EMERGENCIES IN GENERAL PRACTICE

ACUTE MENINGITIS

BY

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Few medical conditions demand more urgent treatment than acute meningitis, yet its early diagnosis is often difficult, particularly in young children and infants, in whom the classical features by which it is recognized are often inconspicuous or absent. Yet early diagnosis is vital, for in general the mortality figures are in direct proportion to the duration of the delay in diagnosis and the institution of treatment. Acute meningitis can be considered under two main headings, acute pyogenic meningitis and acute lymphocytic meningitis (Table I), according to the nature of the meningeal reaction and the corresponding cellular changes in the cerebrospinal fluid. A detailed consideration of the lymphocytic meningitides is beyond the scope of this article, though some of its causes are noted below.

TABLE I.—Commoner Forms of Acute Meningitis

Acute pyogenic meningitis:

Meningococcal meningitis
Pneumococcal meningitis
Haemophilus influenzae meningitis
Haemolytic streptococcal and staphylococcal meningitis

Acute lymphocytic meningitis:

Poliomyelitis
Lymphocytic choriomeningitis ("benign lymphocytic meningitis")
Mumps meningo-encephalitis
Infectious mononucleosis (glandular fever)
Leptospirosis
Acute syphilitic meningitis
Acute meningo-encephalitis (post-infectious and otherwise)
(Acute tuberculous meningitis)

The commoner forms of acute pyogenic meningitis are listed in Table I and only these are discussed, although many other pathogenic organisms, including some of such low virulence as to provoke only mild symptoms and signs elsewhere in the body, may cause severe meningitis—for example, *Bact. coli*. The infection is frequently due to a bacteraemia or septicaemia; the primary source is often unidentified, although meningitis quite commonly may complicate pneumonia (due, for example, to a pneumococcus) or arise secondarily to local infection of the ears, cranial air sinuses, or nasopharynx. Cranial trauma may lead to osteomyelitis of the skull complicated by meningitis or, more importantly, result in a fracture of the anterior or middle fossa allowing direct spread of infection from the sinuses or ears to the meninges through a dural tear.

Clinical Picture of Acute Pyogenic Meningitis

Acute pyogenic meningitis occurs at all ages but is commonly met with in infants and children. Most cases are isolated, though epidemics of meningococcal meningitis still occur from time to time, particularly in communities living in close quarters. The typical clinical features are well known and need little emphasis. The onset is abrupt, with fever, severe headache, vomiting, and photophobia. These may be accompanied by rigors and in children by generalized convulsions. Mental changes are usually not conspicuous at an early stage, although with severe infections clouding of consciousness progressing rapidly to coma may occur. The

typical signs of meningeal irritation are due to reflex muscle spasm associated with inflammation of the spinal nerve roots; they include neck rigidity and Kernig's sign.

Neck rigidity is best elicited with the patient lying flat on his back. The examiner places one hand behind the head or, alternatively, approaching from the front, supports the head with both hands: he then attempts to flex the neck passively until the chin touches the chest, a manoeuvre which is prevented by spasm of the posterior cervical muscles if neck rigidity is present. Kernig's sign is elicited with the patient flat on his back: with the knee flexed one hip is bent to a right angle; if the sign is positive passive extension of the knee-joint is resisted by spasm of the hamstrings provoked by downward traction of the inflamed cauda equina. In children another useful indication of meningeal irritation is provided by their inability to kiss their knees. In more advanced cases increasing spasm of the neck and back muscles leads to neck retraction and opisthotonos. A point of some note, however, is that if coma supervenes these signs of meningeal irritation may disappear altogether. Other neurological signs are relatively uncommon in the early stages of the infection, but transient cranial nerve palsies may be seen. The tendon reflexes are often depressed and temporary retention of urine may occur.

Meningococcal infections not infrequently cause a purpuric eruption (hence "spotted fever") and this should be looked for when meningitis is suspected. It usually takes the form of a petechial rash appearing by the third day of the illness, though it may be more extensive, notably in the fulminating "adrenal" syndrome in which a profound fall in blood pressure occurs though consciousness remains unclouded. By contrast, coma and convulsions develop rapidly in the "encephalitic" type. In both of these rare manifestations of meningococcal infection the clinical features of meningitis are inconspicuous.

Of fundamental importance is the fact that in young children and infants the classical features of acute meningitis are often absent or delayed in onset to a time when treatment is no longer of avail. Neck rigidity and Kernig's sign may not be elicited and fever may be inconspicuous. Increased tension or bulging of the fontanelle is an important sign in infants, but even this may be lacking on account of dehydration or because widening and separation of the skull sutures fully compensates for the rising intracranial pressure. In these circumstances experienced observers believe that drowsiness alternating with irritability, a high-pitched cry, a vacant look in the eyes, or the development of a squint is a valuable sign at this stage. They insist that a diagnostic lumbar puncture should not be withheld until typical meningeal signs develop.

Diagnosis

The diagnosis of acute pyogenic meningitis can be confirmed only by examining the cerebrospinal fluid. It is imperative that this investigation be undertaken as soon as is possible whenever the diagnosis is entertained. A lumbar puncture* can be safely performed in most cases, though a ventricular tap is indicated if a coexisting cerebral abscess is suspected. The changes in the cerebrospinal fluid which are characteristic of acute pyogenic meningitis† need not

*See "Lumbar Puncture," by Dr. William Gooddy (*British Medical Journal*, 1953, 2, 1040).

†See "The Cerebrospinal Fluid in Diagnosis," by Dr. J. N. Cumings (*British Medical Journal*, 1954, 1, 449).

be detailed. The responsible organism can often be identified on direct examination of the cerebrospinal fluid obtained either from the lumbar sac or from the ventricles provided a careful examination is made on a fresh specimen.

TABLE II.—*Differential Diagnosis of Acute Pyogenic Meningitis*

Other infections:
Acute lymphocytic meningitis
Acute tuberculous meningitis
Acute encephalitis
Acute cerebral thrombophlebitis and cerebral abscess
"Meningismus"
Local infections in the neck
Tetanus
Subarachnoid haemorrhage
Cerebral tumours
Other causes of coma

Differential Diagnosis

Table II illustrates the wide variety and range of the conditions which may have to be considered. It is often not possible on clinical grounds alone to differentiate between acute pyogenic and acute lymphocytic forms of meningitis before the cerebrospinal fluid is examined (the development of paralysis after the onset of the pre-paralytic meningitic phase of poliomyelitis is an obvious exception), though typically both poliomyelitis and lymphocytic choriomeningitis run a diphasic course, the meningitic phase being preceded by an initial febrile illness—the "minor illness" of acute poliomyelitis. Parotitis or orchitis would naturally suggest the diagnosis of mumps meningo-encephalitis, as would the local prevalence of the infection. Similarly enlarged glands and a palpable spleen might suggest infectious mononucleosis. Other pathological examinations are of help; the Wassermann reaction of the cerebrospinal fluid allows of identification of acute syphilitic meningitis, while in leptospiral infections the spirochaete may be isolated from the blood and urine in acute cases. The serum agglutination reactions are of diagnostic value both in the latter condition and in the forms of acute lymphocytic meningitis of virus origin.

Tuberculous meningitis rarely presents as an acute illness, though when it does the cellular content of the cerebrospinal fluid often reaches much higher figures (over 1,000 cells per c.mm., for example) than are considered typical of the condition. A large proportion of these cells may be polymorphs, though they are nearly always exceeded in number by lymphocytes. Acute inflammatory conditions of the brain itself—encephalitis, thrombophlebitis, and cerebral abscess—often present with fever and neck rigidity, though usually focal symptoms and signs of cerebral involvement predominate. However, their occasional coexistence in acute meningitis should be remembered (see below), as the signs of the latter may mask those due to an abscess.

Sometimes in children signs of meningeal irritation may develop during an acute infection elsewhere without any accompanying changes in the cerebrospinal fluid save for an increase in its pressure. This state of meningismus or meningism as it is called is thought to be due to temporary overproduction of cerebrospinal fluid consequent on a reduction of the osmotic tension of the blood. Neck rigidity, furthermore, may be mimicked by local neck conditions—for example, acute cervical adenitis—and it is also an important feature of tetanus. Again the spinal nerve roots may be irritated by other causes, notably by haemorrhage into the subarachnoid spaces, while neck rigidity is a feature of some posterior fossa tumours—usually in association with a very high intracranial pressure. However, the latter rarely present so acutely as to mimic acute meningitis.

With fulminating infections the patient may be in coma when first seen and show few signs of meningeal irritation. On such an occasion many other conditions will have to be considered.* A blood culture may be of diagnostic value when this state is due to a meningococcal infection.

Complications and Sequelae

A variety of complications may occur at the height of the illness. *Cranial nerve palsies* are not uncommon. They usually clear up if the infection is rapidly controlled, though permanent deafness is a well-recognized sequel of meningococcal meningitis. Evidence of *cerebral involvement* may be provided in severe cases by aphasia, hemiparesis, and other indications, including focal or generalized epilepsy. *Status epilepticus* is a highly lethal complication in the young and is often difficult to control. Such focal cerebral signs may also be due to a coexisting *cerebral abscess*. The cerebrospinal fluid pathways may become obstructed at strategic sites by purulent exudate causing *obstructive hydrocephalus*, while in young children *subdural effusions* may form which, though sterile and rarely purulent, may reach large proportions and cause cerebral compression.

The severity of post-meningitic sequelae is naturally related to the type and gravity of the infection, the stage at which the diagnosis is established, and the thoroughness of subsequent treatment. Now that highly potent antibacterial agents are readily available it is, to say the least, disquieting that grave sequelae still occur quite frequently. In unfavourable circumstances *chronic hydrocephalus* due to organization of purulent exudate in the cerebrospinal fluid pathways may ensue and lead to dementia and visual failure among other disturbances. This is fortunately a comparatively rare sequel nowadays, though more commonly a liability to *epileptic seizures* with or without *mental retardation* and *focal neurological signs* results either from direct damage to the hemispheres or from a subdural effusion during the acute stages of the illness which was not dealt with at that time. More commonly still the patient may for weeks or months experience symptoms very similar to those of the post-traumatic syndrome—namely, headaches, depression, insomnia, inability to concentrate, etc. These ultimately clear up satisfactorily in most instances.

Treatment

It has been said that with modern antibacterial agents it is now possible to obtain a cure in almost all patients with the commoner forms of pyogenic meningitis. It is true that there has been a marked decline in the mortality since their introduction, yet many avoidable deaths still occur through neglect of the fundamental principles of treatment. These are *early diagnosis*, including isolation of the responsible organisms, *adequate therapy*, and *thorough treatment of complications*.

As has already been emphasized, it is essential that the cerebrospinal fluid should be examined whenever the diagnosis is suspected, and in almost all circumstances this will mean admitting the patient to hospital as soon as possible. Meanwhile the patient's condition may occasion immediate concern. If he is in coma steps will have to be taken to ensure a clear airway, including the adoption of the head-down position with the patient lying prone. Usually he is conscious and restless; the latter is not infrequently due to retention of urine and may need attention. Analgesics are often required, though morphine is contraindicated. Children rapidly become dehydrated from vomiting, etc., and this may require immediate treatment. They should be given phenobarbitone routinely even if they have not had convulsions, for the prevention of epilepsy in the acute stage is of great importance. The dose used will naturally depend on the age and weight of the child, but children tolerate it well. Thus during the first day or two a 1-year-old child could be given $\frac{1}{4}$ gr. (16 mg.) of phenobarbitone three times a day by mouth or by intramuscular injection of the sodium salt, but if he has begun to have fits larger doses will be required—for example, $\frac{1}{2}$ gr. (32 mg.) of soluble phenobarbitone by immediate injection followed by $\frac{1}{4}$ gr. (16 mg.) six-hourly by the same route or by mouth.

There are certain valid objections to the speculative use of antibiotics and chemotherapeutic agents before the

*See "The Differential Diagnosis of Coma," by Dr. M. J. Parsonage (*British Medical Journal*, 1955, I, 217).

diagnosis has been established. They may mask clinical signs, and if used for any length of time in inadequate dosage may favour the multiplication of resistant organisms. Yet if the diagnosis is confirmed and definitive therapy is begun in a matter of hours these objections are of little import. Should confirmation of the diagnosis by examination of the cerebrospinal fluid be unavoidably delayed, their use at this stage might be life-saving provided really adequate quantities of penicillin and sulphonamide are given (see below). They should be unhesitatingly given immediately if the patient has a petechial rash making the presumptive diagnosis of meningococcal infection very likely.

Antibacterial Therapy

Only the commoner forms of pyogenic meningitis are considered. The standard agents used in the treatment of *meningococcal meningitis* are the sulphonamides and penicillin. Some use both drugs routinely, others think that the former alone will give optimum results in all but severe infections. However, substantial doses of a sulphonamide—for example, sulphadiazine—must be used: at least 9 g. for an adult and 3 g. for an infant a day for the first three or four days. An initial intravenous dose is desirable to establish a high blood level, and if the patient is comatose or vomiting subsequent doses could be given by this route. A five- to seven-day course of treatment is usually adequate. If penicillin is used there is no merit in restricting the quantity; some authorities recommend 1 mega unit (1,000,000 units) of procaine penicillin twice a day for five days. It is neither necessary nor desirable to give penicillin intrathecally for meningococcal meningitis.

Pneumococcal meningitis is usually treated with a combination of a sulphonamide and penicillin, the latter being given both intramuscularly and intrathecally, 20,000 units being introduced intrathecally daily for four to seven days or until the meningitis is controlled. Some consider that if very high doses of penicillin, of the order of 12 mega units a day, are given systemically for at least ten days, using the intravenous route for the first few days, intrathecal injections can be dispensed with after an initial one, but most authorities prefer to continue with the latter for a longer period. If chloramphenicol is used in addition, it should be given for at least a week. The dose for infants and children is 200 mg. per kg. body weight per 24 hours, given at six-hourly intervals by mouth. In any case treatment should not be terminated too hastily, as pneumococcal meningitis is notoriously prone to relapse.

Streptococcal and *staphylococcal meningitis* should be treated along the same lines as pneumococcal meningitis, chloramphenicol being used instead of penicillin if the organism is resistant to the latter. *H. influenzae meningitis* will often respond to chloramphenicol alone, but some prefer to give sulphadiazine in addition, continuing with both for at least a week. If for any reason chloramphenicol cannot be used, streptomycin in full doses intramuscularly and intrathecally is of value. For children 20 mg. per lb. (0.45 kg.) body weight a day, injected twice daily intramuscularly, and 50 mg. intrathecally a day has been recommended.

The treatment of the complications of acute meningitis is beyond the scope of this article, but it should be noted that neurosurgical aid will be required in dealing with some of them, including the tapping of ventricles if it is necessary to give penicillin by this route owing to obstruction of the spinal theca, investigation and treatment of a coexisting cerebral abscess, the relief of hydrocephalus, and the treatment of some cases with subdural effusion. It is therefore highly desirable that when practicable patients with acute pyogenic meningitis should be treated in institutions within easy reach of a neurosurgical unit.

Mortality

Pneumococcal meningitis carries by far the highest mortality of the three common forms of the disease, the average fatality rate being around 40%. The prognosis is worse in

patients over 50, often because they are suffering from some intercurrent illness, and is better in infants and children. Over 90% of patients with *H. influenzae meningitis* should recover, though fulminating infections are occasionally encountered. As with other forms of meningitis, late diagnosis or prolonged suboptimal treatment also adversely influences the outlook. In good hands the mortality of meningococcal meningitis should be under 10%, though the official mortality figures of the Ministry of Health for notified cases are much larger. This discrepancy underlines the importance of the principles of treatment discussed above.

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ERADICATION OF TUBERCULOSIS* IMPRESSIONS DERIVED FROM A SCANDINAVIAN TOUR†

BY

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As far back as the 1920's the Scandinavian countries began to realize that pulmonary tuberculosis is very largely an asymptomatic disease, diagnosable only on x-ray examination. To wait for the patient with symptoms was to wait too long, as by then he was infectious and had probably disseminated his disease widely. In order to stop the spread of tuberculosis it was necessary to leave the dispensary and go out into the field looking for the disease before it became infectious. Two weapons were available: the x-ray machine and the tuberculin test. The x-ray machine would detect early disease and the tuberculin test would detect tuberculous infection in man and cattle.

During the 1930's the mass x-ray machine and the technique of its use were being developed. Portable fluoroscopy was used at first. The centres for these were village halls, public buildings, and even private houses, and the public were invited to attend in a rather haphazard fashion. I had the pleasure of meeting one of the pioneers in this field in Yuvaskula, in Finland; his fingers and hands showed evidence of x-ray dermatitis.

From these beginnings evolved the present-day mass community x-ray surveys. These are highly organized

*A lecture given to the East Anglian Group of the Society of Medical Officers of Health.

†This tour was undertaken as a result of my being awarded the N.A.P.T. Hunter Scholarship.