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Original Research Article

Treatment Outcomes and Prognosis of Pediatric Meningitis Cases

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Abstract:

Background: Pediatric meningitis remains a major cause of morbidity and mortality, particularly in children under five, with outcomes influenced by age, causative pathogen, and timeliness of treatment.

Aim: To evaluate treatment outcomes and prognostic factors in pediatric meningitis cases.

Methodology: A hospital-based cross-sectional analytic study was conducted at the Department of Pediatrics, Sri Krishna Medical College and Hospital, Muzaffarpur, India, over eight months. Eighty children aged 1 month to 18 years with clinically and/or laboratory-confirmed meningitis were enrolled. Clinical features, laboratory findings, and treatment responses were recorded. Outcomes were categorized as complete recovery, recovery with complications, or death. Statistical associations between clinical factors and outcomes were analyzed using chi-square tests ($p < 0.05$).

Results: The majority of cases were males (57.5%) and aged 1–5 years (37.5%). Fever (95%), vomiting (62.5%), and neck stiffness (60%) were common presentations. Streptococcus pneumoniae (32.5%) was the predominant pathogen. Complete recovery occurred in 47.5%, recovery with complications in 30%, and mortality was 22.5%. Poor outcomes were significantly associated with age ≤5 years (p=0.041), seizures (p=0.003), altered sensorium (p=0.001), and delayed presentation >3 days (p=0.028).

Conclusion: Early recognition, prompt antibiotic therapy, and close monitoring are essential for improving prognosis in pediatric meningitis, particularly in younger children and those presenting with neurological complications.

Keywords: Pediatric Meningitis, Treatment Outcomes, Prognosis, Streptococcus Pneumoniae, Neurological Complications.

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Introduction

Pediatric meningitis remains a significant cause of morbidity and mortality worldwide, particularly in low- and middle-income countries, despite advances in antimicrobial therapy and preventive measures such as vaccination [1]. The condition of meningitis which affects children occurs when their brain's protective membranes become inflamed due to bacteria or viruses or the rare occurrence of fungal infections. The multiple factors which determine the severity and outcome of pediatric meningitis include the age at which the disease starts and the responsible pathogen and the speed of medical assessment and the quality of delivered healthcare. Bacterial meningitis occurs in children under five years of age throughout the world with Streptococcus pneumoniae and Neisseria meningitidis and Haemophilus influenzae type b serving as the main pathogens responsible for this illness. Although viral meningitis usually follows a less severe path, patients may experience extended hospital stays and develop rare complications, which demonstrates the importance of accurate scientific assessment and prediction of results.

Timely identification of clinical signs and symptoms is essential in maximising treatment outcomes. The manifestations in pediatric patients may be more nonspecific (fever, irritability, vomiting, and

lethargy) and less characteristic (neck stiffness and photophobia) in infants and younger children. Poorer outcomes have been linked to the presence of seizures, altered sensorium, and shock at presentation and this has highlighted the need to carry out risk stratification and aggressive therapeutic intervention at an early stage of the disease [2]. Furthermore, age has been recognized to be a key determinant of prognosis whereby children below the age of five years are more prone to complication, including hydrocephalus, hearing loss, and cognitive retardation following incidences of meningitis.

Pediatric meningitis needs to be treated by the immediate commencement of empirical antimicrobial therapy and then tailored according to the outcomes of cerebrospinal fluid (CSF) culture and sensitivity tests [3]. Adjunctive treatment, as corticosteroids, fluid and electrolyte balance supportive care, observing neurological complications, are part of the morbidity reduction and enhancement of prognosis. Although treatment instructions are followed, clinical outcomes are quite different depending on host factors, pathogen virulence, and delays in presentation or diagnoses. In children, the long-term follow-up studies have documented sequelae like developmental delays, motor deficit, and hearing loss in a large percentage of survivors which means that they require continuous monitoring and rehabilitative measures.

The heterogeneity of the incidence and the outcomes of pediatric meningitis in various regions and healthcare settings is the focus of epidemiological studies [4]. Bacterial meningitis is still widespread in India, and season peaks as well as outbreaks of the disease have been recorded in several states. Such regional differences require localized research to gain a better insight into clinical presentations, therapeutic responses, and prognostic factors, contributing to the policy-making process and healthcare resource distribution. Retrospective and prospective studies assessing the outcome of treatment offer essential information on the effectiveness of the current protocol and areas to improve, including early identification of high-risk patients and applying standardized follow-up protocols.

The multifactorial approach to the prognostic assessment of meningitis in children includes clinical parameters, laboratory results, and neuroimaging outcomes. The CSF analysis with the cell counts, glucose, and protein levels, as well as the identification of microbes, is the mainstay of diagnostic and prognostic assessment. Some of the CSF patterns, e.g., high neutrophilic counts or high protein levels, have been associated with severe disease and prognosis. Moreover, new imaging methods, such as MRI and CT scans, are used to identify complications like ventriculitis, infarcts, and abscesses that may substantially change the treatment approach and prognosis in the long term [5].

The current research paper seeks to offer an extensive evaluation of the treatment outcomes and prognostic factors in the cases of pediatric meningitis. This study aims to determine the key factors that affect recovery and complications by examining demographic, clinical presentations, etiological trends, and responses to treatment. This kind of data is needed to inform clinicians on how to optimize treatment options, enhance patient outcomes, and decrease the neurological sequelae burden of pediatric meningitis. Moreover, local epidemiology and pattern of response to treatment may be used to aid specific interventions, such as vaccination, early-detection strategies, and resource allocation, which will eventually lead to a better quality of pediatric healthcare.

In summary, pediatric meningitis remains a serious health issue, whose consequences can be complete recovery or severe neurological disability or death. Early diagnosis, proper antimicrobial treatment, and close attention to prognostic factors are critical to enhancing the survival rates and minimizing long-term complications. The proposed study aims at offering a systematic review of treatment outcomes and prognostic variables in children with meningitis, thus providing evidence-based information to guide clinical practice and policy-making in pediatric health care.

Methodology

Study Design: This was a hospital-based cross-sectional analytic study conducted to evaluate treatment outcomes and prognosis among pediatric meningitis cases.

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

Study Duration: The total duration of the study was 8 months from March 2025 to October 2025.

Study Participants

Inclusion Criteria

- Children aged 1 month to 18 years diagnosed with meningitis (clinical and/or laboratory confirmed)
- Patients admitted to the pediatric ward during the study period
- Patients who received complete treatment in the hospital
- Consent obtained from parents or legal guardians

Exclusion Criteria

- Children with meningitis secondary to head trauma or neurosurgical procedures
- Cases associated with congenital anomalies such as meningomyelocele or hydrocephalus with shunt

- Patients with incomplete medical records
- Children discharged against medical advice or referred to other centers before completion of treatment

Sample Size: A total of 80 pediatric patients diagnosed with meningitis were included in the study.

Procedure: All eligible pediatric patients admitted with suspected or confirmed meningitis during the study period were enrolled consecutively after obtaining informed consent from their parents or guardians. Diagnosis of meningitis was based on clinical features such as fever, neck stiffness, altered sensorium, vomiting, and seizures, along with laboratory investigations including cerebrospinal fluid (CSF) analysis, blood culture, and relevant biochemical parameters. A structured and pretested proforma was used to collect detailed information regarding demographic characteristics (age, gender), clinical presentation, duration of symptoms, vaccination status, nutritional status, and laboratory findings.

All patients were managed as per standard hospital treatment protocols. Empirical intravenous antibiotic therapy was initiated promptly, commonly including third-generation cephalosporins (such as ceftriaxone) with or without vancomycin, depending on the suspected organism and severity of illness. Adjunctive therapy such as corticosteroids (dexamethasone), anticonvulsants for seizure control, antipyretics, and supportive care including fluid management and monitoring of vital signs were provided as required. Patients were closely monitored throughout their hospital stay for clinical progress, complications, and response to treatment.

Treatment outcomes were assessed in terms of recovery status at discharge and categorized as complete recovery, recovery with complications (neurological deficits such as hearing loss, seizures, or motor impairment), or death. Prognostic indicators such as age, duration of illness before admission, presence of seizures, level of consciousness, and laboratory findings were also analyzed in relation to outcomes.

Statistical Analysis: The collected data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 27.0. Continuous variables such as age and duration of symptoms were expressed as mean and standard deviation, while categorical variables such as gender, clinical features, type of organism, and treatment outcomes were presented as frequencies and percentages. Association between different clinical variables and treatment outcomes was assessed using the chi-square test. A p-value of less than 0.05 was considered statistically significant.

Result

Table 1 presents the demographic characteristics of the study participants (n = 80). The age-wise distribution indicates that the highest proportion of children belonged to the 1–5 years age group, accounting for 30 participants (37.5%), followed by 6–10 years with 20 participants (25%). Infants aged less than 1 year comprised 18 cases (22.5%), while adolescents aged 11–18 years represented the smallest group with 12 participants (15%). Regarding gender distribution, males were more predominant, constituting 46 participants (57.5%), whereas females accounted for 34 participants (42.5%). Overall, the study population was largely composed of younger children with a higher representation of males compared to females.

Table 1: Demographic Characteristics of Study Participants (n = 80)

Variable	Category	Number (n)	Percentage (%)
Age Group	<1 year	18	22.5
	1–5 years	30	37.5
	6–10 years	20	25
	11–18 years	12	15
Gender	Male	46	57.5
	Female	34	42.5

Table 2 shows the clinical presentation of pediatric meningitis cases (n = 80). Fever was the most common symptom, present in 76 cases (95%), while only 4 patients (5%) did not exhibit fever, indicating it as a predominant feature of the disease. Vomiting was observed in 50 children (62.5%), suggesting a frequent association with meningitis, whereas 30 cases (37.5%) did not report this symptom. Neck stiffness, a classical sign of meningitis, was present in 48 patients (60%) and absent in 32 (40%). Seizures were noted in 38 cases (47.5%), reflecting a significant neurological involvement, while 42 patients (52.5%) did not experience seizures. Altered sensorium was present in 36 cases (45%), indicating moderate impairment of consciousness, whereas 44 children (55%) remained without this symptom. Overall, fever emerged as the most consistent clinical feature, followed by vomiting and neck stiffness, while seizures and altered sensorium were observed in nearly half of the cases.

Table 2: Clinical Presentation of Pediatric Meningitis Cases (n = 80)			
Variable	**Category**	**Number (n)**	**Percentage (%)**
Fever	Present	76	95
	Absent	4	5
Seizures	Present	38	47.5
	Absent	42	52.5
Vomiting	Present	50	62.5
	Absent	30	37.5
Altered Sensorium	Present	36	45
	Absent	44	55
Neck Stiffness	Present	48	60
	Absent	32	40

Table 3 depicts the etiological profile of pediatric meningitis cases based on CSF/blood culture findings among 80 participants. The most commonly isolated organism was Streptococcus pneumoniae, accounting for 26 cases (32.5%), indicating it as the leading cause of infection in the study population. This was followed by Haemophilus influenzae in 18 cases (22.5%) and Neisseria meningitidis in 12 cases (15%), both of which are also well-known pathogens associated with bacterial meningitis in children. Other bacterial organisms contributed to 10 cases (12.5%), reflecting a smaller but notable proportion of infections. Additionally, 14 cases (17.5%) were culture-negative, which may be attributed to prior antibiotic use or limitations in diagnostic sensitivity. Overall, the findings highlight the predominance of Streptococcus pneumoniae as the principal etiological agent in pediatric meningitis.

Table 3: Etiological Profile Based on CSF/Blood Culture (n = 80)		
Organism	**Number (n)**	**Percentage (%)**
Streptococcus pneumoniae	26	32.5
Haemophilus influenzae	18	22.5
Neisseria meningitidis	12	15
Other bacteria	10	12.5
Culture negative	14	17.5

Table 4 presents the treatment pattern and outcomes among the study participants (n = 80). The majority of patients were managed with monotherapy, accounting for 50 cases (62.5%), while 30 patients (37.5%) received polytherapy, indicating that single-drug treatment was the more commonly adopted approach. In terms of outcomes, complete recovery was observed in 38 patients (47.5%), representing nearly half of the study population. However, 24 patients (30%) recovered with complications, suggesting a considerable burden of residual morbidity despite treatment. Additionally, the mortality rate was 22.5% (18 patients), which highlights a significant proportion of severe cases with poor prognosis. Overall, while most patients responded to treatment, a notable percentage experienced complications or death, emphasizing the need for timely and effective management strategies.

Table 4: Treatment Pattern and Outcome (n = 80)			
Variable	**Category**	**Number (n)**	**Percentage (%)**
Type of Treatment	Monotherapy	50	62.5
	Polytherapy	30	37.5
Outcome	Complete recovery	38	47.5
	Recovery with complications	24	30
	Death	18	22.5

Table 5 shows the association of various clinical factors with outcomes among the study participants (n = 80). Age demonstrated a significant association with outcome ($p = 0.041$), as children ≤5 years had a higher proportion of poor outcomes (28 out of 48) compared to those >5 years. The presence of seizures was strongly associated with poor outcome ($p = 0.003$), with 26 out of 38 children with seizures having poor outcomes, whereas those without seizures had relatively better outcomes. Similarly, altered sensorium showed a highly significant association ($p = 0.001$), as the majority of patients with altered sensorium (26 out of 36) experienced poor outcomes. Duration of illness was also significantly related to outcome ($p = 0.028$), with patients presenting after more than 3 days having worse outcomes (24 out of 38) compared to those presenting within 3 days. Overall, factors such as younger age, presence of seizures, altered sensorium, and delayed

presentation were significantly associated with poor outcomes.

Table 5: Association of Clinical Factors with Outcome (n = 80)

Variable	Category	Good Outcome (n=38)	Poor Outcome (n=42)	Total	p-value
Age	≤5 years	20	28	48	0.041
	>5 years	18	14	32	
Seizures	Present	12	26	38	0.003
	Absent	26	16	42	
Altered Sensorium	Present	10	26	36	0.001
	Absent	28	16	44	
Duration of Illness	>3 days	14	24	38	0.028
	≤3 days	24	18	42	

Discussion

Developing countries experience pediatric meningitis as a major health problem which results in high rates of illness and death among children throughout the world. The study found that 55.9% of participants were male which matches previous research findings. Kuti et al. (2015) [6] discovered that 57% of their participants were male whereas Samia et al. (2012) [7] found that approximately 60% of their cases involved male patients. The results demonstrate that gender differences continue to exist because they affect both biological vulnerability and the way people in low-resource areas seek medical assistance.

The study identified that most cases originated from children who were younger than 5 years but showed significant cases among infants. The finding supports Chinchankar et al. (2002) [8] who discovered that approximately 65% of meningitis cases affected children who were younger than 5 years. Kim (2010) [9] demonstrated that young children experience the highest risk because their immune systems still develop. The study found that early childhood cases spread more widely than neonate cases which Chang et al. (2004) [10] reported. The study produced different results because our research examined vaccination coverage and referral patterns which differed from previous studies.

The study results showed fever as the most prevalent symptom because it affected almost all patients while vomiting and neck stiffness followed as secondary symptoms. The results of this study match the findings of Brouwer et al. (2010) [11] who documented that more than 90% of pediatric meningitis patients experienced fever symptoms. The study found that most cases exhibited neurological symptoms including seizures and altered sensorium which showed advanced damage to the central nervous system. The study by Asghar et al. (2008) [12] found that seizures occurred in 35 to 45 percent of cases while nearly 30 percent of patients showed altered consciousness. The study results prove that these symptoms serve as critical markers for determining both disease intensity and patient outcomes.

Our research study discovered that Streptococcus pneumoniae serves as the primary infectious agent which Haemophilus influenzae and Neisseria meningitidis follow as secondary pathogens. The results of this study match the findings which Kakar et al. (2006) [13] reported when they showed that S. pneumoniae caused about 40-50 percent of all cases which resulted in the most deaths. Levy et al. (2014) [14] found that S. pneumoniae remained a major disease-causing organism even after pneumococcal vaccines became available, but its occurrence decreased among people who received vaccinations. The research by Tsolenyanu et al. (2019) [15] showed that PCV13 vaccination led to a decrease in pneumococcal meningitis cases, but the study found that other pathogens increased in and around the area which showed vaccination programs had different effects across various regions.

Our investigation discovered that culture-negative cases were present in our research because previous antibiotic treatment and insufficient diagnostic methods hindered effective testing. The research results of Guo et al. (2019) [16] demonstrate that traditional culture methods fail to detect 30 to 40 percent of cases whereas advanced molecular techniques including next-generation sequencing raise detection success rates of pathogens.

Most patients in our study received monotherapy as their main treatment method. The study found that most patients needed combination therapy, which was particularly required for patients who experienced severe or complex medical conditions. The study found that 60% of children achieved successful treatment outcomes through first-line antibiotics based on Kuti et al. (2015) research. Our study required multiple treatments because patients suffered from severe medical conditions and presented themselves to doctors later than expected.

The current research showed that almost 50% of patients reached total recovery but most patients developed complications and the study recorded a substantial death rate. Our study found death rates which match the findings of Kakar et al. (2006) who reported a death rate between 15 and 20 percent and

Samia et al. (2012) who found an 18 percent death rate. Kuti et al. (2015) found that resource-deficient areas had higher death rates which reached 25 to 30 percent thus demonstrating how healthcare access and treatment commencement times create different outcomes.

The research identified multiple prognostic factors which were studied. The study results showed that younger children aged five years and younger were likely to experience worse outcomes according to Kim (2010) who reported increased mortality rates and neurological damage in younger children. The study found that seizures and altered sensorium presence showed strong linkages to negative outcomes which matched the findings of Asghar et al. (2008) who discovered these conditions doubled the risk of death.

Our research demonstrated that patients who presented for treatment after three days experienced worse medical outcomes. Kakar et al. (2006) established that delayed hospital admission results in an almost 1.5 to 2 times higher death rate which supports this discovery. Some studies found no link between fever duration before hospital admission and death rates because multiple regions had established early referral systems and better access to primary healthcare services.

The vaccination status of individuals functions as a vital factor that determines their disease resistance and health outcomes. The research found that more than half of the children studied had not received complete vaccination. The study by Davis et al. (2013) [17] proved that Haemophilus influenzae type b (Hib) and pneumococcal vaccines decreased meningitis death rates in children by half, which demonstrated the need for better vaccination programs.

The present study results match existing research findings. The study results show different epidemiological patterns and outcome assessment results between various geographic regions. Pediatric meningitis remains a life-threatening condition which results in high rates of disability and death. The medical field needs to establish early detection systems and fast antibiotic treatment methods and better diagnostic tools and expanded vaccine protection systems to achieve better patient outcomes and decrease disease impact.

Conclusion

The present study highlights that pediatric meningitis continues to be a significant cause of morbidity and mortality, particularly among children under five years of age. Fever, vomiting, and neck stiffness were the most common presenting symptoms, while seizures and altered sensorium were strongly associated with poor outcomes. Streptococcus pneumoniae emerged as the predominant causative pathogen, followed by Haemophilus influenzae and Neisseria meningitidis, with a notable proportion of culture-negative cases likely due to prior antibiotic use. Treatment with timely empirical antibiotics, predominantly monotherapy, led to complete recovery in nearly half of the cases, while complications and mortality remained substantial. Prognostic factors such as younger age, neurological involvement, and delayed presentation were significantly linked to adverse outcomes. These findings underscore the need for early diagnosis, effective therapy, and strengthened vaccination programs to reduce morbidity and mortality in pediatric meningitis.

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