

***Salmonella typhi* Meningitis in Infants**

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Salmonella infections are usually limited to the gastro-intestinal tract, but invasion of the bloodstream and focal complications can occur(1-3). Intracranial infection particularly meningitis is rare. In 1975 Rocha found 22 cases of meningitis in 1727 children aged <18 months with salmonellosis(4). We present five infants aged below six months with *Salmonella typhi* meningitis.

Description of Cases

During a prospective study of bacterial meningitis in children aged between 1 month and 1 year presenting during the one year period starting from May 1994 at the Princess Badia Hospital, the main Pediatric referral hospital in Northern

Jordan, 5 cases of meningitis due to *Salmonella typhi* were identified from a total of 85 cases of bacterial meningitis. *Salmonella typhi* was cultured from CSF in all cases, and all had CSF findings consistent with meningitis. Survivals were followed up for at least 6 months.

Blood culture was positive in 3 cases that were below the age of 2 months. Stool culture was negative in all. Clinical data pertaining to the cases are summarized in *Table I*. The main clinical features were fever, irritability, reluctance to feed and bulging anterior fontanel. The mean age of the patients was 2.9 months (range 1-6 months). There were two girls and three boys. All had lumbar puncture performed as part of a sepsis evaluation. In all cases the CSF cell count and biochemical findings were consistent with bacterial meningitis. Two infants died, giving a case fatality rate of 40%. One patient developed a large left temporoparietal subdural empyema that was discovered on the first follow up head computerised tomography (CT) scan. This CT scan was done three months after the onset of meningitis due to poor compliance (discharged initially against medical advise) complicated later on by hydrocephalus. Another infant developed moderate hydrocephalus.

The antibiotics used empirically in infants beyond the neonatal period at our hospital were either a combination of intravenous Ampicillin and Chloramphenicol or intravenous Cefotaxime, modified later according to the sensitivity pattern (*Table II*). The duration of treatment was at least 4 weeks.

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Discussion

World-wide, it has been estimated that approximately 35 million cases and 500,000 deaths occur annually from *Salmonella typhi* infection(5). A disproportionately high incidence of bacteremia, sepsis and meningitis complicates *Salmonella* infection in infants

younger than one year of age(6).

Salmonella meningitis is rare in developed countries but is a relatively common cause of meningitis in developing countries(7-11). In our series from Northern Jordan, *Salmonella typhi* accounted for 5.9% of all cases of bacterial meningitis, a result which is similar to that obtained elsewhere

TABLE I- Clinical and CSF findings

Patient	Sex	Age (mo)	CSF (cells/mm ³)	CSF sugar (mmol/dl)	CSF protein (mg/dl)	Head CT scan	Outcome
1	F	1.0	4,752	0.5	726	Not done	Died
2	M	2.0	2,925	0.5	488	Ischemic changes	Died
3	M	1.0	40,000	0.09	693	Hydrocephalus	CNS sequelae
4	F	4.5	1,000	2.8	230	Normal	Recovered
5	M	6.0	2,529	0.9	640	Subdural empyema, hydrocephalus	CNS sequelae

TABLE II- Antibiotic Susceptibility Pattern of *Salmonella typhi*.

Antimicrobial agent	Number tested	Resistant
Chloramphenicol	4	1
Gentamicin	5	1
Co-trimoxazole	4	0
Cefotaxime	5	2
Ampicillin	2	1
Amikacin	3	0
Amoxicillin	3	1
Augmentin	3	1
Nalidixic acid	2	0
Ciprofloxacin	1	0

in other studies(6,8,9,12). In our cases there was nothing unusual in the clinical features, or CSF analysis, which might point to the correct bacteriological diagnosis; the clinical presentation closely resembled that of other causes of bacterial meningitis in infancy.

Salmonella meningitis is associated with considerable morbidity and mortality, especially in neonates(13). West *et al.*(14) reviewed the acute neurological complications of salmonella meningitis in 1977 and found ventriculitis, subdural empyema, hydrocephalus and chronic neurological abnormalities in as many as 43% of their cases; the same authors also reported a 64% relapse rate. However, focal

focal intracranial infections due to *Salmonella* are rare(3). Subdural empyema requiring surgical intervention was seen in one case of our series, three months after treatment, where fever was the main presenting feature. Two infants with hydrocephalus required shunt and recovered with CNS sequelae; ischemic changes were found in one patient. Two of our patients died (mortality 40%); this high mortality and morbidity is comparable with that reported in other studies (15,16).

There are several possible reasons for the high mortality rate and neurological damage. *Salmonella* is a facultative intracellular micro-organism, so inadequate drug penetration may result in progression of the infection(13,17). In addition *Salmonella* species multi-resistant against Chloramphenicol, Ampicillin, Cephalosporins and Cotrimoxazole have been reported(13,18-20). The pattern of resistance in our cases was consistent with previous reports, making the initial choice of antibiotic difficult. Many recent reports recommend the use of third generation Cephalosporins in multi-resistant *Salmonella* CNS infection (13,21-23).

In summary, *Salmonella typhi* meningitis, particularly in infancy, remains a devastating disease with high mortality and a high prevalence of neurological damage. In developing countries, where *Salmonella typhi* infection accounts for significant percentage of meningitis in infancy, initial empirical antibiotic therapy should be designed to include cover for this organism.

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