CURRENT SURVEY

The diagnosis of pyogenic meningitis

F. CLIFFORD ROSE
M.R.C.P.
Consultant Neurologist

JOHN CONDON
M.R.C.P.
Clinical Assistant

Charing Cross, West London and Fulham Hospitals

PYOGENIC meningitis is defined by the presence of polymorphonuclear leucocytes ('pus cells') in cerebro-spinal fluid (CSF). This virtually excludes infection with viruses, rickettsiae, fungi, and, except in the acute stages, with the tubercle bacillus.

Although the mortality and morbidity of this condition have decreased considerably since the introduction of chemotherapy, it still remains regrettably high and, even with the introduction of newer drugs, has remained about the same during the past 10 years.

Meningitis is comparatively rare, the incidence being only about five in 100,000 of the population per year. All the cases indexed as meningitis admitted in the last 10 years (1955-65) to the three hospitals of the Charing Cross Hospitals Group were analysed (Table 1). There were fifty-two cases in all, distributed fairly evenly depending on the

were in their 1st year and the incidence is, in fact, highest in the 1st month of life), but also because the type of organism isolated is closely related to age. Over three-quarters of cases recorded were admitted in the 6 months December to May, reflecting the well-known seasonal incidence of meningitis and presumably related to respiratory disease; ten gave a history of an influenza-like illness 1-3 weeks before the onset of the meningitis.

The chief reason for failed treatment is delay in diagnosis and the semeiology is thus of utmost importance.

The symptoms and signs (Tables 2 and 3) can be divided into four groups, namely those due to: (1) any infection, (2) raised intracranial pressure, (3) meningeal irritation, and (4) cerebral irritation (Table 4).

TABLE 1
Meningitis: Charing Cross Hospital Group, 1955-65

Charing Cross	19
West London	12
Fulham	21
Total	52
Age incidence	
0-1 years	13
Sex incidence:	1-5 years 11
Equal	6-19 years 7
	> 20 years 21

number of beds (the West London having fewer beds than either Charing Cross or Fulham Hospitals). Although the sex incidence in the literature shows a predominance in males, particularly in pneumococcal cases, in this small series the sex incidence was equal. The age incidence is of great importance, not only because nearly half the cases occurred under the age of 5 years (most of these

TABLE 2
Meningitis: symptoms (fifty-two cases)

Symptom	%
Fever	40
Headache	35
Vomiting	30
Irritability	20
Fits	20
Photophobia	15
Earache	5

TABLE 3
Meningitis: signs (fifty-two cases)

Sign	%
Neck rigidity	65
Kernig's +	40
Alteration in consciousness	35
Petechiae	10
Papilloedema	2
Ocular palsy	5
Hemiparesis	5
Tetraparesis	2
Tense fontanelle	15
Opisthotonos	10

TABLE 4
Meningitis

	Symptoms	Signs
1. Infection	Irritability Anorexia	Pyrexia Petechiae
2. Raised intracranial pressure	Headache Vomiting	Alteration in consciousness Papilloedema Tense fontanelle (in children)
3. Meningeal irritation	Photophobia	Neck stiffness Kernig's sign Brudzinski's sign Opisthotonos
4. Cerebral irritation	Fits Diplopia Paralysis	Ocular palsy Hemiparesis Tetraparesis

In babies the only manifestation may be irritability or a refusal to feed. In about one-quarter of cases the onset is sudden and in this group the mortality and morbidity proves to be higher. Where the patient is admitted in coma, the organism is usually pneumococcal and the mortality is particularly high. Meningism (i.e. symptoms and signs of meningeal irritation) is present in over 80% of cases. Petechiae in the skin are present in over 60% of meningococcal cases, and are occasionally, but only rarely, found in other types.

This series of fifty-two cases included fourteen in which the meningeal reaction was lymphocytic, while in twelve others no organism was identified (Table 5).

TABLE 5
Meningitis: causative organism (fifty-two cases)

Causative organism	%
Meningococcal	6
Pneumococcal	7
<i>H. influenzae</i>	4
Streptococcal	2
Staphylococcal	4
<i>E. coli</i>	1
<i>Proteus</i>	2
Unknown	12
Others (including lymphocytic)	14

Tables 6 and 7 analyse the 6000 cases of pyogenic meningitis published in the last 10 years. The three commonest causative organisms accounting for more than three-quarters of cases are the meningococcus, pneumococcus and *Haemophilus influenzae* (Table 6).

The organism responsible for the meningitis may be guessed clinically, by the age of the patient, a history of pharyngitis (70% of meningococcal meningitis), the rapidity of the onset

TABLE 6
Pyogenic meningitis (6000 cases in literature)

Causative organism	Relative frequency	Mortality (%)
Meningococcus	50	10
Pneumococcus	20	40
<i>H. influenzae</i>	12	15
Streptococcus	5	40
Staphylococcus	2	55
<i>E. coli</i>	1	60
Other	5	60
Unknown	5	15

TABLE 7
Pyogenic meningitis (6000 cases in literature): age incidence

Organism	Age incidence (%)		
	0-5 years	6-19 years	> 20 years
<i>H. influenzae</i>	90	8	2
Meningococcus	55	25	20
Pneumococcus	35	10	55

(commonest in pneumococcal), the presence of petechiae (nearly always meningococcal), or the presence of otitis or mastoiditis (in 60% of children with *H. influenzae* meningitis). Ninety per cent of *H. influenzae* cases occurred under the age of 5, whereas the majority of pneumococcal cases occur in adults. The meningococcus may occur at any age, especially during a time of epidemics, but it commonly affects children and adolescents. The presence of backache suggests a staphylococcal infection which is also commoner in neuro-surgical cases, e.g. post-operatively, whereas *E. coli* and *proteus* infections are found in infants or with genito-urinary diseases. In neonatal meningitis there is often a history of obstetrical complications. Less than 10% of cases are due to Gram-negative bacilli, but if diabetes mellitus, endocarditis or a cerebral abscess is present then the organism is often an unusual one. When diphtheroids are reported as a contaminant, *Listeria monocytogenes* should be suspected as the causative organism, since they look very much alike. Another rare organism is *Mima polymorpha* which looks like the meningococcus. Other rare organisms, which tend to occur in neonates, and in adults with underlying cerebral pathology, include *Pseudomonas*, *E. coli*, *Aerobacter aerogenes*, *Achromobacter*, *Flavobacterium* and *Alkaligenes*. *Haemophilus influenzae* is a Gram-negative, non-motile, non-spore-bearing, aerobic bacillus and requires blood to grow. Of the six types A-F, the causative organism in meningitis is usually type B, and not the type that is found with respiratory infections. It is rare in neonates because of passive immunity.

The incidence of influenzal meningitis is increasing whereas cases of pneumococcal meningitis are becoming less frequent. Influenzal meningitis is three times commoner in America than in Britain, whereas meningococcal and pneumococcal meningitis are less than half as common. In pneumococcal meningitis, which is often secondary to otitis, sinusitis, pulmonary disease or trauma, there may be a fibrinous reaction in the CSF.

The most important investigation, mandatory in every case of suspected meningitis, is a lumbar puncture. The CSF pressure is usually raised and the fluid cloudy. The CSF should be collected in a fluoride bottle to prevent clotting and taken to the laboratory for immediate culture. Although the CSF cell count can be several thousand per mm³ in a fulminating case, there may not be a marked pleocytosis; there is no relationship between the CSF count and prognosis. Ninety per cent of cases of meningitis have a pleocytosis of over 100 cells/mm³, mainly polymorphs, but in treated cases the CSF can rapidly become lymphocytic, the CSF becoming sterile within 12–36 hr after the institution of antibiotic treatment.

The CSF glucose is still an important estimation in meningitis, being less than 40 mg/100 ml in 70% of cases; a blood glucose estimation must be done at the same time. In a case of meningitis, if the CSF sugar is normal it is more likely to be meningococcal (in one-third of cases) than due to other organisms (where it only happens in about one-tenth of cases). The fall in CSF glucose is probably due to bacterial metabolism and not to phagocytosis.

The CSF protein is raised in 90% of cases. The estimation of activity of phosphohexose isomerase in the CSF has been found to be useful as it is markedly raised in tuberculous meningitis, moder-

ately raised in pyogenic meningitis, but not increased in viral meningitis.

The organism can be found in over 60% of cases by direct smear, and in another 20% after culturing for 2 days. The Gram stain is misleading in about 10% of cases, sometimes because *H. influenzae* looks like a coccus due to polar staining, especially after microbial therapy.

A blood culture should always be done for it is positive in nearly 50% of cases, helps to identify the bacteria and is a guide to prognosis. Nasal swabbing is worth while especially in institutions with a close proximity of beds (when the meningococcal carrier rate goes up from 2% to 70%). In those cases of presumed meningococcal meningitis where the organism is not found, the complement fixation test may be helpful as Group A occurs in epidemics and Group B at other times.

Selected bibliography

- CARPENTER, R.R. & PETERSDORF, R.G. (1962) The clinical spectrum of bacterial meningitis. *Amer. J. Med.* **33**, 262.
- HAGGERTY, R.J. & ZIAI, M. (1964) Acute bacterial meningitis. *Advanc. Pediat.* **13**, 129.
- HERWEG, J.C., MIDDELKAMP, J.N. & HARTBRAUN, A.F. (1963) Simultaneous mixed bacterial meningitis in children. *J. Pediat.* **63**, 76.
- JERVEY, L.P. (1963) Adult influenzae meningitis. *Arch. intern. Med.* **111**, 376.
- LEPPER, M.H. (1964) Treatment of meningitis. *Modern Treatment*, p. 956. Harper & Row, New York.
- ROSE, F.C. (1967) The treatment of pyogenic meningitis. *Postgrad. med. J. Suppl.* March, p. 116.
- ROSS, C.A.C. & STEVENSON, J. (1962) Meningococcal 'aseptic' meningitis. *J. Hyg. (Camb.)*, **60**, 501.
- SWARTZ, M.N. & DODGE, P.P. (1965) Bacterial meningitis—a review of selected aspects. *New Engl. J. Med.* **272**, 725.
- SNYDER, S.N. & BRUNGES, S. (1965) Hemophilus influenzae meningitis in adults. *Amer. J. med. Sci.* **250**, 658.
- THOMASSIN, N., BAROIT, A. & RAPIN, M. (1965) Traitement des meningites purulentes. *Rev. Prat. (Paris)*, **15**, 3927.
- WHITECAR, J.P., REDDIN, J.L. & SPINK, W.W. (1966) Recurrent pneumococcal meningitis. *New Engl. J. Med.* **274**, 1285.