PURULENT (NON-MENINGOCOCCAL) MENINGITIS IN CHILDREN

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Purulent meningitis is not uncommon in hospital paediatric practice and our experience of the disease in infants and children is reported in this paper.

During the 14-year period 1951 - 1964, 542 patients with meningitis of all types were admitted to the children's wards of Groote Schuur Hospital. After removing a group with tuberculous meningitis (144), those with meningococcal infection who, when diagnosed, were sent to the fever hospital (28), and another 89 children with aseptic meningitis, there remained 281 children with purulent meningitis who are the subjects of this survey.

In Table I the causes of purulent meningitis are divided into 4 groups. Pneumococci and *H. influenzae* were the most frequently found organisms. The third large group consisted of patients with a purulent but bacteriologically negative cerebrospinal fluid (CSF). Small numbers of patients infected with other organisms were placed in a miscellaneous group which numbered 30.

The predominating organisms in our patients are the same as found by others, although *H. influenzae* is found more commonly than the pneumococcus.[1-3] We found the opposite.

TABLE I. PURULENT MENINGITIS, 1951 - 1964*

Organism	*No. of cases*
Pneumococcal	114
H. influenzae	72
Miscellaneous	30
No organism	65
Total	281

*Excluding tuberculous and meningococcal causes.

Survival Rates in the 3 Main Groups (Table II)

Pneumococcal meningitis. Our survival rate of 63% is not very good when compared with other series where survival rates of over 70% have been reported.[1,4,5] Even these fall short of the 80% survival which, according to Smith,[6] should be attainable. Nineteen of the 42 deaths in our patients occurred within 24 hours of admission to hospital. If these deaths were excluded our survival rate would have climbed to 80%.

TABLE II. SURVIVAL RATE, 3 MAIN GROUPS

Organism	*Admissions*	*Deaths*	*Survival rate*	
			Over-all	*Excluding 1st day deaths*
Pneumococcus	114	42	63%	80%
H. influenzae	72	14	81%	82%
No organism	65	19	71%	85%
Total	251	75	—	—

H. influenzae. Here our survival rate of 81% compares well with other reports[1,4-7] and our 14-year figure is better than Zilberg's[5] finding of a 74% survival rate in a 2-year sample from the present series taken in the late 1950s. Smith's[6] ideal of over 90% survival is not reached, but there were probably good reasons for this which will be discussed later.

No organism. A survival rate of 71% is disappointing when compared with other series where 90% or over has been reported.[1,4,6,7] Nine of our 19 deaths occurred in the first 24 hours and exclusion of these would have brought the survival rate up to 85%.

Survivors with Sequelae in the 3 Main Groups (Table III)

The figures in the final column of Table III are not completely accurate since full information is lacking on a few patients. We do know that sequelae involving the central nervous system were found in 19 patients who survived pneumococcal meningitis, 17 following *H. influenzae* meningitis and in 7 where no organism was identified. The full recovery rates, therefore, are at least as good as indicated and possibly a little better, since among the patients whose data are incomplete there may have been some who made full recoveries.

TABLE III. FATE OF SURVIVORS, 3 MAIN GROUPS

Organism	*Admissions*	*Lived*	*Well*	*Sequelae*	*Uncertain or unrecorded*	*Full recovery*
Pneumococcus	114	72	45	19	8	39%
H. influenzae	72	58	40	17	1	55·5%
No organism	65	46	35	7	4	54%

Sequelae = Neurological or mental disabilities (details in Table IV).

Details of the neurological and mental sequelae are to be found in Table IV. Paralysis, of upper motor neurone type, was mostly unilateral, but in some patients all 4 limbs were affected.

TABLE IV. NEUROLOGICAL AND MENTAL SEQUELAE

Disability	*Pneumo-coccal*	H. influ-enzae	*No organism*	*Total*
Spastic paralysis	12	11	3	26
Hypotonia	1	1	2	4
Mental retardation	9	7	2	18
Hydrocephalus	3	2	2	7
Cerebral atrophy (by AEG)	4	2	—	6
Blindness	1	—	1	2

Miscellaneous Group

The organisms found in this group, and the outcome, are shown in Table V. One of the patients, with salmonella meningitis, was transferred to the fever hospital after one day and we do not know her subsequent fate. Of the other 14 who survived, 5 made a complete recovery and 4 more appeared normal on discharge, but were not seen again. Hydrocephalus developed in 4 of the remaining 5 children, the 5th one appearing to be less bright mentally than before his illness. A child with *torula* meningitis, though discharged alive, was in a very poor physical and mental state when sent home at her parents' request.

TABLE V. PURULENT MENINGITIS OWING TO MISCELLANEOUS ORGANISMS

Organism	*Lived*	*Died*	*Total*
Staphylococcus aureus	4	3	7
Salmonella	3	3	6
Proteus	2	4	6
E. coli	2	2	4
Haem. streptococcus	1	1	2
Enterococci	1	—	1
Listeria monocytogenes	—	1	1
Torula (*C. neoformans*)	1	—	1
Pseudomonas	—	1	1
Bacillus	1	—	1
Total	15	15	30

Neonatal Meningitis

Most authors report a mortality rate of over 60%, with a high incidence of serious sequelae in the survivors.[10-13] Our own group (Table VI) is a small one, which may account for the lower mortality rate. One of our 10 survivors developed hydrocephalus. Four others were all making normal progress when seen at varying intervals after leaving hospital. The other 5 appeared to be normal on discharge, but were not seen again for follow-up studies.

TABLE VI. NEONATAL MENINGITIS

Organism	*Lived*	*Died*	*Total*
Pneumococcus	4	1	5
Proteus	1	3	4
E. coli	2	—	2
Salmonella	—	1	1
Haem. streptococcus	—	1	1
Bacillus	1	—	1
No organism	2	3	5
Total	10	9	19

Five babies developed meningitis in the first week of life. Four died and the 5th has hydrocephalus, as mentioned. The last baby, aged 7 days, had had unilateral convulsions for 24 hours before admission to hospital and organisms of the genus bacillus were grown from the CSF on 2 occasions. Despite adequate treatment, mental retardation and a severe degree of hydrocephalus resulted. Organisms of the bacillus group, with the exception of *B. anthracis*, are regarded as harmless soil saprophytes, but occasionally they have been known to become pathogenic and at least one case of meningitis with a fatal outcome has been reported.[13]

There were 2 cases of *E. coli* meningitis in babies of 13 and 17 days respectively. Both made full recoveries and, when seen over a year later, both were developing very well.

Subdural Effusion

This complication is well recognized and the condition was recently reviewed by Platou *et al.*[9] Subdural effusions were found in 33 (12%) of our patients (Table VII), a figure which

TABLE VII. SUBDURAL EFFUSIONS

Organism	*Lived*	*Died*	*Total*
Pneumococcus	12	6	18
H. influenzae	9	—	9
No organism	5	1	6
Total	26	7	33

nearly corresponds with Platou's 16%. In 18 of our patients, subdural fluid was found over both cerebral hemispheres giving support to the view that these effusions are bilateral in over 50% of cases.

Racial Distribution (Table VIII)

There were many more cases of purulent meningitis in non-White compared with White children. As the admission rate to the children's wards is about 3 to 1 in favour of non-Whites, it is evident that the incidence, as well as the mortality, of purulent meningitis is considerably higher in non-White than in White children.

TABLE VIII. RACIAL DISTRIBUTION

Race	*Lived*	*Died*	*Total*
White	26	7	33
Non-White	165	83	248
Total	191	90	281

DISCUSSION

In an attempt to find out why our results were not better, certain features were examined.

Age Distribution

In our series, 70% of the children were under 1 year old. Table IX shows the highest death rate in the neonatal group. This fell in the next 2 groups, but between 1 and 2 years there was no further improvement. There was, however, a slight fall in those over 2 years of age. There is little difference between the mortality rate for those up to 12 months old (30%) and for those after that time (28%). Sequelae, however, indicate a definite age incidence, as 36 of the 43 who survived with sequelae were 12 months old or less and only 7 were in the older age group. The high percentage of young children in our series, therefore, had no marked influence on the mortality figures but had a very pronounced effect on the number of sequelae in survivors.

TABLE IX. AGE DISTRIBUTION 3 MAIN GROUPS

	Organism	*Lived*	*Died*	*Total*	*Mortality rate*
A. Neonates	Pneumococcus	4	1	5	40%
	H. influenzae	0	0	0	
	No organism	2	3	5	
		6	4	10	
B. Over 1 month, up to 6 months	Pneumococcus	20	19	39	32%
	H. influenzae	26	4	30	
	No organism	19	8	27	
		65	31	96	
C. Over 6 months, up to 12 months	Pneumococcus	22	8	30	27%
	H. influenzae	18	7	25	
	No organism	12	4	16	
		52	19	71	
D. Over 12 months, under 2 years	Pneumococcus	12	5	17	32%
	H. influenzae	7	2	9	
	No organism	4	4	8	
		23	11	34	
E. Over 2 years	Pneumococcus	14	9	23	25%
	H. influenzae	7	1	8	
	No organism	9	0	9	
		30	10	40	

Duration of Symptoms

The mean duration of symptoms before admission was 5·3 days in those who died and 7 days in those who recovered with sequelae, against 3·3 days in those who fully recovered.

Early Hospital Deaths

Death occurred within 24 hours of admission in 19 of the pneumococcal cases, 9 of the 'no organism' group, 7 of the miscellaneous, but only 1 of the *H. influenzae* group. Over one-third of all the deaths, therefore, occurred before treatment had a chance to become effective.

Effects of Fits and Disturbance of Consciousness

Convulsions or disturbed states of consciousness are said to carry a bad prognosis.[5,14,15] In our patients, 91 of the children in the 3 main groups had convulsions and only 30% recovered fully. There were 64 who were stuporose or comatose on admission and only 18% of these made a full recovery. These figures lend support to the view that children with purulent meningitis who present in this way have a poor prospect of complete recovery.

Drug Therapy

Many combinations of drugs were used in our patients, those most frequently given being penicillin, chloramphenicol and sulphadiazine in pneumococcal meningitis, and chloramphenicol and sulphadiazine in the *H. influenzae* and 'no organism' groups. Tetracyclines and streptomycin were also sometimes used. With so many combinations it is not possible to draw conclusions about the effects of treatment, but it is unlikely that our patients were undertreated. No particular combination of drugs appeared to influence a patient's death or survival, with or without sequelae. Corticosteroids were used in a few patients, but it was not evident that they had been of material benefit.

The efficacy of a drug in meningitis depends on its ability to get to the CSF in adequate concentration. Seelemann and Stegmann[16] showed that all members of the tetracycline group attained fairly adequate CSF levels, but that chloramphenicol in comparable dosage reached a far higher concentration. Penicillin also reaches the CSF, but in earlier reports[17,18] the levels were not consistently high in the dose range then recommended. Dowling's[19] recommendation of ½ - 1 million units of penicillin intravenously every 2 hours for pneumococcal meningitis is followed today by many physicians[10,13,21] and seems to be the treatment of choice, either with or without sulphonamides, which also attain a good concentration in the CSF.

In *H. influenzae* meningitis, chloramphenicol with sulphadiazine is a good combination, and some would add streptomycin, especially in seriously ill children.

When no organism is grown, a combination of penicillin, chloramphenicol and sulphadiazine gives good general cover and this may be the best commencing therapy in all cases of purulent meningitis until the organism has been identified. If pneumococci are found, chloramphenicol would be dropped, while penicillin would be discarded if the growth is of *H. influenzae*.

If, in spite of the above therapy, the child's condition deteriorates, consideration may be given to another drug, but not until the possible complications of subdural effusion or cerebral abscess have been excluded.

In view of the urgent necessity for starting treatment without delay, it is suggested that when a turbid CSF is found at lumbar puncture, immediate injections of 1

million units of crystalline penicillin and 50 mg./kg. of chloramphenicol be given intramuscularly. In addition, and in spite of the statements that intrathecal injections are unlikely to make much difference to the course of the disease,[2,22] it may be of value to inject 5,000 - 10,000 units of penicillin and 25 mg. of streptomycin through the lumbar puncture needle while still *in situ*.

Results in Early and Late Parts of the Survey

As the survey covered the rather long period of 14 years, the figures were divided at the half-way mark to see whether the results had improved with the passage of time. This was indeed so, and the survival figures in each group have been better since 1958 than before. It is, perhaps, of interest to compare the figures for the same diseases in patients admitted to the Red Cross War Memorial Children's Hospital, Cape Town, for the same 7-year period (1958 - 1964). There is, in fact, little difference in survival rate at the two hospitals (Table X).

TABLE X. SURVIVAL RATE IN PURULENT MENINGITIS—A COMPARISON

Type of	*Groote Schuur Hospital*		*Red Cross Hospital*
Meningitis	1951-57	1958-64	1958–1964
Pneumococcal	56%	70%	70%
H. influenzae	75%	85·5%	81%
No organism	61%	81%	86%

Although there have been fewer deaths since 1958, sequelae have increased, there being 26 against 17 before that date. The figures for full recovery for the second period are as follows, with the 14-year figures given in brackets:

Pneumococcal meningitis 47% (39%)
H. influenzae meningitis .... 59% (55·5%)
No organism 69% (54%)

Examination of the figures for the last 2 years (1963 - 4) did not indicate any improvement over these figures with the exception of pneumococcal meningitis where the full recovery rate had reached 56%.

CONCLUSIONS

Although 70% of our patients were in the 0 to 1-year-old group, there was little difference in mortality rate between these children and the 30% over 1 year old. Age, therefore, did not appear to influence our death rate very much but there were many more sequelae in those under 1 year old.

The mean duration of symptoms before coming to hospital was 5·3 days in the fatal cases, 7 days in those who survived with sequelae and 3·3 days in those who recovered completely. The delay in reaching hospital may well have affected the outcome in many patients.

Death occurred during the first day in hospital in 36 out of our 90 deaths. This appreciably raised the mortality figures.

If convulsions occurred before admission, 44% of the children so affected died, only 30% making a full recovery. If they were admitted in a stuporose or comatose state, 52% died and only 18% made a full recovery.

It was not possible to relate the type or duration of drug therapy to the outcome, but the urgency of immediate treatment, as soon as the condition is diagnosed, is recognized.

In the second 7 years there has been an all-round improvement in results compared with the first half of the survey. Early admission to hospital of the child with purulent meningitis is essential for the production of better results. It is appreciated that the gravity of the child's condition is not always realized by the parents and that difficulties of a familial or economic nature may hinder early attendance at hospital. It is, however, not always the parents' fault, since the diagnosis of purulent meningitis in small children may present difficulties. Neck stiffness and other signs of meningeal irritation may be entirely absent and a full fontanelle the only sign pointing to raised intracranial pressure. Even this may not be present and the infant may merely be irritable, drowsy, or may twitch. Any of these features make an immediate lumbar puncture mandatory.

Earlier diagnosis, rather than newer and more potent antibiotics in whatever combination, is the chief way in which better results are likely to be obtained in children suffering from the serious disease of purulent meningitis.

SUMMARY

A report is given of purulent, non-meningococcal meningitis, in patients admitted to the children's wards of Groote Schuur Hospital over a 14-year period.

Figures for survival and sequelae are given and special mention is made of subdural effusions and neonatal meningitis.

Various factors are considered which may have prevented better results, and suggestions are made to try to improve them.

There has been an over-all improvement in survival rates during the last 7 years, but this appears now to have become static.

Our experience confirms the views of others, in regarding pneumococcal meningitis as the most serious type of purulent meningitis, with the worst prognosis.

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