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Assessment of Serum Electrolyte Disorders and Associated Factors among Patients with Neurologic Diseases Admitted to Jimma Medical Center, South West Ethiopia

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Abstract

Background: Electrolyte disorder is the most frequent systemic complication in patients with neurologic diseases. Disorders of sodium and potassium concentration are the most common electrolyte abnormalities and may contribute to mortality unless corrected urgently.

Objective: To assess the magnitude of serum electrolyte (sodium, potassium, calcium, and chloride) disorders and associated factors among adult patients with neurologic diseases admitted to Jimma Medical Center.

Methods: Institutional based cross-sectional study was conducted among selected 119 adult neurologic patients by using stratified sampling technique. Blood was drawn from patients with neurologic diseases, centrifuged and level of serum electrolyte (Na, K, Cl and Ca) was determined. Data was fed into epidata 4.4.2.win 64 and exported to SPSS version 20. Binary logistic regression was used to identify the associated factors to electrolyte disorder. Data was expressed in percentage, mean, ± SD and P-value ≤ 0.05 considered as a statistically significant. Data was presented with text, tables.

Results: The prevalence of at least one electrolyte disorder was 71.4%. The prevalence of hyponatremia, hypokalemia, hypochloremia, hyperchloremia, hypocalcemia, hypernatremia and hyperkalemia were seen in 37%, 35.3%, 21.8%, 19.3%, 16%,14.3% and 1.7%, of patients), respectively. Hypercalcemia was not found. Occupation, comatose state, taking intravenous fluids, taking thiazides, both antibiotics and analgesics, history of chronic diseases like hypertension and diabetes were factors associated with serum electrolyte disorders.

Conclusion and Recommendation: Hyponatremia and hypokalemia were common electrolyte disorders. Therefore, early screening or measurement of serum electrolyte should be done for high risk groups.

Keywords: *Prevalence; Electrolyte Disorders; Associated Factors; Neurologic Diseases; JMC*

Abbreviations

BSc: Bachelor of Science; Ca: Calcium; CI: Confidence Interval; Cl: Chlorine; CNS: Central Nervous System; K: Potassium; MRI: Magnetic Resonance Imaging; Na: Sodium; SD: Standard Deviation; SPSS: Statistical Program for Social Sciences

Introduction

Electrolyte homeostasis in the central nervous system is essential for brain function [1]. Electrolyte derangements are common after neurologic disorders presented with weakness, hyperreflexia, tremor, chorea, myoclonus, drowsiness or coma, including seizures [2-4].

Neurologic disorders represent 7% of the total global burden of disease measured in disability-adjusted life years (DALY) for all causes and ages [5].

Patients with neurologic diseases had a high risk of developing different type of electrolyte imbalance, at the time of admission and duration of their Intensive Care Unit (ICU) stay. Electrolyte disorders affect treatment and outcome of patients with neurologic diseases [6].

At least one electrolyte disorder was common in patients with neurologic diseases [7]. But electrolyte disorders sometimes overlooked in patients with neurologic diseases [8]. Mild electrolyte disorders can have a reduced performance in mental function tests and disturbances of balance [3,9]. Electrolyte disorders can significantly impact the medical course of patients with neurological diseases [10-14]. Hyponatremia is more common in patients with neurologic disease and is particularly associated with aneurismal subarachnoid hemorrhage (SAH), traumatic brain injury (TBI) and meningitis [15,16]. Prevalence of electrolyte disorders in India among stroke patients shows Hypocalcemia (40%), Hyponatremia (38.5%), Hypomagnesaemia (38%) and Hypokalemia (26.5%) [17].

Another recent study in India showed, the prevalence of electrolyte disorders (hyponatremia, hypocalcemia, hyperkalemia, hypernatremia, hyperchloremia, hypokalemia and hypochloremia) was seen in 71.66%, 48.3%, 5%, 5%, 3.33%, 3.33%, and 3.33% of stroke patients, respectively [18]. A study on TBI patients in India showed, prevalence of electrolyte disorders (hyponatremia, hypokalemia, hypocalcemia, hypernatremia, hyperkalemia and hypercalcemia) 25%,20.9%,14.7%, 13.8%, 11%, and 5.2%, respectively [19]. A study in Nigeria showed the prevalence of hyponatremia, hypokalemia and hypochloremia among Traumatic Brain Injury patients was 18.3%, 8.3% and 6.7% respectively [20].

Disorders of sodium and potassium concentration in Neurologic diseases may contribute to mortality unless corrected urgently. Hyponatremia and Hypernatremia can lead to complications like seizures and death [21]. A study in Texas among Traumatic Brain Injury patients shows lower survival rates for patients with greater degrees of hypernatremia [22]. Apart from Sodium and Potassium, Serum calcium is also is important electrolyte abnormality associated with a variety of clinical manifestations in patients with traumatic brain injury [23].

Prevalence of hyponatremia in patients with CNS infections was observed in 42.71% (82/192) patients and associated with a mortality increase of 7 to 60% [8,24]. Severe hyponatremia patients had higher risks of suffering dementia than the non-severe hyponatremia patients [25]. The annual cost of managing patients with hyponatremia has been estimated at $3.6 billion [26]. Alcoholic patient exhibit severe electrolyte derangements than non-alcoholics [27]. Women have a 25-fold increased risk of death or permanent neurologic damage compared with men due to hyponatremia [1].

A study in China showed significant relationship between hypochloremia and increased risk of mortality with 2.3 fold in 23.1% of hospitalized patients [28]. A study in India and Iran also showed 23% of patients who had serum electrolyte imbalances were dead but those who have no serum electrolyte imbalance had good outcome [13,29].

Prospective observational study in Egypt shows that out of eighty-five stroke patients, twenty-six patients had hyponatremia and seven patients had hypernatremia. Hypernatremia significantly increased the odds of postoperative death in the first 24 hours after head injury. Around 76.7% of hypernatremia patients dead in the first 24 hours after cranial surgery [30,31].

Electrolytes derangements play a major role in secondary brain injury. Therefore, early detection and correction of the electrolyte's derangement are essential for early recovery and will prevent further neurologic injury in Neurologic patients. Proper management of electrolyte imbalances in patients with seizures is needed to reduce common and serious neurologic morbidity [32,33].

Scarcity of data about electrolyte disorders had seen in Neurologic diseases especially in developing countries [33]. Most of the clinical manifestations of electrolyte derangements predominantly are neurologic and parallel with the severity of neuronal damage. Sometimes,

electrolyte disorders overlooked in patients with neurologic disorders. This study identified serum electrolyte disorders and associated factors among patients with neurologic diseases. Therefore, based on this finding, clinicians will get attention to serum electrolyte disorders among neurologic patients and manage their patients optimally. Appropriate management of electrolytes derangements not only improves neurological status but also decreases morbidity and mortality [34]. No study was conducted on electrolyte disorders among patients with neurologic diseases in Ethiopia. Therefore, this study may be used as a baseline for further studies and an input for policy makers.

Materials and Methods

Study area and period

The study was conducted in Jimma Medical Center (JMC) found in Jimma town, South West Ethiopia, has a latitude and longitude of 7°40′N 36°50′E. Currently, it is the only teaching and referral hospital in the Southwestern part of the country, providing services for approximately 15,000 inpatients, 160,000 outpatient attendants, 11,000 emergency cases and 4500 deliveries in a year coming to the hospital from the catchment population of about 15 million people. It has around 800 beds. According to 2010 E.C JMC Health Management Information System (HMIS) report, there were a total of 1956 admitted neurologic patients each accounted for Stroke (960), Traumatic Brain Injury (840) and Meningitis (156). This study was conducted among adult neurologic patients admitted to Jimma Medical Center from March 30, 2019 to May 30, 2019.

Study design

Institutional based cross-sectional study design was used to assess the magnitude of serum electrolyte disorders among adult neurologic patients admitted to Jimma Medical Center.

Source and study population

Source population

Patients with neurologic diseases (stroke, meningitis, traumatic brain injury) admitted to Jimma Medical center.

Study population

Those selected patients with neurologic diseases admitted to Jimma Medical center and fulfilled the inclusion criteria.

Inclusion criteria

- Patients admitted with neurologic diseases (stroke, meningitis, traumatic brain injury) with age greater than 18.

Exclusion criteria

- Patients diagnosed only based on clinical history without CT/MRI/Cerebrospinal fluid analysis.
- Patients who had no care givers.
- Patients with neurologic diseases and had kidney diseases, liver diseases, thyrotoxicosis were excluded.

Sample size determination and sampling technique

Sample size

Sample size was calculated based on study conducted in Egypt in 2016 taking the prevalence of hyponatremia as 30%. Therefore, with single population proportion formula sample size will be:

$n = (Z\alpha/2)^2 . p . q/d^2$ with 95% confidence interval

Where n = Required sample size

$Z\alpha/2$ = Critical value at 0.05

p = Prevalence of hyponatremia which is 30%

q = Negative prevalence of hyponatremia which is 70%

d = Margin of error taking 5%

n = 323

In JMC in 2010 E.C. the average two-month report of neurologic diseases (Stroke, TBI and meningitis) was 163 (N) which is less than 10,000. Therefore, we used correction formula i.e. n final (nf) = no/1+no/N = 323/1+323/163 = 108 and adding 10% non-response rate n final becomes 119.

Sampling technique

Stratified sampling technique was used among patients with neurologic diseases (stroke, meningitis, traumatic brain injury) admitted to Jimma Medical Center based on annual report or registration and allocated proportionately.

Variables

Dependent variable

Serum electrolyte disorder.

Independent variables

- Age
- Sex
- Marital status
- Residence
- Occupation
- Level of education

- Income
- Smoking
- Alcohol habit
- Chewing Khat
- Using salt with food
- Being in coma
- Fluid (IV) therapy
- Fever, vomiting
- Chronic history of diseases (hypertension, diabetes)
- Patient condition/severity of the disease.

Operational definitions

For adults

- **Hyponatremia**: Serum sodium level below 135 meq/l.
- **Hypernatremi**a: Serum sodium level above 145 meq/l.
- **Hypokalemia**: Serum potassium level below 3.5 meq/l.
- **Hyperkalemia**: Serum potassium level above 5 meq/l.
- **Hypocalcemia**: Serum calcium (ionized) level below 1.1 meq/l.
- **Hypercalcemia**: Serum calcium (ionized) level above 1.4 meq/l.
- **Hypochloremia**: Serum chloride level below 98 meq/l.
- **Hyperchloremia**: Serum chloride level above 108 meq/l.
- **Smoker:** Is someone who has smoked greater than 100 cigarettes in their lifetime and has smoked in the last 28 days.
- **Non- smoker:** Is someone who has not smoked greater than 100 cigarettes in their lifetime and does not currently smoke.
- **Chewer**: Was chewing khat within 30 day preceding the study.
- **Non-chewer**: Person who has never used khat in any form including ever use.
- **Alcohol drinking status**: Yes, if a patient drinks alcohol more than four times/four beer per week and No if a patient drinks less than three times/three beer or less than 60 gram per week.

- **Electrolyte disorder**: Blood test results indicate deviation of at least one of serum electrolytes (sodium, potassium, chloride, or calcium) level from the normal.
- **Neurologic diseases**: Patients admitted with a diagnosis of stroke, traumatic brain injury, meningitis.
- **Patient condition**: Physician's comment to the patient as critical, sub-critical and non-critical.

Data collection procedures

Data collection tools were adapted from reviewing different literatures. Semi-structured questionnaire was used to collect relevant information based on the study objectives. One BSc Nurse for data collection/interviews and one laboratory technologist for drawing blood specimen were assigned. Vital signs like blood pressure in sitting position at left arm and axillary temperature were measured.

5 ml of venous blood was drawn from fasting individuals using serum separator tube and stayed for 30 minutes then centrifuged at a speed of 4000 rpm for 3 minutes. Serum was taken and stored under -80°C till the time of biochemical analysis to measure level of serum electrolytes based on ion-selective electrode which had six different electrodes used in the analyzer: Na^+, K^+, Cl^-, Ca^{2+}, Li^+ and a reference electrode was used under standard operating system. Measurement of serum electrolytes was done at Jimma Medical center laboratory section with hemolyte plus five analyzers (Germany).

Data entry, processing and analysis

Data was checked, cleared and fed into Epi-data (version 4.4.2.0.win.64) and then exported to SPSS (version 20) software for statistical analysis. After complete entry of all the data, soft copy was checked with its hard copy to see the consistency. The study employed descriptive analysis to determine magnitude of electrolyte disorders. Binary logistic regressions (bivariate and multivariate with Backward LR) were used to identify associated factors to electrolytes disorder. In Bivariate analysis, Variables who had P-value less than 0.25 were entered into multivariate analysis. Data expressed in mean, ± SD, texts, tables and $P < 0.05$ was considered as a statistically significant.

Data quality management

Questionnaire, which contains socio-demographic and behavioral characteristics, was translated to local languages Afaan Oromo and Amharic then back to English for its consistency. A total of two days training on the contents of the questionnaire, data collection techniques, and research ethics was given for data collectors. Any doubts/question in the method was clarified.

The principal investigator supervised data and specimen collectors and controlled any kind of procedures and processes that might affect the result at each step. The specimen was collected, stored and transported according to the guideline and suspected specimen that had poor quality was rejected. Working and acceptable commercial kits were used. Measuring instruments and biochemical analyzers were calibrated by their respective reference materials. Pretest of the questionnaire was conducted in 5% study subjects two weeks prior to actual data collection at Shenan Gibe Hospital, Jimma Zone for validation of questionnaire and to make some adjustment. So that additional preparations were made. During the actual data collection period, the questionnaire was checked every night for completeness.

Results

Socio-demographic characteristics of patients

In the present study among 119 adult neurologic patients, 64.7% (77) were males. The mean age was 42.42 (SD ± 17.17) with minimum and maximum age of 18 and 90, respectively. Majority of cases 52.1% (62) were rural residents. Majority of patients 48.7% (58) had no formal education and 42% (50) of patients are farmers (Table 1).

Characteristics		Frequency	Percentage (%)
Age	≤ 24	24	20.2
	25 - 34	19	16
	35 - 44	20	16.8
	45 - 54	21	17.6
	55 - 64	21	17.6
	≥ 65	14	11.8
Sex	Male	77	64.7
	Female	42	35.3
Marital status	Single	31	31.9
	Married	89	68.1
	Total	119	100
Level of education	No formal education	58	48.7
	Elementary (1 - 8)	32	26.9
	Secondary school (9 - 12)	20	16.8
	College	7	5.9
	University	2	1.7
Residence	Urban	57	47.9
	Rural	62	52.1
Occupation	Farmer	50	42
	Merchant	17	14.3
	Government employee	15	12.6
	Student	17	14.3
	House wife	14	11.8
	Others	6	5
Income(birr)	Quartile 1 (≤ 3000)	84	70.6
	Quartile 2 (> 3000)	35	29.4

Table 1: *Socio-demographic characteristics of adult neurologic patients in JMC, South West Ethiopia from March 30, 2019 to May 30, 2019.*

Clinical characteristics of study patients

Out of 119 neurologic patients 23.5% (28) were in coma. Regarding medications 31.1% (37) of patients took antibiotics, 19.3% (23) of patients took both antibiotics and analgesics, 16% (19) of patients took thiazides, 11.8% (14) of patients took calcium channel blockers, 9.2% (11) of patients took analgesics and 8.4% (10) of patients took loop diuretics and 2.5% (3) took benzodiazepines. Majority 85.7% (102) and 82.3% (98) of patients had normal systolic and diastolic blood pressure, respectively. The remaining 15.2% (18), 12.6% (15), 2.5% (3) and 21.7% (2) had high systolic, high diastolic, low systolic and low diastolic blood pressure, respectively.

According to this study, majority 61.3% (73) of patients were in sub-critical condition. The remaining were in critical and non-critical condition accounting 41 (34.5%) and 5 (4.2%), respectively. Among 119 neurologic patients 31.9% (38) of patients had history of chronic

diseases. Of these, majority of them had history of hypertension followed by history of Diabetes, Congestive Heart Failure (CHF), Cancer and history of others (Chronic obstructive diseases, asthma), accounts 71.05% (27), 10.53% (4), 7.9% (3), 2.63% (1) and 7.9% (3), respectively.

Characteristics		Frequency	Percentage (%)
Comatose state	Yes	28	(23.5%)
	No	91	(76.5)
Medications taken	Loop diuretics	10	8.4
	Benzodiazepines	3	2.5
	Thiazides	19	16
	Antibiotics	37	31.1
	Analgesics	11	9.2
	Both antibiotics and analgesics	23	19.3
	Calcium channel blockers	14	11.8
	Others	2	1.7
Mean systolic Blood pressure	Low	3	2.5
	Normal	98	82.3
	High	18	15.2
Mean diastolic blood pressure	Low	2	1.7
	Normal	102	85.7
	High	15	12.6
Fever	Yes	9	7.6
	No	110	92.6
Vomiting	Yes	13	10.9
	No	106	89.1
Has the patient taken fluid	Yes	91	76.5
	No	28	23.5
Smoking status	Yes	9	7.6
	No	110	92.4
Drinking alcohol status	Yes	24	20.2
	No	95	79.8
Chewing Khat status	Yes	58	48.7
	No	61	51.3
Using salt with food	Yes	115	96.6
	No	4	3.4
History of chronic disease	Diabetes	4	3.4
	Hypertension	27	22.7
	CHF	3	2.5
	Cancer	1	0.8
	Others	3	2.5
Patient's condition	Critical	41	34.5
	Subcritical	73	61.3
	Non-critical	5	4.2

Table 2: *Clinical and behavioral characteristics of study patients admitted to JMC, 2019.*

Serum electrolyte status of study patients

The mean serum Na, K, Cl and Ca was 137.3, 3.73, 102.95 and 1.15 with standard deviation of 8.43, 0.73, 7.33, and 0.07, respectively. The prevalence of Serum electrolyte disorder i.e. having at least one electrolyte disturbance among four electrolytes (Na, K, Cl, and Ca) in neurologic patients was 71.4%, the remaining 28.6% had normal electrolyte level. 52 (43.7%) of patients had at least two electrolyte disorders, 26 (21.8%) of patients had at least three electrolyte disorders and 3 (2.5%) of patients had four electrolyte disorders.

Sodium (Na)

Hyponatremia was found among 24 (41.3%) stroke, 16 (32.6%) of TBI patients. Hypernatremia was found among 7 (12%) stroke, 8 (16.3%) of TBI and 2 (16.7%) meningitis patients. Severe hyponatremia (< 125 mmol/L) was seen in 3 (2.5%) of patients, Moderate hyponatremia (125 - 129.9 mmol/L) was seen in 10 (8.4%) and Mild hyponatremia (130 - 134.9 mmol/L) was seen in 31 (26.1%) of patients. Mild hypernatremia (145.1 - 149.9 mmol/L) was found in 8 (6.7%) of patients, Moderate hypernatremia was seen in 8 (6.7%) of patients and Severe hypernatremia was found in 1 (0.8%) patient.

Potassium (K)

Hypokalemia was found among 18 (31%) stroke, 19 (38.8%) of TBI and 5 (41.7%) of meningitis patients. Hyperkalemia was found in 1 (2.8%) of stroke and in 1 (2%) of TBI patients. In this study Severe hypokalemia (< 2.5 mmol/L) was found in 2 (1.7%) of patients, Moderate hypokalemia (2.5 - 2.99 mmol/L) was found in 14 (11.8%) of patients and mild hypokalemia was seen in 26 (21.8%) of patients. Mild hyperkalemia (5.51 - 6.49 mmol/L) Moderate hyperkalemia (6.5 - 7.49 mmol/L) was found in 2 (1.7%) but Severe hyperkalemia (≥ 7.5 mmol/L) was not found.

Chlorine (Cl)

Hypochloremia was found in 26 (21.8%) of patients. Hyperchloremia was found in 23 (19.3%) of patients.

Calcium (Ca)

Hypocalcemia was found among 19 (16%) but Hypercalcemia was not found (For details see table 3).

Characteristics	Ischemic stroke (n = 36)	Hemorrhagic stroke (n = 22)	TBI (n = 49)	Meningitis (n = 12)	Total (n = 119)	Mean (SD)
Hyponatremia	18 (50%)	6 (27.3%)	16 (32.7%	4 (33.3%)	44 (37%)	
Normal Na	14 (38.9%)	13 (59.1%)	25 (51%)	6 (50%)	58 (48.7%)	137.35
Hypernatremia	4 (11.1%)	3 (13.6%)	8 (16.3%)	2 (16.7%)	17 (14.3%)	(8.43)
Hypokalemia	10 (27.8%)	8 (36.4%)	19 (38.8%)	5 (41.7%)	42 (35.3%)	
Normal K	25 (69.4%)	14 (63.6%)	29 (59.2%)	7 (58.3%)	75 (63%)	3.73
Hyperkalemia	1 (2.8%)	-----	1 (2%)	----	2 (1.7%)	(0.73)
Hypochloremia	15 (41.7%)	3 (13.6%)	6 (12.3%)	5 (16.7%)	26 (21.8%)	
Normal Cl	17 (47.2%)	16 (72.7%)	29 (59.2%)	8 (66.7%)	70 (58.8%)	102.95
Hyperchloremia	4 (11.1%)	3 (13.6%)	14 (28.6%)	2 (16.7%)	23 (19.3%)	(7.33)
Hypocalcemia	4 (11.1%)	1 (4.5%)	12 (24.5%)	2 (16.7%)	19 (16 %)	
Normal	32 (88.9%)	21 (94.5%)	37 (75.5%)	10 (83.3)	100 (84%)	1.15
Hypercalcemia	----	----	----	----	----	(0.07)

Table 3: *Serum electrolyte status in mmol/L among neurologic patients in JMC, South West Ethiopia, 2019.*
**TBI: Traumatic Brain Injury; SD: Standard Deviation.*

On bivariate analysis serum electrolyte disorder was significantly associated with age i.e. patients in the age group of 35 - 44 years were more likely to have serum electrolyte disorder compared to patients in the age group of 18 - 24 years (p-value = 0.036, COR = 4.795,with 95% CI (1.106 - 20.785)). Similar to patients in the age group of 55 - 64 were more likely to have serum electrolyte disorder in comparison with the age group of 18 - 24 years (p-value = 0.029, COR = 5.077, with 95 CI (1.176 - 21.94)). On bivariate analysis serum electrolyte disorder was significantly associated with patient's condition i.e. critical patients were more likely to develop serum electrolyte disorder than non-critical patients (COR = 8.75 with 95% CI (1.199 - 63.868)), P-value = 0.032.

Occupation, chewing status, comatose state, medications (thiazides, both antibiotics and analgesics), fluids (IV) and history of chronic diseases like hypertension and diabetes, were factors associated with serum electrolyte disorders.

Serum electrolyte status	Number of patients (%)
Normal level of electrolyte	34 (28.6%)
At least one electrolyte disorders	85 (71.4%)
At least two electrolyte disorders	52 (43.7%)
At least three electrolyte disorders	26 (21.8%)
Four electrolyte disorder	3 (2.5%)

Table 4: *Serum electrolyte disorders among neurologic patients in JMC, 2019.*

Characteristics	Serum electrolyte disorder				
	N (%)	COR (95% CI)	P - value	AOR (95% CI)	P - value
Age					
18 - 24	24 (20.2)	1		1	
25 - 34	19 (16)	3.2 (0.8 - 12.41)	0.097	3.056 (0.322 - 28.985)	0.33
35 - 44	20 (16.8)	4.8 (1.1 - 20.8)	0.036*	6.686 (0.378 - 118.149)	0.195
45 - 54	21 (17.6)	1.37 (0.418 - 4.5)	0.600	0.614 (0.054 - 6.993)	0.695
55 - 64	21 (17.6)	5.07 (1.176 - 21)	0.029*	3.628 (0.260 - 50.569)	0.338
≥ 65	14 (11.8)	1.12 (0.29 - 4.3)	0.859	0.369 (0.022 - 6.164)	0.488
Sex					
Male	77 (64.7)	1			
Female	42 (35.3)	1.2 (0.5 - 2.79)	0.671	----------	-------
Marital status					
Single	38 (31.9)	1			
Married	81 (68.1)	2.13 (0.92 - 4.87)	0.074	2.508 (0.855 - 7.362)	0.094
Level of education					
No formal education	58 (48.9)	1			
Elementary	32 (26.9)	1.46 (0.55 - 3.8)	0.443		
Secondary school	20 (16.8)	1.4 (0.46 - 4.62)	0.518		
College	7 (5.9)	2.923 (0.33 - 26)	0.336	---------	
University	2 (1.7)	0.48 (0.029 - 8.2)	0.616		

Residence					
Urban	57 (47.9)	1			
Rural	62 (52.1)	1.04 (0.47 - 2.28)	0.925	----------	
Occupation					
Farmer	50 (42)	1		1	
Merchant	17 (14.3)	0.36 (0.17 - 1.89)	0.367	0.104 (0.008 - 1.399)	0.088
Government employee	15 (12.6)	2.05 (0.4 - 10.4)	0.385	1.465 (0.137 - 15.713)	0.752
Student	17 (14.3)	0.28 (0.09 - 0.88)	0.031*	0.066 (0.005 - 0.89)	0.041*
House wife	14 (11.8)	0.78 (0.2 - 2.98)	0.727	0.177 (0.018 - 1.782)	0.141
Others	6 (5)	1.58 (0.17 - 14.8)	0.690	1.457 (0.093 - 25.975)	0.761
Income (birr)					
Quartile 1	84	1.7 (0.27 - 10.7)	0.567	----------	
Quartile 2	35	1			
Smoking					
Yes	9 (7.6)	1.436 (0.28 - 7.3)	0.662		
No	110 (92.4)	1			
Alcohol drinking					
Yes	24 (20.2)	0.75 (0.29 - 1.97)	0.564	----------	
No	95 (79.8)	1			
Chewing chat					
Yes	58 (48.7)	0.56 (0.25 - 1.26)	0.166	0.05 (0.007 - 0.368)	0.003*
No	61 (51.3)	1			
Salt with food					
Yes	115 (96.6)	0.8 (0.08 - 8.25)	0.872	----------	
No	4 (3.4)	1			
Mean systolic BP					
Normal	98	1			
Low	3	0.76 (0.06 - 8.73)	0.826	----------	
High	18	0.76 (0.26 - 2.23)	0.618		

MDBP					
Normal	102	1			
Low	2	0.74 (0.05 - 8.24)	0.562	----------	
High	17	0.72 (0.21 - 2.45)	0.672		
Coma					
No	91 (76.5%)	1			
Yes	28 (23.5%)	2.1 (0.7 - 6.2)	0.158	5.5 (1.1 - 27.6)	0.037*
Medications taken					
Antibiotics	37 (31.1%)	1		1	
Benzodiazepines	3 (2.5%)	1.7 (0.14 - 20.4)	0.676	0.2 (0.008 - 1.39)	0.280
Thiazides	19 (16%)	15. (1.85 - 126)	0.011	23.5 (1.1 - 500.8)	0.043*
Loop diuretics	10 (8.4%)	3.4 (0.6 - 18.24)	0.153	1.05 (0.12 - 9.3)	0.963
Analgesics	11 (9.2%)	1.02 (0.26 - 3.9)	0.977	1.1 (0.137 - 8.9)	0.923
Both antibiotics and analgesics	23 (19.3%)	2.4 (0.7 - 7.5)	0.128	7.1 (1.24 - 40.6)	0.027*
Calcium channel blockers	14 (11.8%)	11 (1.3 - 93.4)	0.027	16.7 (0.98 - 286)	0.051
Others	2 (1.7%)	0.8 (0.05 - 14.6)	0.911	0.03 (0.00 - 2.7)	0.125
Fever					
Yes	9 (7.6%)	1.45 (0.29 - 7.3)	0.651	----------	
No	110 (93.4)	1			
Vomiting					
Yes	13	2.34 (0.49 - 11)	0.277	----------	
No	106	1			
IV fluid					
Yes	91 (76.5%)	3.55 (1.4 - 8.65)	0.005*	7.9 (1.89 - 33.3)	0.005*
No	28 (23.5%)	1			
History of chronic disease					
No	81 (68.1)	1			
Yes	38 (31.9)	5 (1.615 - 15.5)	0.005*	11.6 (1.6 - 80.9)	0.013*
Patient condition					
Non - critical	5 (4.2)	1			
Subcritical	73 (61.3)	2.88 (0.451 - 18.	0.263	3.7 (0.25 - 57.46)	0.338
Critical	41 (34.5)	8.7 (1.12 - 63.8)	0.032*	9 (0.43 - 188.8)	0.157

Table 5: *Association of factors to serum electrolyte disorder among neurologic diseases admitted to JMC, South West Ethiopia, 2019. *P - value < 0.05 was used as statically significant. AOR: Adjusted Odds Ratio. Percentages were calculated based on the total number of participants.*

Discussion

In this study hyponatremia and hypokalemia are commonest electrolyte abnormalities represent 37% and 35.3%, respectively. This finding is in line with the studies conducted in India (37%, 33%) on electrolyte abnormality in acute stroke with respective prevalence of sodium and potassium disturbances [29] and Iran (32%) [16].

The prevalence of hyponatremia (41.3%) in this study is higher than in studies conducted in Egypt and Indonesia on Acute stroke, which is 30.5% and 8.2%, respectively. This difference may be due to different management protocol [30,32].

The prevalence of hyponatremia (32.7%), hypokalemia (38.8%) and hypocalcemia (24.5%) is close to studies done in Brazil (45%), Pakistan (36.7%) and India (21.58%) on serum electrolyte Imbalances in TBI patients, respectively [19,35,36]. In this study next to hyponatremia and hypokalemia, hypernatremia in 17 (14.3%), hypochloremia in 26 (21.8%), hyperchloremia in 23 (19.3%) and hypocalcemia in 19 (16%) of patients were seen. But studies in Thailand, Pakistan and India, hypernatremia was found more common than hyponatremia. This may be due to difference in study design, management protocol or severity of the disease [23,31,35].

The finding of this study shows slightly higher disturbances of sodium (51.3%) and potassium (41.7%) than studies conducted in Nepal (36.5%, 10.6%) and Nigeria (18.3%, 8.3%) on TBI patients. This variation might be due to difference in severity of the disease, management or treatment protocol [26,45].

In this study the prevalence of hyponatremia (33.3%) on meningitis patients was lower than a study conducted in South Africa, which was 62.5%. This might be due to difference in study design, management protocols or severity of the disease [38].

Serum electrolyte disorder was significantly associated with occupation. i.e. the odds of having serum electrolyte disorder among students was less likely than farmer, taken as a reference category. (P-value = 0.041, AOR = 0.066 with 95% CI (0.005 - 0.89)). This might be due to students have good dieting habit than farmers [39].

In this study serum electrolyte disorder was associated with chewing chat status i.e. the odds of having serum electrolyte disorder among patients who had history of chewing chat was less likely than those who had no history of chewing chat (P-value = 0.003, AOR = 0.05 with 95% CI (0.007 - 0.368). This is may be due to chat contains vitamins or minerals [40].

In this study, the odds of having serum electrolyte disorder among comatose patients was five times more than those in non-comatose state (AOR = 5.529 with 95% CI (1.106 - 27.651)). This is may be due to syndrome of inappropriate secretion of antidiuretic hormone (SIADH) in comatose patients [11]. This is in line with a study done in Thailand [31] and India [23].

There was significant association between serum electrolyte disorder and medications taken. i.e. the odds of having serum electrolyte disorder among patients who took thiazides was more likely than those who took antibiotics taken as a reference category (COR = 5.455 with 95% CI (1.09 - 27.283), p-value = 0.039) and AOR = 23.5 with 95% CI (1.103 - 500.809). The odds of having serum electrolyte disorder among patients who took both antibiotics and analgesics was seven times more likely than those who took antibiotics (COR = 10.909 with 95% CI (1.304 - 91.268), p-value = 0.027) and AOR = 7.109 with 95% CI (1.244 - 40.642), p-value = 0.027). This finding is in line with studies conducted in Switzerland, Netherlands, China and Carolina [12,41-43] and may be due to effect of thiazides to cause secondary aldosteronism, stimulation of vasopressin secretion or direct antidiuretic effect in the kidney [12].

There was significant association between serum electrolyte disorder and patients taking intravenous fluid. The odds of having serum electrolyte disorder among patients who took fluid was eight times more likely than those who were not (P-value = 0.005, COR = 3.55 with 95% CI (1.455 - 8.659) and AOR = 7.938 with 95% CI (1.89 - 33.332), P-value = 0.005. This is in line with studies conducted in Pakistan and India. This might be due to inability to perform regular check up to serum electrolytes to those taking intravenous fluid [23,35].

There was significant association between serum electrolyte disorder and history of chronic diseases i.e. the odds of having serum electrolyte disorder patients among patients who had history of chronic disease was eleven times more likely than those who had no history of chronic disease (P-value = 0.005, COR = 5 with 95% CI (1.615 - 15.477) and AOR = 11.666 with 95% CI (1.681 - 80.966), p-value = 0.013). This finding is in line with studies conducted in Netherlands and Pakistan (12,44). This may be due to hyperglycemia increases serum osmolality resulting in osmosis of water out of the cells and decreases serum electrolytes by dilution or the effect of chronic diseases on the kidney or the brain leading to serum electrolyte imbalances.

Strength and Limitation of the Study

Strength of the study

- It was the first study to assess serum electrolyte disorders among hospitalized neurologic patients in Ethiopia.
- We had relatively reduced experimental errors since we analyzed blood by CONTEC hemolyte plus 5 analyzers.

Limitation of the study

- Due to lack of machine, serum level of Mg was not done.
- Using cross sectional study design by itself did not differentiate cause and effect relationship.

Conclusion

In this institutional based cross-sectional study, the prevalence of at least one, at least two, at least three and four electrolyte disorder were seen in 71.4 %, 43.7%, 21.8% and 2.5% of neurologic patients, respectively. The remaining 28.6% of patients had normal level of electrolytes (Na^+, K^+, Cl^-, Ca^{2+}). Except hypercalcemia, other electrolyte disorders (hyponatremia, hypokalemia, hypochloremia, hyperchloremia, hypocalcemia, hypernatremia and hyperkalemia were seen in 37%, 35.3%, 21.8%, 19.3%, 16%, 14.3% and 1.7%, of patients), respectively. In this study, hyponatremia and hypokalemia were common electrolyte disorders.

Occupation, chewing chat status, comatose state, medications (thiazides, both antibiotics and analgesics), Intravenous fluids and history of chronic diseases like hypertension and diabetes, were factors associated with serum electrolyte disorder.

Ethical Approval and Consents

Ethical clearance was obtained from Jimma University Institutional Review Board (IRB.) After getting letter of cooperation from JMC and permission from the study participant, written consent was obtained from study participant. Each study participant was informed about the research, their right to abandon, the involvement at any time and confidentiality of information was maintained. Findings were communicated in aggregated form

Availability of Data and Materials

Datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have competing interests.

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Authors Contribution

LM, ST, WR and CK designed the study and contributed in manuscript writing. AA, MBG, AAB, EKW, GBB and BZW analyzed and interpreted the patient data. All authors read and approved the final manuscript.

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