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Factors predicting early outcome in patients admitted at emergency department with severe head trauma

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ABSTRACT

Objective: To determine predictive factors of early mortality among severe traumatic brain injury in emergency department.
Methods: This study is based on a retrospective analysis of 198 admitted in emergency depatment with severe head injury (Glasgow coma scale score ≤8) of an university hospital (Sfax, Tunisia). Basic demographic, clinical, biological and radiological data were recorded on admission and during emergency department stay.
Results: Forty two patients were died. Univariate analysis showed that the presence of shock, cardiac arrest, bilateral mydriasis, high value of injury severity score and low value of Glasgow coma scale were associated with mortality. Moreover, meningeal hemorrhage, cerebral and subdural haematoma were associated with poorer outcome. Multivariate analysis showed that factors associated with a poor prognosis were cardiac arrest cerebral and the presence of cerebral haematoma.
Conclusions: Improving pre-hospital care and ovoid futile resuscitation to given priority in resource allocation and urgent CT scan of the head to look for operable mass lesions as early detection should improve the prognosis of severe head injury at emergency department.

1. Introduction

Traumatic brain injury (TBI) is a major cause of disability, death and economic cost in the world. It poses a major public-health problem, with an estimated annual incidence of up to 500 per 100 000 population and more than 200 hospital admissions per 100 000 admissions in Europe each year[1,2]. The first head trauma data bank in China and one of the largest head trauma data banks in the world account for 7 145 acute head trauma patients[3].

TBI is heterogeneous in terms of cause, pathology, severity, and prognosis, which poses diagnostic challenges. A severe traumatic brain injury (TBI) is defined by a Glasgow coma scale (GCS) score of 8 or less during the first post-traumatic day. Such trauma need intensive treatment in the intensive care unit (ICU), and their management puts enormous strain on emergency because mortality is dramatic in the first day with more than 40% of all death occuring in the first 24 h and 60% in the first 48 h[4,5] of which resources are particularly and frequently limited.

Much research has been done to identify early predictors of mortality and functional outcome, as assessed by the Glasgow outcome scale on admission, after moderate or severe TBI[6]. A number of factors are believed to influence the outcome of head trauma patients including age, gender, GCS, intracranial pressure (ICP), pupillary size and responsiveness, hypoxia and computed tomography (CT) findings[7-9].

In the Sfax area (South Tunisia), everyone with severe traumatic head injury is admitted to our emergency room before to be transfered to the medicosurgical ICU, where specific monitoring tools (jugular venous saturation, intracranial pressure monitoring and transcranial Doppler sonography) are, however, not available either in emergency department or ICU unit.

The current study aimed to evaluate the incidence and causes of head injury, and to define simple predictive factors that can be used in practice in emergency department as indicators of a poor prognosis.

2. Materials and methods

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2.1. Data collection and management of the patients

This retrospective study included all the consecutive patients with severe traumatic brain injury admitted to the emergency room of the Habib Bourguiba University Hospital during the 2-year period, from 2011 to 2012. The data were recorded from the clinical notes, with multiple contributors. Our emergency department is formed by three emergency rooms (medical, surgical and trauma), a resuscitation room with two beds and eight beds of hospitalization in a teaching hospital of 510 beds, which serves as a first-line medical centre for an urban population of one million inhabitants and as a referral centre for a larger population coming from Southern Tunisia. Our department receives almost 104 800 with 4 000 admissions per year.

Patients were admitted directly from the scene of the accident, within 6 h of injury. They were all examined and neurologic status was assessed using the GCS score at hospital arrival before the use of sedative but after resuscitation scored according to GCS at arrival. In the resuscitation room, all the patients with a GCS score of 8 or less, respiratory distress, or shock were intubated, ventilated, and sedated as necessary. They underwent secondary, cerebral CT scan, as soon as feasible. If any significant operable lesion was found, they were operated. Other patients were managed conservatively using ventilatory support, anti convulsants, ICP monitoring, anti edema drugs. When extracranial pathology was suspected, appropriate investigations were conducted.

The medical files of the patients were reviewed retrospectively, and data were collected on age, gender, cause of injury, vital signs (heart rate, respiratory rate, systolic and diastolic blood pressure), GCS score, abbreviated injury score (AIS), injury severity score (ISS), revisited trauma score (RTS), trauma injury severity score (TRISS), calculated within 24 h after admission, pupil response, motor deficit, convulsion, use of mechanical ventilation, use of inotropic drugs, the presence of shock (defined as systolic blood pressure lower than 90 mmHg), the presence of cardiac arrest, fluid intake volume.

The biochemical parameters measured at admission and during the ICU stay were arterial blood gases and acid base state, hemoglobin concentration, platelet count, sodium level, blood urea. Cranial CT scan and plain radiographic study of the neck were performed for all patients. The CT scan results were simplified to the presence or absence of hematoma (whether extradural, subdural, or intracerebral), meningeal hemorrhage, cerebral edema, cerebral contusion, pneumocephalus, intracranial mass lesion. All clinical, biologic, and radiologic parameters and relevant therapeutic measures were registered at admission.

2.2. Statistical analysis

Categorical data were expressed in terms of proportions, and subgroups (survival and death). The data were analysed by statistical package for social sciences (SPSS) 18.0. Continuous variables were expressed as mean±SD, and subgroups were evaluated using student's *t*-test. *Chi*-squared analysis was used to evaluate the relationship between mortality and the various factors (gender, age, causes of trauma, GCS, brain herniations, ICP, traumatic subarachnoid haemorrhage, cerebral contusion and intracranial haematomas). *P* values of less than 0.05 were considered significant. Risk factors were also evaluated by multivariate analyses using a multiple logistic stepwise regression procedure. Odds ratios were estimated from the b coefficients obtained, with respective 95% confidence intervals (95% *CI*).

ISS score, RTS, TRISS and GCS score were used to predict mortality and were analyzed by means of receiver operating characteristic curves. The area under the receiver operating characteristic curve estimated by the method of Hanley and McNeill23 provides a measure of overall mortality.

3. Results

A total of 198 individuals were included in the study, amont which 177 were male and 21 were female. This represented 37.2% of all head trauma admissions and 19.8% of the adult posttraumatic admissions. Their mean age was (32.65±15.90) years, (range, 4–78) years. Blunt head injury was due to road traffic accident in 171 (86.4%) cases and to fall from height in 27 (13.6%). Of the whole group, 51% were from Sfax city and district and 49% were referred from other hospitals in Southern Tunisia. Transport and stabilisation of vital functions were performed by a pre-hospital team in 87 cases (44%) and firefighters in 22 cases (11.1%). Others ambulances performed the transfer of 68 patients (34.3%) and 1% of patient undertaken by their family. The demographic and clinical parameters at admission are shown in Table 1.

Table 1
Demographic and clinical parameters of study population in emergency room.

Parameter	Mean±SD	Number (%)
Age (years)	32.65±15.90	–
Gender M/F	–	177/21
HR (beats/min)	89.48±28.00	–
SBP (mmHg)	111.97±30.00	–
Cardiac arrest		16 (8.1)
GCS score	4.97±1.90	–
Anisocoria	–	17 (8.6)
Bilateral mydriasis	–	15 (7.6)
Convulsion	–	9 (4.5)
Epistaxis	–	14 (7.1)
Otorrhagia	–	11 (5.6)
AIS chest ≥4	–	46 (23.2)
AIS abdomen ≥4	–	9 (4.5)
AIS extremities ≥4	–	3 (1.5)
ISS	26.30±12.00	–
RTS	5.29±4.70	–
TRISS	40.60±31.50	–
Pathologic antecedent		18 (9)

Brain CT was performed on admission for all patients. The results of brain CT scanning are presented in Table 2. Meningeal haemorrhage and skull fracture were the most frequent finds in respectively 60.6% and 58.6%. On admission, 51 (25.8%) patients needed surgury+++.

The head trauma was isolated in 22.2% and associated to chest trauma in (54%), abdominal trauma in 31.3% and a pelvis and/or orthopedic trauma in 50%. The frequency of each secondary systemic insult is represented in Table 3. During emergency department stay, 28.8% of patients required catecholamines; 12 patients (6.1%) for epinephrine, and 45 patients (22.7%) for norepinephrine. Transfusion was needed for 46 patients (23.2%). A total of 70 patients (35.7%) were admitted in operative room. The mean stay in emergency department was (0.8±1.2) days. The mortality rate was 21.2%.

Table 2
Cerebral CT findings.

CT signs	Number (%)
Normal	6 (3)
Meningeal haemorrhage	120 (60.6)
Cerebral oedema	58 (29.3)
Cerebral contusion	102 (51.5)
Extradural haematoma	40 (20.2)
Subdural haematoma	78 (39.4)
Pneumocephalus	36 (18.2)
Mass lesion	17 (8.6)
Skull fracture	116 (58.6)
Depressed skull fracture	27 (13.6)

Table 3
Frequency of each secondary systemic insult.

Insult	Number (%)
Arteriel hypotension (<90 mmHg)	46 (23.2)
Hyponatraemia	19 (9.6)
Hypernatraemia (>145 mmol/L)	23 (11.6)
Hypoxaemia	22 (11.1)
Hypercapnia (>45 mmHg)	32 (16.2)
Hypocapnia	31 (15.7)
Anaemia (<10 g/dL)	60 (30.2)
Hyperglycaemia (>11 mmol/L)	32 (20.1)

The study population was divided into survivors and non–survivors, and the groups were compared in univariate analysis as in Table 4.

Univariate analysis showed that the presence of shock, cardiac arrest and bilateral mydriasis were associated with mortality. In our study, the mean age did not differ significantly between survivors and non–survivors (P=0.18). Moreover, meningeal hemorrhage, cerebral and subdural haematoma were associated with poorer outcome. Acidosis (P=0.001), hypernatraemia (P=0.009), anaemia (P=0.03) and coagulopathy (P=0.03 for platelet count and P<0.001 for total protein) greatly affected outcome in patients with severe head injury.

On admission high value of ISS (P=0.01) and low value of GCS (P<0.001) were found to affect significantly the outcome. There was no significant difference in mean hospital stay (P=0.19) between non–survivors [(0.6±0.6) days] and survivors [(0.9±1.3) days].

Multivariate analysis showed that factors associated with a poor prognosis were cardiac arrest cerebral (P=0.02, OR=549) and cerebral haematoma (P=0.01, OR=207).

Table 4
Factors associated with death in univariate analysis.

Factor	Non–survivors (n=42)	Survivors (n=156)	P–value
Age (years)	36.24±20.50	31.68±14.30	0.18
Gender M/F	38/4	139/17	0.50
HR (beats/min)	96.78±34.20	87.56±25.90	0.11
Pre–hospital ventilation	33/42	102/156	0.07
Shock	20/21	26/130	<0.001
Cardiac arrest	15	1	<0.001
GCS score	4.43±1.70	5.12±20.00	<0.001
Anisocoria	5/35	12/144	0.27
Bilateral mydriasis	7/35	8/148	0.02
Convulsion	3/39	6/150	0.29
ISS	30.47±12.80	25.17±11.60	0.01
RTS	4.24±1.60	5.52±5.10	0.17
TRISS	46.22±29.10	39.37±32.00	0.25
Meningeal haemorrhage	31/11	89/67	0.03
Intra–cerebral haematoma	10/32	7/148	<0.001
Subdural haematoma	23/19	55/101	0.01
Cerebral contusion	18/24	84/72	0.10
pH	7.26±0.10	7.36±0.10	0.001
HCO_3–(mmol/L)	16.88±3.80	18.86±3.30	0.003
Hypercabnia (>45 mmHg)	10/32	22/134	0.10
Anaemia	18/32	42/114	0.03
Platelet count (×10/mL)	165.82±61.20	191.59±68.60	0.03
Prothrombinaemia (%)	53.58±16.70	63.88±15.90	<0.001
Hypernatraemia (>145 mmol/L)	10/32	13/143	0.009
Emergency department stay (days)	0.6±0.6	0.9±1.3	0.19

4. Discussion

Trauma ranks as the ninth leading cause of global disease burden, resulting in 5 million deaths annually (164)[10]. TBI constitutes a major health and socioeconomic problem throughout the world[11]. It is more common in young adults, particularly men (75%), which causes high costs to society because of life years lost due to death and disability and the road traffic accident was the commonest (83.64%) mode of severe head injury[12,13]. In Tunisia, Bahloul *et al*. report that almost 13 000 motor vehicle crash cases are registered per year, resulting in approximately 1 500 deaths[12]. In the current study, the mean age of patient was (32.65±15.90) years and road accident was responsible of 86.4% of head trauma. TBI can be isolated, but is associated with extracranial injuries (limb fractures, thoracic or abdominal injuries) in about 35% of cases which increases the risk of systemic insults which leads to secondary brain damage[14]. In our study, the head trauma was isolated in 22.2%. The outcome and prognosis were generally assessed in the ICU and until 6 month after injury and the most frequently used global outcome measure in TBI is the Glasgow outcome scale. Mortality and morbidity rates in patients sustaining severe head injuries remain high. The meta–analysis of Georgoff *et al*. shows that the mortality rate of severe head trauma in the developing countries, range from 29.1% to 62.3%, which are higher than in USA and developed countries[15]. In our study, the early mortality in emergency department was 21.2%, a value consistent with other series occurred in emergency department. We analyzed mortality rates using only variables from the initial ED assessments of the patients[16–18].

Many studies have reported on the univariate association between predictors and outcome after TBI. The IMPACT study group, which analysed individual patient data from over 9 000 patients with severe or moderate TBI from 11 studies, confirmed age, GCS motor score, pupillary response, and CT characteristics as the most powerful independent prognostic variables[19]. In our study, and only in the univariate analysis, unfavorable outcome was significantly increasing with decreasing GCS and with presence of bilateral mydriasis. However, as in the others studies, the age on the outcome of head trauma is not significant in this current study.

Many others important prognostic factors include hypotension, hypoxia, eye and verbal components of the GCS, and laboratory variables (glucose, platelets, and haemoglobin) have shown an association poorer outcome[20]. In the current study, hypotension was significantly associated with poor outcome. Hypoxia was not found to be associated with poor outcome in our study. For those patients needing airway support, 31.8% arrived to the ED already intubated and on mechanical ventilation. The need for MV was found to be a risk factor for mortality in many study[18,21,22], but our results did not support this finding. The mortality rate from cardiac arrest associated with trauma is extremely high. Before 2005, the published literature suggested that the resuscitation of patients who suffer traumatic cardiac arrest on scene was at worst futile and at best associated with very poor rates of survival[23]. This visibly true in our study, 15 patients presented with cardiac arrest died in the emergency department.

The ISS score is commonly used scoring system in traumatology[24]. Many studies were controversial about his quality as outcome predictor even with serious injuries[25,26]. We demonstrated a significant relationship between ISS and prognosis only in univariate analysis.

The CT findings have been shown to affect outcome, which guide further management[13,27]. However, some lesions appear to be associated with a poor prognosis. Among all the CT findings many studies showed that midline shift is the most important factor that influences the outcome[28–30]. Even there was increase in mortality with increase in midline shift, with mortality reaching up to 61.90% in patients with midline shift of more than 5 mm[13]. Bahloul *et al*. found the presence of a subdural hematoma correlated with mortality in both the univariate and multivariate analyses, which has been explained by the frequent presence of other lesions such as contusion and meningeal hemorrhage[12,31]. Posttraumatic meningeal hemorrhage was also been evocated to be correlated with death by Bahloul *et al*.[12] and Eisenberg *et al*[32]. These lesions appear to reduce cerebral blood flow in acute stage and then a slight increase to levels near the lower limit of the normal range in the subacute stages[32,33]. In the present study, meningeal hemorrhage, subdural hematoma and intracerebral haematoma were, in univariate analysis, associated with death and only the cerebral haematoma remains in multivariate analysis. This dynamic and expansile nature of cerebral contusions can lead to rise in intracranial pressure and delayed neurological deterioration[34]. Making a decision on which hematoma needs to be evacuated can be difficulty as it depends on the size of haematoma and the location and clinical picture of the patient[35].

In conclusion, this study has significant limitations. Firstly, this was a single centre, retrospective study and is subject to the biases of studies of this type. There was no opportunity for long–term follow–up, therefore we have no data on long–term disability or mortality after discharge emergency department. The implementation had many difficulties including large losses of data and the sample size is relatively small.

Despites this, all professionals working with trauma patients aim to improve the outcome of such patients. Here, we provide findings that should improve quality control for our own department and serve as an example for hospitals that lack to specific monitoring tools in their emergency department. The identification of factors which reliably predict outcome can help in optimising the use of limited resources. First, improved pre–hospital care, even in cases of cardiac arrest by application of the guidelines like the International Liaison Committee on Resuscitation resuscitation guidelines[36] should improve the prognosis of severe head injury, ovoid the risks to rescuers and costs of futile resuscitation and should give priority in prehospital, emergency and intensive care resource allocation. Second, Urgent CT scan of the head should be done in a very short time to look for operable mass lesions as early detection and evacuation of the mass lesions.

Conflict of interest statement

The authors report no conflict of interest.

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