Original Article

Acute bacterial meningitis among children <5 years of age in Oman: a retrospective study during 2000-2005

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Abstract

Background: During the last two decades, significant changes have taken place in the epidemiology of meningitis, especially due to the global availability and expanding use of Hib vaccines. The introduction of conjugate Hib vaccine in the Expanded Programme of Immunization (EPI) in Oman and recent availability of meningococcal vaccines against serogroups A and C plus the introduction of pneumococcal heptavalent conjugate vaccine are expected to influence the epidemiology of the disease in the country. We conducted this periodic review of acute bacterial meningitis in children younger than five years of age in Oman from January 2000 to December 2005 to reflect changes in the epidemiological pattern of these pathogens.

Methodology: Retrospective analysis of all cases of acute bacterial meningitis in children younger than five years of age reported to the Department of Communicable Diseases Surveillance and Control, Ministry of Health, Oman.

Results: There were 344 cases of meningitis due to suspected bacterial etiologies reported in children younger than 5 years of age. Although *Haemophilus influenzae* 76 (22%) was the most common pathogen identified during the study period, the incidence of meningitis due to *Haemophilus influenzae* has been dramatically reduced since the introduction of conjugate Hib vaccination in Oman in October 2001. *Streptococcus pneumoniae* 53 (15%) and *Neisseria meningitidis* 37 (11%) were the next two leading agents of meningitis respectively. In one hundred seventy four (52%) cases of presumptive bacterial meningitis, the etiologic organism remains unidentified. The peak occurrence of meningitis was in young children younger than one year old. The total male to female ratio was 1.4:1 and the case fatality rate (7deaths) was 2%.

Conclusions: With the introduction of Hib vaccine in Oman in October 2001, the absolute number of cases due to *Haemophilus influenzae* significantly declined over the years. The incidence of meningitis due to other pathogens such as *S. pneumoniae* and *N. meningitidis* remains steady. There is significant need to improve laboratory methods of bacterial detection and identification, which will help to formulate better antibiotic policies and strengthen control measures through newly introduced vaccines in Oman.

Key Words: meningitis, etiology, bacterial, Oman.

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Introduction

Despite advances in vaccine development, chemoprophylaxis and treatment of acute bacterial meningitis remains a significant cause of substantial morbidity and mortality in children worldwide. According to the Pediatric Bacterial Meningitis Surveillance Network WHO/AFRO, an estimated 100,000 to 160,000 child deaths per year is attributed to *Haemophilus influenzae* type B; 250,000 to 400,000 deaths per year is caused by *Streptococcus pneumoniae* and *Neisseria meningitidis* is responsible for large epidemics causing thousands of deaths in many western and central African countries [1]. The above three mentioned pathogens remain the most common causative agents accounting for almost 90% of reported cases of acute bacterial meningitis throughout the world [2].

In Oman, prior to the introduction of Hib vaccine in October 2001, *Haemophilus influenzae* was the most common cause of acute bacterial meningitis in children accounting for 45% of all bacteriologically proven meningitis cases admitted over a one-year period in 1990-1991 [3]. The inclusion of conjugate Hib vaccine in the Expanded Programme of Immunization (EPI) in Oman and recent availability of meningococcal vaccines against serogroups A and C plus the introduction

of pneumococcal heptavalent conjugate vaccine are expected to influence the epidemiology of the disease in the country. We conducted this periodic review of acute bacterial meningitis to reflect changes in the epidemiological pattern of these pathogens.

Materials and Methods

In Oman, meningitis is a reportable disease, and mandatory notification of each case to the Department of Communicable Diseases Surveillance and Control in the Ministry of Health is required within 24 hours. We conducted a retrospective review of the medical records on cases of acute bacterial meningitis in children younger than 5 years old reported to the Department of Communicable Diseases Surveillance and Control from January 2000 through December 2005. A standardized data collection form was used to extract all the required relevant information including age, gender, underlying conditions, vaccination status, etiological agent, and clinical outcomes from each case.

Criteria used for inclusion of cases in the study were the presence of a clinical picture compatible with a diagnosis of bacterial meningitis with either a cerebrospinal fluid (CSF) neutrophilic pleocytosis of at least 100 neutrophils per cubic mm (presumptive) and /or a positive CSF culture for bacterial pathogens and/or a positive latex agglutination test for antigen detection (confirmed) [4]. Meningitis cases caused by Mycobacterium tuberculosis were not included in the study.

Results

Three hundred forty four cases of bacterial meningitis cases were reported in children younger than five years of age during the study period from January 2000 through December 2005. The most common causative pathogens were *Haemophilus influenzae* isolated in 76 (22%) cases, *Streptococcus pneumoniae* in 53 (15%) cases and *Neisseria meningitidis* in 37 (11%) cases. There were two cases each of *Escherichia coli* and Group B Streptococci seen in neonates. All except one (75 out of 76) cases of meningitis due to *Haemophilus influenzae* were reported before November 2003; thereafter, only a single case of Hib meningitis in a 2-year-old male child with incomplete immunization status was reported in 2005. One hundred seventy four cases (52%) of presumptive bacterial meningitis cases in our study remain without final identification of the causative agent (Table 1).

The sex distribution shows a male to female ratio of 1.4:1 and the mean age of involvement was found to be 8 months. Children under one year of age (224 of 344; 65%) had the highest incidence of meningitis in the study population. Omani children constituted 92% and children from other nationalities were 8% (expatriates constitute 15 to 20% of the Oman population). There were seven deaths (2%) among children reported due to meningitis. None of the children in the study population were immunocompromised or had any underlying chronic medical condition.

Table 1. Causative agents of bacterial meningitis, according to age.

Age in year	Cases	*H.influenzae*	*S.pneumoniae*	*N.meningitidis*	*E. coli*	Group B Streptococci	Presumptive bacterial meningitis
<1	224	40	37	10	2	2	133
1-2	55	24	6	9			16
2-3	28	6	4	6			12
3-4	24	4	5	7			8
4-5	13	2	1	5			5
Total	344	76	53	37	2	2	174

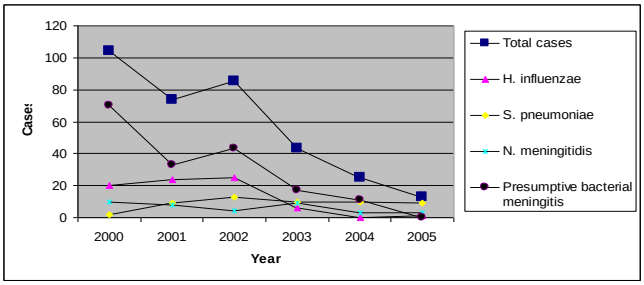
Discussion

This retrospective study shows that the agents most commonly associated with bacterial meningitis in children younger than five years of age were *Haemophilus influenzae* (22%), *Streptococcus pneumoniae* (15%) and *Neisseria meningitidis* (11%), while in 52% of presumptive bacterial meningitis cases no bacterial pathogen was identified. Although, *Haemophilus influenzae* is the predominate pathogen of meningitis in children aged below five years, all except one (75 out of 76) cases of meningitis due to *Haemophilus influenzae* were reported before November 2003; thereafter, only a single case of Hib meningitis in a 2-year-old male child with incomplete immunization status was reported in 2005. This

clearly indicates the incidence of meningitis due to *Haemophilus influenzae* has been dramatically reduced since the introduction of conjugate Hib vaccination in Oman in October 2001. Most neighboring countries of Oman including United Arab Emirates, Saudi Arabia, Kuwait and Qatar have demonstrated remarkable success in reducing invasive Hib diseases, especially meningitis with systematic and mandatory immunization of all children[5-9].

However, during the same study period, the incidence of meningitis due to other pathogens such as *Streptococcus pneumoniae* and *Neisseria meningitidis* remained unchanged (Figure 1). Similar incidence of meningitis due to *Streptococcus pneumoniae* and *Neisseria meningitidis* as the leading etiological agents after the introduction of Hib vaccine have been reported worldwide in many developing and developed countries [5, 10-12]. One hundred seventy four cases (52%) of presumptive bacterial meningitis cases in our study remain without final identification of the causative agent. All these children had clinical and/or CSF features that suggested bacterial meningitis; however, due to various contributing factors such as use of antibiotic prior to lumber puncture, parents' refusal to perform lumber puncture in some children as part of local customs, and laboratory insufficiencies to isolate the microorganism, the etiology could not be established [13]. The diagnosis of meningitis in children relies on clinical suspicion and correct interpretation of available laboratory tests including CSF culture. Alternative laboratory methods such as antigen detection and nucleic acid amplification should be integrated into routine laboratory procedures to improve the detection of microorganisms in CSF [14, 15].

Figure 1. Distribution of meningitis cases by year.



The sex distribution shows a male to female ratio of 1.4:1 and the mean age of involvement was found to be 8 months. Children under one year of age (224 of 344; 65%) had the highest incidence of meningitis in the study population. There were seven deaths (2%) among children reported due to meningitis. Similar gender difference and case-fatality rate due to meningitis among children are provided in many published studies [16, 17]. Information on vaccination status versus Hib was available for the study cohort but was lacking for pneumococcal and meningococcal vaccines. None of the subjects in our cohort were immunocompromised.

The study had several potential limitations. First, this is a retrospective study analyzing only notified cases of meningitis; thus the true incidence of disease in the community may have been under-reported. Second, detailed information on antibiotic use before presentation of meningitis was missing, and cases of presumed viral meningitis could have represented cases of partially treated bacterial meningitis, thus affecting the results. A final limitation of our study is our inability to follow up and record the complications including the neurological ones in the survivor of acute bacterial meningitis.

In conclusion, our study reports bacterial meningitis caused by *Haemophilus influenzae* dropped remarkably after the national introduction of Hib vaccine in 2001, while the prevalence of meningitis due to other etiologies remained stable. A large number of suspected bacterial meningitis cases remain without final identification of causative agents. This warrants a significant need to strengthen diagnostic capabilities to isolate and identify the causes of bacterial meningitis and to record their sensitivity pattern. This will help to formulate better antimicrobial policies, prevent emergence of resistance and adopt newer vaccination strategies. Baseline data on the etiologies of meningitis in children are of great importance to the country in particular and to the region at large to monitor surveillance and introduce effective interventional strategies to achieve a significant reduction of the disease burden in communities in Oman.

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Conflict of interest: No conflict of interest is declared.