ISSN: 2581 – 3633
PubMed - National Library of Medicine - ID: 101745081

International Journal of Medical Science and Advanced Clinical Research (IJMACR)

Available Online at: www.ijmacr.com

Volume – 5, Issue – 4, July – August - 2022, Page No. : 197 - 207

A prospective Analytic study of Correlation Between the severity of Head Injury and Electrolytes in Patients with Traumatic Brain injury presenting to emergency Department of Tertiary care hospital.

[1]Dr. Avinash Sharma, Senior Resident, Department of Emergency Medicine, Government Medical College, Surat, India.

[2]Dr. Dhawanth Rathod, Senior Resident, Department of Emergency Medicine, Government Medical College, Surat, India.

[3]Dr. Pratik Kucha, Consultant General Medicine, Government Medical College, Surat, India.

Corresponding Author: Dr. Dhawanth Rathod, Senior Resident, Department of Emergency Medicine, Government Medical College Surat, India.

How to citation this article: Dr. Avinash Sharma, Dr. Dhawanth Rathod, Dr. Pratik Kucha, "A prospective Analytic study of Correlation Between the severity of Head Injury and Electrolytes in Patients with Traumatic Brain injury presenting to emergency Department of Tertiary care hospital", IJMACR- July – August - 2022, Vol – 5, Issue - 4, P. No. 197 - 207.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Introduction: Head injury is considered as a major health problem. Traumatic Brain Injury (TBI) is a leading cause of death and disability worldwide. It is the leading cause of brain damage in children and young adults and plays a significant role in half of trauma deaths. The consequences of TBI results in disability with lifelong financial, medical, emotional, family trauma.

In this study we establish a correlation between the severity of head injury and serum electrolytes. Hyponatremia is a common electrolyte disturbance following intracranial disorders. K+ is found in high concentration in cell with comparatively low extra-cellular concentration levels. Small changes in K+ ions can severely affect conduction, heart rhythm and muscle contraction. Also role of serum creatinine in Traumatic Brain Injury determining AKI affecting the physiological cycle of the events following injury and the outcome of the patient. Aim of our study is find the correlation of severity of head injury with serum electrolytes.

Methodology: Patients with head injury presented and admitted at Emergency Medicine department of New civil hospital, Surat over the period of six months. All patients came in emergency department with head injury are included in the study after full filling my inclusion criteria. Analysis of 70 patients was done during this period.

Result: Road traffic accidents was the most common mode of head injury that is found in 67.14%, followed

by Fall from heights which was found to be 25.71% and others contribute about 7.14%. Most of the population out of these presented with vomiting which was 47.14% and unconsciousness which was 35.71%. Also, CT finding of all head trauma patients showed that SDH was most common among all TBI found in 38.57% followed by SAH found in 17.14%.EDH was found in 12.86%. Patients with severe traumatic brain injuries are often accompanied by electrolyte abnormalities especially the hyponatremia and hypokalemia are common. Serum potassium level especially hypokalaemia more commonly found, must be looked for as it play an important role in prevention of secondary brain insults. Also, mortality is more in those patients who are having RTA (road traffic accidents) as the cause of their traumatic brain injury (83.33%) are maximum.

Conclusion: Trauma continues to be a major health problem all around the world and head trauma is a major challenge among all of them. Young and youth population which is most active and mobile population of society comprises the majority in head injury cases. Vomiting is most common presentation. Hyponatremia and hypokalemia found in most of cases. Mortality rate with RTA is highest compare to other cause.

Keywords: Head injury, Serum Sodium, Serum potassium.

Introduction

Traumatic Brain Injury is a leading cause of death and disability worldwide. It is the leading cause of brain damage in children and young adults and plays a significant role in half of trauma deaths. Because a head injury occurs every 15 seconds and a patient dies from head injury every 12 minutes, a day does not pass that an emergency physician is not confronted with a head injured patient (1).

There are various causes of TBI, but common are:

1. Road traffic accidents
2. Fall down from height or tree in rural areas
3. Assault
4. Blast injuries

In this study we establish a correlation between the severity of head injury and serum electrolytes. Hyponatremia is a common electrolyte disturbance following intracranial disorders. Hyponatremia is of clinical significance as a rapidly decreasing serum sodium concentration as well as rapid correction of chronic hyponatremia may lead to neurological symptoms. K+ is found in high concentration in cell with comparatively low extra-cellular concentration levels. Small changes in K+ ions can severely affect nerve conduction, heart rhythm and muscle contraction. Also role of serum creatinine in Traumatic Brain Injury determining AKI affecting the physiological cycle of the events following injury and the outcome of the patient. Cerebral injury can lead to polyuresis through a variety of mechanisms. In addition, the role of electrolyte abnormalities in the secondary neurologic injury cascade is being delineated and may offer a potential future therapeutic intervention.

In head trauma, brain injury occurs due damage of the primary insult followed by potential secondary insult which may be the result of both ischaemic and non-ischaemic mechanism. This may lead to further loss of potentially viable cerebral tissue and decreasing the chance of good functional recovery. The goal of treatment in patients with severe head injury without neurological intervention is minimizing secondary injury.

Secondary injury is influenced by different factors such as hypo perfusion hyper perfusion of cerebral blood

flow, impairment of cerebrovascular auto-regulation, cerebral vasospasm, cerebral metabolic dysfunction, electrolyte derangements. Aim of our study is find the correlation of severity of head injury with serum electrolytes. This thesis represents patients of head trauma frequently arriving at Emergency medicine Department and learning to manage them with complete evaluation. Head injury is considered as a major health problem that Is a frequent cause of death and disability and makes considerable demands on health services. In developing countries accident rates in general and traumatic brain injury in particular are increasing as traffic increases besides other factors like industrialization, falls and ballistic trauma. Head injuries account for one quarter to one third of all accidental deaths, and for two thirds of trauma deaths in hospitals. Road traffic injury is an increasing health problem globally and especially in South-East Asia. Epidemiological studies of head trauma patient in our country are rare. South Gujarat having population of more than 50 lacs, with high accident rate, Better understanding of nature of head trauma risk and outcome could lead to more effective prevention and treatment strategies in south Gujarat region.

Material and method

Study design: prospective analytic study

Study setting: Department of General Medicine, Tertiary care hospital, Surat.

Study Participants: All patients of head injury who were attending the Tertiary care hospital, Surat to avail the health services.

Inclusion criteria

- Patient > 18 years of age with traumatic head injury
- With GCS <15/15 or
- With GCS 15/15 with any of the risk factors related to trauma (amnesia, vomiting. unconsciousness, seizures, ear-nose bleeding)

Exclusion criteria

- Patient <18 years of age.
- Tomographic or clinical diagnosis of stroke
- Patient who had taken Discharge against medical advice
- Patients who does not fulfill inclusion criteria
- Those patients who does not give consent

Sample size calculation

Patient with TBI admitted to new civil hospital Surat over the periods of six Months. All patient came with the TBI (Traumatic Brain Injury) at ED from 27th November 2019 to 27th May 2020 are expected to be a part of study fulfilling my inclusion criteria. Analysis of 70 patients was done in my study.

Sample size: 70

Procedure

This study is a prospective analysis of the patients who admitted from emergency Department with head trauma over periods of 6 months.

All patients were given emergency care at trauma center and were admitted under surgery department of NCH Surat.

1. Data obtained from medical records and the hospital registration system.

2. All traumatic head injuries that resulted from any physical injury, falls, assault and suicide attempt will be included.

3. The patients were evaluated for age, gender, trauma, aetiology, Glasgow Coma Scale, the Results of treatment and mortality rates.

4. Head trauma patients were classified as mild (GCS 13-15), moderate (GCS 9-12) and severe (GCS 3-8).

5. Patient of head injury arrived at emergency department and examined clinically and GCS assessed.
6. All the details of the study explained to the relative patient and written and informed consent taken.
7. Patient considered for the study according to inclusion and exclusion criteria.
8. Patient blood samples will be drawn for parameters (Hb, Na+, K+, serum Creatinine) at the of admission after 24hrs, at final outcome and then sent to the biochemistry Department.
9. Finally, all the data collected and recorded according to the well-prepared Performa and all data was entered in Microsoft Excel and analysed using SPSS. Descriptive statistics was used to analyse data collection.

Result and discussion

Table 1: Sex Distribution of the patients

Sex	No. of Patients	Percentage
Male	57	81.43
Female	13	18.57
Total Patients	70	100

In this study male were predominantly in 81% patients and 19% female patients which as closely co-relate in a study Kaul et al.2005(2) 75% males and 25% females affected.

In an Solagberu et al., 2003 (3) study found 76% males and 24% females involved, which was comparable with present study. This is because of male have more outdoor life and more high-risk taking behaviour that is more of driving vehicles and others, then the females.

Table 2: Age Distribution of Patients

Age Group of patients	No. of Patients	Percentage
19-30	32	45.71
31-40	17	24.29
41-50	10	14.29
51-60	5	7.14
>60	6	8.57
Total	70	100

Youth population from 19-30 years comprises the majority of 45% patients, which is in accordance with the study Neeraj et al.2012 (4) followed by 24% from 31-40 years of age group, followed by 14% from 41-50years of age, patient above >50yr of age that is old age people comprises least number of cases.

In our study mean age is 35.7+/-15.1 years. In a Veysi T, Veysi et al study (5) mean age is 40.8+/-12.2 years.

Table 3: clinical symptoms

Presenting symptoms	Number of patients	Percentage
Vomiting	33	47.14
Unconsciousness	25	35.71
Convulsion	7	10.00
Ear/Nose Bleeding	10	14.29
Amnesia	3	4.29

Out of all head trauma patients present to ED the most common clinical presentation among them was vomiting that is 47.14% that is in accordance with Ledic et al., 2012(6), followed by unconsciousness that is 35.71%, patients with presentation of convulsion was 10%,

Ear-nose bleeding presentation showed 14.29%, and with the least common presentation was amnesia that is 4.29%.

Table 4: severity of head injury-based on gcs

Severity of head injury	No. of Patients	Percentage
Mild (13-15 GCS)	39	55.71
Moderate (9-12 GCS)	19	27.14
Severe (<9 GCS)	12	17.14
Total	70	100

Out of all 70 patients' in our study 55.71% patients had mild head injury that is with GCS 13-15, 27.14%

patients have moderate head injury that is with GCS 9-12 and 17.14% patients have severe brain injury that is with GCS <9.

Table 5: NCCT findings in head trauma patients

NCCT Finding	No. of Patients	Percentage
EDH	9	12.89
SDH	27	38.57
SAH	12	17.14
Contusion	7	10.00
Hematoma	2	2.86
NAD	13	18.57
Total	70	100.00

In our study most common NCCT findings at the time of admission were 38.57% patients have SDH (Subdural Hematoma) followed by 17.14% patients have SAH (Subarachnoid Hemorrhage) followed by 12.86% patients having EDH (Extradural Hemorrhage),10% patients had CONTUSION injury followed by least HEMATOMA in only 2.86% patients. Also it was found that 18.57% patients out of all 70 patients of our study showed Normal NCCT findings.

Table 6: correlation of sodium level with TBI

	Hypernatremia	Hyponatremia	Norm natremia
Mild TBI	2	5	32
Moderate TBI	4	0	15
Severe TBI	1	6	5
Total	7	11	52

(P=0.0015)

In our study serum sodium levels of these 70 patients were (mean+_2SD) 137.15+_5.25. Out of these 70 patients 52 patients have normal sodium level (135-145mmol/l) that is 74.29%, 11 patients have low sodium level (<135mmol /l) that is 15.71% and 7 patients have high sodium level (>145mmol /l) that is 10%. Out of all 39 mild TBI patients 32 patients have normal sodium level 5 patients have low sodium level and only 2 patients have high sodium level.

Out of all 19 patients of moderate TBI 15 have normal sodium level and 4 patients have high sodium level and have low sodium level. But among all 12 severe traumatic brain injuries 7 had abnormal sodium level that is 58.3% (6 having low sodium level and 1 having high sodium level) which were found to be significant ($p<0.0015$). Most common electrolyte imbalance was sodium. Hyponatremia may have developed as a result of SIADH (syndrome of inappropriate secretion of antidiuretic hormone) characterized by dilutional hyponatremia or cerebral salt wasting (CSW) syndrome featured by natriuresis in TBI patients. Brain natriuretic peptide (BNP) may also responsible for hyponatremia. BNP is a potent diuretic natriuretic. Vasodialating agent, and inhibitors of the secretion of aldosterone renin and vasopressin (7). Increased BNP is most commonly found in patient with subarachnoid haemorrhage with base of the brain or in the third ventricle. Atrial natriuretic peptide (ANP) is a potential hormonal mediator of hypo natrmia in intracranial disorders (8). Damage to ANP & BNP containing cells in intracranial disorders and passage of these peptides across the blood brain barriers might cause inappropriate release of natriuretic peptides.

Brain injury is a stress, responding to which the sympathetic nervous system hormones are stimulated which in turn cause both arterial and venous contraction, leading to increased preload, inotropic, and systemic blood pressure. The kidneys could respond to these cardiovascular changes with a pressure induced natriuretic. ANP is produced in the atria of the heart band activated when the atrial stretch receptors become stimulated in response to hypervolemia increased sodium, and/or an expanded preload. Incidence of

hypernatremia was 10%. The causes for hypernatremia could be diabetes insipidus, hypothalamic pituitary dysfunction particularly growth hormones deficiency, ACTH and gonadotropin deficiency and use of mannitol (9). Changes in fluid level; secondary to resuscitative measures and pharmacological therapy (use of Furosemide and Mannitol) are mainly responsible for hypernatremia. Volume replacements with isotonic fluids not only is therapeutically of limited efficacy but may aggravate post traumatic brain oedema. And the main aim was to achieve normovolumia. All this lead to achieve normal sodium levels in post 24 hours days of stay.

Table 7: correlation of potassium level with TBI

	Hyperkalemia	Hypokalemia	Normokalemia
Mild TBI	2	3	34
Moderate TBI	1	1	17
Severe TBI	0	4	8
TOTAL	3	8	59

In our study serum potassium levels of these 70 patients were (mean+_2SD) 4.06+_0.53. Out of these 70 patients 59 patients have normal potassium level (3.5-4.5mmol/l) that is 84.29%, 08 patients have low potassium level (<3.5mmol/ l) that is 11.43% and 7 patients have high potassium level (>5.5mmol/ l) that is 4.29%. Out of all 39 patients of mild traumatic brain injury 34 have normal potassium level 3 have low potassium level and 2 of them have high potassium level.

Out of all 19 patients of moderate TBI 17 have normal potassium level and 1 have high and 1 has low potassium level. Also it is found that out of 12 severe traumatic brain injuries 4 had abnormal potassium level that is 33.3% (all 4 have low potassium level) which were found to be significant (p<0.016). Potassium was the second most common electrolyte which underwent significant derangements followed by serum sodium levels. This is in accordance with the study by Pomeranz et al (10). Patients with severe head injury are at high risk for the development of hypokalemia. Low potassium levels in these patients might be due to an increase in their urinary loss, caused by neurologic trauma. The incidence of hyperkalemia is 4.29%. The changes in the potassium levels are thought to be due to the large catecholamine discharge that is known to accompany severe head trauma, with resultant beta 2-adrenergic stimulation of the Na+-K+ pump.

Table 8: correlation of creatinine level in TBI

	In ceased Creatinine	Normal/Decrease Creatinine
Mild TBI	2	37
Moderate TBI	3	16
Severe TBI	1	11
Total	6	64

(P=0.39)

Out of these 70 patients 58 patients have normal creatinine level (0.6-1.3mg/dl) that is 82.86%, 06 patients have low creatinine level (<0.6mg/dl) that is 8.57% and 06 patients have high creatinine level (>1.3mg/dl) that is 8.57%. Out of all 39 patients with mild TBI 2 patients have high creatinine level and 37 have normal or low creatinine level. Out of all 19 patients of moderate TBI 3 have high creatinine level and 16 have normal creatinine level. Also among all 12 severe TBI patients only 1 have increased creatinine level rest 11 have normal levels. So, brain injury is not associated with rise of serum creatinine level. (p=0.39)

The incidence of AKI in TBI patients was explored by Zygun et al (11). Who found that only 1 of 209 patients with TBI developed renal failure and 7% developed renal dysfunction. However, these investigators used an invalidated tool to assess for AKI, which has limited sensitivity.

Table 10: final outcome of patient with severity of TBI

	Total No. of patients	No. of patients Discharged	No. of patients Expired
Mild TBI	39	39(100%)	0 (0%)
Moderate TBI	19	17(89.47%)	2 (10.53%)
Severe TBI	12	8 (66.67%)	4 (33.33%)
TOTAL	70	64 (91.43%)	6 (8.57%)

The above table shows out of all 39 patients with mild TBI all patients got discharged that suggest that the mortality in mild TBI is 0%. Out of all 19 patients with moderate TBI 17 patients that are 89.47% got discharged and the mortality was of only 2 patients that is 10.53%. Also, it was found that out of 12 patients having severe traumatic brain injury mortality rate was 33.33% that is 4 patients out of 12 Severe TBI patients expired. Victims of traumas with severe injuries have a greater risk of dying and mortality is generally related to the presence and development of brain lesions. The development of brain injuries, such as intracranial hematomas, can be hours after the trauma, resulting in the clinical deterioration of the patient. A loss of temporary consciousness followed by a lucid interval and a lowering in the consciousness level is a clinical manifestation of the dynamic process of the brain injury. A large part of the neuronal damage after a TBI occurs in the development of secondary lesions, such as increased brain volume. The victims (33.33%) that died in this study presented a lower average score on the GCS than that of survivors. A statistically significant difference was observed between survivors and patients who died in relation to the three analysed GCS scores ($p<0.001$).

Table 11: mortality related to mode of injury

Mode of Injury	Total No. of patients	No. of patients Discharged	No. of patients expired	Mortality %
RTA	47	42	5	83.333
Fall down & others	23	17	1	16.67
Total	70	64	6	100.00

($p=0.52$)

In our study out of all 6 patients expired 4 have severe Traumatic brain injury and 5 patients out of all expired have Road traffic accident as the most common mode of injury that is 83.33% of the patient are more or the less involved in road traffic accidents leading to severe injuries to brain and leading to death which is in accordance with study by R. Dandona et al.(11)where 58.8% of death are due to road traffic accidents.Also,16.67% of death are due to fall from heights that is the second common mode of injury leading to severe brain injury and death.

India is a country with RTA as most common mode of injury which leads to death in head traumas. The poor enforcement of speed limits, drink-driving laws, motorcycle helmet use, and seatbelt laws contribute to the burden of deaths due to road injuries in our country.

Table 12: mortality correlation to symptoms

Symptoms & Signs	Total No. of patients	No. of patients Discharged	No. of patients expired	Mortality %
Vomiting	33	30	3	50.00
Unconsciousness	25	21	4	66.67
Other Symptoms	12	13	2	33.33
Total	70	64	6	100.00

(p=0.70)

In our study it is visible that out of all 6 patients expired 4 of them had history of unconsciousness as a symptom associated with traumatic brain injury that is 66.67% patients out of all expired patients had clinical presentation of unconsciousness to ED.

Also, vomiting is the symptom involved in 3 patients out of all 6 expired patients that is 50% of patient had vomiting as an associated symptom in head trauma, and 2 patients out of 6 have multiple symptom together that is ENT bleeding, convulsion also associated vomiting, amnesia. Thus, patients who are expired due to head trauma have associated loss of consciousness in history more common depicting to be more severe brain injury and required urgent intervention for treatment of the patient. Mortality in different study is variable depending upon various factor including clinical presentation and severity of injury and hospital set up. This study correlates with Kelly, 2001(12) study which dealt with the level of consciousness and grading of brain injury and outcome.

Table 13: serum na+ and mortality in TBI

Serum Sodium	Total No. of patients	No. of patients Discharged	No. of patients expired	Mortality %
Hyponatremia	11	8	3	50.00
No hyponatremia	59	56	3	50.00
Total	70	64	6	100.0

Here in present study out of all 6 expired patients 3 of them had hyponatremia that is 50% of all death via traumatic brain injury develop hyponatremia which is most common electrolyte abnormality found and most common derangement seen in death via traumatic brain injury. Hyponatremia is more common after brain injury, especially in those patients who are critically ill (13) that is with severe head injury and low GCS score, it usually develops between 2 and 7 days after the injury and is associated with mortality increases of up to 60% (14) (15), which is found about 50% (mortality) in our study. Thus, hyponatremia had significant correlation with mortality in TBI (p=0.015)

Table 14: serum k+ and mortality in TBI

Serum Potassium	Total No. of patients	No. of patients Discharged	No. of patients expired	Mortality %
Hypokalemia	8	6	2	33.33
No Hypokalemia	62	58	4	66.67
Total	70	64	6	100.00

In our study out of all 6 patients expired 2 of them had hypokalemia that is 33.33% of all death via traumatic brain injury develops hypokalemia which is found commonly associated following severe brain injury which has high chances of mortality. Hypokalaemia is common after brain injury, especially in those with severe head injury and low GCS score, it usually develops between 2 and 7 days after the injury and is associated with mortality increases of up to 50% as per "Serum Electrolytes Imbalances in Head Injury: An

Institutional Analysis", 2017 (16), which is found about 33.33% (mortality) in our study. Thus, electrolyte imbalances are common after traumatic brain injury especially derangements of sodium and potassium level were found common following head injury and mortality caused in head injury decreased level of both the electrolyte (serum Na+ and serum K+).

Conclusion

Trauma continues to be a major health problem all around the world and head trauma is a major challenge among all of them. Young and youth population which is most active and mobile population of society comprises the majority of 45.71% 19-30 years of age group involved in head injury cases. 81.43% males and only 18.57% females were involved in this study.

Road traffic accidents was the most common mode of head injury that is found in 67.14%, followed by Fall from heights which was found to be 25.71% and others contribute about 7.14%. Most of the population out of these presented with vomiting which was 47.14% and unconsciousness which was 35.71%. Other less presenting symptoms were Ear/ nose bleeding, convulsion and amnesia which were found to be least.

Patients with Mild (13-15 GCS) Traumatic brain injury were the maximum among all found in 55.71%, and one with severe brain injury are the least around 17.14%. Also CT finding of all head trauma patients showed that SDH was most common among all TBI found in 38.57% followed by SAH found in 17.14%.EDH was found in 12.86%, Brain Contusion injury was reported in almost 10% of the patients and hematoma was the least common injury found around 2.86% only. Even NCCT finding showed no abnormality in 18.57% of patients generally involving mild injury.

NCCT brain was found to be useful investigation for further decision of operative intervention or the conservative management of the patient. And calculating the Glasgow coma scale (GCS) of the patient helped in dealing with consequences and further early management for the survival of the patient. Associated other injuries with the head trauma are found a very few in our study.

Patients with severe traumatic brain injuries are often accompanied by electrolyte abnormalities especially the hyponatremia and hypokalemia are common. Polyuresis due to SIADH, CSW and use of osmotic diuretics like mannitol, hypernatremia due to diabetes insipidus may occur but lower in incidence than hyponatremia. A falling serum sodium level can lead to central nervous system changes, including confusion, seizures and even coma. Early diagnosis and appropriate treatment of hyponatremia are essential for the recovery of the patients. Serum potassium level especially hypokalaemia more commonly found, must be looked for as it play an important role in prevention of secondary brain insults, Preservation of cerebral perfusion pressure and optimization of cerebral oxygenation if done early following resuscitation.

Also patients with high creatinine level that is moving towards AKI are commonly found in severe head trauma patients and indicating the increasing changes of poor prognosis and mortality. Severe head injury patients having high creatinine, went in AKI having associated with the GCS have predictive ability on poor outcome.

In present study mortality rate (33.33%) was higher in patient with lower GCS that is with severe traumatic brain injury as compared with the moderate (10.53%) injuries. Also mild injuries have high discharge rate of

100% depicting no any severe injury and complication in them.

Also, mortality is more in those patients who are having RTA (road traffic accidents) as the cause of their traumatic brain injury (83.33%) as the patients with RTA as mode of injury are maximum.

Patients as clinical presentation of unconsciousness at the ED are found to be critically ill and having higher chances of mortality (66.67%). In patients having severe head trauma and are critically ill, hyponatremia is associated in 50% of all those patients leading to mortality having significant relation (p=0.015).

Similarly, in critically ill patients hypokalemia is found in 33.33% of patients involving neurological pathology and leading to mortality in them.

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