






Study of cost determinants in the care of subjects with traumatic spinal cord injury

Estudo dos determinantes dos custos no atendimento dos pacientes com lesão medular decorrente de trauma raquimedular

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ABSTRACT

Spinal cord injury (SCI) is the main etiology related to spinal cord injury in young men. Due to the complexity of health care for these patients and their complications, the costs involved in these cases are high. **Objective:** To evaluate the costs associated with hospital and outpatient care for patients with traumatic spinal cord injury at a university service. **Methods:** This study was based on the review of clinical information about spinal cord injury and its complications, as well as the search for monetary amounts related to inpatient and outpatient care of individuals with traumatic SCI in a university service in 2009. **Results:** There were 51 patients with spinal trauma, of which 14 had SCI (age= 38.9 ± 20.8 years; men: 86%). Costs were R\$402,908.68 in the absence of spinal cord injury and R\$304,433.77 with spinal cord injury, and were statistically associated to the length of stay, the number of clinical complications and surgical procedures. Rehabilitation accounted for 23% of costs for patients with SCI. **Conclusion:** The costs related to the care of patients with SCI are higher than those associated with spinal trauma without neurological damage. The number of clinical complications is directly correlated with the length of hospital stay and the costs of this care. Rehabilitation corresponds to a smaller part of the expenses in the care of patients with SCI.

Keywords: Spinal Cord Injuries, Costs and Cost Analysis, Length of Stay, Postoperative Complications, Rehabilitation

RESUMO

O trauma raquimedular (TRM) é a principal etiologia relacionada à lesão medular em homens jovens. Em decorrência da complexidade ao atendimento desses pacientes e às suas complicações, os custos envolvidos nesses casos são vultosos. **Objetivo:** Avaliar os custos associados ao atendimento hospitalar e ambulatorial dos pacientes com lesão medular traumática num serviço universitário. **Métodos:** Este estudo baseou-se na revisão de informações clínicas sobre a lesão medular e suas complicações, bem como a busca de valores relacionados ao atendimento no período hospitalar e ambulatorial de indivíduos com lesão medular traumática num serviço universitário em 2009. **Resultados:** Foram contabilizados 51 pacientes com trauma na coluna vertebral, dos quais 14 apresentaram TRM (idade= 38,9 ± 20,8; homens: 86%). Os custos do atendimento foram R\$402.908,68 na ausência de lesão medular e R\$304.433,77 com lesão medular. Os custos do atendimento estiveram relacionados com o tempo de internação, o número de intercorrências clínicas e procedimentos cirúrgicos. A reabilitação correspondeu a 23% dos custos dos pacientes com TRM. **Conclusão:** Os custos relacionados ao atendimento do paciente com TRM são maiores que aqueles associados ao trauma de coluna sem lesão neurológica. O número de complicações clínicas correlaciona-se diretamente ao tempo de internação e os custos desse atendimento. A reabilitação corresponde a menor parte das despesas no cuidado aos pacientes com TRM.

Palavras-chaves: Traumatismos da Medula Espinal, Custos e Análise de Custo, Tempo de Internação, Complicações Pós-Operatórias, Reabilitação

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Conflict of Interests

Nothing to declare

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INTRODUCTION

Spine injury corresponds to 0.2% of public hospitalizations in Brazil and 2.7% of them are attributable to external causes¹ like trauma.^{2,3} Among the causes of spinal cord injury in Brazil, car accidents, falls from heights, accidents caused by diving in shallow waters and injuries caused by firearm projectiles stand out.⁴ Men aged between 20 and 29 years old are the group in which this type of trauma is most frequent, the lumbar level is the most common and the cervical level is more associated with spinal cord injury.⁵

There are few studies about the costs involved in the care of patients with spinal trauma. A recent Brazilian study shows that the average period of hospitalization is around 8.2 days, being influenced by the level of injury and the occurrence of spinal cord injury.¹ Recent North American data indicate, however, that this figure can vary from US\$340,787.00 to US\$1,044,197.00 in the first year after the onset of the disability, varying according to the level and severity of the injury, up to values of US\$41,393.00 to US\$181,328.00 per subsequent year, without considering the indirect losses in productivity,⁶ however, it is not possible to compare it with the Brazilian reality.

There is no national study that tries to define the costs related to the outpatient rehabilitation program or the management of complications observed until the end of the rehabilitation program. North American data indicate that the main sources of expenses for wheelchair users in the years subsequent to the onset of spinal cord injury are: a) direct costs of rehabilitation clinics, including assessments and reassessments; b) expenses with orthoses and means of transportation; c) home care; d) laboratory; e) radiology, among others. The average cost of care related to the rehabilitation of these patients is US\$21,450.00⁷ annually.

Specific aspects of the rehabilitation program also become important in determining treatment costs, such as the number of therapeutic sessions, the need for orthoses and walking aids, specific medications, in addition to medical procedures such as neuromuscular blocks or debridement of decubitus and dressings for pressure ulcers.⁸

OBJECTIVE

The objective of this study is to determine the costs involved in the care of patients with spinal trauma at the Hospital das Clínicas de Ribeirão Preto (HCRP), associated or not with spinal cord injury, both in the acute phase and in outpatient rehabilitation.

METHOD

This study was based on a review of the medical records of all patients with spinal trauma treated at the HCRP between January and December 2009, and was approved by the local Internal Review Board (CAAE 00783012.1.0000.5440, there was waiver of the free and informed consent form). At the HCRP, at the end of periods of hospitalization, clinical conditions related to health care are identified with codes from the International Classification of Diseases, which are fed into electronic records.

Thus, the search for the medical records followed a broad search strategy, described in Chart 1, where several clinical conditions potentially associated with spinal cord injury are listed, since this diagnosis is not always defined by the acute care team, particularly in very severe cases. Polytrauma or milder injuries

with incomplete injuries. The confirmation of spinal cord injury was performed using the specific codes of ICD10 (G82), when present, or by reading the information contained in the medical records. The medical records of individuals of both sexes and all age groups with evidence of spinal injury, with or without spinal cord injury, were included. Medical records in which information was so scarce as not to allow a conclusion about the injuries mentioned above were excluded.

Chart 1. ICD categories used in the Search for medical records

ICD codes	Descriptions
S12	Neck fracture
S14	Trauma of cervical nerves and spinal cord
S17	Crushing injury of the neck
S19	Other non-specified traumas in the neck
S22	Fracture of ribs, sternum and thoracic spine
S24	Trauma of thoracic nerves and spinal cord
S28	Crushing injury of the neck and traumatic amputation of part at thorax
S29	Other non-specified traumas in the thorax
S32	Lumbar or pelvic fracture
S38	Crushing injury and traumatic amputation of part of the abdomen, back and pelvis
S39	Other non-specified trauma to the abdomen back and pelvis
T02.0	Head and neck fracture
T02.1	Fractures involving the thorax, with the lower back and pelvis
T04.1	Crushing injury of the thorax, abdomen, lower back and pelvis
T04.2	Crushing injuries of multiple parts of the upper limbs
T09.3	Spinal cord trauma, unspecified level
T09.4	Trauma to nerves, spinal nerve roots and plexuses
T91.1	Impairments from spine fracture
T91.3	Impairments from spinal cord trauma
G82	Paraplegia and tetraplegia
G82.0	Flacid paraplegia
G82.1	Spastic paraplegia
G82.2	Unspecified paraplegia
G82.3	Flacid tetraplegia
G82.4	Spastic tetraplegia
G82.5	Unspecified tetraplegia

Thus, 52 medical records were selected, of which only one was excluded due to lack of records. Patients' demographic data,

clinical characteristics, reason for the trauma, functional impairment of the spinal cord and its characteristics, need for spinal surgery and clinical complications of the acute phases were extracted.

In cases of thoracolumbar trauma, care can be provided, in this hospital, by the orthopedic trauma team or by the neurosurgery team, which alternate every month for didactic reasons to expose residents of both specialties to the care of this health condition, so this information was also collected systematically (Table 1).

Table 1. General characteristics

	General	Spinal injury	No injury	p
N	51	14	37	
Age (years)	43.1 ± 19.4 (15-85)	38.9 ± 20,8 (19-85)	44.8 ± 18.8 (15-82)	0.369
Men	39 (76%)	12 (86%)	27 (73%)	0.338
Working	31 (61%)	8 (57%)	23 (62%)	0.743
<i>Nature of trauma</i>				
Fall of height	24 (47%)	5 (36%)	19 (51%)	0.071
Traffic accident *	21 (41%)	5 (36%)	16 (43%)	
Other**	6 (12%)	4 (28%)	2 (6%)	
<i>Surgical team</i>				
Orthopedic	33 (65%)	7 (50%)	26 (70%)	0.176
Neurosurgery	18 (35%)	7 (50%)	11 (30%)	

* Includes pedestrian, bike, motorbike and car accidents

** Includes firearm, diving in shallow waters and fall of objects to the head

Data regarding the costs of treating these patients were obtained with the help of the hospital controller, which provided the costs related to treatment in the in-hospital and outpatient phase, including expenses with rehabilitation care. Specifically, the following parameters were evaluated:

- Days of hospitalization, corresponding only to the first hospitalization for the acute phase, other hospitalizations would be computed for the late phase of rehabilitation;
- Laboratory, imaging or functional exams;
- Surgery and duration of anesthetic recovery, including instruments used for osteosynthesis or surgical procedures related to other injuries concomitant with spinal trauma;
- Outpatient procedures: control of spasticity through the application of botulinum toxin type A (TBA) or phenolization of peripheral nerves, therapeutic sessions by the multidisciplinary team, distribution of orthoses, walking aids and wheelchairs.

For continuous variables, data were summarized using means and standard deviations, or medians when appropriate, while categorical variables were presented as percentages. Total treatment costs were presented as the sum of direct treatment costs, being subdivided into a group with spinal cord injury and without spinal cord injury. Costs of the acute phase, or in-hospital costs, were those related to days of hospitalization, surgical procedures, and exams.

On the other hand, the costs of the outpatient phase included care provided by the multidisciplinary team, medical procedures such as the application of botulinum toxin and the provision of orthoses, wheelchairs, and mobility aids. Quantitative variables

had their distribution evaluated using the Shapiro-Wilk test and comparison of costs between groups was performed using the Mann-Whitney U test. And the significance level adopted was 5%. The reduced sample size did not allow for multivariate analysis or regression studies

RESULTS

Of the 51 cases selected for this study, 14 patients (27%) constituted the group with spinal cord injury. Spinal cord injury resulted in tetraplegia in 64% of cases and was incomplete in 57%. Fifty percent of the patients aged less than 40 years-old and were economically active men (Table 1). The main reasons for trauma to the spine were falls from heights and car accidents, and about half of the patients were polytraumatized, that is, they had simultaneous involvement of several body segments or trunk structures. The treatment of spinal injuries was performed by the orthopedics team in 65% of the patients. Spinal arthrodesis was the intervention chosen for 64% of patients with spinal cord injury, but only in 38% of cases when there was no neurological injury. There was no statistically significant difference for any of these variables.

Eight patients (21%) required mechanical ventilation, all of which were associated with polytrauma. On the other hand, the occurrence of spinal cord injury resulted in a greater number of complications such as the need for mechanical ventilation, neurogenic bladder, urinary tract infection, decubitus and pneumonia, implying a longer hospital stay (Table 2).

Table 2. Clinical characteristics

	General	Spinal injury	No injury	p
N	51	14	37	0.369
Arthrodesis	23 (45%)	9 (64%)	14 (38%)	< 0.001
Polytrauma	24 (47%)	5 (36%)	19 (51%)	0.318
Mechanical ventilation	8 (16%)	3 (21%)	5 (13%)	< 0,001
Length of stay (days)	15.22 (1-68)	24.36 (2-68)	11.76 (1-61)	0.039
Neurogenic bladder	9 (18%)	9 (64%)	0	< 0,001
<i>Acute complications</i>				
UTI	11 (21%)	7 (50%)	4 (11%)	0.002
PNM	7 (14%)	4 (28%)	3 (8%)	0.058
Decubitus	7 (14%)	6 (43%)	1 (3%)	0.002
<i>SCI characteristics</i>				
Paraplegic / Tetraplegic		5 (36%) / 9 (64%)		
Complete / Incomplete		6 (43%) / 8 (57%)		

UTI: urinary tract infection, PNM: pneumonia, SCI: spinal cord injury

Patients with tetraplegia did not differ from patients with paraplegia at statistically significant levels regarding the same biodemographic variables, etiologies and clinical complications or length of stay (Table 3).

Regarding treatment costs, a total amount of BRL 707,243.45 was recorded during the hospitalization period, BRL 304,433.77 for patients with spinal cord injury and BRL 402,809.68 without injury. The factors that most weighed in this amount were the length of stay (average of 15 days, BRL 5,608.58/patient), exams (average of BRL 2,194.61/patient), surgical procedure (BRL 2,170.79/patient).

Table 3. Comparison between paraplegic and tetraplegic subjects

	Paraplegic	Tetraplegic	p
N	5	9	
Age (years)	41.4 ± 26.3 (22-85)	37.6 ± 18.6 (19-68)	0.782
Men	4 (80%)	8 (88.8%)	0.91
Working	3 (60%)	5 (55.6%)	0.84
<i>Nature of trauma</i>			
Fall of height	2 (40%)	3 (33.3%)	0,87
Traffic accident*	2 (40%)	3 (33.3%)	
Other**	1 (20%)	3 (33.3%)	
Orthopedic/neurosurgery	2 (40%) / 3 (60%)	4 (45%) / 5 (55%)	> 0.05
Arthrodesis	3 (60%)	6 (67.7%)	0.76
Politrauma	0 (0%)	3 (33.3%)	0.25
Length of stay (days)	15.6 ± 6.5 (6-23)	29.2 ± 23.0 (2-68)	0.23
Mechanical ventilation	4 (80%)	2 (22.2%)	0.18
Neurogenic bladder	4 (80%)	5 (55.5%)	0.36
<i>Acute complications</i>			
UTI	3 (60%)	4 (44.5%)	0.41
Decubitus	2 (40%)	4 (44.5%)	0.89
PNM	0 (0%)	4 (44.5%)	0.21

UTI: urinary tract infection, PNM: pneumonia, SCI: spinal cord injury); *Includes pedestrian, bike, motorbike and car accidents; **Includes firegun, diving in shallow waters and fall of objects to the head

The cost associated with the care of patients with spinal cord injury was statistically higher in terms of length of stay, surgical procedure and expenses related to rehabilitation, but not in terms of the tests requested or assistance from the medical and multi-disciplinary team. The median cost of in-hospital care added to the rehabilitation program among patients with spinal cord injury during hospitalization was BRL 16,637.00, more than twice the cost of patients without spinal cord injury (BRL 7,566.00) (Table 4).

Table 4. Median costs (percentiles 25 and 75) associated to care of spinal cord injured subjects (x 1,000.00) in BRL (R\$)

	General	Spinal injury	No injury	P
Length of stay (days)	3.16 1.42 – 7.53	7.35 2.78 – 13.46	2.82 0.79 – 7.57	0.015*
Surgical procedure	1.88 0 – 3.14	2.49 0.70 – 4.35	1.86 0 – 3.09	0.005*
Exams	1.43 0.89 – 2.44	2.36 1.03 – 3.26	1.32 0.89 – 2.07	0.218*
Consultations	1.66 0.99 – 2.57	2.03 1.23 – 4.22	1.47 0.96 – 2.31	0.347
Total in-hospital	8.94 4.95 – 18.59	16.51 7.50 – 35.69	7.52 4.57 – 10.29	0.034*
Rehabilitation	0.07 0 – 0.35	0.35 0 – 0.69	0.03 0 – 0.21	0.015*
Total + rehabilitation	8.94 5.04 – 18.77	16.63 7.84 – 40.87	7.56 4.57 – 10.71	0.011*

* Mann-Whitney U Test

Despite the median cost of hospitalization of patients assisted by the neurosurgery service being higher than that of orthopedics (BRL 9,281.00 x BRL 7,650.00, p>0.05), no statistically significant differences were observed in relation to any of the items of expenses between these services (Table 5).

Table 5. Median costs (percentiles 25 and 75) associated to care of SCI subjects in BRL (R\$) (x 1,000.00)

	Paraplegic	Tetraplegic	P
Length of stay (days)	1.47 1.15 – 1.65	4.70 4.53 – 7.43	0.317*
Surgical procedure	2.49 0.70 – 4.35	1.86 0 – 3.09	0.548*
Exams	2.36 1.03 – 3.26	1.32 0.89 – 2.07	0.502*
Consultations	2.03 1.23 – 4.22	1.47 0.96 – 2.31	0.352*
Total in-hospital	16.51 7.50 – 35.69	7.52 4.57 – 10.29	0.533*
Rehabilitation	0.24 0.16 – 0.45	1.63 0 – 7.65	0.880*
Total + rehabilitation	12.74 7.73 – 15.56	29.10 8.15 – 43.00	0.689*

* Mann-Whitney Test

Total expenditure on rehabilitation was about 9 times higher for individuals with spinal cord injury (BRL 69,667.48 x BRL 7,489.1), but represented only 23% of the total cost of care for these patients (Table 6). The number of clinical complications showed a moderate correlation with the number of days of hospitalization (Spearman= 0.501) and with the total cost of care (Spearman= 0.661) (Figure 1).

Table 6. Total and rehabilitation costs associated to the care of all the patients

	Spinal injury (BRL)	No injury (BRL)	General (BRL)
Rehabilitation	69,667.48 (23%)	7,489.10 (2%)	77,156.58 (11%)
Total	304,433.77 (100%)	402,809.67 (100%)	707,243.45 (100%)

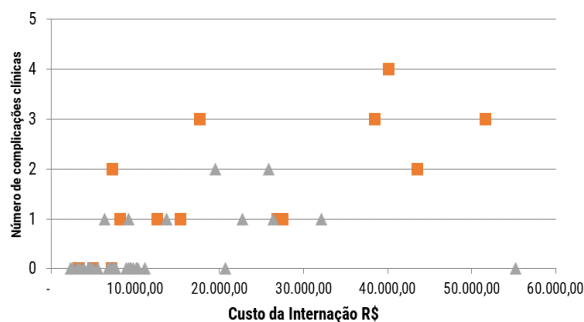


Figure 1. Correlation between the number of clinical complications and the total cost of care of spinal trauma subjects

DISCUSSION

This study confirmed the suspicion of the existence of a statistically significant difference between the groups with and without spinal cord injury in terms of hospitalization costs and outpatient rehabilitation during the observation period.

As for hospitalization, this study can be compared with Tuono et al.¹ which used reports from dataSUS from 2000 to 2005 through the characteristics of hospitalizations that occurred throughout Brazil. These authors found that spinal cord involvement ranged from 15.1% to 17.2% of spinal trauma cases, which is close to 27.4% in our sample. The median expenditure per patient with spinal cord injury was BRL 16.51, approximately twice the expenditure in relation to the total number of patients with spinal trauma (BRL 8,940.00), which was explained by the longer hospital stay in the first group (median with injury 12 days/patient x without injury 8 days/patient, $p < 0.05$). This characteristic was also observed by Munce et al.⁹, who found higher hospitalization costs for patients with spinal cord injuries (R\$ 1,523.12/patient) compared to patients with spinal trauma (R\$ 1,318.85/patient), in the however the difference was not great. On the other hand, the reason for the order of up to 10 times the average cost of care in our study may be partly due to the historical evolution of care costs and the type of surgical instruments used. In addition, multidisciplinary rehabilitation care is not systematically offered throughout the country and was not accounted for in that study.⁹

This sample is similar to other studies in the national and international literature, with a predominance of young adult patients, male and economically active,^{9,10} which makes these results potentially generalizable for the condition of care throughout the country. The groups were similar in terms of clinical interurrences, excluding those related to spinal cord injury, so we believe that comparisons between groups are not influenced by other clinical factors.

The prolonged period of hospitalization of patients with spinal cord injury was due to the high number of complications, totaling 50% of patients with urinary tract infection, 28% with pneumonia and 43% with pressure ulcers. In Brazil, the presence of ulcers does not prevent the patient from being discharged from the hospital, to complete the treatment on an outpatient basis, which can be a problem, since many rehabilitation services in Brazil consider the presence of decubitus as an ineligibility criterion.¹¹ On the other hand, therapeutic objectives are important in the length of hospitalization for rehabilitation, both in the USA and Brazil.¹²⁻¹⁴ Regardless of the country in which the studies originate, pressure ulcers, respiratory complications and urinary infections are the complications that most prolong the hospitalization of these patients.^{15,16}

Urinary complications, in particular urinary incontinence caused by detrusor overactivity, are causes of impaired quality of life in patients with spinal cord injury and are responsible for increased health care expenses, regardless of the etiology. The factors directly related to the routine and clinical care of these individuals are due to the use of pads and instruments to aid in the collection and storage of urine, diagnostic procedures and consultations or procedures with health professionals. Indirectly, urinary incontinence in spinal cord injury still has the complication of being associated with motor limitation, which increases the time for excretion care (toileting) and may require more attention from a caregiver.^{5,17}

Munce et al.⁹ demonstrated that, in Ontario, Canada, the cost of rehabilitation corresponded to 58% of the total expenses with patients with spinal cord injury, which differs greatly from the 23% found in this study. This is probably seen because they are different rehabilitation treatment regimes, where in Ribeirão Preto, rehabilitation has an outpatient regime, as in most rehabilitation centers in Brazil.

As there are no Brazilian studies on rehabilitation costs, it is difficult to make a comparison, which denotes the need for further studies. A substantial part of the expenses involved in the rehabilitation of patients with spinal cord injury in our study was due to the application of botulinum toxin and provision of a motorized wheelchair, which was only done for 5 of the 14 patients in this condition. Certainly, if these procedures were universalized for all patients with spinal cord injury, rehabilitation expenses would assume a proportion similar to that in Canada. The discrepancy in hourly wages for health professionals between the two countries may explain the difference in the cost of rehabilitation care.

A substantial part of the cost associated with rehabilitation of individuals with spinal cord injury was related to the delivery of motor wheelchairs. Those subjects with good upper limb mobility, appropriate cognitive and emotional profiles as well as good resources and home conditions are elected to receive motor wheelchairs, once they can prevent the occurrence of musculoskeletal overuse injuries and are cost-effective.¹⁸ The costs associated to the use of exoskeletons were not added to cost-benefit studies.¹⁹

Limitations of this study are related to use of medical and administrative records, which limited the precise definition of injury extension. Computing the complications was, thus, the best estimate of cost. Costs related to rehabilitation in other services were not collected, because we noticed that many subjects would continue with physical therapy on their own after discharge from rehabilitation center. Indirect costs with transportation, days lost from work were not considered and would certainly somewhat increase this reported figures.

CONCLUSION

The costs with patients with spinal cord injury are higher in relation to spine trauma without spinal cord injury, with rehabilitation contributing only a small percentage to these costs and hospitalization contributing the highest percentage. However, it is necessary to carry out new studies to analyze the costs of rehabilitation in Brazil, where data that were not accounted for in this study should be included and include institutions where there is a rehabilitation regime with hospitalization.

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CONTRIBUTION OF AUTHORS

Conception and supervision: Riberto M, Herrero CFPS; Revision of medical charts: Alves LBP, Honorato DLP, Galliano FT, Albuquerque TVC; Revision and typing of care-associated costs: Galliano FT, Albuquerque TVC; Data analysis: Riberto M, Herrero CFPS; Writing: Riberto M, Herrero CFPS, Galliano FT, Albuquerque TVC.

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