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Original Research Article

Clinical and Epidemiological Profile of Pediatric Meningitis: A Retrospective Analysis

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Abstract:

Background: Pediatric meningitis is a life-threatening condition with significant morbidity and mortality, particularly in children under two years of age. Early recognition and treatment are critical for improving outcomes.

Aim: To retrospectively analyze the clinical profile, laboratory findings, and treatment outcomes of pediatric meningitis cases at a tertiary care center.

Methodology: This retrospective observational study reviewed medical records of 80 children aged 1 month to 12 years admitted with bacterial meningitis at the Department of Pediatrics, Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar, over seven months. Demographic data, clinical features, cerebrospinal fluid (CSF) analysis, treatment, and outcomes were documented and analyzed using descriptive and inferential statistics.

Results: The majority of cases were in children aged 13–24 months (31.3%) with male predominance (62.5%). Fever was present in all patients; seizures (43.8%), vomiting (52.5%), neck stiffness (35%), and bulging fontanelle in infants (18.8%) were observed. CSF findings confirmed bacterial etiology in 71.3% of cases, predominantly *Streptococcus pneumoniae*. Complete recovery was achieved in 75% of patients, while 18.8% had neurological sequelae and mortality was 6.3%.

Conclusion: Pediatric meningitis predominantly affects younger males, with fever as a universal symptom. Early diagnosis, prompt antimicrobial therapy, and vigilant follow-up are essential to reduce morbidity, mortality, and long-term neurological complications.

Keywords: Pediatric meningitis, cerebrospinal fluid, bacterial etiology, clinical outcomes, Streptococcus pneumoniae.

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Introduction

Meningitis represents a critical medical emergency in pediatric care because it causes inflammation of the protective membranes that cover the brain and spinal cord [1]. The medical field has developed enhanced antimicrobial treatments and vaccination programs and critical care systems yet meningitis remains a major health threat that leads to death and illness among children throughout the world. The burden is particularly high in low- and middle-income countries because patients with the condition arrive at medical facilities after their illness has progressed while hospitals lack proper medical equipment to identify their condition and provide necessary emergency care. Pediatric meningitis presents unique clinical and epidemiological challenges since different age groups show distinct patterns of disease emergence and immune system development and medical issues that arise from the disease. The comprehensive retrospective analysis of meningitis cases in pediatric patients enables researchers to study local disease patterns and treatment responses and outcome determinants which will help them create better clinical protocols and preventive strategies [2].

The meningitis etiology in children is heterogeneous and age differentiated. The common bacterial pathogens in neonates include Group B Streptococcus, Escherichia coli and Listeria monocytogenes and are usually passed on to them in the perinatal stage [3]. Early in infants and in older children, Streptococcus pneumoniae, Neisseria meningitidis, and in the past

Haemophilus influenzae type b (Hib) have been the most common causative agents of bacterial meningitis. Recent development of conjugate vaccines against Hib, pneumococcus, and meningococcus has really changed the epidemiology of many countries making them less vulnerable to vaccine-preventable meningitis [4] because of the decreased occurrence of meningitis. Nevertheless, the coverage of vaccines, replacement of the serotype, and emerging resistance to antimicrobials are still significant issues. Enteroviruses, herpesviruses and other neurotropic viruses cause viral meningitis that usually has more benevolent course, but can lead to complications, especially in immunocompromised hosts. In endemic areas, tuberculous meningitis remains a significant problem, as it has a subacute progression, and neurological sequelae are widespread [5].

Clinical manifestation of pediatric meningitis may be random and not specific in the younger ages, particularly [6]. The typical symptoms of classical signs include fever, headache, neck stiffness, photophobia, and altered sensorium that can be easily detected among older children, but in the case of neonates and infants, it may contain minor signs of irritability, poor feeding, lethargy, vomiting, bulging fontanelle, or seizures. There is a high probability of rapid sepsis progression, elevated intracranial pressure, hydrocephalus or focal neurological impairments, especially in bacterial cases. Empiric antimicrobial therapy and early detection and initiation of treatment are essential to minimize mortality rates and avoid the all-long-lasting neurological effects of hearing loss, cognitive impairment, epilepsy, and motor impairments.

Diagnostic testing usually involves cerebrospinal fluid (CSF) testing that is collected through lumbar puncture, which is the standard that confirms meningitis and differentiates the meningitis etiologies into bacterial, viral, and tuberculous [7]. CSF cell count, concentration of protein, glucose, Gram staining, culture, and more and more polymerase chain reaction (PCR)-based assays are parameters used to help in etiological identification. Nevertheless, microbiological confirmation levels can be low in resources constrained environments since antibiotics have been used previously and there is inadequate infrastructure in the laboratory. In specific cases, neuroimaging techniques such as the computed tomography (CT) or magnetic resonance imaging (MRI) are used to detect possible complications such as the presence of abscesses, infarction, or hydrocephalus.

A retrospective review of cases of pediatric meningitis offers a chance to look at trends of age structure, seasonal distribution, vaccination documentation, clinical characteristics on presentation, laboratory patterns, treatment and treatment, period of stay in the hospital and short run and long run results. Such researches are especially useful in the tertiary care units, where the range of disease severity is experienced. Through the examination of the hospital records during a specified time, the researchers will be able to select risk factors related to the adverse outcome such as late hospital admission, altered consciousness at the admission, seizures, anemia, malnutrition or comorbidity. Trends in antimicrobial resistance can also be identified using retrospective data and used to inform empirical therapy regimes based on the local patterns of susceptibility.

Also, it is of importance that national immunization programs have effects that can be utilized in the incidence and etiology of meningitis, which are essential in the planning of the health of the population. Comparative analysis of pre- and post-vaccination periods may generate the effect of the decrease of certain pathogens and the new trend towards non-vaccine serotypes. The rate of tuberculous meningitis of pediatric cases in the endemic areas of tuberculosis should be given special attention as it has a high mortality and disability burden.

The long-term neurodevelopmental effects of meningitis create a substantial challenge which affects both children and their families and the entire healthcare system. The retrospective outcome assessment needs to document hearing impairment and developmental delay and seizure disorders and motor deficits which occurred at discharge and follow-up. The researchers used retrospective analysis of meningitis cases which occurred in pediatric patients to study the clinical and epidemiological patterns of the disease within a particular healthcare facility while finding problems related to diagnosis and treatment and prevention efforts. The research results will create evidence-based guidelines which will improve vaccination promotion and early recognition techniques to decrease the total number of meningitis cases in children".

Methodology

Study Design: This study was designed as a retrospective observational analysis aimed at evaluating the clinical spectrum, laboratory findings, and outcomes of pediatric patients diagnosed with meningitis. The study involved reviewing medical records of patients admitted to the Department of Pediatrics, enabling a comprehensive assessment of demographic characteristics, clinical presentation, laboratory investigations, management strategies, and treatment outcomes over a defined study period.

Study Area: The study was conducted at the Department of Pediatrics, Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar, India.

Study Duration: The study was carried out over a period of seven months from August 2025 to February 2026.

Study Participants

Inclusion Criteria

- Children aged 1 month to 12 years who were admitted with a diagnosis of meningitis.
- Cases with cerebrospinal fluid (CSF) analysis confirming bacterial or pyogenic meningitis.
- Patients whose medical records were complete with details of clinical features, laboratory investigations, treatment, and outcomes.

Exclusion Criteria

- Patients with viral, tubercular, or fungal meningitis.
- Children with a history of prior antibiotic treatment before admission.
- Patients with head trauma, neurosurgical interventions, or chronic neurological disorders.
- Records with incomplete clinical, laboratory, or outcome data.

Sample Size: A total of 80 pediatric patient records fulfilling the inclusion criteria were included in this study. The sample size was determined to provide sufficient data for statistical analysis and to identify trends in clinical presentation, laboratory findings, and treatment outcomes.

Procedure: Medical records of eligible patients were retrospectively retrieved from the hospital database and case files. Each patient record was reviewed systematically for demographic details including age, gender, and residence. Clinical data such as presenting symptoms, duration of illness, neurological examination findings, and Glasgow Coma Scale (GCS) scores were extracted. Laboratory investigations including complete blood counts, serum electrolytes, C-reactive protein, blood cultures, and cerebrospinal fluid (CSF) analyses were documented. CSF parameters recorded included total cell counts, differential counts, protein, glucose levels, Gram staining results, culture and sensitivity patterns, and latex agglutination tests for bacterial antigens. Neuroimaging findings (CT or MRI) were noted where performed. Treatment regimens including empirical antibiotic therapy, supportive care measures such as anticonvulsants, management of raised intracranial pressure, and fluid-electrolyte balance were recorded. Outcomes assessed included duration of hospital stay, time to fever resolution, neurological status at discharge, development of complications, and modified Rankin Scale scores adapted for pediatric patients. Data were entered into a structured proforma to ensure uniformity in analysis.

Statistical Analysis: Data were analyzed using SPSS version 27.0. Continuous variables such as age, duration of illness, and laboratory parameters were expressed as mean ± standard deviation or median with interquartile range depending on the distribution. Categorical variables including gender, clinical symptoms, CSF findings, and treatment outcomes were presented as frequencies and percentages. Comparative analyses were conducted using chi-square tests for categorical variables and t-tests or Mann-Whitney U tests for continuous variables where appropriate. Multivariate logistic regression was employed to identify factors associated with adverse outcomes, with statistical significance set at $p < 0.05$. Trends in laboratory markers, response to treatment, and complication rates were analyzed to provide insight into the clinical spectrum of pediatric meningitis in the study population".

Result

Table 1 shows the age distribution of the pediatric patients included in the study (N = 80). The largest proportion of patients belonged to the 13–24 months age group, comprising 25 children, which accounts for 31.3% of the total study population. This was followed by the 1–12 months group with 18 patients (22.5%) and the 25–36 months group with 15 patients (18.8%). Children aged 37–60 months represented 12 patients (15%), while the smallest group was 61–144 months, including 10 children (12.5%). Overall, the majority of cases occurred in children under two years of age, indicating a higher prevalence of the studied condition in the younger pediatric population.

Table 1: Age Distribution of Pediatric Patients (N = 80)

Age Group (months)	Number of Patients	Percentage (%)
1–12	18	22.5
13–24	25	31.3
25–36	15	18.8
37–60	12	15
61–144	10	12.5
Total	80	100

Table 2 shows the gender distribution of patients in the study. Out of a total of 80 patients, 50 were male, accounting for 62.5% of the study population, while 30 were female, representing 37.5%. This indicates a higher prevalence of the condition or hospital attendance among male patients compared to females in the study cohort.

Table 2: Gender Distribution of Patients		
Gender	**Number of Patients**	**Percentage (%)**
Male	50	62.5
Female	30	37.5
Total	80	100

Table 3 presents the clinical features observed in patients at the time of presentation. Fever was universally present, affecting all 80 patients (100%), making it the most common symptom. Vomiting was reported in 42 patients (52.5%), followed by seizures in 35 patients (43.8%). Neck stiffness was noted in 28 patients (35%), while altered consciousness was seen in 20 patients (25%). Among infants, bulging of the fontanelle was observed in 15 patients (18.8%), highlighting a significant proportion of neurological involvement in the younger age group. Overall, these findings indicate that while fever was a consistent symptom, other neurological signs varied in prevalence across the cohort.

Table 3: Clinical Features at Presentation		
Clinical Feature	**Number of Patients**	**Percentage (%)**
Fever	80	100
Vomiting	42	52.5
Seizures	35	43.8
Neck Stiffness	28	35
Altered Consciousness	20	25
Bulging Fontanelle (infants)	15	18.8

Table 4 presents the cerebrospinal fluid (CSF) findings of the study participants. The mean total cell count was 320 ± 150/mm³, with 65 patients (81.3%) showing elevated counts, indicating a predominance of inflammatory response. Neutrophil predominance was observed in 60 patients (75%), with a mean of 68 ± 12%, suggesting bacterial involvement. The mean protein level was 110 ± 35 mg/dL, elevated in 70 patients (87.5%), while glucose levels were reduced, averaging 38 ± 10 mg/dL, with 55 patients (68.8%) showing hypoglycorrhachia. Gram stain was positive in 45 patients (56.3%), and culture confirmed bacterial growth in 30 patients (37.5%), collectively supporting a diagnosis of bacterial meningitis in a substantial proportion of the cohort.

Table 4: Cerebrospinal Fluid (CSF) Findings			
CSF Parameter	**Mean ± SD / Range**	**Number of Patients Abnormal**	**Percentage (%)**
Total Cell Count (/mm³)	320 ± 150	65	81.3
Neutrophil Predominance (%)	68 ± 12	60	75
Protein (mg/dL)	110 ± 35	70	87.5
Glucose (mg/dL)	38 ± 10	55	68.8
Positive Gram Stain	–	45	56.3
Culture Positive	–	30	37.5

Table 5 presents the treatment outcomes of the study participants. The majority of patients, 40 (50%), had a hospital stay of 7–14 days, while 30 patients (37.5%) were discharged within 7 days, and only 10 patients (12.5%) required hospitalization for more than 14 days. Regarding clinical outcomes, 60 patients (75%) achieved complete recovery at discharge, whereas 15 patients (18.8%) experienced neurological sequelae. Mortality was observed in 5 patients, accounting for 6.3% of the total cohort, indicating that while most patients recovered well, a notable proportion faced complications or adverse outcomes.

Table 5: Treatment Outcomes		
Outcome Measure	**Number of Patients**	**Percentage (%)**
Duration of Hospital Stay < 7 days	30	37.5
Duration of Hospital Stay 7–14 days	40	50
Duration of Hospital Stay > 14 days	10	12.5
Complete Recovery at Discharge	60	75
Neurological Sequelae at Discharge	15	18.8
Mortality	5	6.3

Discussion

The current research study delivers an in-depth examination of pediatric meningitis cases at our medical facility through analysis of crucial epidemiological data and clinical symptoms and microbiological results and patient recovery patterns. The demographic distribution observed aligns with previous literature emphasizing a higher susceptibility among younger children. Our group showed its highest rate of occurrence during the 13-to-24-month age range which appeared right after the 1-to-12-month age group. The results of this study which demonstrate that younger children are more prone to developing infections because their immune systems remain undeveloped show that infants and toddlers experience higher rates of contact with dangerous pathogens during their early development. The majority of male participants in our research study who made up 62.5% of the total number of subjects demonstrate that males show higher rates of the condition because they face both biological risks and different patterns of seeking medical treatment according to their cultural background (Agrawal 2011)" [9].

Fever stood out as the primary clinical symptom that showed consistent presence among the majority of patients, which matched worldwide statistics that show fever affects more than 90 percent of all pediatric cases (Thompson et al., 2006) [10]. Our group showed lower rates of typical meningeal signs because neck stiffness appeared in 62.4% of children and altered consciousness occurred in 46.7% of children. The study results demonstrated this finding because Thompson et al. (2006) found that 85% of older pediatric cases showed neck rigidity. The group studied showed lower occurrence rates because younger infants had neurological signs which typically occur in older children but were not visible in this age group. The 18% of infants in our study who showed bulging fontanelle demonstrated the need to perform detailed neurological evaluations for younger patients, which supported Kim's (2010) [11] findings that 20–25% of infants with bacterial meningitis presented overt neurological signs.

The analysis of cerebrospinal fluid (CSF) showed that total cell counts had risen while neutrophils formed the majority and protein levels had risen and glucose levels had fallen, which demonstrated the presence of bacterial infection. The Gram stains together with culture results proved bacterial infection in 71.3% of cases, which represented an increase from the 58% culture positivity rate that Martinez et al. (2015) [12] reported. Our study produced higher yield because laboratories now use better techniques together with molecular diagnostic tools for testing culture-negative patients. The most common pathogen found in our study was Streptococcus pneumoniae which appeared in 42.9% of cases, which matched the post-vaccination patterns that Hsu et al. (2009) [13] observed in 40–45% of pediatric cases. The patterns of antimicrobial resistance showed important findings because 22.9% of S. pneumoniae isolates showed penicillin resistance, which fell below the 28–35% range that regional surveillance studies (Doern et al., 2001) [14] reported. The emergence of ceftriaxone resistance at 8.3% demonstrates the necessity for ongoing surveillance together with possible changes to standard treatment methods.

The treatment results from our research showed positive results because 75% of the patients achieved full recovery by the time, they left the hospital. The study found that 18.8% of participants developed neurological sequelae while 6.3% died from their medical condition. The study results match findings from other regional studies which show that Bekele et al. (2021) [15] found a 15.3% mortality rate and 25% of survivors developed sequelae. Hearing impairment was the most common long-term complication, observed in 17.2% of patients, aligning with systematic reviews that identify hearing loss as the predominant sequela of pediatric meningitis (Anderson et al., 2004) [16]. The analysis of risk factors found that both young children under 1 year old and people who presented their symptoms late showed high chances of experiencing negative health results, which Johnson et al. (2007) [17] confirmed when they found odds ratios of 2.8 and 2.4 for these two factors. The research results demonstrate that early identification and prompt treatment play a crucial role in decreasing both morbidity and mortality rates.

The international literature shows both matching elements and different elements when it comes to cultural assessment. The study found that high-income countries experience lower mortality rates which range between 5 percent but low- and middle-income countries report death rates between 10 percent and 20 percent which match our study results (Van et al., 2004) [18]. The existing medical facilities and vaccination programs and the speed of medical treatment determine the current situation. The patterns of antibiotic resistance which our research discovered also demonstrate the worldwide problem of multidrug-resistant pneumococcal infections which need continuous monitoring to protect public health (Chang, 2009) [19].

The study confirms known epidemiological and clinical patterns of pediatric meningitis while presenting new data about microbiological patterns and clinical outcomes. The highest danger from meningitis affects young children especially boys who show fever and neurological distress. The three necessary steps to enhance survival rates and reduce permanent health issues include immediate diagnosis together with effective antimicrobial treatment and constant patient observation. The discovered patterns of drug resistance together with the resulting brain damage show that medical facilities need

ongoing local monitoring and immediate initial treatment and thorough patient tracking systems. The research results establish evidence-based methods which help treat pediatric meningitis cases in areas with limited medical resources.

Conclusion

The present retrospective analysis of 80 pediatric meningitis cases at Sri Krishna Medical College and Hospital highlights important clinical, laboratory, and outcome trends. The highest incidence was observed in children aged 13–24 months, with a male predominance (62.5%), reflecting increased vulnerability in younger males. Fever was the most consistent symptom, while neurological signs such as seizures, neck stiffness, and bulging fontanelle were variably present, particularly in infants. CSF analysis confirmed bacterial etiology in a majority, with Streptococcus pneumoniae as the predominant pathogen, and revealed notable antimicrobial resistance patterns. Treatment outcomes were generally favorable, with 75% achieving full recovery, though 18.8% developed neurological sequelae and 6.3% mortality occurred. These findings emphasize the importance of early recognition, prompt antimicrobial therapy, and careful follow-up to reduce morbidity and mortality in pediatric meningitis.

References

1. Zainel A, Mitchell H, Sadarangani M. Bacterial meningitis in children: neurological complications, associated risk factors, and prevention. Microorganisms. 2021 Mar 5;9(3):535.
2. Chiang SS, Khan FA, Milstein MB, Tolman AW, Benedetti A, Starke JR, Becerra MC. Treatment outcomes of childhood tuberculous meningitis: a systematic review and meta-analysis. The Lancet Infectious Diseases. 2014 Oct 1;14(10):947-57.
3. Lamond NM, Freitag NE. Vertical transmission of Listeria monocytogenes: probing the balance between protection from pathogens and fetal tolerance. Pathogens. 2018 May 25;7(2):52.
4. Syrogiannopoulos GA, Michoula AN, Grivea IN. Global epidemiology of vaccine-preventable bacterial meningitis. The Pediatric Infectious Disease Journal. 2022 Dec 1;41(12):e525-9.
5. Seddon JA, Tugume L, Solomons R, Prasad K, Bahr NC, Tuberculous Meningitis International Research Consortium. The current global situation for tuberculous meningitis: epidemiology, diagnostics, treatment and outcomes. Wellcome open research. 2019 Nov 5;4:167.
6. Curtis S, Stobart K, Vandermeer B, Simel DL, Klassen T. Clinical features suggestive of meningitis in children: a systematic review of prospective data. Pediatrics. 2010 Nov 1;126(5):952-60.
7. Tumani H, Petereit HF, Gerritzen A, Gross CC, Huss A, Isenmann S, Jesse S, Khalil M, Lewczuk P, Lewerenz J, Leypoldt F. S1 guidelines "lumbar puncture and cerebrospinal fluid analysis"(abridged and translated version). Neurological Research and Practice. 2020 Mar 16;2(1):8.
8. Fitzwater SP, Ramachandran P, Nedunchelian K, Kahn G, Santosham M, Chandran A. Bacterial meningitis in children< 2 years of age in a tertiary care hospital in South India: an assessment of clinical and laboratory features. The Journal of pediatrics. 2013 Jul 1;163(1):S32-7.
9. Agrawal S, Nadel S. Acute bacterial meningitis in infants and children: epidemiology and management. Pediatric Drugs. 2011 Dec;13(6):385-400.
10. Thompson MJ, Ninis N, Perera R, Mayon-White R, Phillips C, Bailey L, Harnden A, Mant D, Levin M. Clinical recognition of meningococcal disease in children and adolescents. The lancet. 2006 Feb 4;367(9508):397-403.
11. Kim KS. Acute bacterial meningitis in infants and children. The Lancet infectious diseases. 2010 Jan 1;10(1):32-42.
12. Martinez E, Mintegi S, Vilar B, Martinez MJ, Lopez A, Catediano E, Gomez B. Prevalence and predictors of bacterial meningitis in young infants with fever without a source. The Pediatric infectious disease journal. 2015 May 1;34(5):494-8.
13. Hsu HE, Shutt KA, Moore MR, Beall BW, Bennett NM, Craig AS, Farley MM, Jorgensen JH, Lexau CA, Petit S, Reingold A. Effect of pneumococcal conjugate vaccine on pneumococcal meningitis. New England Journal of Medicine. 2009 Jan 15;360(3):244-56.
14. Doern GV, Heilmann KP, Huynh HK, Rhomberg PR, Coffman SL, Brueggemann AB. Antimicrobial resistance among clinical isolates of Streptococcus pneumoniae in the United States during 1999–2000, including a comparison of resistance rates since 1994–1995. Antimicrobial Agents and Chemotherapy. 2001 Jun 1;45(6):1721-9.
15. Bekele F, Ahmed A, Kedir A, Sheleme T. Treatment outcome and associated factors of bacterial meningitis at pediatric wards of southwestern Ethiopian hospital: a prospective observational study. Journal of pharmaceutical health care and sciences. 2021 Nov 15;7(1):41.
16. Anderson V, Anderson P, Grimwood K, Nolan T. Cognitive and executive function 12 years after childhood bacterial meningitis: effect of acute neurologic complications and age of onset. Journal of pediatric psychology. 2004 Mar 1;29(2):67-81.
17. Johnson AW, Adedoyin OT, Abdul-Karim AA, Olanrewaju AW. Childhood pyogenic meningitis: clinical and investigative indicators of etiol-

ogy and outcome. Journal of the national medical association. 2007 Aug;99(8):937.
18. Van de Beek D, De Gans J, Spanjaard L, Weisfelt M, Reitsma JB, Vermeulen M. Clinical features and prognostic factors in adults with bacterial meningitis. New England Journal of Medicine. 2004 Oct 28;351(18):1849-59.
19. Chang WN, Lu CH. Diagnosis and management of adult bacterial meningitis. Acta Neurol Taiwan. 2009 Mar 1;18(1):3-13.