

A Study of Systemic Factors Affecting Mortality and Morbidity of Traumatic Brain Injury

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Abstract

Head injury is a devastating problem worldwide including India. Loss of young people at their productive years is a great emotional and financial concern for the families affected by it which contributes to the economic loss of 3% to GDP [1]. The incidence of head injury shows a rising trend due to urbanization and industrialization. Injury to the head can be either primary or secondary. Primary injury occurs due to the initial processes occurring in neuronal tissue as a result of trauma to brain where as secondary injury is the consequence of further physiological insult [2-3]. Despite of major steps being taken during the "golden hour" to prevent head injury, regrettably secondary brain injuries contributes to a huge number in patients transferred to neurosurgical units [4]. Prognostication in Traumatic Brain Injury (TBI) is a multivariate analysis. Some of these factors are favourable while others unfavourable. Most commonly used factors to predict TBI are age, Glasgow Coma Scale, Pupils, CT findings, hypotension, hypoxia. Few factors like hyperglycemia and anemia are studied to have strongest effect on the outcome of TBI [5-7] However, rest metabolic and neurochemical abnormalities that underlie TBI remains poorly understood. So, the purpose of this study is to correlate few of these parameters in one study in order to generate fruitful results. *Objective of the Study: Primary Objective:* To study the effects of these systemic markers of traumatic brain injury on mortality and morbidity of the patient. *Secondary Objective:* To predict which amongst these markers has the highest effect on the outcome of the patient. *Methods and Materials:* Study was done at Max Superspeciality Hospital, Shalimar Bagh. Patients coming with complaints of traumatic brain injury were included in the study. After obtaining informed consents, all the details of the patients were filled in a data collection forms. All the in hospital events were recorded from July 2015 to March 2017. *Statistical Analysis Used:* The data collected was entered in the Excel spreadsheet using Microsoft Excel Software. Then this data was transferred to Statistics Package for Social Sciences (SPSS) version 20, IBM Inc. for analysis. It was subjected to descriptive statistics for calculation of mean, standard deviation, frequencies and percentages. Summarized data was presented using Tables and Graphs. Shapiro Wilk test was used to check which all variables were following normal distribution. Chi-square test was used for comparison between categorical variables. Therefore, bivariate analyses was performed using the parametric tests i.e Independent 't' tests (for comparing two groups). *Results:* Total number of patients reported to the Emergency Department who fulfilled the criteria of the study during the time period mentioned were 226 out of which 175 agreed and gave consent for the study as the rest did not gave consent for different reasons. Out of 175 who fulfilled the criteria, 127 were males, 48 were females. The purpose of the study was to individually calculate mortality and morbidity of five factors i.e., blood pressure, carbon dioxide levels, serum sodium, serum lactates and temperature and to identify the factor most likely responsible for poor outcome of the patient. The mortality was calculated by the number of deaths in the ICU and morbidity by the length of hospital stay. The abnormal values was the sum of the variables above and below the reference range of

individual marker. The results which we were able to calculate by the study are: 1. Mortality associated with abnormal systolic pressure was found to be 78.8% and morbidity is 88.2% 2. Mortality associated with abnormal diastolic pressure was found to be 51.8% and morbidity is 63.2% 3. Mortality associated with abnormal carbon dioxide levels was found to be 31.7% and morbidity is 63.1% 4. Mortality associated with abnormal levels of serum sodium was found to be 32.1% and morbidity is 36.8%. 5. Mortality associated with abnormal values of serum lactates was found to be 3.8% and morbidity is 84.2% 6. Mortality associated with abnormal temperature range was found to be 8.2% and morbidity is 100%. *Conclusion:* The results generated from the study strongly emphasize strict temperature control along with serum sodium and lactate maintenance in a TBI patient with temperature control as the most significant criteria. Although keeping the values of blood pressure and carbon dioxide within limits was important in such patients but the results generated in this study were insignificant. So we drew a conclusion that it is important to quickly chart all the parameters of primary survey in a TBI patient and draw an ABG sample to look for serum sodium and lactate levels so that immediate action may be taken to maintain them in the ED and thereafter in the ICU. The results of all these factors were dependent on patients age, sex, co-morbidities, GCS or CT/MRI findings as all these are found to have a direct affect on the outcome of TBI patients.

Keywords: Traumatic Brain Injury (TBI); Computed Tomography (CT); Arterial Blood Gas (ABG); Emergency Department (ED); Intensive Care Unit (ICU); Glasgow Coma Scale (GCS); Magnetic Resonance Imaging (MRI).

Introduction

Since the early management of TBI is directed towards minimizing the progression of injury to the at risk brain, it is important to know few parameters like hyponatremia, blood pressure levels, arterial pressures of CO₂, lactates, fever which are not being studied in detail to prove their significance on outcome of TBI.

A high risk of hyponatremia is confronted in patient with TBI. CNS plays a major role in regulation of sodium and water homeostasis. Adequate treatment needs to be given in case of symptomatic hyponatremia to decrease neurological complications and hence severe outcomes. It occurs more frequently because of Syndrome of Inappropriate Antidiuretic Hormone or Cerebral Salt Wasting Syndrome [8,9]. So a gradual correction of sodium deficit is advised to decrease the risk of Central Pontine Myelolysis [10].

In patients with severe TBI, maintenance of blood pressure levels is considered as an important mechanism for sustaining adequate cerebral perfusion pressure and hence Intra Cranial Pressure [11]. Systolic BP > 160mmHg have a mortality of 25.3% as compared to normotensive having a mortality of 13.5% [12].

The arterial partial pressure of CO₂ signifies a balance between carbon dioxide production and

consumption. Decrease in this value can result in severe damage to the central nervous system, where as an increase in it causes altered levels of consciousness, spasticity and risk of intra cranial hemorrhage [13].

Recent studies states that during stress, brain cells undergo anaerobic metabolism to generate energy by metabolizing lactates [14]. However, lactates itself have the potential to elevate oxygen consumption to high levels and therefore could potentially impose a danger to the tissue with low Cerebral Blood Flow [15].

Following trauma damaged neurons releases endogenous pyrogens disturbing the hypothalamic set point leading to fever [16]. For every 1 degree Celsius increases in temperature relative risk of poor outcome rises to 2.2 times [17]. It has been seen that there is decrease in fever burden with score 1 of Glasgow outcome scale which increases significantly as Glasgow outcome decreases from 5-2 [18].

Methods and Materials

The study was conducted after approval from the Institutional Scientific and Ethical committee. The study was a *prospective observational study* where in data was collected prospectively with no interventions on behalf of the investigator. For the

purpose of statistical significance we recruited *one hundred and seventy five* patients in the study.

The study will be conducted in the Emergency department (ED) of Max Super Specialty Hospital, Shalimar Bagh, which is a tertiary care referral hospital with an average of 9000 visits per annum.

Recruitment of subjects was done on the basis of the inclusion and exclusion criteria.

Inclusion Criteria

- Age group (18-70 yrs)
- GCS (4-13): moderate to severe head injury
- Both genders

Exclusion Criteria

- Recent Myocardial Ischemia or Arrhythmias (<1MONTH)
- Severe hypoxia (PaO₂ <60)
- RBS (>200mg/dl)
- Patient whose medical records could not be found.
- Patients who were a part of some other study.

Baseline data including age, mode of injury will be recorded at the time of presentation to the ED. The defined parameter (*serum sodium, blood pressure, CO₂ pressure, lactates and temperature*) along with heart rate, respiratory rate, arterial oxygen pressures, lactates and CT findings will be collected at presentation and at specified intervals as per the data collection form. The study subjects were followed prospectively during the duration of hospital stay.

Patient’s parameters like the total length of hospital stay along with other comorbidities and final outcome in terms patient’s death were recorded.

Results

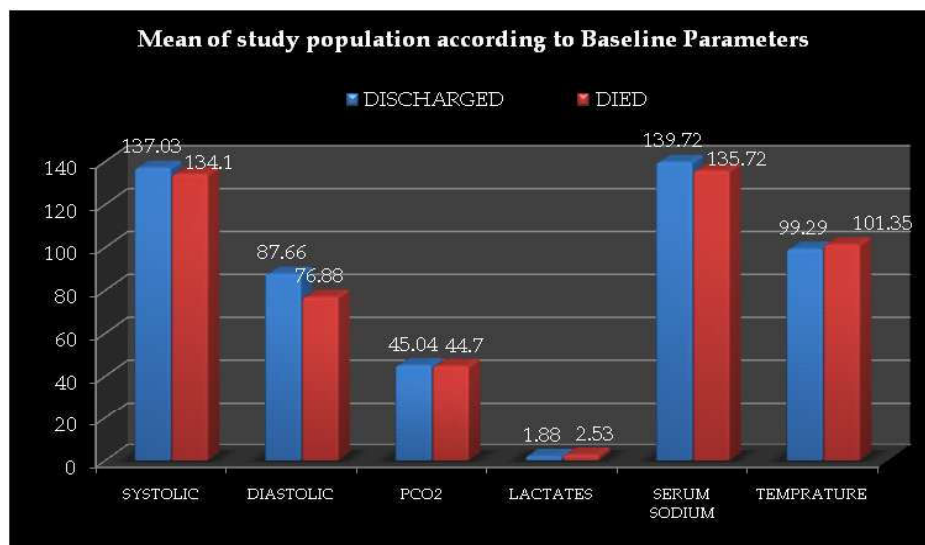
The Mean and standard deviation for base line parameters in patients with TBI was compared in the two groups (i.e. discharged and survival) using *Independent ‘t’ Test*.

It was found to be *most significant for Temperature* and significant for Serum Sodium and Lactates.

Table 1:

	Discharged		Died		T value	P value
	Mean	SD	Mean	SD		
Blood Pressure (mm/Hg)						
Systolic (mm/Hg)	137.03	28.81	134.10	53.39	0.374	0.70
Diastolic (mm/Hg)	87.66	24.2	76.88	32.32	1.720	0.08
PCO ₂ (Pa)	45.04	7.13	44.7	10.5	0.168	0.86
Lactates (mmol/L)	1.88	1.11	2.53	1.61	-2.293	0.02*
Serum Sodium (mmol/L)	139.72	6.76	135.72	14.5	2.034	0.04*
Temperature (F)	99.29	1.45	101.35	1.91	-5.484	0.00*

Independent T test , * Significance of relationship at p < 0.05



Grpah 1:

Mean and standard deviation of study population according to Base Line Parameter (Serum Sodium, Blood Pressure, CO₂ Pressure, Lactates And Temperature) in patients with TBI.

Discussion

Traumatic brain injury contributes to a high number of patients received in the emergency department. Not all the patients who have TBI are able to receive the facilities provided at a tertiary care centre. So it is important to identify the patients who require priority one treatment in the ED and help correct the measures responsible for high mortality and morbidity.

To our knowledge this study is first in India which correlates factors like blood pressure, carbon dioxide levels, serum sodium, serum lactates and temperature and find the most significant factor affecting mortality and morbidity of TBI patients.

In this cohort, we measured all these five factors at the time of patient's presentation to the ED and followed the patient daily in the ICU till the patient was either discharged or expires.

As soon as a patient with traumatic injury arrives in the ED, we start our primary survey from securing the airway, maintaining the C-spine, blood pressure control, GCS, pupillary reaction, RBS and trying to secure bleeding injury and stabilizing it. We then come to the next part of examination which includes investigations and relieving pain, administering antibiotics, tetanus, blood or intravenous fluids, forgetting the importance of temperature control as an important part of the survey.

In this study we found the importance of temperature, serum sodium and lactates maintenance in a TBI patient. However temperature control was found to play the most significant role.

So, the results of this study strongly recommend active interventions, medications and various methods to control temperature and maintain serum sodium and lactate levels while managing a TBI patient and not solely measuring them.

However it was found that all these results were inter-dependant.

It was noticed that a 25-40 years male with road traffic accident and prior history of any co-morbidity, low GCS with multiple findings on CT/MRI findings and abnormal blood pressure, carbon dioxide levels, serum sodium, serum lactates and temperature parameters has a poor morbidity and high mortality.

Conclusion

From the above mentioned results we draw a conclusion that it is important to quickly chart all the parameters of primary survey in a TBI patient and draw an ABG sample to look for serum sodium and lactate levels so that immediate action may be taken to maintain them in the ED and thereafter in the ICU.

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