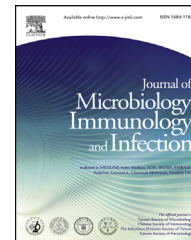




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ORIGINAL ARTICLE

# Evolving trends of neonatal and childhood bacterial meningitis in northern Taiwan



Meng-Chin Lin <sup>a</sup>, Nan-Chang Chiu <sup>a,b,\*</sup>, Hsin Chi <sup>a,b,c</sup>,  
Che-Sheng Ho <sup>a</sup>, Fu-Yuan Huang <sup>a</sup>

<sup>a</sup> Department of Pediatrics, Mackay Memorial Hospital, Taipei, Taiwan

<sup>b</sup> Mackay Medicine, Nursing, and Management College, Taipei, Taiwan

<sup>c</sup> Graduate Institute of Clinical Medicine, National Taiwan University College of Medicine, Taipei, Taiwan

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## KEYWORDS

Bacterial meningitis;  
Children;  
Neonates;  
Outcome;  
Pathogen

**Background:** The epidemiology of bacterial meningitis varies in different areas, age groups, and times. To know the trend of neonatal and childhood bacterial meningitis in northern Taiwan, we performed this 29-year-long assessment.

**Methods:** Eligible patients were aged 18 years or younger, hospitalized in Mackay Memorial Hospital between 1984 and 2012, and proven by positive cerebrospinal fluid bacterial cultures. Analysis included the patient numbers and pathogens in different age groups, periods, complications, and outcomes.

**Results:** Males were predominant in all the age groups through the years. Almost half of the patients were in the neonatal period. Patient numbers went up in the early study period and declined after 1993–1997. Group B *Streptococcus* and *Escherichia coli* were the most common pathogens in neonates, whereas in childhood were *Streptococcus pneumoniae* and *Haemophilus influenzae* type b (Hib). Patient numbers of Group B *Streptococcus*, *S. pneumoniae*, and Hib meningitis declined in the late study period, but *E. coli* meningitis increased. The mortality rate decreased but sequela rate increased. Among the four most common pathogens, *S. pneumoniae* had the worst outcome and had highest mortality rate. All Hib meningitis patients survived, but their sequela rate was the highest.

**Conclusion:** This study provides an epidemiological data on trends of neonatal and childhood bacterial meningitis in northern Taiwan during the past 29 years, including male and neonatal

\* Corresponding author. Department of Pediatrics, Mackay Memorial Hospital, Number 92, Section 2, Zhongshan North Road, Taipei 10449, Taiwan.

E-mail address: [ncc88@ms2.mmh.org.tw](mailto:ncc88@ms2.mmh.org.tw) (N.-C. Chiu).

predominance, decrease of total patient number in recent years, change of major pathogens, and declined mortality but raised morbidity.

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## Introduction

The main pathogens of bacterial meningitis are known to be different in different age groups, eras, and geographic areas. Group B *Streptococcus* (GBS), *Escherichia coli*, and *Listeria monocytogenes* are the most common causative organisms of neonatal bacterial meningitis in western countries,<sup>1,2</sup> but *L. monocytogenes* is hardly found in neonatal meningitis of Asian countries, including Taiwan.<sup>3–6</sup> *Haemophilus influenzae* type b (Hib), *Streptococcus pneumoniae*, and *Neisseria meningitidis* are considered to be the three most common pathogens for childhood bacterial meningitis prior to introducing the specific vaccines. However, the incidence of Hib meningitis in Taiwan was found to be lower than that in western countries in 1992–1994.<sup>7</sup> Compared with some countries, meningococcal meningitis is infrequently reported in Taiwan. The annual incidence of meningococcal disease was below 0.001/100,000 population between 1980 and 1987 and increased only to 0.2 cases/100,000 population in 2001.<sup>8</sup> Vaccination frequently has great impact on specific infectious diseases. In France, the invasive Hib disease in children aged < 5 years declined by 96% 15 years after the introduction of vaccination.<sup>9</sup> In Senegal, a near elimination of Hib meningitis burden was found after Hib conjugate vaccine was implemented into their routine infant immunization program.<sup>10</sup> Pneumococcal conjugate vaccine also has good results for decreasing disease burden.<sup>11,12</sup> There are some other factors that might influence the epidemiology of bacterial meningitis. Because epidemiology changes with time and place, knowing the local condition would be very important for clinicians. Herein, we review the data of proven bacterial meningitis in our pediatric patients during the past 29 years to reveal the trends of neonatal and childhood bacterial meningitis situations in our area.

## Materials and methods

### Patient selection

The patients in this study were selected from the administrative database of the Mackay Memorial Hospital, a medical center with around 200 pediatric beds in northern Taiwan. The bed number had only minor changes during the past three decades. This study was approved by the institutional review board of the hospital. The hospitalized patients aged 18 years or younger with a positive cerebrospinal fluid (CSF) bacterial culture results during the period from January 1984 to December 2012 were enrolled. Tuberculous meningitis was excluded. Patients diagnosed as having meningitis without bacteria isolated from the CSF were not included, even those who had elevated CSF cell

counts, positive blood culture results, or clinical presentations of meningitis were excluded. The CSF cultures yielded normal skin flora (e.g., coagulase-negative staphylococci) considered to be contaminations were excluded unless CSF cell counts and clinical presentations fit the diagnosis of meningitis. Patients with evidence of congenital infections were also excluded.

### Data collection

We searched the patients from both the diagnostic database and microbiological database to find eligible patients. The analyzed data included patients' age and sex, meningitis occurrence year, CSF pathogens, complications, and outcomes. If a patient had more than one spinal tap within an episode of meningitis, only the first CSF result was analyzed. If a patient had more than one episode of bacterial meningitis, i.e., recurrent meningitis, the findings were calculated separately in each episode.

### Statistical analysis

According to their age, the patients were divided into four groups: <1 month; 1 month to <1 year, 1–6 years, and 7–18 years. We further divided the 29 years into 6 periods, from 1984 to 1987, then every 5 years in each period. The outcomes of the patients were classified into death, having sequelae, recovery, and loss of follow-up. Sequelae were defined as having consequent physical or psychological morbidities lasting for >6 months after the meningitis episode. Recovery was defined as survival without sequelae.

We compared the patient numbers in different age groups and periods, pathogens in different age groups and periods, complications and outcomes in different age groups, periods, and pathogens. The lost follow-up patients were excluded from comparison of mortality rates. The sequela rates and recovery rates were calculated only in survivors.

Significant differences among different year periods, age groups, and pathogens were determined by  $\chi^2$  or Fisher exact test for comparison. Trends of patient numbers, pathogens, and outcomes during the study period were tested. All reported  $p < 0.05$  were considered statistically significant. Statistical analyses were performed using SPSS version 20.0 software (SPSS, Inc., Chicago, IL, USA).

## Results

### Characteristics of patients

A total of 323 episodes of proven pediatric bacterial meningitis were enrolled during the 29-year period. The male to

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