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Original Article

Recovery of functional capacity in severe trauma victims at one year after injury: association with trauma-related and hospital stay aspects

Cauê Padovani[1, 5)*], Janete Maria Da Silva[2)], Bruna Peruzzo Rotta[3, 5)], Ruy De Camargo Pires Neto[4)], Carolina Fu[5)], Clarice Tanaka[1, 5)]

[1)] *Hospital das Clínicas da Faculdade de Medicina, University of São Paulo: Avenida Doutor Enéas Carvalho de Aguiar, 44, Cerqueira César, São Paulo, SP, CEP: 05403-900, Brazil*
[2)] *Hospital Alemão Oswaldo Cruz, Brazil*
[3)] *Hospital do Servidor Público Estadual, Brazil*
[4)] *Department of Pathology, University of São Paulo, Brazil*
[5)] *Department of Physiotherapy, Communication Science and Disorders, Occupational Therapy, University of São Paulo, Brazil*

Abstract. [Purpose] The aim of this study was to investigate the functional capacity of trauma survivors one year after hospital discharge and to identify associations with trauma- and hospital stay-related aspects in a developing country. [Subjects and Methods] This study included severe trauma patients (*Injury Severity Score* ≥16; ≥18 years old) who were admitted to an intensive care unit in Sao Paulo, Brazil. Hospital stay data were collected from the patients' records. Functional capacity was assessed using the *Glasgow Outcome Scale* and *Lawton Instrumental Activities of Daily Living Scale* one year after hospital discharge. Patients were asked if they had returned to work/school. [Results] Forty-nine patients completed follow-up. According to the *Glasgow Outcome Scale* data, most patients had moderate or mild/no dysfunction. The *Lawton Instrumental Activities of Daily Living Scale* showed that 60–70% of the subjects performed most activities independently. Multiple linear regression of the Glasgow score, *Acute Physiology and Chronic Health Disease Classification System II* score, length of mechanical ventilation, and hospital length of stay revealed an association between the *Lawton Instrumental Activities of Daily Living Scale* and hospital length of stay. Overall, 32.6% of the subjects had returned to work/school. [Conclusion] Most severe trauma patients experienced functional recovery, although only one-third had returned to work/school one year after hospital discharge. Hospital length of stay was identified as a significant predictor of functional recovery.
Key words: Trauma centers, Hospitalization, Outcome assessment (health care)

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INTRODUCTION

Trauma is one of the most important causes of morbidity and long-term disability in the young adult population (18–45 years) worldwide. Patients who suffer multiple traumatic injuries often acquire further complications and experience difficulties in performing activities of daily living. These individuals also require long periods of rehabilitation to achieve an adequate condition to return to work and obtain their own income, resulting in negative social and economic impacts for patients and their families[1–8)].

Considering that the majority of trauma cases are young people who are in an economically active phase, this prevalence makes trauma a major public health problem. It seems that the occurrence and type of trauma are related to the level of local

*Corresponding author. Cauê Padovani (E-mail: cauepadovani@usp.br; caue.padovani@hc.fm.usp.br)

development, such as in the case of frequent spinal cord injuries in recently industrialized countries like China[9, 10], traumatic brain injury as in South Korea[11], or traffic-related trauma as in Brazil[12]. It was recently reported that in December 2014, 82,845 trauma admissions were logged in the Brazilian public health system[13].

The assistance for trauma victims has improved, and the number of survivors from severe injuries has grown rapidly. In addition to the primary objective of preserving life, the treatment offered to polytrauma patients is currently also focusing on functional recovery and reintegration into society[2, 14–17].

Assessment of the functional status of polytrauma patients is particularly challenging due to the large range of types and severity of injuries. The functional status of trauma survivors has been inferred in health-related quality of life (HRQOL) studies in this population, as in studies conducted in Spain[17] and Greece[18]. At three months post injury, severe trauma victims show drastically reduced functionality and HRQOL[5]. At six months, trauma victims still show a deteriorated HRQOL; although improvement may be observed at 12 months, complete recovery of previous condition is not obtained[17]. For injured victims of motor vehicle crashes, serious problems in terms of HRQOL gradually improve during the 2 years after hospital discharge[18].

With regards to functional recovery, some studies have indicated that victims of serious injuries show good recovery when evaluated one year after trauma[19, 20]. However, Evans et al.[1] revealed significant disability in a cohort of young people 5 years after severe injury; only 20% of these subjects experienced no disability.

In Brazil, despite the high number of polytrauma patients, the assessment of the functional status of long-term trauma patients is relatively new. In addition, to our knowledge, no study has evaluated a population of severe trauma victims and assessed the association between functional capacity and factors related to trauma and hospital stay. Thus, the objectives of this study were to investigate the functional capacity of severe trauma survivors who were admitted in a large trauma center in Brazil, at one year after hospital discharge, and to verify the association of functional capacity with trauma-related aspects and hospital stay.

SUBJECTS AND METHODS

A prospective cohort study was conducted with polytrauma patients admitted to the Surgical Emergency Room and Trauma Intensive Care Unit (ICU) of Hospital das Clínicas da Faculdade de Medicina, University of Sao Paulo. This is a large public hospital that is a tertiary referral center for trauma victims in the city of Sao Paulo. The Surgical Emergency Room and Trauma ICU comprises 18 beds, and the staff of this unit includes emergency surgeons, neurologists, neurosurgeons, and orthopedics physicians, who remain in-house 24 hours a day, in addition to physiotherapists and psychologists working closely with the medical and nursing teams.

Ethical approval was granted by the Ethics Committee of Hospital das Clínicas da Faculdade de Medicina, University of Sao Paulo (1159/07), and written informed consent was obtained from all patients or their legal representatives. In addition, oral consent was obtained at the start of telephone interviews.

The inclusion criteria for this study were as follows: polytrauma patients admitted to the unit between June and September 2010, 18 years of age or older, an Injury Severity Score (ISS) ≥ 16[8, 15, 21], mechanical ventilation (MV) for more than 24 hours, and discharge from the hospital. Patients with functional or neurological impairments prior to the trauma event or those who died in the ICU or during their hospital stay were not included in the study. Patients were considered lost to follow-up when one of the following criteria was met: did not respond to four consecutive phone calls made at different times of the day or declared on the phone that they were not interested in participating in the study.

Eligible patients were identified during their ICU stay, and within 48 hours after discharge to the ward, written informed consent was obtained and collection of data for variables related to trauma and hospital stay was performed. The following data were obtained from patient records: age, gender, Glasgow score, Acute Physiology and Chronic Health Disease Classification System II (APACHE II) score, trauma mechanisms, number of injuries, body region injured, number of surgeries, and MV duration. Hospital length of stay (LOS) was verified through the hospital's electronic management system.

Follow-up was performed between June and September 2011. If the patient was unable to participate in follow-up because of limitations of speech or language comprehension, a close family member was allowed to participate on their behalf. The assessment was conducted by phone and lasted approximately 10 to 20 minutes. The following instruments were used:

A) Glasgow Outcome Scale (GOS): This widely used five-point scale assesses the functional recovery of patients who have suffered a traumatic brain injury. The scale focuses on how the injury has affected functioning in major areas of life. It is intended to classify a patient's functional capacity in general and is graded as follows[22–24]:

Grade 1) Death

Grade 2) Vegetative state: The patient is unable to significantly interact with and respond to the environment. The individual does not follow simple commands, cannot pronounce words, and presents only reflexive responses.

Grade 3) Severe dysfunction: The patient is unable to live independently. The individual is conscious but depends on the help of another person for daily support (self-care activities, moving inside and outside the residence) by reason of mental and/or physical disability.

Grade 4) Moderate dysfunction: The patient is able to live independently but has some deficiencies and limitations. The individual fails to return to all activities performed prior to the trauma by reason of physical and/or mental impairment.

Grade 5) Mild or no dysfunction: The patient is able to return to normal activities without any changes or complaints related to trauma even in the presence of mild difficulties in physical and/or mental activities.

B) Lawton Instrumental Activities of Daily Living Scale (LIADL): This scale evaluates the tasks necessary for the individual to live independently in the community. The scale consists of eight activities (using a telephone, shopping, food preparation, housekeeping, going to a bakery, using transportation, handling medications and finances). For each of the tasks, the patient is classified into a capability category: 0=unable to perform, 1=needs some assistance, and 2=able to perform independently. The LIADL score ranges from 0 (disability) to 16 (full capacity)[25–27].

In addition to these instruments, we also asked the patients questions regarding the following: a) the need of caregivers after trauma; b) the assistance of health professionals such as a physician, physiotherapist, psychologist, speech therapist, or other professional; and c) return to work or school.

Data were analyzed using the Statistical Package for the Social Sciences for Windows®, version 15.0 (SPSS Inc., Chicago, IL, USA). Clinical data and characteristics of the patients are presented as the frequency (%), mean ± standard deviation, or median ± interquartile range as appropriate. Quantitative variables, including the Glasgow score, APACHE II score, number of injuries, number of surgeries, MV duration, and hospital LOS, were assessed for correlation with the LIADL score using the nonparametric Spearman's rank correlation. After verifying the correlations, we performed a multiple linear regression considering all variables with statistical power. The level of statistical significance was set at $p \leq 0.05$ for all analyses.

RESULTS

A total of 58 polytrauma patients were eligible to participate in this study. Nine individuals did not respond to consecutive phone calls or refused to participate in the study. The follow-up at one year after trauma was completed with 49 subjects.

The majority of the participants were young (36 ± 11 years) male (81.6%) victims of traffic accidents (71.5%). Each patient suffered approximately four injuries, with a mean ISS of 31 ± 14.4. Traumatic brain injury was the most common type of injury (65.3%). The characteristics of the study population are presented in Table 1.

Regarding the GOS scale, most of the trauma survivors were classified in the two categories indicating moderate dysfunction (grade 4) or mild or no dysfunction (grade 5) (Table 2).

Therefore, to continue the analyses, we chose to categorize the patients with regards to the GOS scale into two groups: patients with a GOS grade of 2–4 and patients with a GOS grade of 5. The Mann-Whitney test showed no significant difference for Glasgow score, APACHE II score, MV duration, and hospital LOS ($p>0.05$) between the two GOS groups (Table 3).

Assessment of LIADL scores (N=43) also showed favorable results indicating good functional recovery of trauma patients one year after hospital discharge. Between 60 and 70% of the subjects were able to independently perform most of the activities assessed with the LIADL (Fig. 1). The average LIADL score was 12 ± 4.

Spearman's rank correlation coefficients showed significant correlation between the LIADL score and the Glasgow score, APACHE II score, MV duration, and hospital LOS (Table 4).

After conducting a multiple linear regression considering all variables with statistical power, a significant association between the LIADL score and hospital LOS was observed ($p=0.017$).

Additionally, the interviews of the trauma victims at one year after hospital discharge showed the following results: 60.4% of participants required a caregiver after trauma. Following hospital discharge, 60.5% were followed by a physiotherapist, 46.5% were followed by physicians, 7% were followed by psychologists, and 7% were followed by speech therapists; 39.5% of patients did not receive any specialized assistance. Regarding return to labor activity, 32.6% of the patients had returned to work or school after one year of follow-up. For these patients, the average time to return to work was approximately 5 months after hospital discharge.

DISCUSSION

In this study, the epidemiological characteristics followed the pattern described worldwide for trauma victims; the patients generally consisted of young males who had been in traffic accidents, with traumatic brain injury the most common type of injury[2, 15, 28]. We verified that 60.4% of the victims required caregivers in the immediate post-hospital discharge phase to assist them in daily activities, probably due to motor deficits and reduced functional capacity in this initial period. However, when trauma victims were evaluated at one year after injury, good functional recovery was observed.

About 20% of patients previously eligible for the study died or had a severe degree of dependence after hospital discharge. According to the GOS, the majority of trauma survivors were classified in the two best categories: 43% of patients were classified as having moderate dysfunction (grade 4), and 37% were classified as having mild or no dysfunction (grade 5). The GOS previously showed good functional recovery with grades of 4 and 5 for two-thirds of neurotrauma patients[23] and approximately 80% of polytrauma patients[19, 20] at one year after trauma.

Our favorable GOS results for trauma survivors were consistent with the assessments using the LIADL. Approximately 60–70% of the subjects were able to independently perform most of the activities assessed with the LIADL. The average LIADL score in our study was 12 ± 4, with 16 being the maximum score. We believe that the prevalence of young and healthy individuals in the studied population supported functional recovery. The LIADL evaluates the functional recovery and the

Table 1. Characteristics of the study population (N=49)

Variables	Values
Male gender	40 (81.6)
Age (years)	36 ± 11
Injury mechanism	
Automobile accidents	12 (24.5)
Motorcycle crash	14 (28.6)
Pedestrian accidents	9 (18.4)
Fall	10 (20.4)
Other	4 (8.1)
Glasgow score	9 ± 4
APACHE II score	13 ± 5.5
ISS	31 ± 14.4
Number of injuries	4 ± 2
Injured body region	
Head	32 (65.3)
Face	10 (20.4)
Thorax	22 (44.9)
Abdomen	13 (26.5)
Spine	6 (12.2)
Upper extremity	11 (22.4)
Lower extremity	14 (28.5)
Pelvis	4 (8.1)
Number of surgeries	2 ± 1
MV duration (days)	9 ± 7
Hospital length of stay (days)	27 ± 25

Data are expressed as the frequency (%) or mean ± standard deviation. APACHE II: Acute Physiology and Chronic Health Disease Classification System II; ISS: Injury Severity Score; MV: mechanical ventilation

Fig. 1. Percentage of trauma survivors (N=43) in each of the three capability categories for the eight LIADL tasks

Table 2. GOS grades one year after hospital discharge (N=49)

GOS grades	Values frequency (%)
Death (grade 1)	6 (12)
Vegetative state (grade 2)	1 (2)
Severe dysfunction (grade 3)	3 (6)
Moderate dysfunction (grade 4)	21 (43)
Mild or no dysfunction (grade 5)	18 (37)

GOS: Glasgow Outcome Scale

Table 3. Mann-Whitney test for differences between the GOS categories in Glasgow score, APACHE II score, MV duration, and hospital length of stay

Variables	GOS 2–4	GOS 5
Glasgow score	7.5 [8]	11 [8]
APACHE II score	13.5 [7]	12 [7]
MV duration	10 [13]	6 [8]
Hospital length of stay	32.5 [23]	25 [19]

Data are expressed as the median [interquartile range]. GOS: Glasgow Outcome Scale; APACHE II: Acute Physiology and Chronic Health Disease Classification System II; MV: mechanical ventilation. Statistical significance: $p \leq 0.05$

Table 4. Spearman's rank correlation coefficients between the LIADL score and variables related to trauma and hospital stay

Variables	Correlation coefficient
Glasgow score*	0.312
APACHE II score*	−0.415
Number of injuries	−0.132
Number of surgeries	−0.189
MV duration*	−0.410
Hospital length of stay*	−0.494

LIADL: Lawton Instrumental Activities of Daily Living Scale; APACHE II: Acute Physiology and Chronic Health Disease Classification System II; MV: mechanical ventilation.
*Statistical significance: $p \leq 0.05$

instrumental tasks necessary for an individual to live independently in the community. Despite this, to the best of our knowledge, there is no other study that has applied this scale for the evaluation of long-term functional capacity in trauma victims.

For neurotrauma victims, a lower score in the initial Glasgow assessment indicates a greater severity of brain lesion; there-

fore, we expect a worse prognosis and a lower level of functional recovery for these individuals. We observed that low scores in the initial Glasgow assessment were associated with worse long-term functional capacity as assessed with the LIADL one year after injury; an association between the initial Glasgow assessment and the GOS was reported by Brazinova et al[29].

The APACHE II is widely used in ICUs for the assessment of disease severity, with higher APACHE II scores indicating greater severity and an increased risk of death. Thus, we expect worse functional capacity for the most clinically severe patients. Our results identified a correlation between the APACHE II and LIADL scores, with a higher APACHE II score correlating with a lower LIADL score.

In our study, the LIADL score was also correlated with MV duration and hospital LOS. In particular, a longer MV duration and longer hospital LOS were associated with a lower LIADL score, thus predicting a worse long-term functional capacity. After conducting a multiple linear regression analysis considering all variables with statistical power, the hospital LOS was revealed as the significant predictor for the LIADL score. The impact of hospital stay on HRQOL has been studied in trauma patients[30] and related to functional capacity in cerebrovascular disease patients[31]; however, to our knowledge, there is no report that has specifically assessed the impact of trauma-related aspects and hospital LOS on the functional recovery of severe trauma victims at one year after discharge.

The physiotherapist stood out as the most active professional providing healthcare assistance after hospital discharge; i.e., this type of professional assisted 60.5% of the studied subjects, likely due to motor deficits and reduced functionality in the immediate post-hospital discharge phase. In developed countries, improvement of activities of daily living performance has also been pointed out as the major aim of rehabilitation for conditions such as stroke[32, 33]. Much effort is required to integrate stroke patients into the local community through the improvement of functional independence and quality of life[34]. Just like for the stroke population, we believe that it is crucial to provide adequate rehabilitation facilities and to initiate efficient rehabilitation programs for trauma patients as soon as possible after hospital discharge.

In our study, only 32.6% of subjects were able to return to work or school. Returning to work is one of the most significant outcome measures after severe trauma. Work participation greatly impacts the social and economic sphere for patients and their families, particularly because trauma predominantly affects young individuals in an economically active phase and often requires long periods of rehabilitation to achieve adequate recovery to return to work and obtain an income[1, 4, 6].

According to Davydow et al.[35], polytrauma patients who survive the ICU are burdened with symptoms of post-traumatic stress disorder, and over half of them are not able to return to work one year after hospital discharge. Indeed, up to 50% of multiple trauma survivors may remain out of the work force up to two years after injury[15]. Studies have also shown that a long hospital stay, a high number of injuries, the presence of severe brain injury, depression, low educational level, and psychological comorbidities are risk factors associated with not returning to work[6, 20, 36].

In this study, we observed positive functional outcomes with the GOS and LIADL for polytrauma survivors one year after hospital discharge. Despite this, only a third of these individuals had returned to work. The present data led us to believe that other determinants, apart from physical ability, may be related to the process of returning to labor activity. In this context, we believe that post-traumatic psychological aspects play an important role, such as depression, which may negatively impact return to work and reintegration of the individual into society. Some studies have indicated that psychological assessment is rarely performed in trauma victims and that the main focus still remains on the treatment of injuries[4, 6]. Indeed, in our study, only 7% of victims were followed by this type of professional.

Hepp et al.[4] showed that the appraisal of injury severity and of the patient's ability to cope with an accidental injury and its job-related consequences predicted the duration of sick leave related to the accidental injury even three years post accident, independent of real injury severity. Another factor to be considered is the social security benefits. According to Zelle et al.[37], trauma patients assisted by insurance seem to become clinically and functionally worse compared with patients with a similar injury severity but who are not financially secure.

Although the study was performed at a national reference center for polytrauma, it was performed at a single center with a relatively small sample. It is possible that the sample size did not allow for a better distribution of participants in GOS categories, particularly in the worst categories, and that it also lead to the lack of correlation between the functional capacity and trauma-related aspects. However, these limitations do not minimize the importance of some of the findings, i.e., mainly those concerning the correlation of hospital stay and long-term functional capacity in severe trauma survivors.

In conclusion, most of the severe trauma patients were able to perform the assessed activities independently; however, only one-third of them returned to work or school one year after hospital discharge. The Glasgow score, APACHE II score, MV duration, and hospital LOS were identified as factors related to the recovery of functional capacity in trauma survivors. Hospital LOS was revealed as the most significant predictor of functional recovery one year after severe injury.

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