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Severe head injury among children: Prognostic factors and outcome

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SUMMARY

Aim: To determine predictive factors of mortality among children after traumatic brain injury.
Methods: A retrospective study over 8 years of 222 children with severe head injury (Glasgow Coma Scale score ≤ 8) admitted to a university hospital (Sfax, Tunisia). Basic demographic, clinical, biological and radiological data were recorded on admission and during intensive care unit stay.
Results: The study included 163 boys (73.4%) and 59 girls, with mean age 7.54 ± 3.8 years. The main cause of trauma was road traffic accident (75.7%). Mean Glasgow Coma Scale score was 6 ± 1.5, mean Injury Severity Score (ISS) was 28.2 ± 6.9, mean Paediatric Trauma Score (PTS) was 3.7 ± 2.1 and mean Paediatric Risk of Mortality (PRISM) was 14.3 ± 8.5; 54 children (24.3%) died. Univariate analysis showed that low PTS on admission, high ISS or PRISM, presence of shock or meningeal haemorrhage or bilateral mydriasis, and serum glucose > 10 mmol l^{-1} were associated with mortality rate. Multivariate analysis showed that factors associated with a poor prognosis were PRISM > 20 and bilateral mydriasis on admission.
Conclusions: In Tunisia, head injury is a frequent cause of hospital admission and is most often due to road traffic accidents. Short-term prognosis is poor, with a high mortality rate (24.3%), and is influenced by demographic, clinical, radiological and biological factors.

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Introduction

Traumatic brain injury is the most common cause of death and of acquired disability among children and young adults in developed countries; even when adequate treatment is provided, there is usually neuronal loss.[10] The pathophysiology of this condition highlights the importance not only of the primary lesions, but also of secondary processes that may lead to cerebral hypoxia and ischaemia.[44] Secondary brain damage is the leading cause of death in hospital after traumatic brain injury.[26,44] Moreover, the outcome of childhood head trauma varies from centre to centre depending on the availability of modern neurosurgical and neuroradiological facilities and qualified expertise.[38] In Tunisia, nearly 13,000 victims of motor vehicle accident are recorded annually and about 1500 of these die, according to the National Guard statistical data.[1] Paediatric morbidity and mortality due to head trauma are increasing because of the high rate of road traffic accidents. Survivors are susceptible to irreversible neurological damage that represents an important socioeconomic problem.[13,31] In the Sfax area (South Tunisia), everyone with severe traumatic head injury is admitted to our medicosurgical intensive care unit (ICU), where specific monitoring tools (jugular venous saturation, intracranial pressure monitoring and transcranial Doppler sonography) are, however, not available.

The aim of the present study was to evaluate outcome of severe head injury among children referred to this unit, and to define simple predictive factors which could be used in routine practice in general ICUs as indicators of prognosis.

Materials and methods

This study was approved by an internal review board.

Patients

In this retrospective study, we included all consecutive patients with severe traumatic brain injury and Glasgow Coma Scale (GCS)

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score ≤ 8, aged less than 15 years and admitted to the ICU of Habib Bourguiba University Hospital during an 8-year period, from 1997 to 2004. The data were recorded from the clinical notes, with multiple contributors. Our department is a 22-bed medicosurgical ICU 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. The total number of admissions in our unit is about 1200 per year, and 3 beds are reserved for paediatric intensive care. The children in this series were admitted directly from the scene of the accident, within 6 h of injury. They were all examined and scored according to the GCS on arrival, and underwent computed cerebral tomography (CT) as soon as feasible.

Methods

The patients' medical files were retrospectively reviewed, and the following data were collected: age, gender, vital signs (heart and respiratory rates, systolic and diastolic blood pressures), body temperature in °C, GCS score,[45] Injury Severity Score (ISS),[2] Paediatric Trauma Score (PTS),[46] Paediatric Risk of Mortality (PRISM) score,[41] cause of injury, pupillary responses, motor deficit, presence of convulsions, use of mechanical ventilation, presence of shock or arterial hypotension,[21] occurrence of cardiac arrest, fluid intake volume, brain CT result and use of catecholamines (dopamine, dobutamine and epinephrine). Before 2005 norepinephrine was not available in our ICU, so it was not used in our study. Biochemical parameters measured on admission and during the ICU stay included arterial blood gases and acid–base status, haemoglobin concentration, platelet count, serum glucose and sodium (Na^+) levels, blood urea and urinary specific gravity.

Plain radiographic studies of the neck were performed in all cases. Cranial CT was carried out in all but four cases (because of reduced availability of CT); for these four children brain magnetic resonance imaging (MRI) was performed on admission. The CT findings were axed according to the presence or absence of haematoma (whether extradural, subdural or intracerebral), meningeal haemorrhage, cerebral oedema, cerebral contusion, pneumocephalus, intracranial mass lesion and herniation. In addition, cranial CT results were stratified according to the Traumatic Coma Databank Computed Tomography Classification for Severe Head Injury.[50] The classification was performed by a university radiologist (K.B.M.).

Neurological status was assessed using the GCS score, at the site of accident and again on hospital arrival, before the use of sedatives but after resuscitation, i.e., the pre-intubation GCS used in our analysis. All the children underwent intubation and ventilation and received sedation with thiopental sodium 50 mg kg^{-1}/day or fentanyl-midazolam as necessary. Those with diabetes mellitus or who received intravenous glucose-containing fluid intravenously were recorded as such. Corticosteroids were not administered for treatment of cerebral oedema. Following the protocol in our ICU, the bedhead was kept elevated in all cases and mannitol was used when raised intracranial pressure was suspected or CT showed cerebral oedema and/or herniation. Hypertonic saline is not used in our practice. Mild hyperventilation ($PaCO_2$ = 30–35 mmHg) was maintained as in all cases of severe traumatic head injury requiring mechanical ventilation. In our practice, anticonvulsants are administered if seizures develop. Neither hypothermia therapy nor decompressive craniectomy were used our series. Therapies were directed by repeated CT. When extracranial pathology was suspected, appropriate investigations were performed.

All clinical, biological and radiological parameters and relevant therapeutic measures were recorded on admission and during ICU stay, including the means and ranges of all daily Na^+, potassium (K^+) and blood sugar levels. In addition, we recorded the development of secondary systemic insults (SSIs) on admission and during ICU stay. SSIs were divided into subgroups: respiratory (hypoxaemia, hypercapnia, hypocapnia),[37,39] circulatory (hypotension or arterial hypertension),[9,40] metabolic/electrolytic (anaemia, hyper- or hypoglycaemia, hyponatraemia, diabetes insipidus)[5,22,37] and hyperthermia. All complications during ICU stay were recorded: nosocomial infections,[20] pneumonia,[33] urinary tract infections,[33] meningitis[20] and septicaemia.[4] Glasgow Outcome Score[27] was estimated after hospital discharge by an ICU physician and a paediatric physician (H.C. and M.H. in most cases).

Statistical analysis

Categorical data were expressed in proportions, and subgroups (survival and death) were analysed by the chi-squared testing.

Continuous variables were expressed as means (±standard deviation) and subgroups were evaluated by Student's *t*-test. In this analysis, to study the influence of age on outcome, we compared mean ages between survivors and non-survivors. In addition, we analysed the association of age ≤ 2 years and age < 5 years and outcome.

Risk factors were evaluated by univariate analysis and multivariate analysis using a multiple logistic stepwise regression procedure. Odds ratios were estimated from the coefficients obtained, with 95% confidence intervals.

PRISM score, PTS, ISS and GCS score were used to predict mortality and were analysed by means of receiver operating characteristic (ROC) curves. The area under the ROC curve estimated by the method of Hanley and McNeill[23] provides a measure of overall mortality. For comparable data a p-value < 0.05 was considered significant.

Results

During the study period, 455 children were admitted to our ICU with traumatic head injury. Of these, 222 had GCS score ≤ 8 and were included in the study. This group represented 16.2% of all paediatric ICU admissions, 80.2% of paediatric post-traumatic cases and 2.3% of all ICU admissions. Transport and stabilisation of vital functions were performed by a pre-hospital team and/or firefighters in 43% of cases. However, in 57% of cases transport was undertaken by the child's family. Of the whole group, 44.4% were from Sfax city and district and (57.6%) were referred from other hospitals in southern Tunisia.

The study group included 163 boys (73.4%) and 59 girls (26.6), with a mean age of 7.54 ± 3.8 years (range 0.3–15 years). Children aged less than 2 years, those between 3 and 5 years and those between 6 and 10 years represented 8.1, 25.6 and 38% of the total population, respectively. The demographic and clinical parameters on admission are shown in Table 1.

Trauma was caused by road traffic accident in 75.7%, occurred at home in 23.9% or was due to assault in 0.4% of cases. In 51.8% extracranial pathology was present, including fracture of ribs or long bones (27.5%), and injuries to the face (18%), chest (9%), abdomen (16.7%), pelvis (3.6%) and spine (1.4%).

Brain CT was performed on admission in 218 cases, and in 4 cases the brain was explored on admission with MRI because of non-availability of CT; 27 (12.2%) showed depressed skull fracture with brain contusions. All the children needed intubation, mechanical ventilation (mean duration 5 ± 6.3 days) and sedation on admission, according to the protocols detailed above.

On admission, 40 (18%) children needed craniotomy (evacuation of subdural haematoma for 5, evacuation of extradural haematoma for 13, lobectomy for 2, cerebrospinal fluid drainage

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