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ORIGINAL RESEARCH

Influence of severity of traumatic brain injury at hospital admission on clinical outcomes

Influência da gravidade do traumatismo cranioencefálico na admissão hospitalar na evolução clínica

Influencia de la gravedad del traumatismo craneoencefálico en la admisión hospitalaria en la evolución clínica

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ABSTRACT | Traumatic brain injury (TBI) is a public health problem with high mortality and socioeconomic repercussions. We aimed to investigate the influence of TBI severity on the length of mechanical ventilation (MV) stay and length of hospital stay and on the prevalence of tracheostomy, pneumonia, neurosurgery and death. This retrospective, observational study evaluated medical records of 67 patients with TBI admitted to Irmandade da Santa Casa de Misericórdia de São Paulo. Severity was determined according to the Glasgow Coma Scale (GCS): mild (13–15 points; 36 patients; 53.7%), moderate (9–12 points; 14 patients; 20.9%) or severe (3–8 points; 17 patients; 25.4%). Severe TBI patients had higher prevalence of tracheostomy, pneumonia and neurosurgery. No significant differences were observed between TBI severity, mortality and length of MV stay. However, TBI severity influenced the length of hospital stay. TBI severity at admission, evaluated according to the GCS, influenced the prevalence of tracheostomy, pneumonia, neurosurgery and was associated to prolonged hospital stay.

Keywords | Craniocerebral Trauma/mortality; Artificial Respiration; Bronchopneumonia; Tracheostomy.

RESUMO | O traumatismo cranioencefálico (TCE) é um problema de saúde pública com muitos casos de mortalidade e repercussões socioeconômicas. Este estudo visa investigar a influência da gravidade do TCE no tempo de ventilação mecânica (VM) e hospitalização, e na prevalência de casos de traqueostomia, pneumonia, neurocirurgia e morte. É um estudo retrospectivo e observacional, que avaliou prontuários de 67 pacientes com TCE na Irmandade Santa Casa de Misericórdia de São Paulo. A gravidade foi avaliada pela escala de Glasgow (ECG): leve (13-15 pontos; 36 pacientes; 53.7%); moderado (9-12 pontos; 14 pacientes; 20.9%); ou grave (3-8 pontos; 17 pacientes; 25.4%). Pacientes com TCE grave apresentaram maior prevalência de traqueostomia, pneumonia e neurocirurgia. Não houve diferença significativa entre gravidade do TCE, óbito e tempo em VM, apesar de a gravidade do TCE ter influenciado o tempo de hospitalização. A gravidade do TCE na admissão, avaliada pela ECG, influenciou a prevalência de traqueostomia, pneumonia, neurocirurgia e de maiores tempos de internação.

Descritores | Traumatismos Craniocerebrais/mortalidade; Respiração Artificial; Broncopneumonia; Traqueostomia.

RESUMEN | El traumatismo craneoencefálico (TCE) es un problema de salud pública con alta mortalidad y repercusiones socioeconómicas. Este estudio ha tenido el objetivo de investigar la influencia de la gravedad del TCE en el tiempo de ventilación mecánica (VM)

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y de hospitalización y en la prevalencia de traqueotomía, neumonía, neurocirugía y mortalidad. Este estudio retrospectivo, observacional ha evaluado historias clínicas de 67 pacientes con TCE admitidos en Irmandade Santa Casa de Misericórdia de São Paulo. La gravedad ha sido evaluada por la escala de Glasgow (ECG): leve (13-15 puntos; 36 pacientes; el 53,7%), moderado (9-12 puntos; 14 pacientes; el 20,9%) o grave (3-8 puntos; 17 pacientes; el 25,4%). Pacientes con TCE grave han presentado prevalencia más grande de traqueotomía, neumonía y neurocirugía. No ha habido diferencia significativa entre la gravedad del TCE, la mortalidad y el tiempo en VM; mientras tanto, la gravedad del TCE ha influenciado el tiempo de hospitalización. La gravedad del TCE en la admisión, que ha sido evaluada por la ECG, ha influenciado la prevalencia de traqueotomía, neumonía, neurocirugía y ha sido asociada la internación prolongada.

Palabras clave | Traumatismos Craniocerebrales/mortalidad; Respiración Artificial; Bronconeumonía; Traqueotomía.

INTRODUCTION

Traumatic Brain Injury (TBI) is a major public health problem with high mortality and socioeconomic repercussions. TBI causes temporary or irreversible physical, cognitive, emotional and/or social deficits. It is caused by external physical forces and results in anatomical injury and/or functional impairment of the scalp, skull, meninges, or brain; with no degenerative or congenital nature[1]. It is the main cause of death and sequelae in young adults[2] and has a high socioeconomic impact[3].

TBI severity is assessed and followed by the Glasgow Coma Scale (GCS), classified as mild (13-15 points), moderate (9-12 points) or severe (3-8 points). The cause and intensity of TBI influences the clinical outcomes[4], as well as seizures, loss of consciousness and other neurological symptoms[5]. Severity is determined by the impact itself and by the pathological and clinical processes that occur as a result of the trauma[5].

In the acute phase of TBI, invasive mechanical ventilation (MV) is often required to maintain airway patency and adequate gas exchanges[6]. Scores below 9 on the GCS indicate the need for endotracheal intubation. MV is related to prolonged hospital stay and higher risks for comorbidities and must be interrupted as early as possible. TBI patients frequently need monitoring, surgery and prolonged MV[6].

Approximately 1.6 million victims of TBI a year are admitted to emergency departments around the world[7]. The mortality rate of victims of TBI in the Brazilian population has shown a slight decrease recently, although one in six hospital admissions were related to TBI[3]. In 2011, 547,468 admissions in Brazil were made and resulted in 12,800 deaths[8]. The highest mortality occurred among victims of car accidents. The real impact of TBI may be even higher, because cases are currently underreported and underdiagnosed[9].

Patients with moderate or severe TBI can develop abnormal respiratory drive[10], causing respiratory failure, and they often require prolonged MV[11]. Ventilation and oxygenation must be priorities in the initial management. However, MV increases the risk of pneumonia. Ventilator-associated pneumonia is an infectious process of the lung parenchyma, which affects patients undergoing endotracheal intubation and MV for more than 48-72 hours[12].

Tracheostomy is a common procedure in patients with TBI, with the purpose of facilitating respiratory management[13]. It is often associated with a lower prevalence of pneumonia, but some studies show the opposite[1,14-16]. Tracheostomy does not influence the length of hospital stay of patients with severe TBI[6], but it can shorten MV duration. Cases of pulmonary complications associated with tracheal aspiration have been observed[17].

TBI can impair swallowing and speaking control, and dysphagia increases the risk of aspiration[18]. Cuffed cannulas avoid aspiration, however, cuff pressure must be monitored to avoid excessive esophageal compression, local ischemia or necrosis and tracheoesophageal fistula[18]. A high occurrence of post-extubating aspiration is reported, ranging from 10%-50% in patients in MV for more than 48 hours[19].

The main objective of intensive care in patients with severe TBI is to maintain cerebral perfusion pressure, as the brain recovers[20]. In such cases, patients need MV for protection and ventilation of airways. Neurosurgery criteria include lesion site, size, volume, midline structures deviation, associated lesions, clinical and neurological status[21].

It is important to understand the influence of TBI severity at hospital admission on invasive MV, tracheostomy, pneumonia, neurosurgery, length of hospital stay and mortality. The GCS score at admission can be a predictor for these other variables and this knowledge may help in the development of treatment and of the follow-up planning.

METHODOLOGY

This is a retrospective observational study, based on records of TBI patients included in the research at the Central Hospital Irmandade de Santa Casa de Misericórdia de São Paulo. The study was approved by the Research Ethics Committee (protocol number 535.842). Patients were selected if they had been scored with the GCS at admission.

Patients were divided into three groups, according to the GCS score at admission: mild (13–15 points), moderate (9-12 points) or severe (3-8 points). The impact of TBI severity on length of MV, tracheostomy, pneumonia, neurosurgery, length of hospital stay and mortality was analyzed.

MV and hospital stay lengths were categorized by the number of days: 10; 11-20; 21-30 and over 30 days. Tracheostomy, pneumonia, neurosurgery and death were computed as yes or no (categorical variables).

Variables were presented by absolute and relative frequencies, means and standard deviations. The association between categorical variables and TBI severity was investigated through chi-square tests. Confidence level was 95% and statistical analysis was performed with Stata, version 11.0.

RESULTS

Sixty-seven charts of patients with TBI were analyzed between September 2013 and February 2014. The mean age was 35.5 years with a standard deviation of 19.2 and male predominance (89.5%). Regarding TBI severity, evaluated according to the GCS, 36 subjects (53.7%) were admitted with mild injury, 14 (20.9%) with moderate and 17 (25.4%) with severe injury.

Sixteen patients (23.9%) underwent neurosurgery. Pneumonia occurred in 23 subjects (34.3%) and 19 (28.4%) patients were tracheostomized. Eight patients (25.0%) were on MV for 0-10 days, 13 (40.6%) for 11-20 days, 4 (12.5%) for 21-30 days and 7 (21.9%) for more than 30 days. Twenty-eight patients (41.8%) stayed at the hospital for 0-10 days, 6 (9.0%) for 11-20 days, 11 (16.4%) for 21-30 days and 22 (32.8%) for more than 30 days (Table 1).

Table 1. Sample characterization

Variables	Absolute number	%
Gender		
Male	60	89,5
Female	7	10,5
Traumatic Brain Injury severity		
Mild	36	53,7
Moderate	14	20,9
Severe	17	25,4
Treatment		
Conservative	51	76,1
Surgical	16	23,9
Pneumonia		
Yes	23	34,3
No	44	65,7
Tracheostomy		
Yes	19	28,4
No	48	71,6
Death		
Yes	10	14,9
No	57	85,1
Invasive mechanical ventilation		
10 days	8	25,0
11 to 20 days	13	40,6
21 to 30 days	4	12,5
Over 30 days	7	21,9
Time of hospital stay		
10 days	28	41,8
11 to 20 days	6	9,0
21 to 30 days	11	16,4
Over 30 days	22	32,8
	Mean	**Standard deviation**
Age (years)	35,5	19,2

Severe TBI was associated to increased prevalence of neurosurgery, pneumonia and tracheostomy, but not to mortality (Table 2). No statistically significant association was found between TBI severity and length of MV stay. However, TBI severity influenced the length of hospital stay (Table 3).

Table 2. Association between clinical factors and traumatic brain injury severity

Variables			*Chisquare test (p value)*
	Treatment		
	Conservative	Surgical	
Severity	**n (%)**		
Mild	**32 (88,9)**	4 (11,1)	
Moderate	10 (71,4)	4 (28,6)	0,015
Severe	9 (52,9)	8 (47,1)	
	Complications from pneumonia		
	Yes	**No**	
Severity	**n (%)**		
Mild	8 (22,2)	28 (77,8)	
Moderate	4 (28,6)	10 (71,4)	0,009
Severe	11 (64,7)	6 (35,3)	
	Tracheostomy		
	Yes	**No**	
Severity	**n (%)**		
Mild	3 (8,3)	33 (91,7)	
Moderate	6 (42,9)	8 (57,1)	0,001
Severe	10 (58,8)	7 (41,2)	
	Deaths		
	Yes	**No**	
Severity	**n (%)**		
Mild	3 (8,3)	33 (91,7)	
Moderate	2 (14,3)	12 (85,7)	0,132
Severe	5 (29,4)	12 (70,6)	

* Chi-square test.

Table 3. Association between invasive mechanical ventilation time and hospital stay according to traumatic brain injury severity

Variables	Invasive mechanical ventilation time				p*
	10 days	11 to 20 days	21 to 30 days	Over 30 days	
Severity	**n (%)**				
Mild	3 (37,5)	1 (12,5)	1 (12,5)	3 (37,5)	
Moderate	2 (28,6)	3 (42,9)	1 (14,3)	1 (14,3)	0,630
Severe	3 (17,6)	9 (52,9)	2 (11,8)	3 (17,6)	
Variables	**Time of hospital stay**				**p***
	10 days	11 to 20 days	21 to 30 days	Over 30 days	
Severity	**n (%)**				
Mild	23(63,9)	3 (8,3)	4 (11,1)	6 (16,7)	
Moderate	4 (28,6)	2 (14,3)	4 (28,6)	4 (28,6)	0,001
Severe	1 (5,9)	1 (5,9)	3 (17,6)	12 (70,6)	

*Chi-square test.

DISCUSSION

In the present study, we investigated the influence of TBI severity at hospital admission on tracheostomy, pneumonia, neurosurgery, length of MV and hospital stay and mortality.

Mild TBI was frequent (Table 1), but in a smaller proportion (53.7%) than in the study by Bazarian et al.[22], who stated that mild TBI generated costs of 17 billion per year[23] and comprised 75% of TBI cases[22]. We observed that patients with mild TBI had lower prevalence of tracheostomy, neurosurgery and pneumonia and a shorter hospital stay. Although these cases are less severe, it is important to follow them, because some may need interventions (Tables 2 and 3). Pneumonia, which was observed in 34.8% of mild TBI cases, may develop complications when multiresistant pathogens are involved[21]. Pneumonia may be related to invasive MV, which was required in 25% of mild TBI cases. Patients in MV are 21 times more likely to develop pneumonia[23].

There is disagreement in the epidemiological records about mild TBI and surgical treatment. In a study by Carlson et al.[24] approximately 7% of patients with mild TBI required neurosurgery. Joseph et al.[25] conducted a study with 876 patients with mild TBI and 47 (5.4%) required neurosurgery. However, in a study with 7678 patients, by Moore et al.[26], only 101(1.3%) required neurosurgery. In a sample of 816 patients with severe TBI, Albanese et al.[27] documented 40 (4.9%) cases of neurosurgery.

The mortality in patients with severe TBI was higher than among the ones mild TBI in some studies[28,29]. However, we did not find such difference in the present study. Prolonged hospital stay increased mortality in patients with moderate and severe TBI, often due to clinical complications. Among mild TBI cases, mortality was observed in patients older than 60 years. Likewise, in cases of moderate and severe TBI, deaths occurred mostly among older adults, which corroborates other studies[30,31]. Brown et al.[32] found a higher mortality rate in patients affected by moderate and severe TBI. In patients staying at the hospital for longer than six months, survival was not influenced by TBI severity.

Some studies addressed the relationship between early tracheostomy and MV. However, they did not discuss the influence of TBI severity on length of MV stay. In the present study, few patients with mild TBI were treated with MV. When MV was needed, the length of hospital

stay was not significantly different, when patients with moderate and severe TBI were compared.

Tracheostomy prevalence was higher in patients with moderate/severe TBI, due to prolonged MV stay, which also resulted in higher pneumonia prevalence. Rincon-Ferrari et al.[33] evaluated patients with ventilator-associated pneumonia, who required prolonged MV and hospital stay. In the present study, among patients with severe TBI who remained hospitalized for more than 30 days, 83.3% (n=10) were diagnosed with pneumonia. The prevalence of pneumonia in TBI patients is variable (4% to 87%) as well as mortality (6% to 59%)[34]. Sixty percent of patients with mild/moderate TBI with more than 30 days of hospital stay (n=10) were diagnosed with pneumonia.

The present study shows that the GCS score at admission influences several clinical outcomes and should be registered. Future studies should be multicentrical, in order to include larger samples of Brazilian centers. The GCS scores' progression should also be assessed, as well as the relationship between GCS progression and outcomes.

CONCLUSION

TBI severity at admission, evaluated according to the GCS, influenced on the prevalence of neurosurgery, tracheostomy, pneumonia. Patients with lower GCS scores at admission had prolonged hospital stay. However, the length of MV stay and mortality were not influenced by TBI severity.

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