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Original Research Article

FREQUENCY OF HYPONATREMIA IN ADULT PATIENTS WITH BACTERIAL MENINGITIS: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: *Hyponatremia is a common electrolyte imbalance observed in central nervous system infections, including bacterial meningitis. It can worsen neurological status and clinical outcomes if left unrecognized and untreated.* ***Objective:*** *To determine the frequency of hyponatremia in adult patients diagnosed with bacterial meningitis.* ***Study Design:*** *Cross-sectional study.* ***Setting:*** *the General Medicine Department of Mufti Mehmood Memorial Teaching Hospital, MTI, Gomal Medical College, Dera Ismail Khan, Pakistan.* ***Duration of Study:*** *The study time frame was 02-Novemeber-2024 to 02-May-2025.* ***Methods:*** *A total of 135 adult patients aged 18–60 years with confirmed bacterial meningitis were enrolled. Diagnosis was based on clinical signs (fever ≥38.5°C, nuchal rigidity, photophobia) and cerebrospinal fluid (CSF) analysis (WBC >1,000 cells/µL or glucose <40 mg/dL). Hyponatremia was defined as serum sodium ≤130 mEq/L with associated clinical symptoms (e.g., nausea, vomiting, confusion). Data were analyzed using descriptive statistics with SPSS, and categorical variables were expressed in percentages.* ***Results:*** *The mean age of participants was 40.13 ± 12.72 years, with 57.8% being male and 42.2% female. Comorbidities included hypertension (31.9%) and diabetes mellitus (21.5%). Hyponatremia was identified in 54.8% of the study population.* ***Conclusion:*** *Hyponatremia was observed in more than half of the patients with bacterial meningitis, highlighting its high frequency and clinical relevance. Routine electrolyte monitoring and prompt correction may improve outcomes in these patients.*

Keywords: Hyponatremia, Bacterial Meningitis, Electrolyte Imbalance, Adults, Cross-Sectional Study

INTRODUCTION

Bacterial meningitis (BM) refers to an infection of the meninges, a protective membrane surrounding the brain as well as the spinal cord, resulting in inflammation (1, 2). BM results from a bacterial infection of the meninges, which causes inflammation. The infection may be classified into two categories: community-acquired and nosocomial. Community-acquired BM occurs when bacteria invade the meninges via bacteremia or by direct extension from localised infection. BM was historically more common among paediatric patients. Vaccinations have raised the median age of infected patients. In 2006, the US recorded 72,000 hospitalizations due to meningitis. A significant proportion of these cases were caused by viral infection (54.6%). Bacterial infections accounted for 21.8% of cases, while fungal and parasitic infections made up 7.3%, and 17.2% were attributed to an unidentified cause. The in-hospital mortality rate among individuals with BM was 8%, increasing significantly for those over the age of 45 (3-5).

Hyponatraemia symbolises a prevalent disarray of water balance, frequently presenting diagnostic as well as therapeutic challenges. This may elucidate suboptimal management of hyponatraemia, just recently demonstrated by a hyponatraemia registry (6-8). This condition is not classified as a disease; rather, it represents a pathophysiological process that signifies disrupted water homeostasis (9). Hyponatraemia necessitates further classification to guide diagnosis and treatment. The categories demonstrate that hyponatraemia is a highly heterogeneous disorder. This has challenging clinical studies, as a single patient with hyponatraemia can't be identified. An underlying disease that complicates hyponatraemia usually defines patients with this condition (10, 11). Common causes of hyponatraemia involve syndrome of inappropriate antidiuresis, adrenal insufficiency, hypovolemia, and liver cirrhosis. Recent advancements in the identification and management of hyponatraemia have occurred; however, the evidence base remains limited (12). A study recorded the frequency of hyponatremia was 66% among BM patients (13).

Hyponatremia is a frequent and serious complication in patients with BM, yet its underlying mechanisms and optimal management strategies remain poorly understood, necessitating further investigation. Since no local data is available on this subject, the goal of this study is to determine the frequency of hyponatremia in patients with BM at our health setup. The results of this study will assist our clinicians in understanding precise drivers of hyponatremia and determining evidence-based treatment protocols, which are critical to improving outcomes. This study will also be helpful to explore the pathophysiology and treatment strategies of hyponatremia in bacterial meningitis, providing new insights that could guide clinical practice and improve prognosis.

METHODOLOGY

This cross-sectional study was carried out in the General Medicine Department of Mufti Mehmood Memorial Teaching Hospital, MTI, Gomal Medical College, Dera Ismail Khan, following ethical approval from the institute. The study time frame was 02-Novemeber-2024 to 02-May-2025. The study population comprised of 135 adult patients aged 18-60 years presenting with clinical features of bacterial meningitis which included fever (body temperature ≥38.5°C), nuchal rigidity, and photophobia, confirmed through laboratory analysis demonstrating either elevated white blood cell count (>1,000 cells/µL) or cerebrospinal fluid glucose levels <40 mg/dL (or <40% of corresponding serum glucose). Patients with ulcerative colitis, end-

stage renal disease, chronic liver disease, or current pregnancy were not enrolled.

Sample size was based on the previous proportion of hyponatremia, 66% (13), 8% absolute precision, and 95% confidence interval. A consecutive non-probability sampling technique was employed.

Before enrollment, each participant gave their consent. Data collection involved recording demographic characteristics such as age, gender, body mass index, socioeconomic status, educational status, occupation, and residential location (urban/rural). Medical history documentation focused on hypertension and diabetes status. For hyponatremia, 5mL venous blood samples under aseptic conditions were collected, with serum sodium analysis performed using standardized laboratory techniques. Hyponatremia was defined as serum sodium concentration ≤130 mEq/L accompanied by characteristic symptoms (nausea, vomiting, confusion).

All clinical assessments and laboratory interpretations were conducted under the supervision of a consultant physician with a minimum of five years post-fellowship experience. Data recording utilized a pre-designed structured proforma. The researcher himself collected all the data.

SPSS 21 was utilized for assessing the gathered data. Age, sodium levels, and BMI were evaluated with mean and standard deviation. Demographic and comorbidities, along with hyponatremia, were expressed as frequency and percentages. Hyponatremia was then stratified with demographics and comorbidities using a chi-square test, where $P \leq 0.05$ was considered statistically notable.

RESULTS

The mean age of 135 patients was 40.13±12.72 years. The average serum sodium level among patients was 133.71±11.12 mEq/dL, while the mean body mass index (BMI) was 24.59±1.37 kg/m².

Gender distribution showed that male patients were 78 (57.8%) and females were 57 (42.2%). Other demographic parameters are shown in Table 1. Comorbidities were also assessed, with hypertension present in 43 (31.9%) patients and diabetes in 29 (21.5%).

Hyponatremia was observed in a notable proportion of the study population, affecting 74 (54.8%) patients, while 61 (45.2%) maintained normal sodium levels (Table 2). Stratification of hyponatremia with demographics and comorbidities can be seen in Table 3.

Table 1: Demographics and comorbidities

Demographics and comorbidities		n	%
Gender	Male	78	57.8%
	Female	57	42.2%
Socioeconomic status	Lower class	30	22.2%
	Middle class	92	68.1%
	Upper class	13	9.6%
Education status	Educated	67	49.6%
	Uneducated	68	50.4%
Profession	Employed	76	56.3%
	Unemployed	59	43.7%
Place of living	Rural	59	43.7%
	Urban	76	56.3%
Hypertension	Yes	43	31.9%
	No	92	68.1%
Diabetes	Yes	29	21.5%
	No	106	78.5%

Table 2: Hyponatremia

Hyponatremia	n	%
Yes	74	54.8%
No	61	45.2%

Table 3: Stratification of hyponatremia with demographics and comorbidities

Demographics and comorbidities		Hyponatremia				P value
		Yes		No		
		n	%	n	%	
Age distribution (Years)	18 to 35	29	39.2%	24	39.3%	1.000
	36 to 50	23	31.1%	19	31.1%	
	> 50	22	29.7%	18	29.5%	
BMI (Kg/m2)	18 to 24.9	40	54.1%	43	70.5%	0.05
	> 24.9	34	45.9%	18	29.5%	
Gender	Male	44	59.5%	34	55.7%	0.66
	Female	30	40.5%	27	44.3%	
Socioeconomic status	Lower class	15	20.3%	15	24.6%	0.61
	Middle class	53	71.6%	39	63.9%	
	Upper class	6	8.1%	7	11.5%	
Education status	Educated	34	45.9%	33	54.1%	0.34
	Uneducated	40	54.1%	28	45.9%	
Profession	Employed	42	56.8%	34	55.7%	0.90
	Unemployed	32	43.2%	27	44.3%	
Place of living	Rural	34	45.9%	25	41.0%	0.56
	Urban	40	54.1%	36	59.0%	
Hypertension	Yes	25	33.8%	18	29.5%	0.59
	No	49	66.2%	43	70.5%	
Diabetes	Yes	21	28.4%	8	13.1%	0.03
	No	53	71.6%	53	86.9%	

DISCUSSION

Our study found a mean age of 40.13±12.72 years among participants, which is consistent with the age ranges reported in earlier studies. Javed et al. documented a mean age of 29±15.27 years in their cohort (14). Mujtaba et al. reported a slightly older cohort with a mean age of 50.02±4.68 years (15). These variations may reflect differences in patient selection criteria or regional epidemiological patterns. The male predominance observed in the current study (57.8%) closely mirrors the gender distributions reported by Javed et al. (60% male)

and Mujtaba et al. (57.8% male), suggesting a potential biological or healthcare-seeking behavior difference between genders in meningitis presentation (14, 15).

Socioeconomic factors, which were not extensively addressed in previous studies, emerged as an important consideration in the current research. The finding that 68.1% of patients belonged to the middle class, with only 9.6% in the upper class, raises questions about healthcare access and disease susceptibility across different socioeconomic strata. The nearly equal distribution between educated (49.6%) and uneducated (50.4%) participants introduces another layer of complexity, as education level may influence health literacy and timely medical intervention.

Comorbidity patterns revealed hypertension in 31.9% of patients and diabetes in 21.5% proportions, which differ from Tunio et al.'s reported hypertension prevalence of 11.8% (16). This substantial discrepancy could stem from variations in regional disease burdens or differences in diagnostic thresholds for hypertension. Electrolyte disturbances in meningitis may be primarily driven by the disease process itself rather than pre-existing conditions (15).

The core finding of hyponatremia prevalence at 54.8% positions this study's results between the extremes reported in existing literature. Javed et al. reported an exceptionally high prevalence of hyponatremia in their research; they documented mild hyponatremia in 66.7% patients, moderate in 30% and severe in 3.3% (14). Mujtaba et al. found only 25.6% of patients with hyponatremia (15).

Tunio et al documented 45% patients having hyponatremia in a cohort of 169 patients presenting with tuberculosis bacterial meningitis (16). Another study reported that patients with tuberculous meningitis and bacterial meningitis had notably lower sodium levels compared to patients presenting with viral meningitis (17). These wide variations likely reflect differences in study methodologies, patient populations, and definitions of hyponatremia.

The mechanisms underlying hyponatremia in meningitis remain an area of active investigation. Tunio et al. emphasized cerebral salt wasting syndrome (26.7%) over SIADH (13.2%) as the predominant pathophysiology (16). When considering clinical implications, the current study's results align with the broader literature in suggesting that hyponatremia represents an important but not necessarily prognostic marker in bacterial meningitis. Studies have proposed that hyponatremia might influence outcomes and is associated with increased morbidity (16).

Several limitations should be acknowledged when interpreting these findings. The single-center design may limit generalizability, and the lack of long-term follow-up precludes assessment of hyponatremia's impact on functional outcomes. Additionally, the study did not systematically evaluate potential confounders such as medication use or fluid management strategies that might influence sodium levels.

CONCLUSION

We conclude that the frequency of hyponatremia in patients with bacterial meningitis was 54.8%, which provides compelling evidence that hyponatremia is a frequent complication in adult patients with bacterial meningitis.

DECLARATIONS

Data Availability Statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department Concerned. (IRB)

Consent for publication

Approved

Funding

Not applicable

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTION

IKHLAQ AHMED SHAH (Postgraduate Resident)
Data Collection, Data Analysis, Drafting of Manuscript, Review of Manuscript, and Final Approval of Manuscript.
NISAR KHAN (Professor)
Conception of Study, Development of Research Methodology Design, Critical Input, and Final Approval of Draft.
MUNEEB ASLAM (Clinical Development Fellow)
Critical Input, and Review of Literature.
SABA WAHEED (Postgraduate Resident)
Review of Literature.
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