Jimma University

Institute of Health

Department of Biomedical Sciences

# Assessment ofSerum Electrolyte Disorder and Associated factors amongAdult Neurologic Patients Admitted to Jimma Medical Center, South West Ethiopia

By: -LemlemuMaru (BSc.)

A ThesisSubmitted to Department of Biomedical Sciences, Institute of Health for Partial Requirements for Master of Science in Medical Physiology.

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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 commonest electrolyte abnormalities and may contribute to mortality unless corrected urgently.Among all neurologic diseases of adult, stroke ranks first.

**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 119adult neurologic patients by using stratified sampling technique. Blood was drawn from neurologic patients, centrifuged and level of serum electrolyte (Na, K, Cl, and Ca)was determined. Data were feed into Epidata 4.4.2.win 64 and exported to SPSS version 20. Binary Logistic Regression (bivariate and multivariate analysis with backward LR)was used to identifythe associated factors to electrolyte disorders. Data were expressed in percentage, mean, ± SD and P-value ≤0.05 considered as a statistically significant. Data were presented with text, tables

**Results**: From a total of 119 neurologic patients included in this study, about 77(64.7%) were males and majority of patients (20.2%) were between ages of 18-24 years. Chewing chat (48.7%) was the most common behavioral practice. The prevalence of at least one electrolyte disorder was 71.4%and 28.6% of patients had normal electrolyte level. The prevalence of hyponatremia, hypokalemia, hypochloremia ,hyperchloremia,hypocalcemia,hypernatremia and hyperkalemia was 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.

**Key words**: prevalence, electrolyte disorders, associated factors, neurologic diseases,JMC

## Acknowledgement

First of all, I thank my almighty God for having given me the strength and wellness until this time.

Next, my grateful acknowledgement goes to my advisors Mr. Samuel Tadesse (Associate professor of Medical Physiology), Mr.WonduReta (Lecturer of Medical Physiology) and Mr. ChalaKenenisa (Lecturer of Medical Biochemistry) for their brilliant effort and for giving me scientific comments throughout the research process.

I also thankJimma Medical Center Health Management Information System staffs, data collectors,Assosa University and JimmaUniversity.

I also thank all of my friends and colleagues for their help and advice. Finally I thank the study participants for their volunteer participation.

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## List of Abbreviations

ADH…….....Antidiuretic hormone

BNP……. Brain natriuretic peptide

CSF……Cerebrospinal Fluid

CT……...Computed tomography

CVA……Cerebrovascular accident

DALY……..Disability Adjusted Life Years

GCS……Glasgow coma scale

ICH……. Intracranial hemorrhage

ICU……. Intensive Care Unit

JMC……Jimma Medical Center

MDBP……...Mean Diastolic Blood Pressure

MRI……. Magnetic resonance imaging

SAH…….Sub- Arachinoid Hemorrhage

SIADH……Syndrome of inappropriate secretion of antidiuretic hormone

TBI……. Traumatic brain injury

# Chapter One. Introduction

## 1.1. Background

Electrolyte homeostasis in the central nervous system is essential for brain function. Regulation of ionic balance is a critical process involving a complex array of molecules for moving ions into and out of the brain and involving blood–brain barrier(1).Electrolyte derangements are common after neurologic disorders, with many having neurologic manifestations presented with weakness, hyperreflexia, tremor, chorea, myoclonus, drowsiness or coma, including seizures(2–4). The neurological disorders that cause electrolyte disorders include neurotrauma, sub-arachnoid hemorrhage, intracerebral hemorrhage, meningitis and stroke(5).

Neurologic disorders represent 7% of the total global burden of disease measured in disability-adjusted life years (DALY) for all causes and ages. Cerebrovascular disease or Stroke accounts for 4.1% of total global DALY. Neurologic disorderscontribute 6.8% of DALY in low and middle income countries and 3.1% of DALY in Eastern Sub Saharan Africa(6).Among all neurologic diseases of adult, stroke ranks first (7). Globally, there were 13•7 million new stroke cases in 2016(8). Stroke causes ~200,000 deaths each year in the United States and is a major cause of disability(9).

Africa and other Asian low middle-income countries account for the greatest burden of the global road-traffic injury(RTI) -related head injury (10). Death from head injuries account for 34% of all traumatic deaths (11). In England and Wales 1.4 million patients per year attend hospital following head injury and the most common cause of death under the age of 40(12).

Incident cases of meningitis globally increased from 2•50 million in 1990 to 2•82 million in 2016.The highest mortality rates and incidence rates were found in African meningitis belt, with six of the ten countries with the largest number of cases and deaths. There were 553,768 incident cases of meningitis in East Sub Saharan Africa and 192,617 incident cases of meningitis in Ethiopia in 2016 (13).

Seizures are especially common in patients with sodium disorders, hypocalcemia, and hypomagnesemia(1).Hyponatremia and hypokalemia are common electrolyte disturbances following Neurologic disorders(9).

.

Patients with neurologic diseases have 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 disorderwill affect treatment and outcome ofNeurologic patients. Hypomagnesemia interferes with the patient's ability to properly replete potassium, thus making magnesium replacement crucial to adequate potassium replacement(4,14).

Syndrome of Inappropriate secretion of Anti Diuretic Hormone (SIADH) is associated with various neurologic diseases and neurosurgical procedures including meningitis,encephalitis and traumatic brain injury. SIADH can affect level of serum electrolytes especially sodium(15).

## 1.2. Statement of the problem

At least one electrolyte disorder is common in neurologic patients(15).But electrolyte disorders sometimes overlooked in patients with neurologic diseases(16).Mild electrolyte disorders can have a reduced performance in mental function tests and disturbances of balance(3,17).Electrolyte disorders can significantly impact the medical course of patients with neurological diseases(5,10,18–20).Hyponatremia is more common in neurologic patients and is particularly associated with aneurismal subarachnoid haemorrhage (SAH),traumatic brain injury (TBI) and meningitis(21,22). Prevalence of electrolyte disorders in India among stroke patients showsHypocalcaemia (40%), Hyponatraemia (38.5%),Hypomagnesaemia (38%), and Hypokalemia (26.5%)(23).

Another recent study in India shows,the prevalence of electrolyte disorders(hyponatremia, hypocalcema ,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 (24). A study on TBI patients in India shows, prevalence of electrolyte disorders(hyponatremia,hypokalemia,hypocalcemia,hypernatremia,hyperkalemiaand hypercalcemia) 25%,20.9%,14.7%, 13.8%, 11%, and 5.2%, respectively (25). A study in Nigeria showed the prevalence of hyponatremia, hypokalemia and hypochloremiaamong Traumatic Brain Injury patients was 18.3%, 8.3% and 6.7% respectively(26).

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(27). A study in Texas among Traumatic Brain Injury patients showslower survival rates for patients with greater degrees of hypernatremia(28). 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(29).

Prevalence of hyponatremia in patients with CNS infections was observed in 42.71% (82/192) patientsand associated with a mortality increase of 7 to 60 %(16,30).Severe hyponatremia patients had higher risks of suffering dementia than the non-severe hyponatremia patients (31).The annual cost of managing patients with hyponatremia has been estimated at $3.6 billion (32). Alcoholic patient exhibit severe electrolyte derangements than non-alcoholics(33). 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 hypochloremiaand increased risk of mortality with 2.3 fold in 23.1% of hospitalized patients(34).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(7,19).

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 died in the first 24 hours after cranial surgery (35,36).

Electrolyte disturbancesare potentially fatal, due to interference with acid–base status, enzyme systems, and the function of excitable tissues including nerves and muscles. Abnormal plasma sodium concentrations are associated with death in critically ill people, independent of disease severity, and even small alterations can increase mortality risk(21).

Electrolytes derangements play a major role in secondary brain injury. Therefore, early detection and correction of the electrolytes 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(37,38).

There is a scarcity of data about electrolyte disorders in Neurologic diseases especially in developing countries (38).

## 1.3. Significance of the study

Most of the clinical manifestations of electrolyte derangements are predominantly neurologic and parallelwith the severity of neuronal damage. Furthermore, these disorders may appear with seizures, or with rapidly progressive neurologic symptoms and signs, and thus require emergency treatment. But sometimes, electrolyte disorders overlooked in patients with neurologic disorders. Therefore, clinicians will get attention to serum electrolyte disorders among neurologic patients and manage their patients optimally, based on this finding.Appropriate management of electrolytes derangements not only improve neurological status but also decrease morbidity and mortality(9). In addition, no study was conducted on electrolyte disorders among neurologic patients in Ethiopia. Therefore, this study may be used as a baseline for further studies and an input for policy makers.

## Chapter two: Literature review

A study in Netherland shows 15.0% of study subjects had at least 1 electrolyte disorder, with hyponatremia (7.7%) and hypernatremia (3.4%) being most common. Diabetes mellitus was identified as an independent risk factor for hyponatremia and hypomagnesemia, whereas hypertension was associated with hypokalemia. Diuretics were independently associated with several electrolyte disorders: thiazide diuretics (hyponatremia, hypokalemia, hypomagnesemia), loop diuretics (hypernatremia, hypokalemia), and potassium-sparing diuretics (hyponatremia). The use of benzodiazepines also was associated with hyponatremia. Hyponatremia and hypomagnesemia were independently associated with an increased mortality risk (18).

Out of 50 stroke patients, 16 (32.0%) of patients had hyponatremiaand 5 (10.0%) had hypernatremia and 29 (58.0%) had normal serum sodiumlevels. Also, 10 (37.0%) ischemic stroke patients had hyponatremia in comparison to 6 (26.1%) hemorrhagic stroke patients (4, 6, 7). 63.83% hemorrhagic stroke patients had dyselectrolytemia& 47.17% ischemic stroke patients had dyselectrolytemia without any significant difference ($p>0.05$)(23).Stroke is more prevalent among men than women with ratios varying from 1.3:1 to 2:1.(38).

Prospective observational study in Egypt shows the prevalence of hyponatremia 30.6%, hypernatremia 8.2% and normonatremia 61.2%. Five patients with ischemic stroke, seven patients with intra cerebral hemorrhage and four patients with subarachnoid hemorrhage were dead. The number of dead patients increased with occurrence of hyponatremia. In addition, the number of the outcomes of dead patients increased with increased stroke severity(35).

Prospective randomized observational study in India shows out of 315 Traumatic Brain Injured patients, 27.3% had hypernatremia, 18.3% had hyponatremia, 21.58% had hypokalemia, 17.77% had hyperkalemia, 11.4% had hypocalcemia and5.7% had hypercalcemia. In this study there is an association between observed electrolytes and Glasgow coma scale ($p<0.05$)(39).Another study in India shows that hyponatraemia is noted in 46% of individuals and hypochloremia is noted in 24% of individuals with alcohol dependence syndrome. Hypokalemia is noted in 67% of subjects with alcohol dependence syndrome(40).

Patients with severe head injury are at a high risk for the development of hyponatremia, hypophosphatemia, hypokalemia, hypocalcemia and hypomagnesemia(29). Resuscitative

measures and pharmacological therapy (use of Furosemide and Mannitol) for Traumatic Brain Injury patients causes electrolyte disorder(9).

The risk to the development of electrolyte disturbance in TBI patients depends on the severity of head injury, underlying disease, age, and primary therapeutic strategy such as the choice of resuscitation fluid, administration of mannitol or diuretics, and hyperventilation. The injection of hypertonic saline produced a rise in the concentration of plasma serum sodium in all cases(9,29,41).

A study in Brazil shows that the incidence of sodium disturbances among TBI was 45%: 20 patients presented hypernatremia and 16 hyponatremia. A greater incidence of sodium disorders was found in patients with subdural, intracerebral hematoma and with diffuse axonal injury. The incidence of sodium disorders among the patients with diffuse lesions was greater than in the group of patients with brain contusion ($P = 0.022$). The incidence of sodium disorders is higher in patients with diffuse traumatic brain injuries. No association was found between focal lesions and proportion of sodium disorders(42).

Development of hyponatremia can cause altered sensorium in neurologic patients and whenit occurs abruptly it causes convulsions and aggravates cerebral edema leading to cerebral ischemia causing further brain damage and leads to deaths. Magnesium deficiency is associated with vasoconstriction and vascular endothelial cell injury. Hyponatremia was commonest electrolyte disorder in 36.11% of ICH and 9.38% of ischemic strokes and hypernatremia in (3.26%) cases of ischemic strokes. Electrolyte disturbances may have negative influences on the outcome of neurologic patients(23).

Prospective cohort study in Thailand showed that Hypernatremia was found more common than hyponatremia. Hypokalemia was the most common electrolyte imbalance in preoperative period (65.5%). Phosphate and magnesium depletion were remarkably high in severe TBI patients. The incidence of electrolyte imbalance was affected by the severity of TBI(36,43).

The most powerful independent variables associated with TBI outcomes were age, GCS motor score, pupil response.Findings werehyponatremia 30.6%, hypernatremia 8.2% and normonatremia 61.2% which are strongly related to a poorer outcome. Hyponatremia was strongly related to a poorer outcome (43).

An observational study shows out of 84 TBI patients, 69(82.1%) had normal sodium levels, 13(15.4%) had low sodium levels and 2(2.3%) had high sodium levels whereas 73(86.9%) had normal potassium levels, 10(11.9%) had low potassium levels and 1(1.1%) had high potassium levels. Out of 18 severe injuries, 10(55.5%) had abnormal sodium levels and 3(16.6%) had abnormal potassium levels which were found to be significant ($p<0.0001$)(44).

Studies in China and Carolina show that hyponatremiaand hypokalemia were associated with thiazide users in patients with cerebral edema(45,46)

A study in Pakistan shows that stroke patients who had history of hypertension had high risk of developing hyponatremia(47)

A study in Nepal shows that mild and moderate head injuries are common than severe head injuries. The incidence of sodium disorders is high (36.5%) with 20% of the patients having hypernatremia and 16.5% having hyponatremia(48).

A study in South Africa shows that hyponatremia was seen in one third of patients withmeningitis(49).

Prospective observational study in Nigeria shows that 18.3% of TBI had hyponatremia, 8.3% hypokalaemia and 6.7% hypochloremia. The mean sodium concentration in Severe TBI (133.52 ± 7.26, p = < .001) was significantly lower than the mean sodium concentration in Moderate TBI (138.20 ± 4.12, p = <.016) and the mean sodium for Mild TBI (140.76 ± 3.28, p = < .001). However, the mean sodium concentration in moderate TBI was not statistically significantly lower than Mild TBI (140.76 ± 3.28, p = < .252). In this study, there was statistically significant association between severe TBI and hyponatremia (p= <.001).Alteration in conscious level and coma are well established clinical features of hyponatremia and explain the association between Glasgow coma score (GCS) and serum hyponatremia(26).

A study in Lahore shows 23.8% and 9.5% of meningitis patients had hyponatremia and hypernatremia respectively(16).

## Conceptual framework

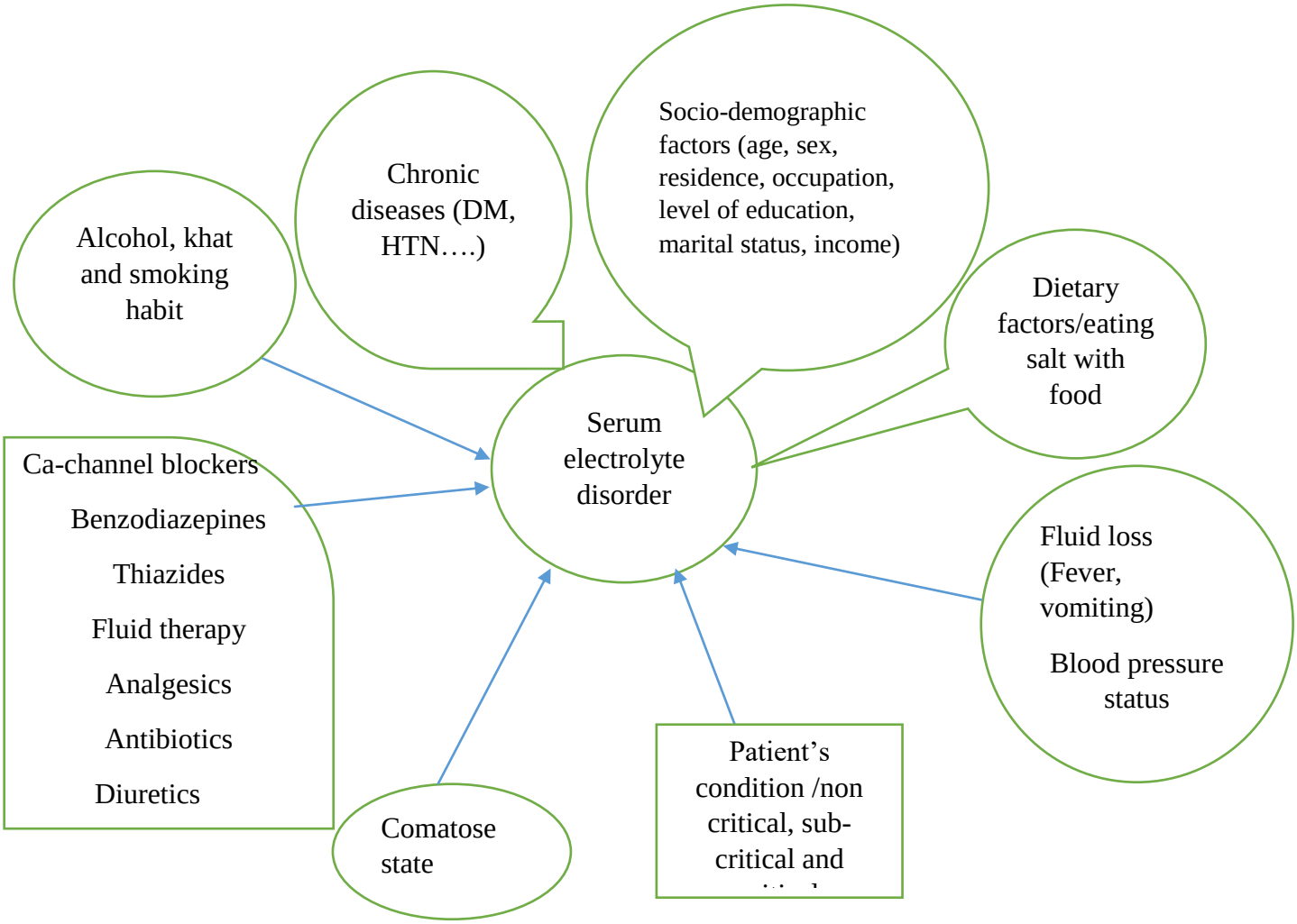


**Figure 1.Conceptal framework for assessment of serum electrolyte disorder**

# Chapter Three: Objective of the study

## 3.1. General objective

-To assess magnitude of serum electrolyte disorders (Na, K, Ca, Cl) and associated factors among adult neurologic patients admitted to Jimma Medical Center from March 30, 2109 to May 30, 2019.

## 3.2. Specific objectives

-To determine the level of serum electrolytes (Na, K, Ca, Cl).

-To assess factors associated with serum electrolyte disorder in neurologic patients.

# Chapter Four: Materials and Methods

## 4.1. Study area and period

The study was conducted in Jimma MedicalCenter (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 accounts 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.

## 4.2. 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.

## 4.3. Source and Study population

### 4.3.1.Source population

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

### 4.3.2. Study population

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

### 4.3.3. Inclusion criteria

- Patients admitted with neurologic diseases (stroke, meningitis, traumatic brain injury

age greater than 18.

### 4.3.4. Exclusion criteria

- Patients diagnosed only based on clinical history without CT/MRI/Cerebrospinal fluid

analysis.

- Patients who have no care givers
- Neurologic Patients having kidney diseases, liver diseases, thyrotoxicosiswere excluded.

## 4.4. Sample Size Determination and Sampling Technique

### 4.4.1. Sample size

Sample size was calculated based on study conducted in Egypt in 2016 taking the prevalence of hyponatremiaas 30%. Therefore, with singlepopulation 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

### 4.4.2. Sampling technique

Stratified sampling technique was used among neurologic patients (stroke, meningitis, traumatic brain injury) admitted to Jimma Medical Center based on annual report or registration and allocatedproportionately as follows:

| | Stroke | TBI | Meningitis | Total |
|---|---|---|---|---|
| Average 2 month report in 2010 E.C. at JMC | 80 | 70 | 13 | 163 |
| Required sample size | 58 | 51 | 10 | 119 |

## 4.5. Variables

### 4.5.1. Dependent variable

Serum electrolyte disorder

### 4.5.1. 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

## 4.6. 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 with in 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 or non-critical

## 4.7. Data Collection procedures

Data collection toolswere 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 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 -80oC till the time of biochemical analysis to measure level of serum electrolytes based on ion-selective electrode that have six different electrodes used in the analyzer: Na+, K+, Cl-, Ca2+,, Li+, and a reference electrode was used under standard operating system.Measurement of serum electrolytes was done at Jimma Medical center laboratory section withhemolyte plus five analyzer (Germany).

## 4.8. Data entry, processing and analysis

Data was checked, cleared and feed into Epi-data (version 4.4.2.0.win.64) and thenexported 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 studyemployed 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 were expressed in mean, ± SD, texts, tables and P <0.05 was considered as a statistically significant.

## 4.9. 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 that they going to undertake was clarified.

The principal investigator supervised data and specimen collectors, directly involved, 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 the suspected specimen that had poor quality was rejected automatically. Working and acceptable commercial kits were used.Measuring instruments and biochemical analyzers was 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 was made. During the actual data collection period, the questionnaire was checked every night for completeness.

## 4.10. Ethical Consideration

Ethical clearance was obtained fromJimma 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.

## 4.11. Dissemination and utilization of results/findings

Results/findings disseminated to Jimma University, Department of Biomedical Sciences and to JMC. Effort will be made to present findings in different workshops, seminars or conferences.

For wider and international effect, effort will be made to publish on reputable journal.

# Chapter five: Results

## 5.1. Socio-demographic characteristics of patients

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

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

| 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 |

## 5.1. Clinical characteristics of study patients

Out of 119 neurologic patients 28(23.5%) were in coma. Regarding medications 37(31.1%)of patients took antibiotics, 23(19.3%) of patients took both antibiotics and analgesics, 19(16%) of patients took thiazides, 14(11.8%) of patients took calcium channel blockers,11(9.2%) of patients took analgesics and 10(8.4%) of patients took loop diuretics and 3(2.5%) took benzodiazepines. Majority 102(85.7%) and 98(82.3%) of patients had normal systolic and diastolic blood pressure, respectively. The remaining 18(15.2%), 15(12.6) 3(2.5%) and 2 (1.7%) had high systolic, high diastolic, low systolic and low diastolic blood pressure,respectively.

According to this study, majority of patients were in sub-critical condition accounts 73(61.3%), the remaining were in critical and non-critical condition accounting 41(34.5%) and 5(4.2%), respectively. Among 119 neurologic patients 38(31.9%) 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 27(71.05%), 4(10.53%), 3(7.9%), 1(2.63%) and 3(7.9%).respectively.

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

| 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 |

## 5.2. Serum electrolyte status of study patients

The mean serum Na,K, Cl and Ca were137.3, 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.

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. 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.Hypochloremia was found in 26(21.8%) of patients.Hyperchloremia was found in 23(19.3% of patients.Regarding to Calcium, Hypocalcaemia was found among 19(16%) but Hypercalcemia was not found (For details see table 3 ).

Severe hyponatremia (<125mmol/L) in 3(2.5%), Moderate hyponatremia (125-129.9mmol/L) in 10(8.4%) and Mild hyponatremia (130-134.9mmol/L) in 31(26.1%) of patientswas seen. Mild hypernatremia (145.1-149.9mmol/L) in 8(6.7%) of patients, Moderate hypernatremia in 8(6.7%) of patients and Severe hypernatremia in 1(0.8%)patient was seen.In this study Severe hypokalemia (<2.5mmol/L) in 2 (1.7%), Moderate hypokalemia (2.5-2.99mmol/L) in 14(11.8%) and mild hypokalemia in 26(21.8%) of patients was found. Mild hyperkalemia (5.51-6.49mmol/L) and Moderate hyperkalemia (6.5-7.49mmol/L) was found in 2(1.7%) but Severe hyperkalemia (≥7.5mmol/L) was not found.

**Table3: Serum electrolyte status in mmol/L among neurologic patients in JMC, South West Ethiopia, 2019**

| 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) |

*TBI=Traumatic Brain Injury, SD=Standard Deviation

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

| 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%) |

In bivariate analysis variables that had p-value <0.25 were candidate variables to multivariate anlysis. Accordigly Candidate variables to multivariate analysis were age,marital status,occupation, chewing chat status,coma,medications,intravenous fluids, history of chronic diseases and patient condition/severity of the disease. Variables such as residence,annual income,level of education,drinking alcohol,smoking,eating salt with food, vomiting and fever were not considered to multivariate analysis.

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( table 5).

**Table 5: Association of factors to serum electrolyte disorder among neurologic diseases admitted to JMC, South West Ethiopia, 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 | | |

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| Characteristics | Serum electrolyte disorder | | | | |
|---|---|---|---|---|---|
| | N (%) | COR(95% CI) | P-value | AOR(95% CI) | P-value |
| 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 diseaseNo | 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 |

*****P-value <0.05 was used as statically significant. AOR- adjusted odds ratio. Percentages were calculated based on the total number of participant.

## Chapter Six: Discussion

The study was conducted among 119 adult neurologic patients who were selected through stratified sampling technique as Stroke, Traumatic Brain Injury (TBI) and Meningitis. 64.7% were males and 35.3% were females.

In this study hyponatremia and hypokalemia are commonest electrolyte abnormalities represent 37% and 35.3%, respectively. This finding is inline with the studies conducted in India(37%,33%)on electrolyte abnormality in acute stroke with respective prevalence of sodium and potassium disturbances(7) and Iran(32%)(22).

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 (35,37).

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(11,25,42).In this study next tohyponatremia and hypokalemia, hypernatremia in 17(14.3%), hypocholeremiain 26(21.8%), hypercholeremia in 23(19.3%) and hypocalcaemia in 19(16%) of patients wereseen. Butstudies 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 (11,29,36).

The finding of this study shows slightly higher disturbances of sodium (51.3%) and potassium (41.7%) than studies conducted inNepal(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 thana study conducted in South Africa, which was 62.5%. This might be due todifference in study design, management protocols orseverity of the disease (49).

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(50).

In this study serum electrolyte disorder was associated with chewing chat status i.e. the odds of having serum electrolyte disorderamong 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 chatcontains vitamins or minerals(51).

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(36)and India(29).

There was significant association between serum electrolyte disorder and medications taken.i.e. the odds of having serum electrolyte disorder among patientswho took thiazides was more likely than thosewho 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 (18,41,45,46) and may be due to effect of thiazides to cause secondary aldosteronism, stimulation of vasopressin secretion or direct antidiuretic effect in the kidney(18).

There was significant association between serum electrolyte disorder and patients taking intravenous fluid.The odds of having serum electrolyte disorderamong patientswho 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 Pakistanand India. This might be due to inability to perform regular check up to serum electrolytes to those taking intravenous fluid(11,29).

There was significant association between serum electrolyte disorder and history of chronic diseases i.e. the odds of having serum electrolyte disorderpatients among patientswho 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 conductedin Netherlands and Pakistan(18,47). 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(52,53).

## Chapter Seven: Strength and limitation of the study

Strength of the study

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

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.

## Chapter Eight: Conclusion

In this institutional based cross sectional study the prevalence of at least one, at least two, at least three and four electrolyte disorderwereseen 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-, Ca2+).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. Hyponatremia and hypokalemia were common electrolyte disorders in this study.

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.

## Chapter Nine: Recommendation

Based on the study finding, the following recommendations can be forwarded;

**To Jimma Medical Center**

- Early screening and detection of serum electrolyte disorders among neurologic patients especially for high risk groups such as farmers, those in coma, those who took thiazides, both antibiotics and analgesics, those who took IV fluids, those who had chronic history of disease like hypertension and diabetes, should be done to manage timely.

**To FMOH, JMC and other responsible organizations**:

- A machine that able to measure serum Mg should be made available in JMC.

**To researchers**:

- Further prospective follow up studies might be needed to clearly address the outcome of electrolyte disorders among neurologic diseases.

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## Annex I: Information sheet (English version)

Information sheet for the participants of the study entitled assessment of serum electrolyte disorders and associated factors among adult neurologic patients admitted to JMC, South West Ethiopia.

Principal Investigator: Lemlemu Maru

Advisors:

Mr. Samuel Tadesse (Associate professor of Medical Physiology)

Mr.ChalaKenenisa (MSc, Lecturer of Medical Biochemistry)

Mr. WonduReta (MSc, Lecturer of Medical Physiology)

Name of sponsor: Jimma University

1. Aim of the study

To assess of serum electrolyte disorders and associated factors among adult neurologic patients admitted to JMC, South West Ethiopia.

2. Study design and procedure

If you agree to take part in this study, you will be given the consent form to sign, and interviewed by health professional. Thedata collector will be asked some questions about the socio-demographic characteristics. Physical measurements like blood pressure and temperature will be taken. 5mL of blood sample will be also collected for laboratory examination to assess serum electrolyte disorders and associated factors.

3. Risks

Participating in this study will not cause more discomfort than the routine examination you required during clinic visit. But minor pain and skin color change may be occur following blood drawing, which will disappear within short duration. The amount of blood required in the study is 5mL, which will not affect your health. The whole procedure will be carried out by health professionals through standard clinical practice, so participating in this study has no major risks.

4. Benefits

Participating in this study is beneficial in such a way that knowing level of serum electrolytes and will be linked to physicians. But it has no financial benefit or incentive.

5. Confidentiality

All information about the participant will be kept confidential. Logbooks used in the laboratory will have no names but codes.

6. Right to refuse

You have full of right to withdraw from participating in this study at any time before and after the consent without explaining the reason.

Email address: lemlemuabel@gmail.com

Telephone: +251909913397

## Annex II Consent Form (English)

Code of study subject _____

I have been informed about a study plan that is entitled with "Assessment of the status of Electrolyte Imbalance in JMC, South West Ethiopia" and for this purpose some information and blood sample will be taken from me. The aims of this study were explained to me. Collection of the sample would follow the usual procedure for laboratory investigation but there might be some pain that is associated with the blood collection.

I am also informed that all the information contained within the questionnaire is to be kept confidential. Moreover, I have also been well informed of my right to keep hold of information, decline to cooperate and make myself withdraw from the study. I have been informed that laboratory results will be disclosed to me whenever the result is ready and incase the result had any pathological indication, I am told that I will be linked to appropriate place for further diagnosis and treatment.

It is therefore with full understanding of the situation that I gave the informed consent voluntarily to the researcher to use the specimen taken from me for the investigation. Moreover, I have had the opportunity to ask questions about it and received clarification to my satisfaction.

Signature (participant)_____ Signature(investigator)_____

Witness name_____ Signature _____

Consent form (AfaanOromoo)

Koodiinamaqorannoorrattihirmaatuu_____

Waa'eeQo'annoo fi qorannoodhimmakeemikaala "Elektirolaayitii" jedhamudhiigakeessattiargamaniiirrattigaggeeffamuuilaalchiseefaayidaanqorannichaa, kaayyoonisaa fi barbaachisummaanisaanattihimameejira.Akkuma kana faayidaa kana qofaafkanoolu, odeeffannoongaaffiidhaanfunaanamuu fi dhiigniqorannoofooluakkanarraafudhatamuhubadheenjira. Akkiittidhiigninarraawaraabamuadeemsaogummaatii fi haalabarameenakkata'uu fi yeroosanattidhukkubbiixiqqaannattidhagahamuuakkadanda'ubareenjira.

Odeeffannoonnarraafuudhamuhundumtuuiccitiidhaanakkanaafqabamunaafibsameejira.Kana malees, yeroonbarbaadettiqorannoo kana keessaabahuu, odeeffannookennuuhinbarbaannekennuudhiisuu fi qorannichagargaaruubaachuuakkandanda'usbeekeenjira.Bu'aanqorannoodhiigakiyyaasyoowaanrakkinafayyaaqabaachuuagarsiisata'enattihimameeogeessafayyaagahuumsaqabuunakkanilaalamu ufwalnaqunnamsiisuufwaadaanaafgalaniijiru. Waannaafhingallekamiyyuusgaafadheeibsagahaaargadheenjira.

Hubannoo fi fedhamataakiyyaatinqorannooo kana keessattiodeeffannoo fi dhiigakennuunhirmaachuufwaliigaleenjira.Waliigaluukiyyakanaaf raga akkatahutti, armaangadittimallattookootinnanmirkaneessa.

Mallattoohirmaataa _____ MallattooQorataa_____

MaqaaRagaa_____ Mallattoo_____

**Consent form (Amharic)**

የ ጥና ቱተሳ ታፊ ማእ ያ ቁጥር _____

"ስ ለ ኤሌክ ትሮ ላ ይትበ ጅ ማ ሜ ዲካ ል ሴን ተር ፤ ደ ቡ ብ ምዕ ራ ብ ኢ ትዮ ጵ ያ "
የ ኤሌክ ትሮ ላ ይትን ሁ ኔ ታ ለ ማእ የ ት ስ ለ ሚ ዳ ው የ ማ ኮ ኛ ዕ ቅ ድ ተ ነ ግ ሮ ኛ ል ::
ለ ዚ ህ ም ኵ ቂ ት ሚ ጃ እ ና የ ደ ም ና መ ኖ ይ ወ ሰ ዳ ል :: የ ዚ ህ ጥ ና ት ዓ ላ ማ እ ኔ ተ ብ ራ ር ቷ ል ::
የ ና መ ኖ ማ ስ ባ ሰ ቡ የ ተ ለ ሚ ዉ ን የ ም ር ሚ ራ ሂ ደ ት ይ ከ ተ ላ ል ፡ ፡ ነ ገ ር ግ ን ከ ደ ም ማ ስ ብ ሰ ብ ጋ ር የ ተ ያ ያ ዘ ህ ማ ማ ኢ ኖ ር ይ ች ላ ል ::

በ ማ ከ ይ ቁ ዉ ስ ጥ የ ተ ካ ተ ቱ ሁ ሉ ም ሚ ጃ ዎ ች በ ም ሥ ጡ ር እ ን ደ ሚ ከ በ ቁ ተ ብ ራ ር ቶ ል ኛ ል ፡ ፡ ከ ዚ ህ ም ክ ላ ይ የ ሚ ጃ ማ ብ ቴ ን የ ማ ከ በ ቅ ,
የ ሞ ተ ባ በ ር ማ ብ ቴ ን እ ና ከ ም ር ሚ ራ ዉ ራ ሴ ን የ ማ ጨ ሓ ት ማ ብ ቴ እ ን ደ ሚ ከ በ ቅ ተ ነ ግ ሮ ኛ ል ፡ ፡ ዉ ጤ ቱ ዝ ግ ጁ በ ሆ ነ ግ ዜ የ ላ ቦ ራ ቶ ሪ ዉ ጤ ቶ ች እ ን ደ ሚ ለ ዱ ል ኝ ተ ነ ግ ሮ ኛ ል ::
በ ም ር ሚ ራ ዉ ም ሞ ህ ማ ም ሜ ክ ት ል ሆ ን የ ሚ ቻ ል ነ ገ ር ከ ተ ገ ኝ ብ ኝ ለ ተ ጨ ሜ ሪ ም ር ሚ ራ እ ና ሕ ክ ም ና እ ን ዳ ገ ኝ ወ ደ ተ ገ ቢ ቦ ታ እ ን ደ ሚ ያ ገ ና ኙ ኝ ተ ነ ግ ሮ ኛ ል ::ከ ዚ ህ ም ክ ላ ይ ስ ለ ጉ ዳ ዩ ጥ ያ ቄ ዎ ች የ ማ ከ የ ቅ እ ድ ል አ ግ ኝ ቻ ለ ሁ እ ና በ ተ ሰ ጠ ኝ ሜ ል ስ ረ ክ ቻ ለ ሁ ፡ ፡

ስ ለ ዚ ህ በ ፈ ቃ ደ ኝ ነ ቴ ስ ለ ጥ ና ቱ ማ ሉ በ ማ ሉ በ ሚ ዳ ት ለ ም ር ሚ ራ ዉ ም አ ሰ ፈ ላ ጊ ሚ ጃ እ ና የ ደ ም ና መ ኖ እ ን ዲ ወ ሰ ድ ተ ስ ማ ም ቻ ለ ሁ ፡ ፡ ይ ህ ን ን ስ ም ማ ቴ ን ለ ሚ ጋ ገ ጥ ከ ስ ር በ ፊ ር ሜ ኤ ረ ጋ ግ ጣ ለ ሁ ፡ ፡

ፊ ር ማ (ተ ሳ ታ ፊ ) _____ ፊ ር ማ (ሚ ሚ ) _____

የ ምክ ክ ር ስ ም _____ ፊ ር ማ _____

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## Annex III. Questionnaire/check list

| Part one identification and socio-demographic questions | | | |
|---|---|---|---|
| No | Questions | Responses | Skip to |
| 101 | MRN | | |
| 102 | Age | _____Years | |
| 103 | Sex | Male……....1<br>Female…….……2 | |
| 104 | Marital status | Single…….…...1<br>Married…….…2<br>Divorced……...…...….3<br>Widowed…….…….4<br>Others……....5 | |
| 105 | Residence | Urban……...….1<br>Rural…….....…2 | |
| 106 | Occupation | Farmer…….....1<br>Merchant…….2<br>Student……3<br>Government employee……4<br>House wife……..5<br>Others……..6 | |

| | | | |
|---|---|---|---|
| 107 | Level of education | No formal education……1<br>Elementary school…….…… ….2<br>Secondary school…….3<br>College and above……...4 | |
| 108 | Annual income | _____birr | |
| | Part two: Risk factors, disease condition and outcome questions | | |
| 109 | Diagnosis at admission | Hemorrhagic Stroke…….……1<br>Ischemic Stroke……2<br>Traumatic brain injury…….……3<br>Meningitis…….4<br>Others……...5 | Q110 |
| 110 | If diagnosis is TBI,what was cause of injury? | Road traffic accident……...……1<br>Falling down accident…….……2<br>Fighting accident……,.....3<br>Others(specify)…….....4 | |
| 111 | Is the patient in coma? | Yes……1<br>No…….2 | |
| 112 | Medications taking | Loop diuretics……1<br>Benzodiazepines…….…….....2<br>Thiazides……3<br>Calcium Channel blockers…….4<br>Analgesics……...5<br>Antibiotics……..6<br>Both antibiotics and analgesics……..7<br>Others (specify)…….8 | |
| 113 | Blood pressure | _____mmhg | |
| 114 | Temperature | _____degree Celsius | |
| 115 | Fever | Yes……..1<br>No……2 | |
| 116 | Vomiting | Yes…….….1<br>No……....2 | |

| | | | |
|---|---|---|---|
| 117 | Is the patient taking fluid? | Yes……...1<br>No……2 | |
| 118 | Smoking | Yes……1<br>No……..…….2 → | Q119 |
| 119 | If yes for Q123,daily consumption | _____cigarettes | |
| 120 | Duration of smoking | _____years_____months | |
| 121 | Drinking alcohol | Yes……1<br>No……2 → | Q121 |
| 122 | If yes to Q 126, daily consumption? | _____beer | |
| 124 | Chewing chat? | Yes……1<br>No……2 → | Q126 |
| 125 | If yes to Q 129, duration of chewing chat? | _____moths | |
| 126 | Dailychat consumption? | _____in grams | |
| 127 | Do you use salt with food? | Yes……1<br>No……..2 → | Q128 |
| 128 | Any history of chronic disease? | Yes……1<br>No……..……..……..2 → | Q 130 |
| 129 | If yes to Q 137, which disease? | DM……...….1<br>HTN…….….2<br>Cancer…….…...….4<br>Others…….…..…..5 | |
| 130 | Patient's condition | Critical…….….1<br>Sub-critical…….…..….2 | |

| | | | |
|---|---|---|---|
| | | Non-critical……..3 | |
| 131 | Serum electrolyte | Na…….. meq/L<br>K……...meq/L<br>Ca……meq/L<br>Cl……..meq/L | |

## Questionnaire (Amharic version)

ቃለ-ማኪይቅ/ቼክ-ሊስት

| ተ.ቁ. | | | |
|---|---|---|---|
| 1 | እድሜ | ----------አ ሞት | |
| 2 | ፆታ | ወንድ……1<br>ሴት……2 | |
| 4 | የ ትዳር ሁኔ ታ | ያገ ባ ……1<br>ያላገ ባ ……2 | |
| 5 | ሞ ር ያ | ከ ተ ማ……1<br>ገ ጠ ር ……..2 | |
| 6 | የ ትምህ ር ትደረ ጃ | ሞ ደ በ ኛ ትምህ ር ትየ ሌለ ዉ……1<br>የ ሞ ጀ ሚ ያ ደ ረ ጃ ……2<br>የ ሁለ ተ ኛ ደ ረ ጃ ……3<br>ኮ ሌ ጅና ከ ዛ በ ላ ይ……..4 | |
| 7 | ስ ራ | ገ በ ሬ ……1<br>ተ ማ ሪ ……2<br>ነ ጋ ዴ……3<br>የ መ ጣ ግ ስ ትሰ ራ ተ ኛ …….4 | |
| 8 | አ ጭ ስ ዊ ገ ቢ | ----------ብር | |
| 9 | ትዉ ክ ትአ ለ | አ ዎ……..1<br>የ ለ ም……..2 | |

| | | | |
|---|---|---|---|
| 13 | ጭስይቅጫሉ | አዎ.....1<br>የለም.....2 | |
| 14 | ጫልስዎአዎከሆነ ለስንትጊዜ | ---------- | |
| 15 | ሲጋራያጨሉ | አዎ.....1<br>የለም.....2 | |
| 16 | ጫልስዎአዎከሆነ ለስንትጊዜ | ---------- | |
| 17 | አልኮልይጠጣሉ | አዎ.....1<br>የለም.....2 | |
| 18 | ጫልስዎአዎከሆነ ለስንትጊዜ | ---------- | |
| 20 | ጨይጠቀጫሉ | አዎ.....1<br>የለም.....2 | |
| 21 | የታወቀየቆየበሽታአለብዎት | አዎ.....1<br>የለም.....2 | |
| 22 | ጫልስዎአዎከሆነ ምንበሽታ | የደምግፊት.....1<br>ስኳር .....2<br>የልብህመም.....3<br>ካንሰር .....4<br>ሌላ (ግለፅ).....5 | |

## Questionnaire (AfaanOromo version)

| | | | |
|---|---|---|---|
| T.L | | | |
| 1. | (umurii) | Waggaa…… | |
| 2. | (saala) | Male(Dhiira)----------1<br>Female(dhalaa)---------2 | |
| 3. | Gaa'ela | Kanfuudhe/heerume……..1<br>Kanhinfuune/hinheerumne….2 | |
| 4. | Bakkajireenyaa | Magaalaa……..1<br>Baadiyyaa…….2 | |
| 5. | Sadarkaabarnootaa | Barnootaidileekanhinqabne……1<br>Sadarkaatokkoffaa……..2<br>Sadarkaalammaffaa……..3<br>Kolleejjii fi isaaol……..4 | |
| 6. | GosaHojii | Qoteebulaa……..1<br>Barataa…… …….2<br>Daldalaa……..3 | |

| | | | |
|---|---|---|---|
| | | Hojjetaamootummaa…4 | |
| 7. | Galiiwaggaatti | Qarshii….. | |
| 8. | Hooqqisiisaanjiraa? | Eeyyee…….1<br>lakki…….2 | |
| 9. | Deebiinkeessan ‘eeyyee’ yootaheguyyaameeqaaf? | _____ | |
| 10. | Garaakaasaanjiraa? | Eeyyee……..1<br>Lakki…….2 | |
| 11. | Deebiinkeessan ‘eeyyee’ yootaheguyyaameeqaaf? | _____ | |
| 12. | Caatiiniqaamtuu? | Eeyyee…….1<br>Lakki……2 | |
| 13. | Deebiinkeessan ‘eeyyee’ yootaheyeroohangamiif? | _____ | |
| 14. | Sigaaraa/tambooniaarsituu? | Eeyyee…….1<br>Lakki……2 | |
| 15. | Deebiinkeessan ‘eeyyee’ yootaheyeroohangamiif? | _____ | |
| 16. | Alkooliinidhugduu? | Eeyyee…….1<br>Lakki……2 | |
| 17. | Deebiinkeessan ‘eeyyee’ yootaheyeroohangamiif? | _____ | |
| 18. | Kuduraa fi muduraaninyaattuu? | Eeyyee…….1 | |

| | | | |
|---|---|---|---|
| | | Lakki……2 | |
| 19. | Ashaboonifayyadamtuu? | Eeyyee…….1<br>Lakki……2 | |
| 20. | Dhukkubabeekamaakanisinirratureqabduu? | Eeyyee…….1<br>Lakki……2 | |
| 21. | Deebiinkeessan ‘eeyyee’ yootahedhukkubamaaliiti? | DhukkubaDhiibbaadhiigaa……1<br>Dhukkubasukkaaraa……2<br>Dhukkubaonnee……..3<br>Kaanserii……..4<br>Kanbiroo(ibsi)……..……5 | |
| | | | |

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Department of Biomedical Sciences

## Declaration Sheet

**DECLARATION**

I, the undersigned, declare that this thesis is my original work, has not been presented for a degree in this or any other university and that all sources of materials used for the thesis have been fully acknowledged.

Name: Lemlemu Maru

Signature: _____

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