Predictors of Mortality among Patients with Head Trauma

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ABSTRACT

Background: Traumatic brain injury (TBI) is one of the leading causes of morbidity and mortality all over the world. Annually, approximately 1.5 million affected individuals die whereas many millions need emergent management. Unfortunately, 90% of the burden occurs in low as well as middle income nations. The outcome of traumatized patient depends on many factors via clinical diagnosis along with the existence & severity of comorbidities and the degree of monitoring and treatment received.

Aim: To assess the importance of the APACHE II (Acute Physiology and Chronic Health Evaluation II), RTS (Revised trauma score), GCS (Glasgow Coma Scale) scores and various variables as age, sex, labs and complications in predicting mortality of cases with TBI in the ICU.

Methods: A Prospective cohort study was carried out on acute TBI cases admitted to I.C.U at Damnoun medical national institute, Egypt during the period from January 2017 until January 2018. Predictive factors as APACHE II, GCS, RTS scores, age, gender, and lab. data, MV days and complications were assessed to predict mortality and outcome for all patients. All patients were followed-up for 2 weeks starting since they were admitted and divided into 2 groups (survivors & non-survivors).

Results: A total of sixty patients were enrolled. Mean age was 40.43±16.90 y, the overall mortality of the total study was 45%. Independent early predictors of mortality were as follows: age mainly between 58-68 years (p <0.001), hypertensive patients (p=0.005), DM and CKD (p<0.001 and =0.005), increased lab values for PT, RBS, creatinine (p<0.005), low GCS, low RTS and high APACHE score (p<0.001), intracerebral hemorrhage (p=0.001) and long stay on MV (p<0.001) Conclusions: Our results suggest that age, GCS, RTS, APACHE II score, RBS, hypertension, ICH and long stay on MV are in dependant early predictors of mortality in patients with traumatic brain injury.

KEYWORDS: Traumatic brain injury, ICU scores, Mechanical ventilation

INTRODUCTION

Traumatic brain injury (TBI) might result from various etiologies such as a blow to the head, penetrating wound of the skull, rapid head acceleration or deceleration, or exposure to a blast. Brain injury is classified into primary and secondary injury. This difference is of great value enabling to understand the pathophysiology as well as to highlights the aims in management of head trauma: prevention and management of secondary injury [1].

Despite decision-making of the traumatized person is almost clinically dependent, it might be fortified via information provided by the scoring systems. Decision can't be made according
to the numerical scale only as an ideal prognostic scale. Mortality Predictors in Head Trauma Patients for the traumatized patients remain nowhere near the documented [2].

Managing TBI patients, in particular those at the severe end of the spectrum should be centered on prevention of secondary cerebral injury. Among the most common are hypotension and hypoxia. Another common secondary insult is increased intracranial pressure (ICP) [3].

PATIENTS AND METHODS

This current study was a prospective cohort study included 60 patients admitted to the ICU Damnhour medical national institute during the period from January 2017 until January 2018. The ethics committee approved the study. All studied populations were diagnosed with an acute TBI with a Glasgow coma scale less than 15 and age older than 16 years. Patients who had GCS=3, post arrest patients, ICU admission > 8 hours after injury and associated cervical spine injury and advanced maxillofacial injury were excluded.

All selected patients were subjected to full examination including full history, complete physical examination (pulse, mean arterial blood pressure “MAP”, general examination with specific focus on injured areas) and full laboratory and selective radiological investigations (CBC, liver enzymes, renal function test, prothrombin activity, international normalized ratio “INR”, arterial blood gases analysis, plain chest X-ray, CT brain and ultrasound abdomen).

All patients were subjected to evaluation using GCS, APACHE II and RTS score. Variables as well as scores were estimated from the worst score reported with the 1st 24 hours of admission; thereafter an estimated approximate mortality percent was calculated.

Endotracheal intubation was carried out and mechanical ventilation was studied for all cases. Additionally, we recorded the plan of neurological management (conservative or surgical intervention).

All patients were subjected to follow up for 2 weeks since they were admitted. Patients were grouped into 2 groups: a-group (1): survivors and 2-group 2: non-survivors.

Statistical analyses

After collection of data for all patients, statistical analysis was carried out using a personal computer via State version 11.2 (StataCorp LP, College Station, Texas, USA) and IBM statistical package for the social sciences statistics version 21 (IBM Corp., Armonk, New York, USA).

The D'Agostino–Pearson test was used for testing normality of numerical data distribution. Median and SD range were used for Non-normally distributed numerical data, and intergroup differences were compared non-parametrically by the Mann–Whitney U-test. Categorical data were presented as number and %.

The predictive value of the results was detected via analyzing the receiver operating characteristic curve (ROC) obtained through plotting the sensitivity &specificity of the probability indices as assessed by Cox model. P values are 2-tailed. P <0.05 was determined as statistically significant.
RESULTS

A total of 60 patients were included. The mean age of the included cases was 40.43±16.90 y and male gender represented 58.3% of the studied individuals. Road traffic accidents (RTA) was the most common mode of trauma. Medical history of hypertension was frequent in the second group (44.4%) in comparison with the 1st group (12.1%), this difference was statistically significant (p=0.005). History of DM was detected in 55.6% of the 2nd group when compared to 9.1% in the 1st group (p less than 0.001). Concerning the presence of renal disorders, 22.2% of patients in the 2nd group had accompanying renal disease (CKD) in comparison with 3.0% in the 1st group (P less than 0.001) Fig (1).

Regarding the lab findings, there was a significant difference in prothrombin time (PT) between the two groups (86.58%±13.40% in group 1 vs. 79.52%±13.65% in group 2, p=0.016). Regarding random blood sugar (RBS) there was the highly significant difference between both groups (mean value in G1 was 157.8±60.27 mg/dl vs.242.9±119.7 for G2, p =0.005). Also, there was a significant difference between both groups regarding creatinine (mean value in group1 was 1.32±0.68 vs. 1.96±0.83 for group2, p less than 0.001) Table (1).

From the above results, patients who had high RBS level, low PT percentage, high serum urea and creatinine and low PLT count were at higher risk for death following TBI (p less than 0.05) Table (1).

The comparison of age between the two groups revealed that there was a highly significant difference between both groups (the 1st group had mean age 33.6±10.30 y. vs. 48.7±19.68 in Group 2, p = 0.001). In addition, on studying the correlation between age and the outcomes, it was determined that highest mortality 33.3% is within age group (58-68) which present 16.7% of study population (Figure 2).

Table (1) Effect of laboratory variables on outcome

<table>
<thead>
<tr>
<th>Lab</th>
<th>Mortality</th>
<th></th>
<th></th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean value in survivors (n=33)</td>
<td>Mean value in non survivors (n=27)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig (1): Comparison between the two studied groups according to medical history
PT (prothrombin time), RBS (random blood sugar), PLT (platelets), WBCs (white blood cells), Hb (hemoglobin), AST (aspartate aminotransferase), ALT (alanine aminotransferase)

<table>
<thead>
<tr>
<th>Lab</th>
<th>Mortality (Mean ± Standard Deviation)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCS</td>
<td>8.88±1.85 (n=33) vs. 6.07±2.0 (n=27)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>APACHE II</td>
<td>12.15±3.71 vs. 18.78±5.64</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Figure (2): Comparison between the two studied groups according to Age (years)

Regarding the ICU scoring systems, GCS score exhibited a highly significant difference between both groups (mean 8.88±1.85 in group1 vs. 6.07±2.0 in group2, p < 0.001). Moreover, upon analysis of APACHE II score, there was a highly significantly different between both groups (the 1st group had mean 12.15±3.71 vs. 18.78±5.64 in the 2nd group, p less than 0.001). Finally, the 2nd group exhibited lower RTS score in comparison with the 1st group (Group1 mean 6.27±0.84 vs. 5.48±0.70 for Group 2, p-value 5.48±0.70 <0.001).

The univariate analysis exhibited that APACHE II, RTS, GCS, as well as age had a statistically significant differences in terms of mortality between both groups (P less than 0.05) Table (2).
On studying the correlation between different ICU scores and outcomes via ROC curve, it was revealed that the optimal cutoff point (OCP) of GCS as a mortality indicator was 7 (yielding 74.07 percent sensitivity & 78.79 percent specificity), with the area under the curve (AUC) at 0.851 (95 percent confidence (CI): 0.753–0.950). Moreover, OCP of APACHE II score as a mortality indicator was 16 (yielding 70.73 sensitivity percent & 84.85 percent specificity) with the AUC at 0.849 (95% CI: 0.748–0.950). Regarding RTS score, the OCP as a mortality indicator was 6 (yielding 96.30% sensitivity & 39.39% specificity) with the AUC at 0.745 (95% CI: 0.622–0.867) Fig (3).

![ROC Curve](image)

**Fig (3): Assessment of effect of scoring systems on outcomes via ROC curve.**

Our results showed that increase LOS on MV had significant effect on the outcome as (mean days of ICU stay was 6.50±4.03 days in group 1 vs. 12.59±6.85 days for group 2, p-value=0.001), (Table; 3), (Figure 4).

With regarding to complications, we found that septic shock, pulmonary embolism, ARDS, Arrythmias (ventricular tachycardia VT, ventricular fibrillation VF) and SCD had significant effect on mortality in our study with significant P value for all ≤ 0.05 (Table 4).

### Table (3): Comparison between the two studied groups according to Mechanical ventilation (days)

<table>
<thead>
<tr>
<th>Total</th>
<th>Mortality</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Survivors</td>
<td>Non survivors</td>
</tr>
<tr>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>Mechanical ventilation (days)</td>
<td>(n=51)</td>
<td>(n=24)</td>
</tr>
</tbody>
</table>
Figure (4): Comparison between the two studied groups according to Mechanical ventilation (days)

Table (4): Comparison between the two studied groups according to complications

<table>
<thead>
<tr>
<th>Complications</th>
<th>Total (n=60)</th>
<th>Mortality</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>Survivors (n=33)</td>
</tr>
<tr>
<td>No</td>
<td>21</td>
<td>35.0</td>
<td>21</td>
</tr>
<tr>
<td>Yes</td>
<td>39</td>
<td>65.0</td>
<td>12</td>
</tr>
<tr>
<td>Chest infection</td>
<td>22</td>
<td>36.7</td>
<td>8</td>
</tr>
<tr>
<td>Midline shift</td>
<td>1</td>
<td>1.7</td>
<td>0</td>
</tr>
<tr>
<td>Sepsis</td>
<td>2</td>
<td>3.3</td>
<td>1</td>
</tr>
<tr>
<td>Septic shock</td>
<td>7</td>
<td>11.7</td>
<td>0</td>
</tr>
<tr>
<td>DVT</td>
<td>8</td>
<td>13.3</td>
<td>3</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>4</td>
<td>6.7</td>
<td>0</td>
</tr>
<tr>
<td>ARDS</td>
<td>7</td>
<td>11.7</td>
<td>0</td>
</tr>
<tr>
<td>Arrhythmia (VT,VF)</td>
<td>5</td>
<td>8.3</td>
<td>0</td>
</tr>
<tr>
<td>SCD</td>
<td>6</td>
<td>10.0</td>
<td>0</td>
</tr>
<tr>
<td>Pnemothorax</td>
<td>2</td>
<td>3.3</td>
<td>1</td>
</tr>
</tbody>
</table>

DVT (Deep vein thrombosis), ARDS (Acute respiratory distress syndrome), VT (Ventricular tachycardia), VF (Ventricular fibrillation), SCD (Sudden cardiac death)

The overall mortality was 45% (27 of 60), we had 33 patients (55%) survived vs. 27 patients (45%) died. On another side, ICU mortality constituted 100% from the non-survivors group and 45% of whole study population. Fig (5).
DISCUSSION

The prediction of the outcomes following TBI is a very difficult issue, due to the extreme heterogeneity of the character of the primary brain injury. In fact, there are no two injuries are precisely similar and the primary injury could be altered as a result of secondary insults. Importantly, patient factors, premorbid condition, as well as the physiologic reserve may affect the response of the patients the trauma [4].

The present study included 60 patients admitted to the ICU following moderate or severe acute TBI. Of note, all patients were followed-up for 2 weeks since they were admitted. Regarding the outcomes, 33 patients (55%) survived and 27 of them (45%) died. On another side, ICU mortality constituted 100% from the non-survivors group and 45% of individuals included in the study. Our results were consistent with a study conducted on 187 patients had a TBI by Tobi et al.[5] who documented that survivor group was 53% vs. 47% from non-survivors and most mortality was in ICU.

On comparing age in both groups, a highly significant difference was observed between both groups (1st group had mean age 33.6±10.30 y. vs. 48.74±19.68 in the 2nd Group, p = 0.001) These findings were in harmony with results of Lindley et al. [6] who revealed that age had noticeable impact on mortality (Mean age range from 24-52 with average 34 in survivors vs. 22-46 with average 30 in non survivors, p = 0.024). In contrast, Strnad et al. [7] found on a study on 52 patients with TBI that age had no noticeable impact on mortality following TBI where survivors had mean age range from 26-54 average 44 years vs. 31-68 average 49 years in non-survivors with ( p= 0.241). This is might be due to the small sample size of patients studied (60 patients).

The results of our study exhibited that decreased GCS is considered one of the risks for in TBI (mean value in the 1st group was 8.88±1.85 versus 6.07±2.0 in the 2nd group, p less than 0.001). These findings were comparable to those reported by Amir et al. [8] who revealed that GCS had significant impact on mortality in TBI with (mean value in non-survivors was 6 (3.0-9.0) vs. 12 (7.0-15.0) in survivors, p < 0.001) with COP of 6, positive predictive value
of 69.2% and negative predictive value of 80.2%. In contrast, a study performed by Andreia et al. [9] on 851 patients found that GCS had no significant effect on mortality with (Mean in non-survivors was 7.4 vs. 8.3 for survivors with p=0.371).

Univariate analysis of APACHE II showed a significant correlation between increasing score and mortality (mean value of APACHE II in the 1st group1 was 12.15± 3.71 vs. 18.78±5.64 in the 2nd Group, p < 0.001). The results were in accordance with a study done by Amir et al.[8] on 125 patient and found that increasing APACHE II had a significant impact on mortality in TBI with (Mean value for non- survivors 19.4±5.5 vs. 12.4±5.5 for survivors with p <0.001) with positive predictive value of 80.6% and negative predictive value of 79.8%.

Regarding RTS score, a highly significant difference between both groups regarding mortality was determined (the 1st group mean value was 6.27±0.84 vs. 5.48±0.70 in the 2nd group, p < 0.001). These results were in coherence with a study performed by Jeong et al. [10] who showed a significant difference regarding RTS score in patients with traumatic brain injury with COP 7 and specificity 80% and (p= 0.001).

In our studied population, patients who were subjected to mechanical ventilation had a significant impact on mortality (52.9% patients in group 2 were ventilated compared to 47.1% in group 1, with p=0.007). Our results were in concordance with data collected by Amanda et al.[11] who found patients subjected to mechanical ventilated after TBI had a higher risk of mortality (35.4% of patients in non-survivors were subjected to mechanical ventilated compared to 13.1% in survivors group, p <0.001). This study and other studied found that exposure to MV increase risk of mortality usually occurred due to increased frequency of infection as VAP. On contrary to our results, Benjamin et al.[12], showed that patients subjected to mechanical ventilation after TBI constitute 50% of total patients and had no significant effect on mortality ( p=1.000).

With regarding to complications, we found that septic shock , pulmonary embolism, ARDS, Arrhythmias (VT,VF) and sudden cardiac death (SCD) had significant effect on mortality in our study with significant p for all ≤ 0.05 while other complications as sepsis, deep vein thrombosis and pneumothorax had no effect on mortality with (p > 0.05).

Our results were in agree with data collected by Meghan et al.[13] who found that pulmonary embolism, ARDS, cardiac arrest after TBI had a higher risk of mortality ( p <0.001) and on contrary with Meghan et al.[13] results as they found that sepsis, DVT have significant effect on mortality (p <0.001).

CONCLUSION

The traumatic brain injury (TBI) outcome can be highly variable, we found the significant predictors of mortality are:
Age especially 58-68 years, patients with a history of HTN, DM, CKD and IHD, patients presented with ICH and midline shift, low PT percentage and low PLT count, high RBS and renal chemistry level, complications as ARDS, septic shock, pulmonary embolism, arrhythmias and SCD, mechanically ventilated patients, patients that had long time on mechanical ventilator and in addition GCS < 7, APACHE II score >16 and RTS score < 6.

Limitations

1. Small number of cases included in the study. A larger number could ameliorate validity.
2. The reliance upon 2 weeks mortality as the primary outcome measure is one of the limitations; some long-term outcome data were missing (such as amnesia or disability).

3. Scores were assessed one-time during the 1st 24 h of admission.

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Conflicts of interest:
There are no conflicts of interest

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