BACTERIAL MENINGITIS IN CHILDREN: CLINICAL PRESENTATION, CAUSATIVE ORGANISMS AND OUTCOME

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Abstract.

Background: Bacterial (Pyogenic) meningitis is an important cause of morbidity and mortality in children. This varies by age and causative organism especially in tropical countries like Nigeria. Young children and those living in resource poor countries are most at risk.

Objective: To determine the prevalence, causative organisms and outcome of children admitted with meningitis into the Department of Paediatrics of Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto, Nigeria.

Methods: This was a 7year retrospective study. Case folders of children aged 2 months to 15 years who were admitted as cases of pyogenic meningitis were retrieved, relevant information extracted and entered into a study proforma sheet. Data was analyzed using SPSS version 20.

Results: About 8435 children were admitted during the study period; 116 had probable meningitis (1.4%) of which 28 (24%) were confirmed by CSF culture. The mean age was 5.6 yrs (SD± 4.50, range- 2 months to 15 years). Male to female ratio was 1.6: 1. CSF appearance was turbid in 66 (56.9%), with low glucose in 67 (57.8%), and elevated protein in 79 (68.1%). *Staphylococcus aureus* and *Streptococcus pneumoniae* were the most frequently cultured organisms. Five (4.3%) patients were discharged against medical advice and 25 (21.6%) had neurological sequelae on discharge. The outcome was significantly related to the depth of coma on admission ($p= 0.00$,) but was not significantly related to the patients age nor gender. There was no mortality recorded.

Conclusion: This study shows low prevalence of bacterial meningitis with different pattern of causative organisms even during an epidemic period and very high morbidity (neurological sequelae). Early presentation and diagnosis, and aggressive management may help reduce morbidity and perhaps prevent mortality.

Key Words: Bacterial, meningitis, children, prevalence, presentation, outcome, Sokoto, Nigeria

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INTRODUCTION

Bacterial meningitis is a common neurological infection in the Tropics.¹ About 170,000 deaths occur annually from this disease worldwide.² It remains a leading cause of morbidity and mortality with case fatality rate of 12 to 50% in developing countries. Fatality rates associated with this disease can be as low as 2% in infants and children, and as high as 20–30% in neonates and adults.³ It also causes long term morbidity from neurological sequelae especially in resource poor countries. In middle and low income countries it is the fourth leading cause of disability.^{2,3} Transient or permanent deafness, or other neurological sequelae, arise in a third of survivors.³

The causative organism varies with age, immune function, immunization status, and geographic region, and empiric therapy for meningitis is based on these factors. The three main aetiological agents responsible for most of the infections worldwide remain *Streptococcus pneumoniae*, *Neisseria meningitides* and *Haemophilus influenza*.²⁻⁶ This is

also the finding from developing countries like Nigeria. Coupled with this, some of these low resource countries including Nigeria lie within the meningitis belt of Africa where climatic conditions and prevalent nasopharyngeal carriage of the causative *Neisseria meningitides* favour large scale epidemics every 5 to 10 years.⁷

Contributing factors to this burden is prevailing poverty, improper use of antibiotics and poor immunization coverage. The brunt of the disease is borne by the young children of lower socioeconomic background who live in hot dry climates in usually overcrowded homes. Late presentation and prior use of antibiotics may hamper elucidation of the aetiological agent especially where laboratory facilities are sub-optimal.¹⁻⁸

Previous studies in the country have highlighted the aetiological agents but there is paucity of information on factors associated with their outcome.^{9,10} This study was carried out to document the pattern of bacterial meningitis seen in Sokoto,

North-western Nigeria. Such information is needed for comparison with other studies and to guide management of patients.

MATERIALS AND METHODS

Study area:

This study was conducted at the Emergency Paediatric Unit (EPU) of the Paediatrics Department of Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto State, North-western Nigeria. Sokoto is located in the Sudan Savannah with five months of rainfall during the year (May - September) and cold Harmattan dusty winds in December, January and February. The temperature fluctuates within wide limits from about 15°C during the cold season to over 40°C during the hot season with an annual average temperature of 28.3°C. This hospital serves as a major referral center for the neighbouring Kebbi and Zamfara States amongst others and border countries like Niger and Benin Republics. The EPU is a 25 bedded facility with an average of 100 admissions monthly.

Study design: This was a retrospective study conducted over a 7 year period (1st January 2007 to 31st December 2013).

Study subjects: Case folders of all children aged 1 month to 15 years documented to have meningitis were retrieved. Subjects included into the study were all children who presented with fever, neck stiffness, convulsions and altered consciousness and had probable diagnosis of meningitis based on the examination of the cerebrospinal fluid (CSF). The CSF characteristics include turbid CSF, elevated protein (> 100mg/dl) and low glucose concentration (< 40mg/dl). Those who had positive Gram stain and culture of organisms from the CSF were included.¹¹ Excluded were suspected cases of meningitis that did not have lumbar puncture for CSF analysis, and referred patients already with neurological sequelae and no confirmation of diagnosis. The records of those who satisfied the eligibility criteria were recruited. Approval for the study was obtained from the Health Research and Ethics Committee of the UDUTH, Sokoto.

Data entry and analysis

The demographic, clinical characteristics including age, presenting symptoms, examination findings, and level of consciousness were documented. Also, their results of CSF analysis including culture and sensitivity pattern were documented. Other relevant investigation results as random blood sugar, malaria parasite test and blood culture were retrieved. All relevant data were entered into a proforma sheet then analyzed using SPSS statistical software version 20. Quantitative data were expressed as means and standard deviation while categorical variables were expressed as proportions. Chi-square or where necessary, Fisher's Exact test, was used to test for statistical significance. A p-value of <0.05 was considered statistically significant.

RESULTS

Demographic and clinical characteristics of patients:

A total of 8435 children aged 1 month to 15 years were admitted throughout the 7- year period of the study. A total of 116 cases (1.4% or 14 per 1000) had meningitis by the inclusion criteria. There were 72 males and 44 females (M: F ratio= 1.6:1). The age distribution showed 46.5% were above 5 years while 29.3% were aged between 1- 5 years and 24.1% were below 1 year of age. The mean $\pm$ SD age was 5.6 $\pm$ 4.5 years (Range 2 months to 14 years). Table I show the age and gender distribution of children with meningitis.

Table I: Age and gender distribution of children with bacterial meningitis

Age (Months)	Male n (%)	Female n (%)	Total n (%)
< 1 year	14 (12.1)	14 (12.1)	28 (24.2)
1 year-< 5 year	21 (18.1)	13 (11.2)	34 (29.3)
5 years- <10 years	20 (17.2)	10 (8.6)	30 (25.8)
>10 years-<15 years	17 (14.7)	7 (6.0)	24 (20.7)
Total	72 (62.1)	44 (37.9)	116 (100.0)

$\chi^2=2.9$, df=3, p= 0.43

Prevalence:

During the seven year period of the study, the highest number of cases were seen in the year 2008 accounting for 43.1% of all cases and cumulatively, most cases were in April accounting for 29.3%. The cumulative prevalence throughout the study was 1.4% as stated earlier. The yearly prevalence was highest in 2008 (3.7%) and lowest in 2012 (0.55%). This is seen in Figures 1 & 2.

Figure 1: Showing the yearly prevalence of bacterial meningitis throughout the study period

Figure 2: Showing the cumulative monthly prevalence of bacterial meningitis throughout the study period

Presenting symptoms and signs:

The symptoms and signs the patients had at presentation including fever, convulsions altered consciousness and vomiting is shown in Table II and III below. The most frequent presenting symptoms were fever (97.4%), vomiting (58.6%), convulsions (59.5%) and headache (42.2%). Though, only 73.3% had elevated temperature on admission, 24.2% had altered consciousness and 60.3% had signs of meningeal irritation. A patient could present with more than one symptom or sign. Most of those who were afebrile at presentation had used anti-pyretics just before presentation.

Table II: Symptoms at presentation of Children with Bacterial Meningitis

S\No	*Symptoms	Present		Absent	
		Freq	(%)	Freq	(%)
1	History of fever	113	(97.4)	3	(2.6)
2	Convulsions	69	(59.5)	47	(40.5)
3	Loss of consciousness	23	(19.8)	93	(80.7)
4	Vomiting	68	(58.6)	48	(41.4)
5	Headache	49	(42.2)	67	(57.8)
6	Neck stiffness	46	(39.7)	70	(60.3)
7	Body rashes	3	(2.6)	113	(97.4)

*A patient may present with more than one symptom

Table III: Signs at Presentation of Children with Bacterial Meningiti

S\No	*Signs	Present		Absent	
		Freq	(%)	Freq	(%)
1	Fever on admission	85	(73.3)	31	(26.7)
2	Meningeal signs	70	(60.3)	46	(39.7)
3	Coma on admission	28	(24.2)	88	(75.9)

*A patient may present with more than one symptom or sign

Pattern of CSF analysis:

CSF appearance was turbid in 66 (56.9%), with low glucose in 67 (57.8%), elevated protein in 79 (68.1%), however, only 28 (24.1%) had a positive CSF culture.

Of the 28 positive CSF culture as seen in Table IV, more than a third (39.3%) were Staph. Aureus, 28.6% were S. pneumoniae while N. meningitides and Pseudomonas species accounted for 11.0% each. E.coli and Proteus species accounted for 7.14% and 3.6% respectively. Hemophilus influenza type b was not cultured. N. meningitides was responsible for 3 cases. (2 of those cases occurred in 2008 and the other in 2009)

Table IV: Pattern of aetiological agents obtained by CSF culture

S/No	Organism	Freq	(%)
1	Staphylococcus aureus	11	(39.3)
2	Streptococcus pneumoniae	8	(28.6)
3	Neisseria meningitides	3	(11.0)
4	Pseudomonas spp	3	(11.0)
5	Escherichia coli	2	(7.14)
6	Proteus	1	(3.6)
7	Hemophilus influenza	0	(0.0)
Total		28	(100)

Outcome:

There were no mortalities on admission, though 5 (4.3%) patients were taken away against medical advice. Eighty-six patients (74.1%) were discharged in normal condition and 25 (21.6%) had neurological sequelae on discharge.

The outcome was significantly related to the depth of coma on admission ($p=0.00$), but was not significantly related to the patients age nor gender (Table V). Twenty –five percent of those with neurological sequelae had a positive CSF culture. Males had higher rates of neurological sequelae with a male to female ratio of 2.5:1.

Table V: Outcome of Children with Bacterial Meningitis

Level of consciousness	Without Sequelae (%)	With Sequelae (%)	Total (%)
Fully conscious	81 (92)	7 (8)	88 (100)
Mild coma	7 (50)	7 (50)	14 (100)
Deep coma	3 (21.4)	11 (78.6)	14 (100)
Total	91 (78.4)	25 (21.6)	116 (100)

$\chi^2 = 43.2$, $df=2$, $p= 0.00$

DISCUSSION

The prevalence of meningitis in this study during the 7year period was 1.4% almost twice 0.74% reported by Johnson⁶ earlier from Ilorin in the Guinea Savannah region of Nigeria over a five year period while Sokoto is in Sudan Savannah. This could be due to the hotter and drier climate in Sokoto compared to Ilorin. The hot, dry season is longer in Sokoto thereby allowing for a longer time of transmission of the causative agents.¹² It is also noteworthy that the study periods were not the same, with the Ilorin study carried out before the onset of this study which probably could reflect a generally increasing occurrence nationwide.

The prevalence reported from an earlier study in Ilesa¹³, South –western Nigeria, also found a slightly higher prevalence than this series of 1.6% and this was also carried out before the onset of our study. Also another study from the same hospital in Ilesa 10 years later found a much higher prevalence of meningitis of 5.5%.⁸ This finding from the second

study in Ilesa was attributed to the increase in number of displaced Northerners from the insurgency areas to the South of the country thus resulting in an unexpectedly higher rate of meningitis in the rain forest areas. However, this is limited by the fact that there was no concurrent study in other areas in the North at that time for proper comparison. This may also lend credence to the fact that the reported incidence of meningitis may vary if cases remain underreported in some areas.² Also, the health seeking behaviour of the populace also matters and would affect the reported number of cases since all the above studies including ours are hospital based.

There are also a host of other reports from Ibadan, Sagamu, and Maiduguri but these were carried out over a shorter time frame and about two to three decades ago, limiting proper comparison.^{14 -16} A more recent report from Zaria got a prevalence of 6.9% in 1 year. This is quite high compared to this study, however it could be due to the shorter duration of the study compared to ours and a probably sporadic increase that year the study was done.¹⁷ After the onset of our study in 2007, the highest prevalence of 3.7% was documented in 2008 and this steadily decreased during the subsequent years to as low as 0.6%. This supports the fact that sudden increases in incidence may occur due to prevailing climatic conditions and immune status of the population.

The pattern of monthly incidence cumulatively throughout the study period shows that the occurrence was highest in the months of January to April with the peak occurring in April. This coincides with the cold dry and later hot Harmattan seasons typical of Northern Nigeria. The incidence reduced sharply in the following month of May and thereafter with advent of the rainy season. This pattern is similar to a report from Gusau by Mado⁷ which showed an epidemic of meningitis occurring in March and April 2009 which were the hottest months. This was the trend seen in other reports^{6,13,18} except the one from Ilesa⁸ which showed a higher occurrence during the rainy season.

The age distribution was also similar to other

reports with those under-fives being the majorly affected.^{1, 6, 13, 17, 19} Other reports by Mado⁷ and Rabasa²⁰ were on meningococcal meningitis and showed a higher prevalence in those above five years of age. Male predilection in this study is also in concordance with similar reports.^{6,7,17,19,20}

The yield of CSF culture noted in this study (24%) was low probably due to use of antibiotics prior to presentation but was better than the 6.5% reported by Mado⁷. The commonest organism cultured from the subjects in this study was *Staphylococcus aureus* as opposed to what is expected as the commonest organisms reported worldwide are *Streptococcus pneumoniae*, *Neisseria meningitidis* and *Haemophilus influenza type b*.² A previous report from the study area by Emele²¹ showed *Staphylococcus aureus* accounted for 6% of isolates. *Staphylococcus aureus* is usually a cause of meningitis in children with VP shunts, communicating NTDs, and immune compromise which were not seen in the patients from this study.^{3, 22} It is also possible that this was a contaminant from either the lumbar puncture procedure or from the laboratory process. However, it was notable that 60% of those with *Staphylococcus aureus* isolates were infants and malnourished. *Staphylococcus aureus* is an organism that commonly infects malnourished children so may explain this finding.

There was no mortality recorded but outcome of DAMA patients was not known. Neurological sequelae were more in males though not significant. They were significant in those who had deep coma on presentation. Outcome was also not related to age though the frequency of sequelae was more in infants.

This probably reflects longer duration of illness prior to presentation as reported by others.^{1, 6, 8, 16} In conclusion, therefore, this study has shown different pattern of causative organisms of meningitis even during an epidemic period. Early presentation and diagnosis, and aggressive management may help reduce morbidity and perhaps mortality.

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