertained. If, therefore, the earliest cases are immediately brought under notice the possibility of keeping the disease in check exists. As I shall presently show, and as Dr. Jehle has truthfully said, the mere isolation of the patient and a routine disinfection of the house constitute a waste of public funds. The spread of infection is not arrested if the disease carrier, the "intermediary," is left to spread meningococci either in the workshop, factory, or other place of public resort. Take, for example, the modern place of public entertainment in which smoking is permitted, and the floors rendered filthy by constant spitting. Should meningococci be in the sputum it requires no stretch of imagination to realize how the atmosphere of such a place becomes laden with disease-producing germs. If this fact could be appreciated by the managers of theatres and music-halls, the necessity for spraying the interiors of their resorts would at once appeal to them. When I look back upon the histories of the earlier cases that occurred in Leith, I can well understand that our outbreak might have been very considerably limited in its extent, because the "intermediaries" would have been promptly dealt with. It was only after investigation proved the presence of meningococci in the upper air passages of "intermediaries" that I was prompted to adopt the practice to be presently detailed. This consisted in the systematic application of a bactericide to the nasal and buccal cavities. As soon as the patient was removed to hospital and the house disinfected, the lady sanitary inspector, who also holds a nurse's qualification, visited the infected houses, and douched the nostrils and sprayed the throats of every remaining member of the household. The disinfectant solution used was chlorine water. This treatment was never resented, because it was pointed out to the people that it might be the means of either averting an attack or the spread of the malady. At intervals of two days this treatment was continued, each "intermediary" being douched three times. The procedure suggests the need for systematic bacteriological examination of swabs taken from the posterior nares before and after treatment by douching. It would certainly be wise to take second swabs from those "intermediaries" who gave positive results before douching.

A very pleasing preparation of formaldehyde came under my notice in the form of formamint lozenges. These are well flavoured, and children are easily persuaded to permit the sweets to slowly dissolve in their mouths. I am satisfied that this formamint preparation is a very valuable accessory in dealing with "intermediaries." The formamint was given out by the lady inspector during her rounds. Another very important consideration in dealing successfully with epidemic cerebro spinal mening-

itis is the isolation of those living in infected houses, especially in the smaller and the dirtier houses. In fact, upon the systematic practice of this procedure much will depend if the spread of the disease is to be cut short. During their residence in the Leith Reception House contacts were periodically treated with the chlorine solution. In the interval their houses were radically disinfected. It has been found on the Continent that epidemic cerebro-spinal meningitis is very prone to spread in barracks, asylums, and workhouses. Accordingly, when within a few days of one another, two children were attacked in a low type of common lodging-house in Leith, I isolated the remaining members of the families, eleven persons in all. Though there were many susceptible children in the lodging-house in question, no other case occurred, and the conditions were distinctly favourable for the spread of the disease. The segregation of the "intermediaries" entails expense, but the money spent constitutes a true system of economy. If, then, the earlier cases are recognized and brought under notice of the medical officer of health, he may reasonably expect to arrest the spread of the death-dealing malady by effectually and immediately controlling the "intermediaries."

SECONDARY CASES.

TABLE IV.

- J.—1st case, February 7th; 2nd case, March 5th. Interval between cases, 36 days.
 A. (1).—1st case, February 22nd; 2nd case, March 15th. Interval between cases, 21 days.
 A. (2).—Next door to above cases, was in house taking tea with first case on February 22nd, sickened on February 28th.
 E.—1st case, February 26th (mother); 2nd case, March 2nd (child). Interval between cases, 4 days.
 F.—1st case, March 8th; 2nd case, March 21st. Interval between cases, 13 days.
 S.—1st case, March 27th; 2nd case, March 29th. Interval between cases, 2 days.
 P.—1st case, April 14th; 2nd case, May 1st. Interval between cases, 17 days.
 G.—1st case, May 3rd (child); 2nd case, May 10th (father). Interval between cases, 7 days.

In only one instance did a second case of the disease arise in a house after douching began to be practised. In this case the father of the child first attacked became the victim. When the lady inspector went to douche the nostrils of the inmates the father complained of feeling out of sorts, and in a few days he himself was struck down by the disease. This case is the last on the list of those noted.

Disinfection of a perfunctory nature is too frequently practised. Accordingly, when epidemic cerebro-spinal meningitis is encountered, more than ordinary methods are called for. The meningococcus is capable of retaining its activity for long periods in its dry state. Jaeger found that meningeal pus dried upon cotton-wool, and retained in Petri dishes for 127 days, contained meningococci which were capable of development. Panienski, in dealing with an epidemic which occurred in the garrison of Karlsruhe during the winter of 1892-3, was convinced that the disease had been conveyed from that town to another by improperly disinfected clothing. Disinfections must, therefore, be twofold; and, to best convey my meaning, I shall instance the practice adopted in Leith during May.

Having removed the patient, every nook and cranny of the interior of the house was sprayed with formaldehyde. The spraying was continued in the case of tenement properties down to the street entrance, the pavement in the immediate neighbourhood being included, the object being to deal with sputum lying about. In addition to the bedding removed for steam disinfection, all wearing apparel that could possibly be spared by the inmates was also taken away. Lastly, in the houses of the poorest classes all foodstuffs were confiscated and replenished with provisions at the expense of the local authority. I am thoroughly satisfied that the time, money, and labour spent in putting the foregoing measures into operation have proved valuable and instrumental in keeping the outbreak under control.

Seaport towns have all suffered very severely from epidemic cerebro-spinal meningitis, and I consider that Leith has escaped the ravages which have characterized outbreaks at other places similarly situated. It is fortunate, therefore, that some confidence can be promised in success-

fully coping with a disease which, if permitted to take its own course, can in an incredibly brief space of time claim too many victims.

Remarks ON OCULAR SYMPTOMS IN CEREBRO- SPINAL MENINGITIS.

NOTES BASED ON THE EXAMINATION OF 73 CASES.

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THROUGH the courtesy of the superintendents and staffs of the Glasgow Fever Hospitals, the writer has, within the last few months, had opportunities of investigating the condition of the eyes in a number of cases of cerebro-spinal meningitis. Adding to these a few cases seen elsewhere, the total number of cases examined amounts to 73.

As clinical reports embracing the details of the eye conditions in this disease have not been numerous, it may be of interest to give an account of the symptoms found in the present series of cases.

In each case where possible a complete examination was made, but it will be readily understood that often, especially in young children who were acutely ill, many points had to be omitted.

The series includes cases in all stages of the disease, from acute cases seen on the second day of illness to others which had long before subsided into a state of chronic hydrocephalus. One of the latter cases was first seen in the thirtieth week of the disease. The ages of the patients ranged from 3 months to 47 years.

Eye symptoms of any kind were absent only in 4 cases; of these 2 were convalescent. The others were seen on the sixteenth and sixty-fourth day respectively.

EYELIDS.

The only lesion found on the lids themselves was an eruption of herpes on both lids of one eye, in an acute case at the end of the first week of illness.

Abnormalities of the palpebral fissures were noted in 17 cases. In 2 of these the only abnormality was inequality. In 2 cases the palpebral fissures were abnormally wide and at the same time unequal. In another, who had alternations of retraction and drooping of the lids, the inequality of the palpebral fissures disappeared when the lids were in a state of retraction. In another similar case the inequality was present both with drooping and with elevated lids. In this one the inequality was perhaps due to weakness of the orbicularis, since voluntary efforts caused only partial closure of the wider palpebral fissure.

In none of the cases was there a drooping of one or both lids which could be described as ptosis.

Retraction of the Eyelids.

This was observed in 15 cases. It was observed as early as the fourth day, but most of the cases in which the symptom was well marked were cases which had passed into the chronic stage. The most marked case of all, in which sclera was well exposed both above and below the cornea, was that of a boy, seen the day of his death, who had been long in the chronic hydrocephalic state. *Post mortem*, no trace of exudate was found, but a great excess of clear fluid both in the ventricle and in the subarachnoid space. The patients in whom the symptom was observed in the early acute stage (4 in number) all died in the acute stage. Seven of the 11 chronic cases have already died; 1 has definitely recovered; the other 3 are still in hospital. The case in which recovery took place is of some interest. The writer first saw her on the fifty-fourth day. She was then convalescent, but four weeks earlier she had had all the appearance of a chronic case likely to prove fatal. The retraction of the upper lids was very marked, 2 or 3 mm. of sclera being visible above each cornea. It was fairly constant, was still present a week later, but had disappeared by the sixty-seventh day. The retraction of the lids in this case was accompanied by typical von Graefe's sign.

In 12 patients retraction of the lids was associated with dilated pupils, in which the light reflex was absent or very defective. In 1 case the pupils were small and inactive. In the other 2 cases the pupils were not investigated. In 3 it was associated with absence of the cilio-spinal reflex. In a fourth the latter was present in a slight degree.

Retraction of the lids was seldom a constant symptom, and it nearly always disappeared while the patient was asleep. In 1 case, in addition to the retraction of the lids a degree of exophthalmos seemed to be present.

Taking into consideration the facts above mentioned as to the further history of the cases in which this symptom was found, it would seem to be confined to cases in which the chance of recovery is small.

The cause of retraction of the lids is obscure. It is a recognized symptom of chronic hydrocephalus, and the majority of the cases above referred to might come under that heading.

In the acute cases it was never quite so marked, and in these cases it might be due to sympathetic irritation, either in the cilio-spinal centre or elsewhere in the sympathetic path to the eye. The dilated inactive state of the pupils would be quite in keeping with such an explanation. It is scarcely likely that sympathetic irritation plays a part in producing lid retraction in the later stages, in which the symptoms as a whole are referable more to the abnormal physical condition set up in the cerebro-spinal system than to inflammatory action. Tooth¹ has suggested that it is a local manifestation of muscular rigidity analogous to head retraction, Kernig's sign, etc. The case I have mentioned, in which the symptom persisted well into the stage of convalescence, may lend some support to this, as it is not uncommon for stiffness of the neck and other manifestations of muscular rigidity to persist in a similar way after the patient is in other respects well. Increased intracranial pressure may be a necessary element in its causation. This is suggested by the frequency of its occurrence in chronic hydrocephalus from other causes. In 1 case of the present series the retraction, which was occasional, was associated with wrinkling of the forehead and complaint of increased frontal headache, and at the same time the eyes were turned strongly downwards and the pupils dilated and inactive.

Blepharospasm.

This was very frequent. In the great majority of the cases general hyperaesthesia was a marked symptom, and in the course of the eye examination this showed itself in the occurrence of a strong lid spasm, sometimes excited by the lightest touch upon the lids, more generally by attempts to separate the lids. This at first sight suggested photophobia and is probably the symptom sometimes described as such in cases of cerebro spinal meningitis, but the writer never observed true photophobia in this series of cases. Spasmodic resistance to separation of the lids was almost the rule, but the patients could often be induced to open the eyes spontaneously, after which even prolonged ophthalmoscopic examination was tolerated so long as the lids were not touched. The absence of true photophobia is somewhat remarkable in view of the great general hyperaesthesia which is present in most of the cases. In one or two early acute cases the lightest touching of the eyelids set up a spasm of all the facial muscles. These occurrences were just as marked in unconscious as in conscious patients.

As a rule reflex blinking occurred on lightly stroking the eyelashes. Its absence was observed only in one hydrocephalic case a few days before death.

In one child who had repeated convulsive attacks, the left eyelids were involved in clonic spasms which affected the left side.

In 4 cases frequent winking was noted, each lid movement being accompanied by a jerky nystagmus-like movement of the eyeballs laterally or vertically.

Conjunctiva.

Hyperaemia of the bulbar and palpebral conjunctivae occurred in many of the cases. A certain degree of bulbar injection is quite common, even in the first few days of the disease, and it may persist for some time.

Actual catarrhal conjunctivitis, with more or less purulent discharge, was found in 13 of the cases. In the majority it was a symptom of the early acute stage, but in several