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Serum Sodium and Potassium Imbalance in Patients with Traumatic Head Injury

Albadawi Abdelbagi Talha[1,2], and Maison ELzein ELhadi Suleiman[3]

[1,2] Department of Clinical Laboratory sciences, College of Applied Medical Sciences, Jouf University, Sakaka, Kingdom of Saudi Arabia

[2] Faculty of Medical Laboratory Sciences, University of Gezira, Wad Medani, Sudan

[3]Gezira Traumatology Center, Ministry of Health, Wad Medani, Gezira state, Sudan

Corresponding Author: Albadawi Abdelbagi Talha. E-Mail: badawiat@gmail.com , badawiat@uofg.edu.sd, aaabdelbagi@ju.edu.sa

Abstract: *Recently traumatic brain injury due to road traffic accidents is increase in Sudan and remains a serious concern and one of the leading causes of death and disability. This study aimed to determine serum Sodium and Potassium levels in traumatic brain injury patients. Fifty Sudanese adult with traumatic brain injury were enrolled in this study and sodium and potassium levels were measured by an automated electrolyte analyzer. The results of this study revealed that the majority of patients were suffering from hyponatremia 26/50(52%) and hypokalemia 22/50(44%). In patients with epidural hematoma, the hyponatremia represent 7/21(33.3 %) , hypokalemia 9/21 (42.9%) , hypernatremia 2/21 (9.5%), While among patient with subdural hematoma the hyponatremia represent 10/29 (34.5 %), hypokalemia 13/29 (44.8%), hypernatremia 5/29(17.2 %), and hyperkalemia 2/29 (6.9 %). Among 50 patients, 5/50 (10%) had Glasgow Coma Scale score ≤ 8, 8/50 (16%) had Glasgow Coma Scale score 9 to 12, and 37/50 (74%) had Glasgow Coma Scale score 13 to 15. The study concludes that, hyponatremia followed by hypokalemia and hypernatremia are more common among patients with traumatic brain injury.*

Keywords: Sodium, Potassium, Traumatic Brain Injury , Sudan

1. Introduction

Worldwide traumatic brain injury is among the most significant one causing high morbidity and mortality. The consequences of traumatic brain injury results in disability with lifelong financial, medical, emotional and family trauma [1]. Patient with traumatic head injury have a high risk of developing different type of electrolyte imbalance, [2,3,4]**.** at the time of admission and duration of their hospital stay. The changes of electrolytes will affect treatment and outcome of patient [5]. Cerebral injury can lead to electrolyte imbalance which may prove critical for survival of patients. And can cause polyuresis through the syndrome of inappropriate antidiuretic hormone secretion and cerebral salt loss. Patients with cerebral trauma are commonly managed with mannitol, which can promote polyuresis [6.7]. Thus, polyuresis is a possible source of loss of different electrolytes in severe head injury patients. Electrolyte imbalance in cases of TBI is associated with the pathology of the brain itself or is iatrogenic in causation [8,9]. 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 [5,10,11]. Among the all serum electrolytes, the most common electrolyte subject to imbalance in patients with TBI is serum sodium [12,13,14] some researchers reported that the most common electrolyte imbalance condition in TBI was hypernatremia followed by hyponatremia and hypokalemia [14]. Severe hypokalemia were also reported among patients with head injury [15]. In Sudan the road fatality rate were increased recently, Thus This study aimed to determine the sodium and potassium imbalance among patients with traumatic brain injury attending Gezira Traumatology Center in Sudan.

2. Materials and Methods

2.1 Study design

Cross sectional laboratory based study.

2.2 Study area and duration

This study was conducted in Gezira Traumatology Center, which is the only specialized center located outside of Khartoum, the center serve the patients in Gezira State and neighboring states. The center located in Wad Medani city which located in Central Sudan in the western bank of the Blue Nile River, in 187 Km south of Khartoum, This study was carried out during the period of May 2017 to March 2018.

2.3 Study population and Sample Size

Fifty patients with traumatic brain injury were enrolled in this study. Patients with Renal failure, Diabetes mellitus, Hypertension and hemolytic anemia were excluded from this study.

2.4 Study variables

The dependent variables of this study were Na+ level, K+ level and Types of TBI and age and sex consider as independent variables.

2.5 Sample collection

Three ml of venous blood samples were collected from each participants -under aseptic condition, in plane containers and allowed to clot. Then centrifuged for 10 -15minutes at 1500 - 2000 rpm to obtain serum and analyzed immediately by electrolyte analyzer after passing of quality control and calibration materials

2.6 Principle of the method

Ion – selective electrode is a kind of chemical sensor that converts the activity of a certain Ion in to an electric potential. It is only sensitive to one kind of ion in the solution. When the ion is selective by the sensor and an electric potential is established against the sensor. The relationship between activity and potential is expressed by Nernst equation.

$$E=E0+\frac{2.303\,RT}{nf}Iogcxfx$$

Where:
E: electric potential of ion – selective electrode in the solution being measured.
E0: standard electrode potential of ion – selective electrode.
N: electrovalence of the ion being measured.
R : gas constant (8.314J/K.mol)
T: absolute temperature (273tt Co)
F: faraday constant (9647c/mol)
Cx: concentration of the ion being measured.
FX: activity coefficient of the ion being measured in given condition such as room temperature.

Nernst equation shows that electrode potential of ion – selective electrode is linear to the logarithm of the activity (or concentration) of the ion being measured. The sodium ion will also affect lithium electrode. A selective coefficient calibrator is used to minimize the interference of sodium.

3. Result

Fifty adult traumatic brain injury patients were enrolled in this study. 66% of the study populations were male and 34% of them were female. According to the serum Sodium level the study population categorized into three groups: High Serum Sodium Level (> 145 mmol/L)**,** 9 patient (18%)**,** Low Serum Sodium Level (< 130 mmol/L)**,** 26 patient(52%), and Normal Serum Sodium Level 15 patient (30%). High Serum Potassium Level (> 5 mmol/L), 8 patient (16%) **,** low serum Potassium (< 3.5 mmol/L)**,** 22 patient (44%) and Normal Serum Potassium Level, 20 patient (40%) Table(1).

Table 1 Distribution of serum sodium and potassium level among the study population

Variables	Number of patients(n=50)	%
Sodium		
> 145 mmol/L)	9	18
> 130 - ≤ 140mmol/L	15	30
< 130 mmol/L	26	52
Potassium		
>5 mmol/L)	8	16
> 3.5 - ≤ 5 mmol/L	20	40
< 3.5 mmol/L	22	44

Table (2)Distribution of study population according to Glasgow coma scale (GCS)

The study population categorized into three groups (Severe, Moderate and Mild) according to the degree of severity of Glasgow coma scale as shown below in Table (2).

Table2 Distribution of study population according to Glasgow coma scale (GCS)

GCS	Degree of severity	Number of patients(n=50)	%
3 – 8	Severe	5	10
9 – 12	Moderate	8	16
13 – 15	Mild	37	74

Distribution of serum Sodium and Potassium levels among study population according to Epidural hematoma and subdural hematoma:

The study population were categorized into two groups according to the type of hematoma: Epidural hematoma (21 patients) and subdural hematoma (29 patient). distribution of serum Sodium level in Epidural hematoma patient as follow : High serum Sodium level (> 145 mmol/L) , 2 patient (9.5%) and Low Serum Sodium Level (< 135 mmol/L) ,7 patient (33.3%), whereas the distribution of serum Sodium level among Subdural hematoma as follow : High serum Sodium level (> 145 mmol/L) , 5 patient (17.2%) and Low Serum Sodium Level (< 130 mmol/L) , 10 patient (34.5%). While the distribution of serum Potassium level in Epidural hematoma patients as follow: There is no patient have High Serum Potassium Level (> 5 mmol/L) , whereas Low Serum Potassium Level (< 3.5 mmol/L), 9 patient (42.9%). The distribution of serum Potassium level in subdural hematoma as follow: high serum potassium level (> 5 mmol/L), 2 patient (6.9%), low serum potassium level (< 3.5 mmol/L), 13 patient (44.8%).

Table 3 Distribution of serum Sodium and Potassium level in study population according to Epidural hematoma(EDH) and Subdural hematoma(SDH)

Variables	EDH (n21)	%	SDH(n29)	%	P. value
High Serum Sodium Level (> 145 mmol/L)	2	9.5	5	17.2	
Low Serum Sodium Level (< 135 mmol/L)	7	33.3	10	34.5	0.461
High Serum Potassium Level (> 5 mmol/L)	0	0.0	2	6.9	0.380
Low Serum Potassium Level (< 3.5 mmol/L)	9	42.9	13	44.8	

4. Discussion

Electrolyte imbalance are more common among patients with brain injury. Monitoring of electrolytes in patients with brain injury are very important to ensure common electrolyte imbalances. The changes of electrolytes level such as hyponatremia, hypernatremia, and hypokalemia, are needed to identify quickly and made the corrections. Most report indicate that serum sodium and potassium levels were changes among patients with traumatic brain injury. The results of this study revealed that the majority of patients were suffering from hyponatremia 26/50(52%). The result of this study agreed with study done by many researchers [12,16,17], in which hyponatremia revealed (64%). Also our study indicated that 9/50(18%) of patients had hypernatremia and this could be due to hypothalamic-pituitary dysfunction. In contrast to our study, a study done in Pakistan by Mirza, et al ., [18] reported hypernatremia as a major abnormalities that occurred in 65.1% of patients with traumatic brain injury, while in our study hypernatremia was represent 9/50(18%). These differences could be due to underlying disease and /or the choice of resuscitation fluids used. Also the hyponatremia among the patients may develop as result of syndrome of inappropriate secretion of antidiuretic hormone characterized by dilutional hyponatremia or cerebral salt-wasting syndrome featured by natriuresis [7]. Hyponatremia may also be caused by the activity of the brain natriuretic peptide (BNP) [4]. Hyperosmolar therapy, including mannitol or hypertonic saline solution, promotes fluid shifts from interstitial compartments into intravascular compartments and then diuresis and this could lead to electrolytes imbalance mainly sodium [13].

Our study revealed that 22/50(44%), 8(16%) and 20(40%) of patients had hypokalemia, hyperkalemia and normal potassium level respectively. This result agree with study done by *Hande G A et al*., and *Pathomporn P., et al* [15,19] they reported that hypokalemia is more common among patients with traumatic brain injury. Hypokalemia among patients could be due to an increase in their urinary loss, caused by neurologic trauma.

Among 50 patients recruited, 29/50(58%) with subdural hematoma and 21/50(42%) with epidural hematoma, 5 (10%) had Glasgow Coma Scale (GCS) score ≤ 8, 8 (16%) had GCS score 9 to 12, and 37 (74%) had GCS score 13 to 15. Subdural hematoma and epidural hematoma were the most common diagnosis of patients with acquired brain injury [19]. Among patients with epidural hematoma, the hyponatremia represent 7/21(33.3 %) , hypokalemia 9/21 (42.9%) , hypernatremia 2/21 (9.5%), While among patient with subdural hematoma the hyponatremia represent 10/29 (34.5 %), hypokalemia 13/29 (44.8%), hypernatremia 5/29(17.2 %), and hyperkalemia 2/29 (6.9 %). There is no significance differences between sodium and potassium imbalances among patients with subdural or epidural hematomas. Hyperkalemia among patients with traumatic brain injury probably due to a secondary shift of potassium from intra to extracellular space.

5. Conclusion

This study concludes that hypokalemia followed by hyponatremia and hypernatremia are more common among patients with traumatic brain injury, there for continuous monitoring of electrolytes are very important to improve patients outcomes.

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Disclosure of conflict of interest

The authors declare that they have no competing interests.

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