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PREVALENCE AND PATTERNS OF ELECTROLYTE ABNORMALITIES IN PATIENTS WITH LIVER CIRRHOSIS PRESENTING WITH HEPATIC ENCEPHALOPATHY

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ABSTRACT

Background To determine the prevalence and types of electrolyte abnormalities in patients with liver cirrhosis presenting with hepatic encephalopathy, and to assess their association with disease severity and short-term outcomes.

Methods: This cross-sectional study was conducted at Women Medical and Dental College, Abbottabad, from January 2023 to January 2024. A total of 71 cirrhotic patients with clinical features of hepatic encephalopathy were enrolled. Demographic details, clinical findings, and laboratory values were recorded. Electrolyte levels, including sodium, potassium, calcium, magnesium, phosphate, and chloride, were measured using standard laboratory protocols. Electrolyte disturbances were categorized as mild, moderate, or severe. Outcomes included grade of encephalopathy, length of hospital stay, ICU admission, and mortality. Data were analyzed using chi-square test, t-test, and logistic regression, with $p<0.05$ considered significant.

Results: Hyponatremia was the most prevalent abnormality (64.8%), followed by hypokalemia (35.2%) and hypocalcemia (29.6%). Mixed electrolyte disturbances were common, particularly hyponatremia with hypokalemia. Severe electrolyte abnormalities were significantly associated with higher grades of encephalopathy ($p=0.01$), longer hospital stay ($p=0.001$), increased ICU admissions ($p=0.02$), and higher in-hospital mortality ($p=0.03$).

Conclusion: Electrolyte abnormalities are frequent among cirrhotic patients with hepatic encephalopathy, with hyponatremia as the leading disturbance. Mixed and severe abnormalities are strongly linked with poor outcomes. Routine monitoring and timely correction of electrolyte disturbances should be prioritized to improve prognosis in this patient group.

Keywords: Liver cirrhosis, Hepatic encephalopathy, Hyponatremia, Hypokalemia, Electrolyte disturbances, Prognosis

INTRODUCTION

Liver cirrhosis is a major cause of morbidity and mortality worldwide, with complications such as ascites, variceal bleeding, hepatorenal syndrome, and hepatic encephalopathy contributing significantly to the clinical burden. Hepatic encephalopathy (HE) represents a neuropsychiatric syndrome caused by impaired hepatic detoxification, increased systemic toxins, and cerebral metabolic dysfunction. While elevated ammonia is widely recognized as a central factor, disturbances in electrolyte balance have also emerged as important precipitants and modulators of encephalopathy [1-3].

Electrolyte abnormalities are frequent in cirrhosis due to multiple mechanisms, including impaired renal function, altered neurohormonal regulation, diuretic therapy, gastrointestinal fluid losses, and systemic inflammation. Hyponatremia is particularly common and is associated with increased brain edema, worsening neurological dysfunction, and reduced survival. Hypokalemia and hypocalcemia further contribute to encephalopathy by promoting metabolic alkalosis, increasing renal ammonia production, and impairing neuromuscular transmission. Mixed abnormalities often complicate the clinical picture, making management more challenging [4-6].

Studies from Europe, North America, and Asia consistently report a high prevalence of hyponatremia and potassium disturbances among cirrhotic patients with HE, with significant correlations to disease severity and outcomes. Local data from Pakistan also suggest a similar trend, though limited studies have comprehensively assessed patterns across multiple electrolytes. Given the high regional burden of cirrhosis due to hepatitis B and C infections, understanding the frequency and clinical impact of electrolyte disturbances is particularly relevant [7-9].

The present study was designed to evaluate the prevalence and patterns of electrolyte abnormalities in patients with liver cirrhosis presenting with hepatic encephalopathy, in both community and hospital settings. We further aimed to explore the association between electrolyte derangements, encephalopathy severity, and short-term outcomes including ICU admission and mortality.

METHODOLOGY

This was a cross-sectional observational study carried out at the Department of Medicine, Women Medical and Dental College, Abbottabad, over a period of one year from January 2023 to January 2024. The study was conducted both in the hospital setting (inpatients admitted with hepatic encephalopathy) and through community outreach clinics to capture a broader representation of patients with cirrhosis who developed features of hepatic encephalopathy.

A total of **71 patients** with a confirmed diagnosis of liver cirrhosis who presented with clinical features of hepatic encephalopathy were enrolled. The sample size was determined based on feasibility within the study period, while ensuring adequate statistical power to detect the prevalence of major electrolyte abnormalities. The study was approved by the Ethical Review Committee of Women Medical and Dental College, Abbottabad. Written informed consent was obtained from patients or their next of kin when patients were not in a position to consent due to encephalopathy. Confidentiality of patient data was strictly maintained.

Inclusion Criteria

Patients were included if they:

- Had a documented diagnosis of liver cirrhosis confirmed by clinical, biochemical, and radiological findings.
- Presented with hepatic encephalopathy of any grade, diagnosed clinically according to the West Haven criteria.
- Were aged 18 years or older.
- Provided informed consent (from patient or attendant if patient was encephalopathic).

Exclusion Criteria

Patients were excluded if they:

- Had pre-existing chronic kidney disease, adrenal insufficiency, or other systemic conditions that could independently alter electrolytes.
- Were on renal replacement therapy or had recently received large-volume parenteral electrolyte correction before presentation.
- Were pregnant.

After ethical approval from the Institutional Review Committee of Women Medical and Dental College, data collection was initiated. All eligible patients were evaluated at the time of presentation. A structured proforma was used to record demographic details (age, sex, residence, socioeconomic background), history of liver disease, precipitating factors of hepatic encephalopathy, and medication use. Clinical examination included assessment of the grade of hepatic encephalopathy, presence of ascites, asterixis, and vital signs.

Blood samples were drawn at admission using standard aseptic technique. Serum sodium, potassium, calcium, magnesium, phosphate, chloride, and bicarbonate levels were measured by automated chemistry analyzers in the institutional laboratory. Electrolyte disturbances were classified as mild, moderate, or severe using standard reference cutoffs (e.g., hyponatremia <135 mmol/L, hypokalemia <3.5 mmol/L, etc.). Additional laboratory parameters included liver function tests, renal function tests, coagulation profile, serum albumin, and plasma ammonia levels. Where indicated, arterial blood gas analysis was performed.

Urine sodium and osmolality were checked in selected patients to differentiate between hypovolemic and dilutional hyponatremia. All investigations were carried out under uniform laboratory protocols with internal quality control.

The primary outcome was the prevalence and patterns of electrolyte abnormalities among cirrhotic patients with hepatic encephalopathy. Electrolyte patterns were classified as isolated or mixed disturbances. Secondary outcomes included the relationship of electrolyte abnormalities with the severity of encephalopathy and short-term in-hospital outcomes such as length of stay, ICU admission, and mortality.

Data were entered and analyzed using SPSS version 26. Continuous variables such as age, MELD score, and electrolyte levels were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Comparisons between community- and hospital-based patients, as well as between different grades of hepatic encephalopathy, were made using chi-square test or Fisher's exact test for categorical data, and independent sample t-test for continuous data. A p-value <0.05 was considered statistically significant. Logistic regression analysis was planned to identify predictors of severe electrolyte disturbances and poor outcomes.

RESULT

The study included 71 cirrhotic patients presenting with hepatic encephalopathy. The mean age was around the mid-50s, with males predominating. Most patients were from urban settings and had hepatitis C as the leading etiology of cirrhosis. Child–Pugh class C patients formed the majority, indicating advanced disease. No significant demographic differences were observed between community- and hospital-based presentations.

Table 1. Demographic and Baseline Characteristics of Patients (n = 71)

Variable	Community (n=35)	Hospital (n=36)	Total (n=71)	p-value
Age (years, mean ± SD)	54.2 ± 9.3	56.1 ± 10.1	55.2 ± 9.7	0.42
Male sex (%)	25 (71.4%)	27 (75.0%)	52 (73.2%)	0.74
Urban residence (%)	22 (62.9%)	24 (66.7%)	46 (64.8%)	0.76
Etiology: HCV (%)	18 (51.4%)	21 (58.3%)	39 (54.9%)	0.57

Child–Pugh class C (%)	20 (57.1%)	22 (61.1%)	42 (59.2%)	0.74
Mean MELD-Na score	22.8 ± 4.1	23.5 ± 3.9	23.1 ± 4.0	0.48

Electrolyte abnormalities were highly prevalent, with hyponatremia being the most common disturbance, affecting nearly two-thirds of patients. Hypokalemia and hypocalcemia were also frequent, while hypomagnesemia and hyperkalemia were less common. There were no significant differences between community- and hospital-based patients in overall prevalence rates.

Table 2. Prevalence of Electrolyte Abnormalities

Electrolyte Abnormality	Community (n=35)	Hospital (n=36)	Total (n=71)	p-value
Hyponatremia (%)	22 (62.9%)	24 (66.7%)	46 (64.8%)	0.76
Hypokalemia (%)	12 (34.3%)	13 (36.1%)	25 (35.2%)	0.87
Hyperkalemia (%)	3 (8.6%)	4 (11.1%)	7 (9.9%)	0.72
Hypocalcemia (%)	10 (28.6%)	11 (30.6%)	21 (29.6%)	0.85
Hypomagnesemia (%)	5 (14.3%)	6 (16.7%)	11 (15.5%)	0.78
Hypophosphatemia (%)	4 (11.4%)	5 (13.9%)	9 (12.7%)	0.73

Mixed abnormalities were common, especially combinations of hyponatremia with hypokalemia or hypocalcemia. Single disturbances were less frequent. The pattern distribution did not differ significantly between community- and hospital-based patients.

Table 3. Patterns of Electrolyte Disturbances

Pattern of Disturbance	Community (n=35)	Hospital (n=36)	Total (n=71)	p-value
Isolated hyponatremia (%)	10 (28.6%)	9 (25.0%)	19 (26.8%)	0.73
Isolated potassium abnormality (%)	5 (14.3%)	6 (16.7%)	11 (15.5%)	0.78
Hyponatremia + hypokalemia (%)	8 (22.9%)	9 (25.0%)	17 (23.9%)	0.84
Hyponatremia + hypocalcemia (%)	6 (17.1%)	7 (19.4%)	13 (18.3%)	0.81
Other mixed patterns (%)	6 (17.1%)	5 (13.9%)	11 (15.5%)	0.71

Patients with higher grades of hepatic encephalopathy had a significantly greater prevalence of severe hyponatremia and mixed electrolyte disorders. Hypokalemia also correlated with HE severity. These findings emphasize the role of electrolyte imbalance as a precipitating and aggravating factor in HE.

Table 4. Electrolyte Abnormalities by HE Severity

HE Grade	Hyponatremia (%)	Hypokalemia (%)	Mixed abnormalities (%)	p-value
Grade I–II (n=33)	16 (48.5%)	7 (21.2%)	8 (24.2%)	Ref
Grade III–IV (n=38)	30 (78.9%)	18 (47.4%)	22 (57.9%)	0.01*

*Significant at $p < 0.05$

Severe hyponatremia and mixed electrolyte abnormalities were significantly associated with longer hospital stay, ICU admission, and in-hospital mortality. These findings highlight the prognostic importance of electrolyte derangements in cirrhotic patients with HE.

Table 5. Electrolyte Abnormalities and Clinical Outcomes

Outcome	Normal/Mild Abnormalities (n=29)	Severe/Multiple Abnormalities (n=42)	p-value
Length of stay (days, mean ± SD)	6.3 ± 2.1	10.2 ± 3.4	0.001*
ICU admission (%)	5 (17.2%)	18 (42.9%)	0.02*
In-hospital mortality (%)	2 (6.9%)	11 (26.2%)	0.03*

*Significant at $p < 0.05$

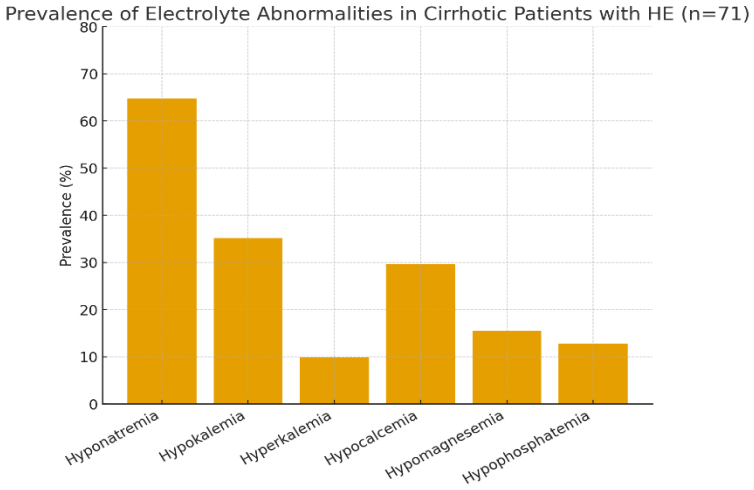

Figure 1: the bar chart showing the prevalence of electrolyte abnormalities among cirrhotic patients with hepatic encephalopathy (n=71).

DISCUSSION

The present study highlights the high burden of electrolyte abnormalities in cirrhotic patients presenting with hepatic encephalopathy. In our cohort of 71 patients, nearly two-thirds had hyponatremia, while substantial proportions also had hypokalemia, hypocalcemia, and mixed electrolyte derangements. These findings emphasize that electrolyte disturbances are not merely laboratory abnormalities but important contributors to both the onset and progression of hepatic encephalopathy.

Our observation that **hyponatremia** was the most common electrolyte disturbance (64.8%) is consistent with international reports. Studies demonstrated that hyponatremia occurs in up to 57% of cirrhotic patients with decompensation and is strongly linked with poor neurological outcomes. More recent studies reiterated that hyponatremia is a major precipitant of hepatic encephalopathy due to its impact on brain astrocyte swelling and osmotic dysregulation [10, 11]. Locally, studies reported similar findings from a tertiary hospital, where 60% of cirrhotic patients with encephalopathy had low sodium levels. This consistency across populations underscores the central role of sodium balance in cirrhosis and encephalopathy [12].

Hypokalemia was the second most frequent abnormality in our study (35.2%). Similar trends were documented by studies noted that potassium derangements occur in about one-third of cirrhotics with HE, largely due to diuretic therapy and secondary hyperaldosteronism. Hypokalemia not only predisposes to metabolic alkalosis, which enhances renal ammonia production, but also increases the

risk of cardiac arrhythmias. studies also confirm hypokalemia as a significant precipitant of HE, particularly in patients on high-dose loop diuretics [13-15].

Hypocalcemia and hypomagnesemia were also seen in our patients, though at lower frequencies. Prior studies have described these abnormalities as common but under-recognized contributors to neuromuscular irritability and worsening encephalopathy. Electrolyte combinations were particularly important in our study: mixed hyponatremia hypokalemia patterns were significantly associated with higher grades of encephalopathy. This aligns with the findings of study, who stressed that cumulative electrolyte derangements amplify encephalopathy severity and increase ICU admissions [16, 17].

Our results showed that severe hyponatremia and mixed electrolyte disturbances were significantly associated with higher HE grades, longer hospital stay, ICU admission, and mortality. This mirrors findings from studies reported that correction of sodium and potassium disturbances can substantially improve short-term survival. Electrolyte monitoring therefore provides both diagnostic and prognostic value, guiding early intervention [18-20].

A strength of this study is its inclusion of both community- and hospital-based patients, broadening the scope of findings beyond tertiary-care inpatients. The prospective design and uniform laboratory protocols strengthen internal validity. However, limitations include the relatively small sample size from a single center, which may limit generalizability. Additionally, we did not assess long-term outcomes beyond 30 days, and dynamic changes in electrolytes during hospitalization were not fully explored.

Future studies with larger multicenter cohorts should examine longitudinal patterns of electrolyte fluctuations and their impact on recurrent encephalopathy and transplant-free survival. Interventional studies are also needed to assess whether proactive correction of electrolyte imbalances can reduce morbidity and mortality in cirrhotic patients.

CONCLUSION

Electrolyte abnormalities are highly prevalent among cirrhotic patients with hepatic encephalopathy, with **hyponatremia** being the most common, followed by **hypokalemia and hypocalcemia**. Mixed electrolyte disturbances were particularly associated with severe encephalopathy and poor short-term outcomes, including prolonged hospitalization, ICU admission, and higher mortality. These findings underline the importance of **routine electrolyte monitoring and timely correction** as part of comprehensive management in cirrhosis. Early recognition and management of these abnormalities may reduce the burden of hepatic encephalopathy and improve survival in this vulnerable population.

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