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Original Article

Pattern, Complications and Short-Term Outcomes of Acute Meningitis

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ABSTRACT

Background: Acute meningitis remains associated with substantial neurological complications and mortality, while contemporary adult data from tertiary-care settings in Peshawar are limited. Objective: To determine the etiological pattern and major complications of acute meningitis and evaluate short-term in-hospital outcomes and their associations with mortality. Methods: This hospital-based descriptive observational study included 182 consecutive adults aged 20–60 years with acute meningitis diagnosed through cerebrospinal fluid assessment at Khyber Teaching Hospital, Peshawar, from 24 November 2024 to 24 May 2025. Demographic characteristics, meningitis category, altered consciousness, seizures, shock/hypotension, ICU admission, and in-hospital mortality were assessed. Categorical data were summarized as n (%), and crude odds ratios (ORs), 95% confidence intervals (CIs), and exact tests were used for mortality associations. Results: Mean age was 35.4 ± 5.8 years and 68.1% were male. Bacterial, viral, and tuberculous meningitis accounted for 65.9%, 27.5%, and 6.6% of cases, respectively. Altered consciousness occurred in 59.3%, seizures in 50.5%, and shock/hypotension in 13.2%. Overall mortality was 13.2%; case-fatality was 33.3% for tuberculous, 15.8% for bacterial, and 2.0% for viral meningitis. Shock/hypotension had the strongest crude association with mortality (OR 361.67, 95% CI 68.50–1909.62; p<0.001), while altered consciousness, seizures, and ICU admission were also associated with mortality. Conclusion: Bacterial meningitis predominated, while substantial in-hospital mortality was observed. Etiology and markers of systemic and neurological severity were closely associated with short-term outcome. Keywords: Acute meningitis, bacterial meningitis, tuberculous meningitis, complications, mortality, Pakistan.

INTRODUCTION

Acute meningitis is a neurological emergency characterized by inflammation of the meninges and may progress rapidly to severe neurological dysfunction, systemic complications, permanent disability, or death. Bacterial meningitis remains particularly important because substantial mortality continues to occur despite advances in antimicrobial therapy, vaccination, diagnostic techniques, and critical care. Hospital-based studies from both resource-limited and developed settings have demonstrated that outcome is strongly influenced by disease severity, neurological impairment, systemic compromise, and the underlying causative organism (1–4).

The etiological spectrum of meningitis varies according to age, geographic setting, immune status, underlying comorbidities, and local epidemiology. Among adults with bacterial meningitis, both the distribution of causative organisms and clinical outcomes have changed over time and differ across healthcare settings (5,6). In regions with a high burden of tuberculosis and human immunodeficiency virus infection, the differential diagnosis is broader,

and tuberculous and other opportunistic forms of meningitis contribute importantly to morbidity and mortality (7). Differentiating bacterial, viral, and tuberculous meningitis during the early phase of illness may nevertheless be challenging because these conditions can present with overlapping neurological and systemic manifestations. Cerebrospinal fluid assessment therefore has an important role in etiological classification, although complete organism-level confirmation may not always be achievable in routine clinical practice, particularly in resource-constrained settings (1,7).

The clinical course of acute meningitis is further complicated by neurological and systemic manifestations that may indicate severe disease. Altered level of consciousness, seizures, hemodynamic instability, and the need for intensive care have been repeatedly associated with adverse outcomes in severe meningitis (3,9,10). In adults with bacterial meningitis, impaired consciousness and systemic compromise are particularly important markers of severity, while critically ill patients admitted to intensive care have a substantial risk of mortality (3,9,10). Tuberculous meningitis presents an additional challenge because complications such as cerebral infarction, hydrocephalus, electrolyte disturbances, and other neurological abnormalities may contribute to poor outcomes, particularly when diagnosis or treatment is delayed (8). Consequently, assessment of both the underlying meningitis category and major clinical complications is important when describing short-term prognosis.

Mortality also differs according to the underlying form and severity of meningitis. Contemporary adult studies have continued to document clinically important mortality from bacterial meningitis, including severe pneumococcal disease, despite improvements in hospital and critical-care management (2–5,9,10). Tuberculous meningitis remains associated with substantial morbidity and mortality because of its complex clinical course and frequent neurological complications (8). These observations indicate that evaluating mortality without considering etiology and clinical severity may obscure important differences between patient groups. Identification of the local distribution of meningitis categories together with common complications and in-hospital outcomes is therefore relevant for clinical triage, early recognition of severe disease, and allocation of critical-care resources.

Evidence from Pakistan cited in the existing literature includes hospital experience describing meningitis among critically ill pediatric patients, in whom seizures, shock, altered consciousness, and mortality were important clinical concerns (11). However, pediatric intensive-care findings cannot be directly extrapolated to adults because the etiological distribution, underlying risk factors, clinical presentation, and prognosis differ according to age and patient population. Contemporary evidence describing the combined pattern of bacterial, viral, and tuberculous meningitis among adults presenting to tertiary-care hospitals in Peshawar remains limited. In particular, locally relevant information is needed on the relative frequency of these meningitis categories, the burden of major neurological and systemic complications, and their relationship with short-term in-hospital outcomes.

Accordingly, the present study was conducted among adults aged 20–60 years with acute meningitis presenting to Khyber Teaching Hospital, Peshawar, Pakistan. The objective was to characterize the etiological pattern of acute meningitis, determine the frequency of major complications including altered consciousness, seizures, and shock/hypotension, and evaluate short-term in-hospital outcomes. The study also aimed to describe differences in in-hospital mortality across bacterial, viral, and tuberculous meningitis and to examine the relationship of major clinical complications with mortality in this tertiary-care population.

MATERIALS AND METHODS

This hospital-based descriptive observational study was conducted in the Department of Medicine, Khyber Teaching Hospital, Peshawar, Pakistan, from 24 November 2024 to 24 May 2025. The study was designed to characterize the etiological pattern and major clinical complications of acute meningitis and to evaluate short-term in-hospital outcomes among adult patients treated at a tertiary-care hospital. The target population comprised male and female patients aged 20–60 years with a diagnosis of acute meningitis confirmed through cerebrospinal fluid (CSF) analysis.

Patients aged 20–60 years of either sex were eligible when acute meningitis had been established on the basis of the clinical evaluation and CSF findings used for diagnosis during hospital care. Patients with alternative major neurological conditions that could substantially affect clinical presentation or outcome, including cerebral malaria, intracranial tumor, traumatic brain injury, or intracranial hemorrhage, were excluded. Patients with a history of previous spinal injection and those who had received antibiotic therapy during the preceding 15 days were also

excluded. Eligible patients were recruited consecutively as they presented during the study period. Informed consent was obtained from the patients or, where appropriate, from their family members before enrollment.

The required sample size was calculated for estimation of in-hospital mortality using an expected mortality proportion of 7.8%, a 95% confidence level, and an absolute precision of 3.9%. The expected mortality estimate was derived from previously reported hospital-based meningitis data from Pakistan (11). Using these assumptions, the required sample size was 182 participants, all of whom were enrolled during the defined study period.

Data was collected for each participant using a standardized study form. Recorded variables included age, sex, presenting clinical condition, meningitis category, major neurological and systemic complications, requirement for intensive care, and in-hospital outcome. Etiological classification was based on CSF analysis and was recorded as bacterial, viral, or tuberculous meningitis according to the clinical and CSF assessment used for patient diagnosis. Major clinical variables evaluated during hospitalization included altered consciousness, seizures, and shock/hypotension. Altered consciousness was defined as a Glasgow Coma Scale score of less than 14. Admission to the intensive care unit was also recorded as an indicator of the level of supportive care required during hospitalization.

Participants were followed throughout their hospital admission for the occurrence or presence of the prespecified clinical complications and for short-term outcome. The principal outcome was in-hospital mortality, categorized as survival to discharge or death during the index admission. Outcomes were additionally examined according to meningitis category to describe differences in case-fatality between bacterial, viral, and tuberculous meningitis. Major complications, including altered consciousness, seizures, and shock/hypotension, were also examined in relation to survival status. Consecutive recruitment was used to minimize selective enrollment, while confirmation of meningitis by CSF analysis and use of a standardized data-collection form provided a consistent approach to case ascertainment and recording of study variables.

Data was entered and analyzed using IBM SPSS Statistics version 23.0. Categorical variables, including sex, meningitis category, complications, intensive-care admission, and in-hospital outcome, were summarized as frequencies and percentages. Age was summarized using the mean and standard deviation. Etiological patterns and complications were described for the overall cohort, and mortality was summarized overall and separately for bacterial, viral, and tuberculous meningitis. Exploratory analyses were used to examine relationships between selected clinical factors and in-hospital outcome, with statistical significance defined as a two-sided p-value of less than 0.05.

The study protocol was reviewed and approved by the ethical review board of Khyber Teaching Hospital before commencement of participant enrollment. Participation followed informed-consent procedures, and clinical and outcome information collected for the study was analyzed for the stated research objectives.

RESULTS

A total of 182 patients with acute meningitis were included in the analysis. The mean age was 35.4 ± 5.8 years, with an observed age range of 25–60 years. Males constituted 124 (68.1%) of the study population and females 58 (31.9%). Bacterial meningitis was the most frequently recorded etiological category, accounting for 120 (65.9%) cases, followed by viral meningitis in 50 (27.5%) and tuberculous meningitis in 12 (6.6%) patients (Table 1).

Table 1. Demographic Characteristics and Etiological Pattern of Acute Meningitis (N=182)

Characteristic	n	%	Mean ± SD	Range
Age, years			35.4 ± 5.8	25–60
Male	124	68.1		
Female	58	31.9		
Bacterial meningitis	120	65.9		
Viral meningitis	50	27.5		
Tuberculous meningitis	12	6.6		

SD, standard deviation.

Altered consciousness was recorded in 108 (59.3%) patients and seizures in 92 (50.5%). Shock/hypotension occurred in 24 (13.2%) patients, while 16 (8.8%) required admission to the intensive care unit. Overall, 24 patients

died during hospitalization, corresponding to an in-hospital mortality of 13.2%, whereas 158 (86.8%) survived to discharge (Table 2).

Table 2. Clinical Complications, Intensive-Care Admission, and In-Hospital Outcome (N=182)

Parameter	n	%
Altered consciousness	108	59.3
Seizures	92	50.5
Shock/hypotension	24	13.2
ICU admission	16	8.8
In-hospital death	24	13.2
Survived to discharge	158	86.8

ICU, intensive care unit.

Mortality differed across the three meningitis categories (Table 3). Tuberculous meningitis had the highest observed case-fatality proportion, with 4 deaths among 12 patients (33.3%; 95% CI 13.8–60.9%), followed by bacterial meningitis with 19 deaths among 120 patients (15.8%; 95% CI 10.4–23.4%). One of the 50 patients with viral meningitis died, corresponding to a case-fatality proportion of 2.0% (95% CI 0.4–10.5%). The overall association between meningitis category and in-hospital mortality was statistically significant on exact analysis (Fisher–Freeman–Halton exact p=0.0028).

Using viral meningitis as the reference category, bacterial meningitis was associated with approximately nine-fold greater crude odds of in-hospital death (OR 9.22, 95% CI 1.20–70.86; p=0.009), while tuberculous meningitis was associated with substantially greater crude odds of death (OR 24.50, 95% CI 2.42–248.12; p=0.004). The wide confidence intervals, particularly for tuberculous meningitis, reflected the small number of patients and deaths in these subgroups.

Table 3. In-Hospital Mortality According to Meningitis Type

Meningitis type	Total, n	Deaths, n (%)	Survived, n (%)	Case-fatality rate, % (95% CI)	Crude OR vs viral (95% CI)	p-value
Viral	50	1 (2.0)	49 (98.0)	2.0 (0.4–10.5)	1.00	
Bacterial	120	19 (15.8)	101 (84.2)	15.8 (10.4–23.4)	9.22 (1.20–70.86)	0.009
Tuberculous	12	4 (33.3)	8 (66.7)	33.3 (13.8–60.9)	24.50 (2.42–248.12)	0.004
Total	182	24 (13.2)	158 (86.8)	13.2 (9.0–18.9)		

CI, confidence interval; OR, odds ratio. Confidence intervals for proportions were calculated using the Wilson score method. Crude odds ratios compare the odds of in-hospital mortality with viral meningitis as the reference category. Pairwise p-values were calculated using Fisher's exact test. The overall association between meningitis type and mortality was assessed using the Fisher–Freeman–Halton exact test.

Clinical complications showed marked crude associations with in-hospital mortality (Table 4). Shock/hypotension was present in 21 of the 24 patients who died compared with 3 of the 158 survivors. Mortality occurred in 87.5% of patients with shock/hypotension compared with 1.9% of those without shock, corresponding to a crude OR of 361.67 (95% CI 68.50–1909.62; p<0.001). Although this represented the largest unadjusted association, the confidence interval was wide because relatively few patients had shock.

Table 4. Crude Associations of Major Clinical Factors With In-Hospital Mortality

Clinical factor	Category	Total, n	Deaths, n (%)	Survived, n (%)	Crude OR (95% CI)	p-value
Altered consciousness	Absent	74	2 (2.7)	72 (97.3)	1.00	
	Present	108	22 (20.4)	86 (79.6)	9.21 (2.09–40.50)	<0.001
Seizures	Absent	90	5 (5.6)	85 (94.4)	1.00	
	Present	92	19 (20.7)	73 (79.3)	4.42 (1.57–12.44)	0.004
Shock/hypotension	Absent	158	3 (1.9)	155 (98.1)	1.00	
	Present	24	21 (87.5)	3 (12.5)	361.67 (68.50–1909.62)	<0.001
ICU admission	No	166	16 (9.6)	150 (90.4)	1.00	
	Yes	16	8 (50.0)	8 (50.0)	9.38 (3.10–28.37)	<0.001

Altered consciousness was present in 22 of 24 deaths. Mortality was 20.4% among patients with altered consciousness compared with 2.7% among those without it, yielding a crude OR of 9.21 (95% CI 2.09–40.50; p<0.001). Seizures were also more frequent among patients who died: mortality was 20.7% among patients with seizures compared with 5.6% among those without seizures (OR 4.42, 95% CI 1.57–12.44; p=0.004).

Among the 16 patients admitted to the ICU, 8 died, corresponding to a mortality proportion of 50.0%. In comparison, 16 of 166 patients not admitted to the ICU died (9.6%). ICU admission was therefore associated with increased crude odds of in-hospital mortality (OR 9.38, 95% CI 3.10–28.37; p<0.001).

CI, confidence interval; ICU, intensive care unit; OR, odds ratio. Percentages are calculated within each category. Odds ratios are crude estimates for in-hospital mortality relative to the indicated reference category. P-values were calculated using two-sided Fisher's exact tests.

DISCUSSION

This study describes the etiological pattern, major clinical complications, and short-term outcomes of acute meningitis among adults treated at a tertiary-care hospital in Peshawar. Bacterial meningitis accounted for most cases, while neurological complications, particularly altered consciousness and seizures, were common. Overall, in-hospital mortality was 13.2%, with the highest observed case-fatality proportion among patients with tuberculous meningitis, followed by bacterial and viral meningitis. Shock/hypotension showed the largest crude association with mortality, while altered consciousness, seizures, and ICU admission were also associated with an increased likelihood of in-hospital death. Because these estimates were derived from unadjusted analyses, they should be interpreted as markers of association and disease severity rather than independent prognostic effects.

The predominance of bacterial meningitis in the present cohort is broadly consistent with hospital-based studies of adult meningitis in which bacterial disease constitutes an important cause of acute neurological infection and substantial clinical morbidity (1,4–6). Studies from different geographic settings have nevertheless demonstrated considerable variation in the distribution of bacterial pathogens and meningitis syndromes, reflecting differences in age structure, vaccination coverage, immune status, referral patterns, and local epidemiology (4–7). The present study classified 65.9% of cases as bacterial meningitis, whereas viral and tuberculous meningitis accounted for smaller proportions. These findings provide useful local descriptive information, although comparison with organism-specific studies should be made cautiously because pathogen-level microbiological results were not available in the present analysis.

The overall in-hospital mortality of 13.2% confirms that acute meningitis remained associated with substantial short-term mortality in this tertiary-care population. Adult studies of bacterial meningitis have continued to report clinically important mortality despite improvements in antimicrobial treatment and critical-care management (2–5). Van de Beek and colleagues reported considerable mortality and neurological morbidity among adults with bacterial meningitis, while subsequent European and Asian cohorts have similarly demonstrated that outcome varies according to causative organism, neurological status, systemic illness, and severity at presentation (3–6). An observational study of adults with meningitis from India reported a higher mortality burden than that observed in the present cohort, illustrating the considerable variation that can occur between resource-limited hospital populations (12). Direct numerical comparisons should, however, be interpreted cautiously because the present study included bacterial, viral, and tuberculous meningitis rather than restricting enrollment to a single etiological group.

Tuberculous meningitis had the highest observed case-fatality proportion in this study, with one-third of affected patients dying during hospitalization. Although this finding is clinically concerning, only 12 patients had tuberculous meningitis, resulting in substantial statistical uncertainty around the mortality estimate. Tuberculous meningitis is recognized as a particularly severe form of central nervous system tuberculosis because delayed recognition, cerebral infarction, hydrocephalus, electrolyte disturbances, and other neurological complications may contribute to adverse outcomes (8). The higher observed mortality among patients with tuberculous meningitis in the present study is therefore clinically plausible, but the small subgroup prevents firm conclusions regarding its mortality relative to bacterial meningitis.

Shock/hypotension demonstrated the most pronounced crude relationship with in-hospital mortality. Among patients with shock, mortality was 87.5%, compared with 1.9% among those without shock, producing a very large unadjusted odds ratio with a correspondingly wide confidence interval. Severe bacterial meningitis can produce systemic inflammatory responses, circulatory instability, impaired tissue perfusion, and multiorgan dysfunction, while hemodynamic compromise may further impair cerebral perfusion in patients already experiencing intracranial inflammation (3,9,10). Previous adult and intensive-care cohorts have similarly identified systemic

compromise and severe physiological disturbance as important features associated with poor outcome in bacterial meningitis (3,9,10). Nevertheless, the magnitude of the crude association observed here should not be interpreted as an independent effect because the analysis did not adjust for etiology, neurological severity, age, treatment, or other potentially related factors.

Altered consciousness and seizures were also associated with mortality. Altered consciousness was present in most fatal cases and was associated with substantially greater crude odds of death, while mortality was also higher among patients who experienced seizures. These findings are compatible with previous studies in which impaired consciousness and neurological complications have been associated with greater disease severity and poorer outcomes in adult bacterial meningitis (3,4,10). A reduced level of consciousness may reflect extensive meningeal inflammation, cerebral edema, vascular complications, raised intracranial pressure, or associated encephalitic involvement, while seizures may accompany cortical irritation or more extensive neurological disease. The present data do not distinguish among these mechanisms, and the associations should therefore be regarded primarily as clinically useful indicators of severe illness rather than evidence of direct causal pathways.

ICU admission was similarly associated with a substantially increased crude risk of in-hospital death, with half of the patients admitted to the ICU dying during hospitalization. This finding is consistent with evidence from critically ill meningitis populations, in whom mortality remains considerable because ICU admission generally reflects advanced neurological or systemic disease (9,10). ICU admission itself should not be interpreted as causing poorer outcomes; rather, it is likely to function as a marker of underlying severity and the need for advanced supportive care. The relationship may also overlap substantially with shock, impaired consciousness, seizures, and other indicators of critical illness that could not be separated using the available aggregate data.

From a clinical perspective, the findings emphasize the importance of recognizing systemic and neurological severity alongside etiological classification in adults presenting with acute meningitis. The coexistence of shock, impaired consciousness, seizures, or a requirement for intensive care identifies a subgroup with a particularly high observed mortality burden. Differentiating bacterial, viral, and tuberculous meningitis is also clinically relevant because their management and expected clinical courses differ, particularly in settings where tuberculosis remains an important diagnostic consideration (7,8). The present study did not evaluate the timing or effectiveness of antimicrobial, antituberculous, corticosteroid, or critical-care interventions; therefore, it cannot determine whether any specific management strategy reduced mortality. Its findings instead support careful early assessment of disease severity and timely etiological evaluation in patients presenting with suspected acute meningitis.

Several features strengthen the study, including consecutive recruitment during a defined study period, inclusion of 182 adult patients, assessment of clinically relevant complications, and documentation of in-hospital outcome across the major meningitis categories encountered in the hospital. The analysis also allowed clinically interpretable crude comparisons between survivors and non-survivors. Important limitations must nevertheless be considered. This was a single-center observational study, limiting generalizability beyond similar tertiary-care settings. Etiological classification was based on the CSF and clinical diagnostic assessment used during routine care, while organism-level culture, molecular confirmation, and standardized pathogen-specific diagnostic criteria were not reported, creating potential for etiological misclassification. Exclusion of patients who had received antibiotics during the preceding 15 days may also have altered the spectrum of patients included and limits extrapolation to previously treated cases.

The analysis was further limited by the relatively small number of deaths and the particularly small tuberculous meningitis subgroup, which resulted in wide confidence intervals for several estimates. Associations with mortality were unadjusted, and the available aggregate data did not permit simultaneous control for potential confounding or interrelationships among shock, neurological complications, etiology, and ICU admission. HIV status, organism-specific microbiology, timing and type of antimicrobial therapy, adjunctive treatment, detailed physiological severity measures, length of hospital stay, and neurological disability after discharge were not systematically available for analysis. In addition, follow-up ended at hospital discharge, so long-term neurological sequelae and post-discharge mortality could not be assessed. These limitations are important when interpreting the observed associations and indicate that the results should be regarded as hospital-based evidence describing disease pattern and short-term outcome rather than as a definitive prognostic model.

CONCLUSION

Among adults with acute meningitis treated at this tertiary-care hospital in Peshawar, bacterial meningitis was the most frequent etiological category and overall, in-hospital mortality was 13.2%. Tuberculous meningitis had the highest observed case-fatality proportion, although the subgroup was small, while shock/hypotension showed the strongest crude association with mortality and altered consciousness, seizures, and ICU admission were also associated with adverse in-hospital outcome. These findings underscore the clinical importance of assessing both meningitis etiology and markers of systemic and neurological severity when identifying patients at increased risk of poor short-term outcomes.

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