Original Article

# Glasgow Coma Scale and quality of life after traumatic brain injury*

*Escala de coma de Glasgow e qualidade de vida pós-trauma cranioencefálico*

*Escala de coma de Glasgow y calidad de vida post-trauma craneoencefálico*

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## ABSTRACT

**Objective:** To evaluate the behavior of different scores on the *Glasgow Coma Scale* (GCS) observed during the first 72 hours after trauma, before the perceived changes to quality of life and health status, and one year after the traumatic event. **Methods:** A study using a quantitative approach, observational, longitudinal, descriptive and correlational with victims of blunt head trauma (BHT) evaluated daily during hospitalization, and after one year by means of the *Medical Outcome Study 36-Item Short Form Health Survey* (SF -36). **Results:** Under the *Reciever Operator Characteristic* curves, the values of the GCS related to the perceived change of health status did not differ significantly and ranged from 0.63 to 0.71. A correlation, statistically significant, although weak, was observed between GCS scores and some of the domains of the SF-36. **Conclusion:** It was found that the different values of the GCS presented limitations for application in clinical practice for estimating the consequences of long term BHT.

**Keywords:** Brain injuries; Glasgow Coma Scale; Prognosis; Quality of life

## RESUMO

**Objetivo:** Avaliar o desempenho de diferentes escores da *Escala de Coma de Glasgow* (ECGl) observados nas primeiras 72 horas pós trauma perante a qualidade de vida e mudança percebida do estado de saúde, após um ano do evento traumático. **Métodos:** Estudo de abordagem quantitativa, observacional, longitudinal, descritivo e correlacional com vítimas de trauma cranioencefálico contuso (TCEC) avaliadas, diariamente durante a internação hospitalar, e após um ano por meio do *Medical Outcome Study 36-item Short Form Health Survey (SF-36*). **Resultados:** sob as curvas *Reciever Operator Characteristics* dos valores da ECGl referentes à mudança percebida do estado de saúde não apresentaram diferença significativa e variaram de 0,63 a 0,71. Correlação, estatisticamente significante, porém fraca, foi observada entre os escores da ECGl e alguns dos domínios do SF-36. **Conclusão:** Verificou-se que os diferentes valores da ECGl apresentaram limitações para que fossem aplicados na prática clínica para estimar as consequências do TCEC a longo prazo.

**Descritores:** Traumatismos encefálicos; Escala de Coma de Glasgow; Prognóstico; Qualidade de vida

## RESUMEN

**Objetivo:** Evaluar el desempeño de diferentes escores de la *Escala de Coma de Glasgow* (ECGl) observados en las primeras 72 horas post trauma frente a la calidad de vida y cambio percibido en el estado de salud, después de un año del evento traumático. **Métodos:** Estudio de abordaje cuantitativo, observacional, longitudinal, descriptivo y correlacional realizado con víctimas de trauma craneoencefálico contuso (TCEC) evaluadas, diariamente durante el internamiento hospitalario, y después de un año por medio del *Medical Outcome Study 36-item Short Form Health Survey (SF-36).* Resultados: bajo las curvas *Reciever Operator Characteristics* de los valores de la ECGl referentes al cambio percibido en el estado de salud no presentaron diferencia significativa y variaron de 0,63 a 0,71. Correlación, estadísticamente significativa, no obstante débil, fue observada entre los escores de la ECGl y algunos de los dominios del SF-36. **Conclusión:** Se verificó que los diferentes valores de la ECGl presentaron limitaciones para ser aplicados en la práctica clínica para estimar las consecuencias del TCEC a largo plazo.

**Descriptores:** Traumatismos encefálicos; Escala del Coma Glasgow; Pronóstico; Calidad de vida

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## INTRODUCTION

Blunt head trauma (BHT) is a complex pathophysiological process that includes multiple concurrent reactions and interactions that cause alterations in cerebral hemodynamics, cellular and molecular changes, cerebral edema and intracranial hypertension [1,2].

The first 72 hours after the trauma are of particular importance in the evolution of BHT victims and bring valuable information on the seriousness of the injury due to the pathophysiological events that occur in this period.

In serious injuries that are capable of inducing a coma, it is known that an approximately 50% reduction in cerebral blood flow occurs in the first 6 to 12 hours post-trauma and that the cerebral blood flow typically increases and stabilizes in the next two to three days post-trauma [1].

Moreover, in the first hours post-trauma, vasogenic and cytotoxic edema appears concurrent and proportional to the severity of the trauma. This edema reaches its maximum level after approximately 72 hours and then begins receding, although it can remain with some intensity for many months, depending on the severity of the injury and other circumstances [1, 2].

The Glasgow Coma Scale (GCS) score is one of the variables that have been extensively studied to estimate the long-term prognosis of BHT victims. Study results indicate that, among the various instruments and variables studied to indicate the prognosis of patients with head trauma, the GCS excels at estimating the progression of these victims [3-5].

Exploring the predictive power of a very common instrument in the clinical trauma routine, such as the GCS, can provide a great contribution to the recovery process of the victims of head trauma (HT), not only through assisting the work conducted by professionals but also by defining the goals and the expectations of the victims and their families, thus facilitating the confrontation and overcoming of the experienced disabilities and impairments.

The injury caused by HT can result in a series of structural, physiological and functional changes of the central nervous system that may cause the death of the patient or compromise the life of the patient and family members through permanent cognitive, physical and behavioral changes [1]. However, to measure the physical, psycho-social and emotional impacts caused by the trauma, a broad evaluation parameter becomes necessary that allows the identification of aspects of the individual's life that can be harmed in any way by HT [6-8].

Thus, the evaluation of the quality of life (QOL) of these patients is demonstrated in studies as an indicator of disease progression, describing how the post-trauma recovery process is being experienced from the perspective of both the patient and the family [8-10] and serving as a tool that assists with therapeutic decisions and the conduct of the health teams.

Based on previous information, the objective of this study is to verify and compare the performance of GCS scores observed in the first 72 hours after BHT to predict the perceived change in the health status of these victims and to verify the association of the GCS scores and the QOL domains one year after the traumatic event.

## METHODS

This study adopts a quantitative, observational, longitudinal, descriptive and correlational approach and was conducted by analyzing the GCS values observed in the first 72 hours after the traumatic event compared with the QOL one year after the trauma.

Initially, the study sample was composed of 277 BHT victims, with ages over 14 years, who were treated in the first 12 hours post-trauma and admitted to a hospital or trauma reference center between December 2006 and October 2007. However, only 73 victims were included in the analyses for the present study, namely, those who remained in the study until one year after the traumatic event, when the *Short Form Health Survey* (SF-36) was applied.

The data used in the analyses of the present study were collected in two distinct phases.

In the first phase, the patients were located and were evaluated daily with the GCS and information on age, sex and the external cause and severity of the BHT. The duration of the hospitalization and the destination of these patients after discharge were also reported.

The second phase of the data collection was characterized by interviews conducted one year after the BHT, during which the SF-36 instrument was applied. This phase occurred between July 3 and December 20, 2008, in an outpatient clinic or locations established through telephone contact with the patients.

All of the subjects who survived until hospital discharge, according to the records of the first phase of research, were contacted and invited to an interview. Those who did not exhibit a desire to participate in the second step or who were unreachable after three telephone calls were excluded from the second phase of the investigation.

The SF-36, the dependent variable of the present study, is a generic, non-extensive health evaluation instrument that is easy to administer and understand and that has been validated for the Portuguese language [11,12]. This instrument has been demonstrated to have correlation with and sensitivity to the health problems present in HT victims, suggesting that it is adequate for the subjective evaluation of QOL in this population [9, 10, 13-15]. Moreover, the SF-36 possesses a question that is not part of the evaluated items and, in an isolated form, allows the recognition of the interviewee's perception, negative or positive, regarding their health [11,12].

The independent variables of the present study were the total GCS scores, and the following values were selected to evaluate the capacity of the GCS to estimate long-term results:

*GCS score after initial resuscitation:* the value obtained by the neurosurgery hospital medical staff in their first evaluation while attending to the victim. Routinely, in the study location, the first evaluation by the medical team is performed after hemodynamic and ventilation stabilization of the patient, within the first hours of assistance.

*Best GCS score within the first 72 hours post-trauma:* the greatest GCS value obtained during the first 72 hours post-trauma, excluding the score obtained during the hospital resuscitation and those preceding that evaluation.

*Worst GCS score within the first 72 hours post-trauma:* the lowest GCS value obtained during the first 72 hours post-trauma, excluding the score obtained during the hospital resuscitation and those preceding that evaluation.

For the victims who remained in the hospital for less than 72 hours, the best and the worst GCS values that were established within the hospitalization period at the study site were used for the analysis.

For data analysis, the statistical software packages *SPSS 12.0 for Windows* and *Stata 9.0 for Windows* were used.

Descriptive statistics and the *Kolmogorov-Smirnov* distribution type test were used for all of the study variables. The *Receiver Operating Characteristic* (ROC) curves allowed the analysis of the performance of the different GCS scores with respect to the perceived change in the health status. In all of the analyses, the level of significance was established as 5%.

To evaluate the internal consistency of the SF-36, when applied to this study sample, the *Cronbach's alpha* was determined. Only values greater than 0.7 in the SF-36 domains were considered to be indicators of the domains presenting good internal consistency and, therefore, the measurement used was reliable [9].

The study was approved by the Ethics and Research Committee of the School of Nursing of the University of São Paulo under Process number 914/2010. The Free and Informed Consent Form was applied and signed by all of the study participants or by their legal guardian.

## RESULTS

The initial study sample consisted of 277 patients, of whom the majority were male (85.9%); moreover, the sample was primarily a young population between 13 and 34 years of age (52.0%). In relation to the external cause, traffic accidents were the most frequent (60.3%), followed by falls (32.1%).

Among the victims, 43% had light BHT, 16.2% had moderate BHT and 40.8% had severe BHT, as defined by the GCS scores after the initial resuscitation in the hospital.

The average length of hospital stay was 15.9 days, with a standard deviation of 30.7 days. However, there was a predominance of patients who remained hospitalized between two and seven days (40.1%), followed by those remaining hospitalized more than 15 days (25.6%).

With regards to the destination after leaving the hospital, 47.3% of the patients were discharged to a residence, and 31.4% were transferred. Of the transferred patients, 6.5% were transferred less than 72 hours post-trauma. There was 19.1% patient mortality in the hospital.

The GCS scores obtained in the first 72 hours post-trauma are presented in Table 1.

Of the total of 277 patients initially considered in the study group, only 73 answered the SF-36 questionnaire one year after the trauma.

There was no significant difference between the groups that did or did not respond to the questionnaire after one year of trauma in terms of the following variables: sex (p=0.174), destination after hospital discharge (p= 0.471), GCS after the initial hospital resuscitation (p=0.314), age (p=0.863) and hospitalization time (p=0.154). However, the groups differed regarding the external cause of the trauma (p=0.002).

Traffic accidents were more common among the victims who participated in the second phase of the study (75.3%) in comparison to those who did not participate (54.1%). By contrast, falls and assaults were less frequent in the group that participated in the second phase.

**Table 1.** The GCS scores of the victims who participated in the first phase of the study (n=277). São Paulo (2006-2008)

| GCS Score | Mean | SD | Median | Min. | Max. | P Value* |
|---|---|---|---|---|---|---|
| After initial resuscitation | 9.9 | 4.4 | 11.0 | 3 | 15 | <0.001 |
| Best score in 72 h | 9.2 | 4.9 | 10.0 | 3 | 15 | <0.001 |
| Worst score in 72 h | 8.3 | 4.9 | 7.0 | 3 | 15 | <0.001 |

***** Kolmogorov-Smirnov test

Figure 1 shows the mean value of the SF-36 domains for the 73 interviewed patients, and the data shown in Table 2 summarize the response to question 2 of this instrument.

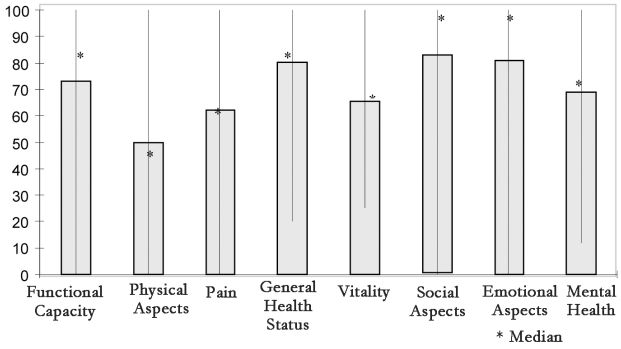


**Figure 1.** The mean values of the SF-36 domains for the patients who participated in the second phase of the study (n=73). São Paulo (2006-2008).

**Table 2.** The distribution of the patients who participated in the second phase of the study, according to the Perceived Change in the Health State (SF-36). n= 73 São Paulo (2006-2008)

| Perceived Change in the Health State | nº | % |
|---|---|---|
| **Better or unaltered** | 43 | 58.9 |
| Much better | 8 | 10.9 |
| A little better | 1 | 1.4 |
| Almost the same | 34 | 46.6 |
| **Worse** | 30 | 41.1 |
| A little worse | 21 | 28.8 |
| Much worse | 9 | 12.3 |

Among the patients who responded to the SF-36 one year after the trauma, it was evident that the following domains had the lowest mean scores: Physical aspects (50.0), Pain (62.1) and Vitality (65.5). The highest values were found in the following domains: Social aspects (82.4), Emotional Aspects (80.8) and General Health Status (80.1) (Figure 1).

The internal consistency of the questionnaires answered in the sample ranged from 0.74 to 0.95. All of the SF-36 domains had values greater than 0.7 in the Cronbach's alpha, which was an indication that the instrument presented good reliability.

The data presented in Table 3 demonstrate that the GCS score established after resuscitation was significantly correlated with three SF-36 domains (Functional Capacity, Physical Aspects and Social Aspects), the best result with four domains (Functional Capacity, Physical Aspects, General Health Status and Social Aspects) and the worst GCS value with six domains (Functional Capacity, Physical Aspects, Pain, General Health Status, Social Aspects and Mental Health). In all of the cases, a positive significant correlation was observed, although it was weak.

The three GCS values were positively and significantly correlated with the perceived change in health status. However, the worst GCS response was more strongly correlated ($r= 0.429$, $p\leq0.001$) than the values after the initial resuscitation ($r= 0.299$, $p= 0.010$) or the best response within the first 72 hours ($r= 0.315$, $p= 0.007$).

Figure 2 shows the ROC curves of the GCS values for the perceived change in health status one year after the trauma. The worst GCS value within the first 72 hours post-trauma had an area under the curve (AUC) = 0.71, whereas the best response and the value obtained

**Table 3.** The correlation coefficients and *p* values between the GCS scores and the SF-36 domains of the victims who participated in the second phase of the study (n=73). São Paulo (2008-2009)

| Domains | After the initial resuscitation | Best result | Worst result |
|---|---|---|---|
| **Physical component** | | | |
| Functional Capacity§ | 0.256 (0.029) | 0.304 (0.009) | 0.374 (0.001) |
| Physical Aspects§ | 0.298 (0.011) | 0.286 (0.014) | 0.343 (0.003) |
| Pain þ | 0.161 (0.175) | 0.228 (0.052) | 0.242 (0.039) |
| General Health Status*§ | 0.171 (0.147) | 0.243 (0.038) | 0.253 (0.031) |
| **Mental component** | | | |
| Vitality* þ | 0.170 (0.150) | 0.112 (0.347) | 0.142 (0.232) |
| Social Aspects§ | 0.280 (0.016) | 0.338 (0.003) | 0.307 (0.008) |
| Emotional Aspects§ | 0.161 (0.174) | 0.131 (0.269) | 0.219 (0.063) |
| Mental health þ | 0.173 (0.142) | 0.190 (0.107) | 0.234 (0.046) |

* Indirectly related to the other component [11, 12]; § Spearman Correlation Test; þ Pearson Correlation Test.

after the initial resuscitation had AUCs of 0.66 and 0.63, respectively. There was indication that the three studied scores demonstrated similar AUCs, although the observed p value (p=0.056) was near the established level of significance (p< 0.05).

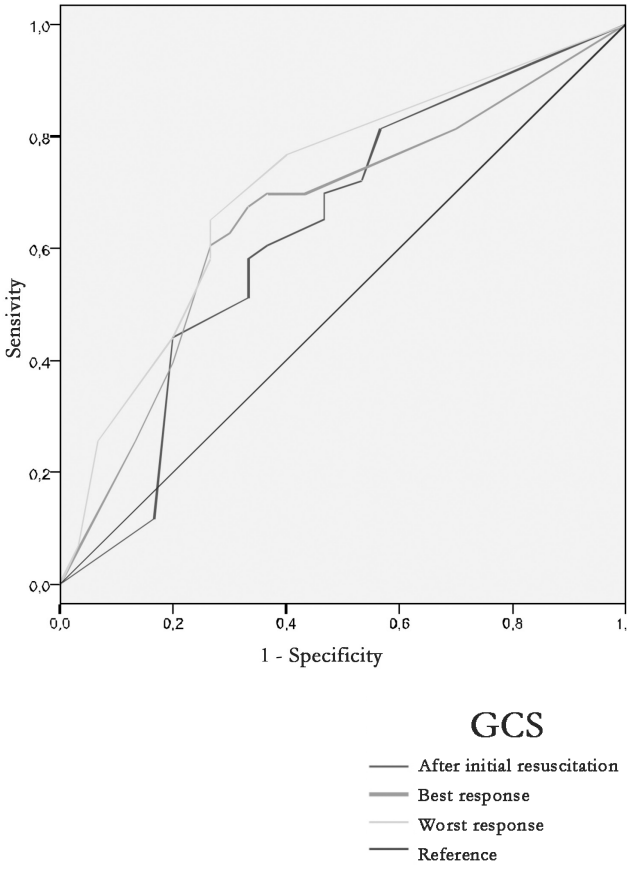


**Figure 2.** ROC curves of GCS scores for the perceived change in health status in the patients who participated in the second phase of the study (n=73). São Paulo (2006-2008).

## DISCUSSION

It is expected that patients who have experienced HT will have a different QOL than the general population due to residual impairments from this type of injury [15]; however, improvements are observed over time, and this difference tends to diminish [16].

The results related to the SF-36 domains corroborate a study conducted with patients, one year after multiple traumas, whose SF-36 domains related to the mental component (Social Aspects, Emotional Aspects and Mental Health) featured a greater mean score and lower scores than were obtained for the same domains in the present study [5].

Due to the scope of the nervous system functions, HT victims exhibit impairments that are characterized by losses, both physical and mental, and the patient's mental capacity is altered not only in the cognitive area but also in behavior. Regarding this combination of physical and mental impairments, several studies have emphasized the predominance of mental impairment and the inability of HT victims to perform their functions and social roles [14, 17]. However, after one year, the majority of the surviving victims exhibit good recovery from HT [18], and the interval of one year of recovery may have modified the initially observed consequences of HT.

The period where the majority of the victims reached their highest level of functional capacity and favorable results related to the return to productivity, was reported in scientific literature to be six months; however, improvements in significant portion of the victims are observed up to one year after the HT [16-18]. It is estimated that, one year after the trauma, most victims had already returned to performing some productive activity [18]. However, the perception of well-being after HT is related to the familiarity of the patients with the new health condition and to socialization and adaptation to the changes after the trauma [19].

The disadvantage of using a generic instrument to evaluate the health-related GOL, such as the SF-36, is that the instrument is unable to recognize the features of specific afflictions; however, this approach allows comparisons between different types of samples [13].

Upon correlating the GCS scores with the SF-36 domains, a weak correlation was found with several of the SF-36 domains. The worst value within the first 72 hours was correlated with the greatest number of SF-36 domains (six of the eight domains).

Studies that analyze the SF-36 based on the GCS were not found. However, the analysis of the behavior of the different severity indices for the prediction of the incapacity and social integration of the HT victim revealed that the GCS was one of the indicators that was most strongly associated with these two characteristics one year after the trauma [20].

Upon observing the differences in SF-36 domains between patients with different HT severities, a study conducted in the United States concluded that victims with injuries scored as 5 or 6 on the *Abbreviated Injury Scale*, which were considered to be serious trauma, had lower scores on the SF-36 domains than patients with injuries scored equal to or lower than 4 [15].

A recent finding regarding the severity of the trauma as perceived by the patient and QOL six months post-trauma found that the severity of the trauma as perceived by the patient influenced the post-trauma QOL more than the trauma severity estimated by anatomical indicators, such as the *Injury Severity Score*. The results of that study suggest that the expectations of the patient regarding the injury play a more important role in the post-trauma recovery than the actual severity [10].

In the present study, most patients considered their health condition to be better or unchanged; however, 12% indicated improvement of their condition. Therefore, most of the trauma victims may have reestablished their health status after one year, or this period was sufficient for them to adapt to the post-trauma conditions, as observed in other studies [15, 20].

After HT, few victims reported better QOL post-trauma, due to the various alterations triggered by the HT. Similarly, a qualitative study that investigated patient perception between one and 10 years after the HT found that many patients complained of communication difficulties, changes in physical appearance due to scars or weight gain, loss of direction in life, loss of the conditions they had before the trauma and negative reactions in social interactions [21].

The results of the GCS values with respect to the perceived changes in the post-HT health status based on the ROC curve do not support the interpretation that there is no difference between the GCS values; instead, they affirm that the evidence is weak regarding these values, as they possess similar predictive value. This result, similarly to the correlations described, emphasizes the need for additional studies exploring the predictive power of the worst GCS score obtained in first the 72 hours post-HT in relation to the long-term consequences of HT.

It should be noted that, as shown in Figure 2, although close, the curves cross at various intervals; moreover, the curve for the GCS values obtained after the initial resuscitation is initially below the diagonal line on the graph. The diagonal is a hypothetical line that shows the ratio between the true positive and false positive rates if the scores did not produce any information about the victims' prognosis [22]. This finding suggests that low scores in the period after the initial resuscitation may not contain sufficient discriminatory capacity for the perceived change in health status one year after BHT.

In relation to the results obtained in the present study, it is important to consider certain limitations related to the necessity for complementary analyses. Only HT was considered among the injuries presented by the patient. Therefore, interference from other bodily injuries present in the GCS results was not considered. The interventions to which the victims were subjected in the first 72 hours post-trauma were also not considered in this study.

## CONCLUSION

The QOL of the BHT victims one year after the trauma exhibited a weak positive correlation between certain SF-36 domains and the GCS results. The GCS scores and the change in the health status as perceived by the victim post-trauma were also weakly and positively correlated. The comparative analysis of the ROC curves related to this outcome resulted in p=0.056, thus indicating a similarity in the discriminatory capacity of the GCS values. The AUCs of the worst and the best GCS results obtained in the first 72 hours after trauma and after the initial resuscitation of the victims demonstrated a modest performance of this indicator for discriminating individuals according to the perceived change in the post-trauma health status.

In this study, the results demonstrated that any of the three analyzed GCS values (best and worst within the first 72 hours and immediately after the victim's initial resuscitation), can be used to predict long-term results, such as the QOL one year after the trauma; however, these indicators present a less than desirable performance. The results of this study demonstrated the weakness of the GCS as an indicator of the severity of the HT, even when considering different evaluations performed during the post-trauma progression of the victim.

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