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Outcome assessment in traumatic brain injury patients: A single centre study

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Abstract
Traumatic brain injury (TBI) is a major health condition where the therapy and the outcome are based on the clinical presentation, severity of injury and secondary brain insults. The present study aimed to assess the outcome of the patients with TBI. It is an observational study conducted in 200 patients during the six months study period. Various parameters are considered to correlate the outcome. 79.5% patients had favorable outcomes and 14.5% patients had severe disability. Overall mortality rate was found to be 5%. Odds ratio has shown positive association for age and outcome. Mortality was seen high in patients with Glasgow Coma Scale 3-8. Electrolyte derangements associated with hyperosmolar therapy found to be statistically significant (P =0.0001) in affecting the outcome as hypernatremia was seen in majority of the patients with GOS grade 1. Age and therapy provided are the significant factors affecting the outcome of TBI. Initial GCS has significantly predicted the outcome of the patients. As the hyperosmolar therapy is the main stay in reduction of ICP in TBI patients, 24 hour monitoring should be done to prevent the electrolyte derangements which are found to significantly affect the outcome of the TBI patients.

Keywords: GCS (Glasgow coma scale), GOS (Glasgow outcome score), Hyperosmolar therapy, ICP (Intracranial pressure), TBI

1. Introduction
Traumatic brain injury is the disruption of the brain function due to externally applied forces either causing acceleration or deceleration of the brain or direct physical contact of the object with the brain or head [1]. It is a major public health problem especially among young age group and is the sixth leading cause of death in India [2]. Annually, at least 10 million TBIs are serious enough to result in death or hospitalization. An estimated 57 million people worldwide have been hospitalized with one or more TBIs [3], but the proportion living with TBI-related disability is not known In 2005, road traffic injuries resulted in the death of an estimated 110 000 persons, 2.5 million hospitalizations, 8–9 million minor injuries and economic losses to the tune of 3% of the gross domestic product (GDP) in India [4].
Traumatic brain injury (TBI) is a condition where the therapy and the outcome are based on the clinical presentation, severity of injury, secondary brain insults such as electrolyte derangements, hypotension, anemia, acid-base disorders and various other factors. Hence the present study aimed to assess the outcome of the patients with TBI correlating to the factors that may affect the outcome.

2. Materials and methods
It is an observational study conducted in a private hospital at Hanumakonda city of Telangana state. It is a150 -bed hospital which is private teritiary care hospital. A total of 200 cases were collected during the study period of 6 months.
All Patients of both genders diagnosed with traumatic brain injury previously & recently receiving Hyperosmolar therapy, steroid therapy, prophylactic and supportive therapy are included in the study. Data such as demographic details, mode of injury, type of injury, plan of care, type of therapy provided, electrolyte derangements and mortality rate was collected from patient case sheets. These factors are correlated and assessed to evaluate the outcome. Initial GCS was used to assess the severity of injury and GOS to assess the outcome at time of discharge.

2.1 Descriptions of Statistical Analysis
The p value, chi-square test value and Odds ratio was calculated wherever required by using Graph Pad Prism software version 7.01.

3. Results
A total of 200 patients with Traumatic Brain Injury were enrolled during the study period. Of these highly effected age group is among 21-40yrs (i.e. 57%), followed by the age groups 41-60yrs (25.5%), less than 20yrs (11.5%), 60yrs and above (6%).
Males are more affected than females with a percentage of 82.5 and 17.5 respectively. The most common mode of injury was road traffic accidents (87.5%) and accidental fall from heights (12.5%).
In all the age groups RTA was found to be the most common cause of Traumatic brain injury followed by fall from heights.

Table 1: Age versus mode of injury

Age (yrs.)	Mode of injury	
	RTA	Accidental fall
Below 20	22	1
21-40	103	11
41-60	43	8
Above 60	7	5
Total	175	25

A total of 29 patients were operated with a percentage of 14.5% and rest of all the patients (171) were managed conservatively with a percentage of 85.5%.

Hematomas are the most frequently seen injuries in TBI patients (46%) followed by Fractures with (27%), Diffuse Brain Injury (15%), Contusions (17%) and Concussions (3.5%).

Table 2: Distribution of patients according to type of injury

Type of injury	No. of patients (%)
Hematomas	92 (46%)
Fractures	54 (27%)
Diffuse brain injury	30 (15%)
Contusions	17 (8.5%)
Concussions	7 (3.5%)

The overall mortality rate was 5% (GOS 1) and 1% remained in vegetative state (GOS 2). 14.5% patients had severe disability and 79.5% had shown better outcome (GOS 4 & 5).

Table 3: Overall outcome in traumatic brain injury patients

Glasgow outcome score	No. of patients (%)
Grade 1	10 (5%)
Grade 2	2 (1%)
Grade 3	29 (14.5%)
Grade 4	52 (26%)
Grade 5	107 (53.5%)
Total	200 (100%)

There was a significantly better outcome with conservative therapy in the patients who are admitted with severe brain injury (P value <0.05) than operated patients (P value >0.05).

Table 4: Survival rate of operated patients based on GCS scale

GCS at admission	Death	Survived	P value
3-8	3	8	$X^2 = 2.942$ P >0.05
9-12	1	11	
13-15	0	6	

Table 5: Survival rate of conservatively managed patients based on GCS scale.

GCS	Death	Survived	P value
3-8	5	37	$X^2 = 27.87$ P < 0.05
9-12	1	56	
13-15	0	72	

The mortality rate was high in the age groups 21-40yrs (2%) compared to > 40yrs age group (2%). There was a positive association of age as a risk factor with the outcome in the age group 21-40yrs, whereas in the age groups < 20yrs and >40yrs odds ratio has shown negative association.

Table 6: Age versus survival in patients with traumatic brain injury.

Age group (yrs.)	Death	Survived	Odds ratio
<20	2	21	0.5526
21-40	4	110	1.44
>40	4	59	0.7763

GCS has been proved to be a significant factor in predicting the outcome of the patients with the P value less than 0.05 (0.0001). Mortality rate was high in patients with severe traumatic brain injury (0.15%) and 0.01% patients in vegetative state, followed by mortality of moderately injured patients (0.02%). Favorable outcome has been seen in patients with mild injuries with no mortality and only 0.01% patients remained in vegetative state.

Table 7: Severity versus outcome in patients with traumatic brain injury.

GCS Score	Glasgow Outcome Score					P value
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	
3-8	8	1	15	10	19	$X^2 = 32.16$ P < 0.05 (0.0001)
9-12	2	0	7	17	41	
13-15	0	1	7	25	47	

Odds ratio has shown positive association for electrolyte derangements and better outcome (GOS grade 4 and 5) in patients, whereas in grades 1, 2, 3 it has shown negative association.

Table 8: Electrolyte derangements versus GOS.

GOS score	Electrolyte derangements		Odds ratio	P value
	Present	Absent		
Grade 1	4	6	0.4231	X^2=14.6 P <0.05 (0.0056)
Grade 2	1	1	0.281	
Grade 3	13	16	0.34	
Grade 4	9	43	1.3476	
Grade 5	17	90	1.4932	

Type of therapy has been proved to be significant in affecting the serum electrolytes with the P value 0.0001. Hyperosmolar therapy has proved to cause high incidence of serum electrolyte derangements followed by prophylactic therapy which includes seizure prophylaxis, antibiotic prophylaxis, anti-emetics, and proton pump inhibitors.

Table 9: Type of therapy versus serum electrolyte derangements.

Type of therapy	Electrolyte derangements		P value
	Present	Absent	
Hyperosmolar therapy	22	27	$X^2 = 19.83$ P < 0.05 (0.0001)
Steroid therapy	4	23	
Prophylactic therapy	18	106	

Hyperosmolar therapy is associated with the higher mortality rate (3.5%), followed by steroid therapy (1%) and prophylactic therapy (0.5%).

Table 10: Type of therapy versus mortality.

Type of therapy	Death	Survived	P value
Hyperosmolar therapy	7	42	$X^2 = 13.82$ P <0.05 (0.010)
Steroid therapy	2	25	
Prophylactic therapy	1	123	

The mean hospital stay was higher (10.29 days) in the age groups between 41-60yrs followed by the age groups <20yrs with a mean hospital stay of 10.21 days, 21-40 age group with a mean hospital stay of 10.13 days and >60yrs age group has shown less mean hospital stay (9.92 days).

4. Discussion

The most commonly affected age group due to TBI is 21-40yrs (57%) followed by the age group 41-60yrs. Similar results have been found in the study conducted by Amitabh singh *et al.* [5], where the 21-40yrs age group was mostly affected (40%). Another study conducted by GH Yattoo and Amin Tabish [6] has contrast findings i.e., majority of the patients belonged to the age group 1-10 years with 25.5% followed by the age group 21-30yrs (21.2%). 21-40yr age group in our study are observed to have high incidence of trauma mainly because of RTA as these group of people are extensively using the motor vehicles for their daily transport. In all the age groups, RTA is the most common mode of injury. This indicates that rash driving, deliberate ignoring of traffic rules and heavy rush on roads are the main reasons for RTA being important cause of TBI.

In our study males are highly affected than females with 82.5% and 17.5% respectively as shown in a study conducted by Shameem Ahmed *et al.* [7] in which males are 71.5% and 28.5% respectively. The reason for males being mostly affected is as they travel frequently and works actively than female. Overall commonest mode of injury is road traffic accidents (87.5%) followed by fall from heights (12.5%). Same findings have been found in a study conducted by Shameem Ahmed *et al.* [7] where the road traffic accidents is the most commonest mode of injury. Another study conducted by N. Andelic *et al.* [8] has found that falls are the leading cause of severe traumatic brain injury with 50% followed by RTA with 40%.

Of all the TBI patients, 14.5% are operated and the rest 85.5% of the patients are managed conservatively. The decision of plan of care to operate the patients depends upon clinical presentation of the patients, type of injury and its severity, penetrating injuries causing gross midline shift and upon the radiological findings like presence of large hematomas causing midline shift, depressed fractures, dural tear or hematoma following the skull fractures etc. Conservative therapy has been mainly indicated for the patients with diffuse brain injury, concussional head injury, mild TBI, presence of small hematoma which is usually treated with the different class of drugs like hyperosmolar agents like 20% Mannitol (4-8 hourly), 3% NaCl; steroid therapy including dexamethasone-4mg BD/TID, prednislone-10mg BD; barbiturate therapy including phenobarbitone; loop diuretics including furosemide 10-20mg BD/TID; and various drugs like Antibiotic prophylaxis, Anti-epileptic drugs, Anti-emetics, Analgesics, Muscle relaxants, Nootropics.

Amitabh Singh *et al.* [5], in his study observed high incidence of scalp laceration (51.08%), followed by skull fractures and contusions (40.29% each). Similar results were observed in the study conducted by GH Yattoo and Amin Tabish [6], where scalp lacerations are high (40.4%) followed by skull fractures (8.9%). In our study hematomas account highest percent (46) compared to the other type of injuries such as fractures (27%), Diffuse brain injury (15%), Contusions (17%) and concussions (3.5%). Computed Tomography scan and skull X-ray was done in 100% of the patients. These findings were helpful for a neurosurgeon to predict the outcome and to provide better treatment strategies.

According to Glasgow Outcome scale, Shameem Ahmed *et al.* [7], in their study found 22% mortality rate followed by 19% in vegetative state, 13% were severely disabled, 17% moderately disabled and 28% were found to have good recovery. Haradhan Deb Nath *et al.* [9], in their study found; 10% patients had good recovery, 43% had severe disability, 26% had moderate disability, 7% were in vegetative state and 14% had mortality. In our study the overall outcome was found to be favorable when compared to the above mentioned studies i.e., 79.5% patients has favorable outcomes (GOS 4 and 5), followed by 14.5% patients had severe disability, 1% remained in vegetative state and the overall mortality was found to be 5%. The mortality rate 1was also less when compared to other studies.

Mortality was found to be high in patients who are managed conservatively (5 patients had GCS 3-8 and 1 had GCS 9-12) compared to the patients who are operated (3 patients had GCS 3-8 and 1 had GCS 9-12). This might be due to the reduction in mass effect by the surgical evacuation of focal lesions. But the overall outcome was found to be good in conservatively managed patients with P value <0.05 when

compared to the operated patients, Whereas in a study conducted by Shameem Ahmed *et al.* [7] surgical intervention was found to be significant compared to conservative therapy. Another study conducted by Paul Leach *et al.* [10] found that better outcome of the patients with surgical intervention was observed compared to the patients with non-surgical intervention (47.3% and 46.6% respectively). They found that the assumption in the past that the patients presenting in coma from traumatic diffuse brain injury will do worse than those that have a mass lesion amenable to surgical decompression is not the case and all severely head injured patients expect a similar outcome.

Navdeep Singh Saini *et al.* [11], in their study found that unfavorable outcome had statistically significant ($p<0.0001$) relationship with the age of the patient. 72.09% of the patients with age above 40 years had adverse outcome which was much higher than 27.27% in below 20 year age group and 40% in patients between age group 20-40 years. Shameem Ahmed *et al.* [5], in their study compared various age transformations to identify simple and accurate descriptions of the associations between age and mortality in patients with TBI. They found that these associations were continuous and the proportion of survivors with poor outcomes (i.e., severe disability or vegetative state) increased with age and that the proportion of the patients with favorable outcomes declined. Our study has shown the similar results as the mortality rate was high in adults and older patients when compared to the younger age group patients (i.e 4 patients died in both 21-40yr and >40yr age groups and 2 in <20yr age group; total no. of deaths are 10) where odds ratio has shown positive association for age and outcome in 21-40yr age group. This increase in decline of outcome with increased age might be due to decrease in functional neurons that help in repairing mechanism.

GCS (Glasgow coma scale) was introduced in 1974 that aimed at standardizing assessment of level of consciousness in head injured patients. It has been used mainly in evaluating the prognosis, comparing different groups of patients and monitoring the neurological status [12]. Amit Agarwal *et al.* [13] in his study found that low Glasgow coma score at admission was significantly associated with mortality as an outcome. In their study highest mortality (67 deaths) has been seen in patients with severe traumatic brain injury (GCS 3-8), Whereas good recovery was observed in 725 patients with mild traumatic brain injury (GCS 13-15). Navdeep Singh Saini *et al.* [11], found GCS as statistically significant (P value = 0.0001) in predicting the outcome of the patients with traumatic brain injury. Our study was consistent with the above mentioned studies where high mortality (8 deaths) was observed in patients with severe traumatic brain injury (GCS 3-8) followed by 2 deaths in moderate TBI patients (GCS 9-12). Good recovery was seen in patients with mild traumatic brain injury (GCS 13-15).

Electrolyte derangements in serum has been found to be a statistically significant ($P < 0.05$) in affecting the outcome of the patients as hypernatremia is seen in majority of the patients with GOS grade 1 which has been followed by hypokalemia. Electrolyte derangements is an important factor which affects the neurological outcome as conditions like hypernatremia may cause cental demyelination syndrome. These electrolyte derangements occur due to the factors like cerebral salt wasting, syndromes of inappropriate ADH secretion, changes in fluid levels as a result of like prescriptions. Mirza Faisal Ahmed Rafiq *et al.* [14] in his study found that sodium was the major electrolyte that underwent significant change followed by potassium. Usha S Adiga *et al.* [15] in her study found that hyponatremia (20%) is the most common electrolyte disturbance which can lead to central nervous system changes, seizures, confusion and even coma.

Electrolyte derangements are highly seen with hyperosmolar therapy and found to be statistically signficant ($P =0.0001$) in affecting the outcome. Mannitol is the key agent causing electrolyte disturbances which was mostly given in combination with furosemide which adds more risk of mannitol causing electrolyte changes. Mannitol initially causes volume expansion and dilutional hyponatremia and later causes volume depletion and hypovolemic hypernatremia. Mortality has been found to be higher (7 deaths) in patients with hyperosmolar therapy group. The type of therapy was found to be significant in affecting the outcome of the patients with traumatic brain injury.

41-60 year age group of patients had a higher mean LOS (length of stay) i.e., 10.29 days followed by the age groups <20yrs with a mean hospital stay of 10.21 days, 21-40 age group with a mean hospital stay of 10.13 days and >60yrs age group has shown least mean hospital stay (9.92 days).

5. Conclusion

Our study was focused on the outcome of patients with traumatic brain injury which depends on various factors. It demonstrated how significantly these factors affected the outcome of TBI patients. Most of the patients belonged to the younger age group and the most common mode of injury is RTA. Hence strict policies should be made and implemented to avoid the road traffic accidents. Conservative intervention was found to be more significant in affecting the outcome of the patients but overall mortality was high in patients with conservative therapy compared to surgical intervention. Hence therapeutic guidelines must be followed and monitoring should be done accordingly. Mortality rate was found to be very less and most of the patients had shown good recovery when compared to most of the other international studies which proved the efficacy of the therapy and critical care facilities provided in our hospital.

Age and therapy provided has been found to be significant factors affecting the outcome of the patients with TBI. Initial GCS has significantly predicted the outcome of the patients. As the hyperosmolar therapy is the main stay of the therapy in the reduction of ICP in TBI patients, 24 hrly monitoring should be done to prevent the electrolyte derangements which are found to significantly affect the outcome of the TBI patients. Besides more number of deaths were noticed in hyperosmolar therapy group patients. A full time clinical pharmacist will play a major role in decreasing the mortality of TBI patients by continuous monitoring and correction of hyperosmolar dose based on serum osmolality of individual patient. This is a unique study correlating the treatment regimen to outcome.

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