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Research Article

Clinical Profile And Outcome Of Pediatric Bacterial Meningitis: A Prospective Study From A Tertiary Institute In Central India

Alok Kumar[1], Namrata Naithani[2], Priyanka Choudhary[3], Satakshi Manwani[4*]

[1]Asst Professor, Dept. of Biochemistry, Lord Buddha Koshi Medical College and Hospital, Saharsa Bihar,
[2]Assistant Professor, Microbiology, Chirayu Medical College & Hospital, Bhopal, M.P.
[3]Associate Professor, Department of Paediatrics, Chirayu Medical College & Hospital, Bhopal, M.P.
[4*]Corresponding Author- Dr Satakshi Manwani, Assistant Professor, Microbiology, Chirayu Medical College & Hospital, +91 96375 54262, satakshimanwani@gmail.com.

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ABSTRACT

Introduction:
Acute bacterial meningitis (ABM) is a critical condition characterized by inflammation of the leptomeninges due to bacterial infection in the subarachnoid space, leading to severe complications and high morbidity. This study aims to determine the incidence, etiological profile, and complications of ABM in children aged one month to five years in Central India.

Methods
This prospective study was conducted from November 2022 to October 2023 at a tertiary care hospital in Central India. Children aged 1 month to 5 years with suspected meningitis based on clinical features were included. Diagnosis was confirmed through lumbar puncture and cerebrospinal fluid (CSF) analysis, including biochemical tests, cell counts, staining, culture, and latex agglutination test (LAT).

Results
Out of 1560 children admitted, 160 were suspected of having meningitis, and 57 cases were confirmed as ABM. The highest incidence (59.6%) was in the 3 to 12 months age group, with a male to female ratio of 2:1. LAT showed 82.45% positivity, CSF biochemistry was positive in 63% of cases, Gram staining in 8.7%, CSF culture in 3.5%, and blood cultures in 17.5%. The pathogens identified included Group B Streptococcus (45.6%), Streptococcus pneumoniae (21%), and Haemophilus influenzae (10.5%). Complications during hospitalization included seizures (45.6%), increased intracranial pressure (28%), and coma (10.5%), with a case fatality rate of 10.5%. Follow-up visits revealed sequelae such as seizures (38%), cranial nerve palsies (31%), and developmental delays (26.2%).

Discussion
The study reaffirms the high prevalence of ABM in Central India, with a significant burden on infants aged 3 to 12 months. The predominant pathogen was Group B Streptococcus, contrasting with higher prevalence of Streptococcus pneumoniae and Haemophilus influenzae in developed countries. The high rate of complications and case fatality rate highlights the need for improved diagnostic and therapeutic strategies.

Conclusion
The study underscores the critical need for enhanced vaccination, early diagnosis, and appropriate antibiotic use to manage ABM effectively. Comprehensive follow-up care is essential to mitigate long-term complications.

INTRODUCTION

The brain is typically a sterile organ, shielded from external threats by the bony skull and internally by the blood-brain barrier (BBB). The vulnerability of the brain to infections is associated with breaches in the BBB and compromised host defenses, allowing pathogen proliferation. These infections can alter cerebral blood

flow, increase intracranial pressure (ICP), and cause brain tissue inflammation, leading to significant complications and long-term sequelae. Acute bacterial meningitis (ABM) involves inflammation of the leptomeninges triggered by bacteria in the subarachnoid space, associated with high rates of acute complications and long-term morbidity. This study aims to determine the incidence, etiological profile, and complications of ABM in children aged one month to five years.

METHODS

This prospective study was conducted over a year at a tertiary care hospital in Central India, from November 2022 to October 2023. Diagnosis of meningitis was based on history, examination, and laboratory investigations. Lumbar puncture was performed, and cerebrospinal fluid (CSF) was analyzed biochemically, for cell counts, staining, culture, and latex agglutination test (LAT).

Inclusion Criteria:

- Children aged 1 month to 5 years.
- Suspected cases of meningitis based on clinical features such as fever, irritability, poor feeding, vomiting, seizures, and altered sensorium.

Exclusion Criteria:

- Children with chronic illness, malignancy, or on immunosuppressive drugs.
- Post-operative and post-lumbar puncture cases.

RESULTS

Out of 1560 admitted children (1 month to 5 years), 160 were suspected of having meningitis, with 57 confirmed ABM cases. The highest incidence (59.6%) was in the 3 months to 12 months age group, with a male to female ratio of 2:1.

Table 1: Age and Sex Distribution of ABM Cases

Age Group	Number of Cases	Percentage (%)
1 month - 2 months	11	19.3
3 months - 12 months	34	59.6
13 months - 59 months	12	21.1
Sex	**Number of Cases**	**Percentage (%)**
Male	38	66.7
Female	19	33.3

Diagnostic Methods and Pathogen Identification:

- LAT showed 82.45% positivity.
- CSF biochemistry was positive in 63% of cases.
- Gram staining was positive in 8.7% of cases.
- CSF culture was positive in 3.5% of cases.
- Blood cultures were positive in 17.5% of cases.

Table 2: Pathogens Identified in ABM Cases

Pathogen	Number of Cases	Percentage (%)
Group B Streptococcus	26	45.6
Streptococcus pneumoniae	12	21.0
Haemophilus influenzae	6	10.5
Klebsiella	1	1.75
Staphylococcus aureus	1	1.75
N. meningitides	1	1.75
E. coli	1	1.75
Unknown	9	15.8

Table 3: Complications During Hospitalization

Complication	Number of Cases	Percentage (%)
Seizures	26	45.6
Increased Intracranial Pressure	16	28.0
Coma	6	10.5
Infarcts	4	7.0
Hydrocephalus	2	3.5

Subdural Effusions	3	5.26

Table 4: Biochemistry Investigations of CSF in ABM Cases

Biochemical Parameter	Number of Cases	Percentage (%)
Elevated Proteins (>100 mg/dL)	36	63
Low Glucose (<40 mg/dL)	36	63
CSF/Serum Glucose Ratio <0.5	36	63

Follow-up visits revealed sequelae such as seizures (38%), cranial nerve palsies (31%), and developmental delays (26.2%). The incidence of complications was higher in cases of S. pneumoniae and H. influenzae meningitis compared to Group B streptococcus.

DISCUSSION

The incidence of acute bacterial meningitis (ABM) in the pediatric population remains a significant health concern, particularly in developing regions such as Central India. Our study found a prevalence of 3.6% among hospital admissions for children aged one month to five years, consistent with previous reports from various parts of India and other developing countries, which range from 0.5% to 3.5%. This persistent prevalence underscores the need for improved public health measures, including widespread vaccination and early intervention strategies.

Age and Gender Distribution: The highest incidence of ABM was observed in the 3 months to 12 months age group, accounting for 59.6% of the cases. This finding aligns with studies by Mani et al. and Ogunlesi et al., which also reported a higher prevalence of ABM in infants under one year of age. The male to female ratio in our study was 2:1, indicating a male preponderance. Similar gender distribution has been noted in other studies, suggesting that males are more susceptible to bacterial infections possibly due to genetic and immunological factors.

Diagnostic Methods: Our study highlighted the efficacy of LAT (Latex Agglutination Test) in diagnosing ABM, with a positivity rate of 82.45%. This is higher than the positivity rates reported by Das et al. (83%) and Chinchankar et al. (66%), indicating that LAT remains a reliable diagnostic tool in resource-limited settings. However, the low positivity rates of Gram staining (8.7%) and CSF culture (3.5%) in our study highlight significant challenges. These rates are considerably lower compared to findings by Bhat et al. and Surinder et al., who reported Gram staining positivity rates of 53% and 36%, respectively. The poor culture results could be attributed to prior antibiotic administration, suboptimal sample handling, and the quality of culture media, which are common issues in many developing countries.

Pathogen Profile: Group B Streptococcus (GBS) emerged as the predominant pathogen in our study, responsible for 45.6% of the cases. This contrasts with many studies from developed countries where Streptococcus pneumoniae and Haemophilus influenzae are more common, especially after the introduction of effective vaccination programs. The high prevalence of GBS in our study, including in the post-neonatal period, is consistent with findings by Florindo et al. and Dwivedi et al., who reported GBS as a significant pathogen beyond the neonatal period. The continued high incidence of H. influenzae (10.5%) and S. pneumoniae (21%) in our cohort underscores the need for enhanced immunization coverage in India.

Complications and Mortality: The rate of complications during hospitalization was notably high, with seizures occurring in 45.6% of cases, increased ICP in 28%, and coma in 10.5%. These findings are comparable to the complication rates reported by Chinchankar et al. and Goetghebeur et al., who noted similar rates of acute complications in their studies. The case fatality rate in our study was 10.5%, which aligns with the 10-30% range reported in other developing nations but is higher compared to the 10% fatality rate in developed countries with advanced healthcare facilities.

Long-term Sequelae: On follow-up, 73.68% of patients revisited for examination, with significant sequelae observed. Seizures (38%), cranial nerve palsies (31%), and developmental delays (26.2%) were the most common complications. These findings are consistent with those reported by Singhi et al. and Grimwood et al., who documented similar rates of long-term neurological sequelae. The higher incidence of hearing deficits and vision impairments in our cohort, primarily associated with H. influenzae and S. pneumoniae, highlights the need for targeted interventions and follow-up care for these patients.

Comparison with Published Literature: Our study's findings are broadly consistent with the existing literature but also highlight regional variations in pathogen prevalence and complication rates. For instance, while GBS remains a significant pathogen in our study, it is less commonly reported in studies from regions with robust neonatal screening and prophylaxis programs. The high complication rates and case fatality

observed underscore the challenges faced in resource-limited settings, where early diagnosis and prompt treatment are often hindered by systemic healthcare limitations.
In summary, our study reaffirms the high burden of ABM in pediatric populations in Central India and underscores the critical need for enhanced vaccination coverage, early diagnostic interventions, and comprehensive follow-up care to mitigate the long-term impact of this serious infection. These findings call for concerted efforts to improve healthcare infrastructure and public health policies to address the ongoing challenges in managing ABM effectively.

CONCLUSION

The incidence of ABM in Central India is significant, with Group B Streptococcus as the main pathogen. The study emphasizes the importance of vaccination, early diagnosis, and appropriate antibiotic use to manage and reduce the complications associated with ABM.

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Conflict of Interest: None declared.

Ethical Approval: The study was approved by the Institutional Ethics Committee.

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