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Original Article

In-hospital mortality and the Glasgow Coma Scale in the first 72 hours after traumatic brain injury[1]

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This study verifies and compares the performance of three different scores obtained in the Glasgow Coma Scale (GCS) in the first 72 hours post trauma in predicting in-hospital mortality. The studied scores included those obtained after initial care was provided at the hospital, and the worst and best scores obtained in the scale in the first 72 hours post trauma. The scale's predictive ability was assessed by the Receiver Operator Characteristic (ROC) curve. A total of 277 victims with different severity levels of blunt traumatic brain injuries were studied. The performance of the three scores that were analyzed to predict hospital mortality was moderate (0.74 to 0.79) and the areas under the curve did not present statistically significant differences. These findings suggest that any of the three studied scores can be applied in clinical practice to estimate the outcome of victims with blunt traumatic brain injuries, taking into consideration the instrument's moderate discriminatory power.

Descriptors: Brain Injuries; Trauma Severity Indices; Glasgow Coma Scale; Prognosis; Mortality.

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Escala de Coma de Glasgow nas primeiras 72 horas após trauma cranioencefálico e mortalidade hospitalar

O estudo teve como objetivos verificar e comparar o desempenho de escores da Escala de Coma de Glasgow (ECGl) observados nas primeiras 72 horas após trauma, para predizer mortalidade hospitalar. Os valores analisados foram os escores obtidos após atendimento inicial intra-hospitalar, além dos piores e melhores resultados da escala nas primeiras 72 horas pós-trauma. A capacidade preditiva dos escores da ECGl para estado vital à saída hospitalar foi avaliada, utilizando-se a curva Reciever Operator Characteristic. Foram estudadas 277 vítimas, com trauma cranioencefálico contuso de diferentes gravidades. O desempenho dos escores da ECGl para estado vital à saída hospitalar foi moderado (0,74 a 0,79) e as áreas sob a curva não apresentaram diferença significativa. Os resultados sugerem que qualquer um dos três valores da ECGl analisados podem ser aplicados na prática clínica para estimar o prognóstico das vitimas de trauma cranioencefálico contuso, considerando-se, no entanto, seu moderado poder discriminatório.

Descritores: Traumatismos Encefálicos; Índices de Gravidade do Trauma; Escala de Coma de Glasgow; Prognóstico; Mortalidade.

Escala de Coma de Glasgow en las primeras 72 horas postrauma encefalocraneano y mortalidad hospitalaria

El estudio tiene como objetivos verificar y comparar el desempeño de puntajes de la Escala de Coma de Glasgow (ECGl) observados en las primeras 72 horas postrauma para predecir la mortalidad hospitalaria. Los valores analizados fueron los puntajes obtenidos después de la atención inicial intra-hospitalaria, además de los peores y mejores resultados de la escala en las primeras 72 horas postrauma. La capacidad de predicción de los puntajes de la ECGl para el Estado Vital a la Salida Hospitalaria fue evaluada, utilizando la curva Reciever Operator Characteristic. Fueron estudiadas 277 víctimas, con trauma encefalocraneano contuso de diferentes gravedades. El desempeño de los puntajes de la ECGl para el estado vital a la salida hospitalaria fue moderado (0,74 a 0,79) y las áreas bajo la curva no presentaron diferencia significativa. Los resultados sugieren que cualquiera de los tres valores de la ECGl analizados pueden ser aplicados en la práctica clínica para estimar el pronóstico de las víctimas de trauma encefalocraneano contuso, considerando, sin embargo su moderado poder discriminatorio.

Descriptores: Traumatismos Encefálicos; Índices de Gravidade del Trauma; Escala de Coma de Glasgow; Pronóstico; Mortalidad.

Introduction

Traumatic Brain Injuries (TBI) are currently one of the main causes of morbidity and mortality in Brazil and in the world. It is estimated that TBI is responsible for nearly half of the deaths related to traumatic events[1-3].

There is a complex physiopathological process in TBI that includes multiple concurrent reactions and interactions that cause changes in brain hemodynamics, cell and molecular changes in addition to cerebral edema and intracranial hypertension[4].

It is known that there is a reduction of approximately 50% of blood flown in the brain in the first six to 12 hours post trauma in severe brain injuries capable of inducing unconsciousness. The brain blood flow usually increases and stabilizes in two to three days post trauma[4].

However, vasogenic and cytotoxic edema in the

first hours post trauma seems to be concurrent and proportional to the trauma's severity. It reaches its maximum level in approximately 72 hours. After that, it starts to regress, though it may persist with some intensity for many months, depending on the injury's severity and other circumstances[5].

Therefore, the initial 72 hours are especially important for TBI victims and provide valuable information concerning its prognosis given the physiopathological events that occur in this period.

The variability in the clinical conditions of TBI victims in the first hours post trauma is related to the physiological changes that occur as a consequence of the anatomic injury and the scores obtained in the Glasgow Coma Scale (GCS) summarizes the clinical manifestations of the injury's development[6].

The clinical indicator most frequently used to quantify the severity of a TBI is the GCS[7]. This scale is currently an essential criterion to assess victims in most of the clinical trials addressing this type of injury[1]; it enables comparisons between different actions implemented for TBI victims and serves as a guide to estimate prognosis[8-9].

The demographic variables, severity indexes, indicator of neurological conditions, neuroimaging results, biochemical markers, and psychosocial variables are also investigated to determine the prognosis of TBI victims[10].

In this context, evidence shows that GCS is a good indicator of prognosis in the case of blunt traumatic brain injuries though studies analyzing the scale with this purpose diverge in relation to the most appropriate time to make such an evaluation given the physiological process triggered by this type of injury[11-15].

Additionally, the GCS scores are affected by the use of alcohol, drugs, sedation and also by acute hypoxia/hypotension conditions due to injuries in other areas of the body. The GCS does not reflect the severity of the brain injury under such conditions[16].

Hence, the scale is limited to assessing the overall lowering of consciousness and does not identify its cause. The injury has a dynamic behavior after a TBI and its physiological consequences do not necessarily occur immediately after the impact but perhaps even after several hours[5-6].

Aiming to identify the GCS score that presents the best performance in the first hours after a TBI in order to predict the hospital mortality of victims, this study verified and compared the performance of GCS scores observed in the first 72 hours after a blunt traumatic brain injury.

Method

This observational, longitudinal, quantitative, descriptive and correlational study presents an analysis of the results of GCS scores obtained in the first 72 hours after a TBI in relation to hospital mortality.

The study was approved by the Ethics Research Committee at the University of São Paulo, School of Nursing (Protocol 914/2010). The study project that generated the database was approved by the Ethics Committee at the institution where the study was carried out (Protocol 1050/06). All the study's participants or their legal guardians signed free and informed consent forms.

The study's primary source of information was a spreadsheet with data from 277 BTBI victims older than 14 years old, cared for and hospitalized at a trauma referral center in the first 12 hours after the traumatic event, between December 2006 and October 2007.

This spreadsheet contained information from patients who were located at the *Hospital das Clinicas*, University of São Paulo and daily monitored there. Information such as age, gender, external cause, BTBI severity, hospitalization length, and destiny after hospital discharge in addition to GCS scores were daily collected. Information concerning the patient's vital condition (death or survival) at hospital discharge was also recorded in the period.

The scores selected to evaluate the discriminatory ability of GCS were:

- GCS scores after initial care was provided: score attributed by the hospital's neurosurgical in the victim's first assessment. The first assessment is routinely performed by this medical team after the patient has his/her hemodynamic and ventilatory functions stabilized within the first hours of care;
- The best GCS score within the first 72 hours post trauma: the highest score obtained in the GCS in the first 72 hours post trauma excluding the score obtained after initial care was provided and those prior to this assessment;
- The worst GCS score within the first 72 hours post trauma: the lowest score obtained in the GCS in the first 72 hours post trauma excluding the score obtained after initial care was provided and those prior to this assessment.

The victims who stayed less than 72 hours at the hospital obtained the worst and best GCS scores established within the hospitalization period in this study's setting.

The SPSS® 12.0 for Windows® and Stata® 9.0 for Windows® were used in data analysis. Descriptive statistics were utilized for all the variables aiming to acquire an

overall characterization of the victims and a description of their vital condition at the time of hospital discharge in addition to the GCS scores. The analysis of this type of data distribution was performed through the Kolmogorov-Smirnov test and comparisons through the Mann-Whitney test. The Receiver Operator Characteristic (ROC) enabled analyzing the performance of the different scores obtained in the GCS. The difference between the scores performed was identified by an Area Under the Curve (AUC) analysis, considering a confidence interval of 95%. The level of significance was fixed at 5% for all the analyses.

Results

The study's population included 277 BTBI patients. Most (85.9%) were male with ages ranging from 14 to 92 years old; the average age was 37.7 years old, with a standard deviation of 16.6 years. A young population aged between 14 and 34 years old prevailed (52%). In relation to the external cause of trauma, transportation accidents were the most frequent (60.3%) followed by falls (32.1%). A total of 43% of the victims presented mild BTBI, 16.2% moderate and 40.8% severe BTBI, according to GCS scores obtained after initial care was provided.

The average time of hospitalization was 15.9 days, with a standard deviation of 30.7 days. The minimum time of hospitalization was less than one day and the maximum was 290 days. There was, however, a predominance of patients who stayed hospitalized from two to seven days (40.1%).

After hospital discharge, 47.3% of the victims were discharged to their homes and 31.4% were sent to another hospital. The database had no information concerning the destination of six (2.2%) of the patients after hospital discharge. Of those sent to another hospital, 6.5% were transferred in less than 72 hours post trauma. In relation to the vital conditions of patients at hospital discharge, a mortality rate of 19.1% was observed.

Table 1 presents the GCS scores obtained in the first 72 hours post trauma. The differences in the score averages obtained in the GCS did reach one point in the scale. Additionally, the Kolmogorov-Smirnov test indicated a non-normal distribution of the GCS scores analyzed in this study.

Table 1 – Scores obtained by BTBI victims at the GCS (n=277). São Paulo, SP, Brazil

GCS scores	Average	Standard deviation	Median	Minimum	Maximum	p*
After initial care	9.9	4.4	11.0	3	15	<0.001
Best score within 72h	9.2	4.9	10.0	3	15	<0.001
Worst score within 72h	8.3	4.9	7.0	3	15	<0.001

*Kolmogorov-Smirnov test

Data in Table 2 reveal statistically significant differences between patients who survived and those who did not survive in relation to all the studied GCS scores.

Table 2 – Comparison between the GCS scores according to hospital mortality of BTBI victims (n=277). São Paulo, SP, Brazil

GCS Scores	Death (n=53)	Survival (n=224)	p*
After initial care	6.71	10.62	
Standard deviation	4.06	4.16	<0.001
Median	6	12.5	
Minimum – Maximum	3-15	3-15	
Best score obtained in GCS	4.88	10.25	
Standard deviation	2.82	4.77	<0.001
Median	3	13	
Minimum – Maximum	3-14	3-15	
Worst score obtained in GCS	4.13	9.26	
Standard deviation	2.49	4.87	<0.001
Median	3	11	
Minimum – Maximum	3-14	3-15	

*Mann-Whitney test

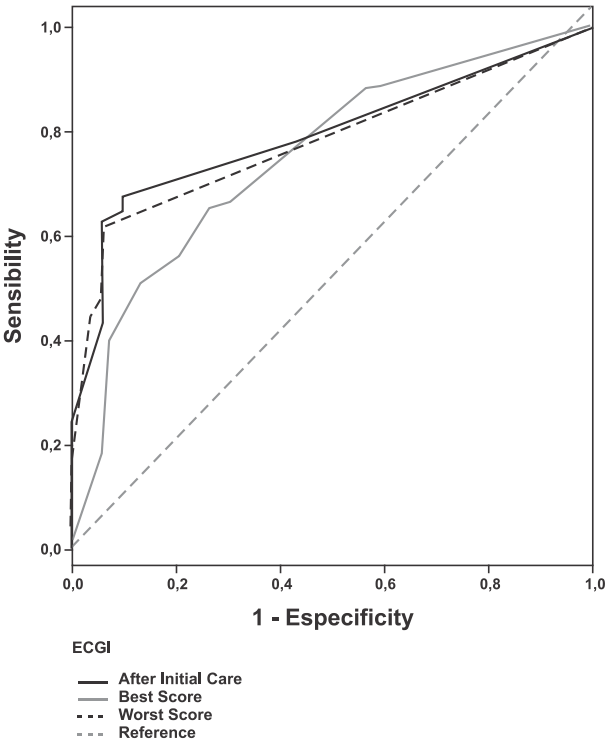

Figure 1 – ROC curves of the GCS scores in the first 72 hours post trauma for hospital mortality in BTBI victims (n=277). São Paulo, SP, Brazil.

Table 3 - AUCs (ROC) for GCS and hospital mortality in BTBI victims (n=277). São Paulo, SP, Brazil

GCS	Area (standard error)	Confidence Interval of 95% for the areas	Test comparing ROC curves (p value)
After first care	0.747 (0.037)	0.675-0.819	0.407
Best score	0.791 (0.029)	0.735-0.848	
Worst score	0.782 (0.029)	0.724-0.839	

As presented in Figure 1, even though the areas are similar, the score attributed to the GCS after initial care presents a visually different performance. While the curves related to the best and worst results are very close, the curve concerning the score after initial care crosses the others, initially presents a dotted line below and a dotted line slightly above at the end in relation to the remaining values.

However the p-value presented in Table 3 indicates there was no statistically significant difference between the AUCs of GCS (p=0.407). This table also shows that AUCs have moderate discriminatory power for predicting hospital mortality (0.747 to 0.791).

Discussion

A total of 40.8% of the studied patients were classified as having severe BTBI according to the score obtained in the GCS after initial care was provided. It is expected that approximately 13% of the hospitalized individuals with a TBI have their traumas classified as severe or life threatening[17], as opposed to what was found in this study. Traumas classified as severe were much more frequent in this study. This characteristic may be related to the study's setting, a referral center for trauma victims that care for severely injured patients as expected in trauma care systems, which is different from other studies' settings[14,18].

Victims of traumas with severe injuries have a greater risk of dying and mortality is generally related to the presence and development of brain lesions[2]. The development of brain injuries, such as intracranial hematomas, can be hours after the trauma, resulting in the clinical deterioration of the patient. A loss of temporary consciousness followed by a lucid interval and a lowering in the consciousness level is a clinical manifestation of the dynamic process of the brain injury. A large part of the neuronal damage after a TBI occurs in the development of secondary lesions, such as increased brain volume[6].

The results indicate that the hospital mortality rate for the victims reached a high percentage, if we consider other information concerning hospital mortality due to brain injury. The mortality rate reached 10.12% and 11.09% in Brazil and in São Paulo, respectively, in 2009 within the Unified Health System[19]. In a study conducted in a trauma center in the United States of America, this rate was 13% on average over an interval of 10 years[20].

The GCS scores are related to mortality: low scores indicate mortality and high scores, survival[14,21]. As shown in the literature[20,22], the victims (19.1%) that died in this study presented a lower average score on the GCS than that of survivors. A statistically significant difference was observed between survivors and patients who died in relation to the three analyzed GCS scores ($p \leq 0.001$).

The results show that the average score obtained on the GCS by the victims who died before hospital discharge was greater than the highest and lowest scores obtained in the first 72 hours post trauma (6.71 in comparison to 4.88 and 4.13). These results indicate that the level of consciousness was lowered in the individuals who died after initial care was provided at the hospital. The results of those who survived indicate that their level of consciousness was more stable in the first hours post trauma (average score obtained in the GCS between 9.26 and 10.62).

Italian researchers state that the prevalence of brain injuries after trauma is related to a decrease in the GCS scores if assessments performed at different times after initial care is provided are taken into account, monitoring the development of injuries[11].

Another study, also evaluating GCS scores in severe BTBI patients, reveals that initial GCS scores between those who died and those who survived did not present statistically significant differences. An increase in scores, though, was observed over time among those who survived; the average score obtained by survivals in the GCS increased 1.25 points 12 hours after admission and 2.14 points after 24 hours[13].

ROC is frequently used in studies to compare the performance of general and partial scores obtained in the GCS (eye opening, best verbal response, and best motor response)[12,14,23]. Analysis concerning the GCS discriminatory capacity is also performed to verify its performance at different times and to compare it in relation to other prognostic models, such as the

probability of survival offered by the Trauma Injury Severity Score (TRISS) [13,21].

An American study has already reported similarity among GCS scores evaluated at different points in time of care delivery to discriminate hospital mortality. Scores at three different times (in pre-hospital care, admission and after hospital admission) presented a similar discriminatory capacity to preview mortality, though the AUCs were greater than those described in this study (0.84 for the three studied times)[24].

The AUCs values of the GCS scores for hospital mortality found in this study were lower than those described in the literature, but an Indian study reported similar values[14]. The AUC value found in this study was 0.796[13] and the discriminatory capacity of GCS for hospital mortality presented AUCs values above 0.8 in North-American studies (one Canadian and five American studies), reaching 0.89 when pre-hospital GCS values of victims cared for at a trauma referral center were analyzed[12,21,23].

The three curves in the results show that the curves of the best and worst scores of GCS initially present an area larger than the area of the curve of the score obtained after initial care was provided, though it crosses both curves and stays above them as it progresses.

The situation in which the curves cross should be carefully analyzed since the AUCs can be equal; the diagnostic test for them, however, may present different performances according to the cut-off point[24].

Figure 1 shows that even though the AUCs are similar, the lower scores obtained in the GCS (initial part of the curve) presented greater discriminatory power when the best and worst scores were considered in the first 72 hours. However, when high GCS scores were considered, the score after initial care presented better performance in comparison to other scores of this indicator.

The difference in GCS performance when estimating hospital mortality, and which is visually observed, calls for new analyses to compare the curves in regions of its extension, according to the intersections and distances between its sets, in case one wishes to explore the discriminatory capacity of the scale's different scores.

In relation to the results observed in this study, it is relevant to consider some limitations related to the need for complementary analyses. Among injuries, only BTBI was considered, thus the interference of other bodily injuries in the GCS result was not investigated. The same consideration is appropriate in relation to the interventions victims experienced in the first 72 hours post trauma.

Despite the limitations previously mentioned, this study contributes to the investigation concerning the behavior of GCS and its application at different points in time during care delivery as an indicator of potential outcomes after BTBI.

Conclusions

The results show that the three studied GCS scores have the same performance in estimating mortality (similar AUCs p=0.407). The AUCs of the different GCS scores are evidence of the fragility of this index as an indicator of BTBI prognosis since its values ranged from 0.747 to 0.791, indicating a moderate discriminatory capacity. Hence, the three GCS scores obtained in the first 72 hours post trauma can be applied in clinical practice to estimate hospital mortality in BTBI victims, taking into consideration, however, its moderate discriminatory power.

Finally, it is worth noting that there is great interest in the use of GCS as an instrument to estimate prognosis on the part of researchers and professionals involved in care provided to trauma victims. The reason is that this scale is already an instrument routinely applied in health services and is essential to the clinical assessment of BTBI victims to standardize assessments concerning level of consciousness. It makes its results available in the medical files of victims and does not require specific procedures to estimate the prognosis of victims after BTBI.

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