ORIGINAL ARTICLE

Characteristics, length of stay and functional outcome of patients with spinal cord injury in Dutch and Flemish rehabilitation centres

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Study design: Multi-centre prospective descriptive study.

Objective: To establish a profile of the population affected with traumatic and non-traumatic spinal cord injury (SCI) admitted to rehabilitation centres in the Netherlands and Flanders (Belgium) and to describe determinants of length of stay (LOS) and functional outcome.

Setting: Eleven rehabilitation centres in the Netherlands and Flanders.

Patients: A total of 919 patients with traumatic and non-traumatic SCI on first admission to rehabilitation centres between 2002 and 2007.

Methods: Information about LOS, functional outcome and personal and injury characteristics was derived from a joint data set developed for this project.

Results: A total of 54.7% of patients with SCI had a non-traumatic lesion. The group of patients with non-traumatic SCI showed a more even gender distribution, a more advanced age and less severe lesion characteristics than the group of patients with traumatic SCI. Linear regression models explained 32% of the variance of LOS and 42% of the variance of functional outcome. Functional status on admission was the strongest determinant of LOS and completeness of the lesion was the strongest determinant of functional outcome. Aetiology (traumatic versus non-traumatic) was a weak independent determinant of LOS but was not an independent determinant of functional outcome.

Conclusion: Patients with non-traumatic SCI formed a majority in the Dutch and Flemish SCI population. Although the characteristics of patients with traumatic and non-traumatic SCI clearly differed, rehabilitation of patients with non-traumatic SCI appears at least as efficient as rehabilitation of patients with traumatic SCI.

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Keywords: rehabilitation; spinal cord injuries; epidemiology; length of stay; outcome

Introduction

Spinal cord injury (SCI) has a worldwide incidence of between 10.4 and 83 cases per million per year.¹ Although patients with SCI have a great impact on the health-care system, few epidemiological studies of SCI are available. Most studies only considered traumatic SCI, while a substantial part of the population with SCI consists of patients with non-traumatic SCI and these groups might have diverging rehabilitation needs.² Consequently, there is a need for more insight into the characteristics of the populations affected with traumatic and non-traumatic SCI in different settings and countries and for a standardized method of reporting personal and injury characteristics in clinical studies.^{1–4} In 2002, a registry was developed by the Dutch-Flemish Spinal Cord Society to examine the char-

acteristics of patients with SCI admitted to initial clinical rehabilitation in the Netherlands and Flanders (the Dutch-speaking part of Belgium), and to facilitate SCI studies. This registry conforms to the International Core Data Set.⁵

The purpose of our study was to describe and compare personal and injury characteristics, length of stay (LOS) and functional outcome of patients with traumatic and non-traumatic SCI admitted to rehabilitation centres in the Netherlands and Flanders.

Materials and methods

Subjects and procedure

Between January 2002 and April 2007, information was collected about patients with SCI who were discharged from initial inpatient rehabilitation. During this period, the number of rehabilitation centres cooperating in the study gradually increased to 11 out of 12 SCI specialized centres in

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the Netherlands (9) and Flanders (2). Patients with SCI admitted with normal sensory and motor function and patients with SCI who were admitted to the rehabilitation centre more than 1 year after SCI were excluded. There were no further inclusion or exclusion criteria.

Data was collected with a form, which was filled in by the patient's rehabilitation physician on admission and at discharge. Each form was sent to the research team, who contacted the physician in case of missing or illegible data and entered all data into a data file (SPSS). All patients gave informed consent for their data to be included in a central data base after name and address information had been removed.

Instruments

The first part of the data collection form concerned general information: date of birth, gender, aetiology, date of injury, date of admission and date of final discharge. LOS was defined as the period between admission and final discharge, ignoring interruptions of the rehabilitation process such as periods of bedrest or readmission to the acute care hospital. Aetiology was divided into traumatic and non-traumatic SCI, the latter category being in turn divided into six subcategories: vascular disease, spinal degeneration, inflammation, benign tumour, malignant tumour and other causes.

The second part of the form concerned SCI characteristics, which were recorded at admission and discharge. The international standards of the American Spinal Injury Association (ASIA) were used to record motor and sensory levels of injury.⁶ SCI was categorized as tetraplegia if the highest motor level was at or above T1 and as paraplegia if below T1. In case of normal motor function, the highest sensory level was taken to be the level of injury. Completeness of the lesion was recorded according to the ASIA Impairment Scale (AIS).⁶ The AIS grades A and B were defined as motor complete lesions, AIS grades C and D as motor incomplete lesions.

The third part of the form concerned information on secondary conditions. However, as uniform scoring of this part was only achieved later in the project, these data were not used in this paper.

The final part concerned functional status at admission and discharge (the latter from now on referred to as 'functional outcome'), using a brief self-developed scale including five items: mobility, self-care, bladder management, bowel management and transfers. A 4-point scale was used for each item: completely dependent, partially dependent, independent with use of an aid and completely independent. The sum of the item scores was recoded into a scale from 0 (complete dependence) to 100 (complete independence). Internal consistency reliability of this scale was excellent (Cronbach's alpha 0.89 on admission and 0.92 at discharge).

Statistical analyses

Descriptive data were analysed separately for patients with traumatic and non-traumatic lesions. The χ^2 test was used to detect significant differences between these groups.

In describing LOS, patients with SCI who died during admission and who were admitted in 2006 and 2007 were excluded to avoid bias towards shorter LOS. As the distribution of LOS was strongly skewed, both mean and median LOS values were computed and a log-transformed LOS score was used in statistical analyses. As both the log-transformed LOS score and the functional outcome score met the assumption of a normal distribution (skewness -0.6 and 0.8, respectively), parametric statistics (*t*-tests and one-way analysis of variance) were used to detect significant differences between subgroups.

The influence of aetiology and other characteristics on LOS and functional outcome was analysed using stepwise backward regression analyses to reveal the most efficient regression model. All determinants were entered together, and the weakest determinant was eliminated at each step until all remaining determinants were related ($P < 0.1$) to the dependent variable.

Results

General characteristics

A total of 919 patients with SCI were included. Thirteen patients with SCI (four traumatic and nine non-traumatic) died during admission.

Most patients with SCI had a non-traumatic lesion (54.7%). Non-traumatic causes were vascular diseases (27.9% of non-traumatic lesions), spinal degeneration (26.1%), inflammation (17.2%), malignant tumour (16.8%), benign tumour (11.2%) and other causes (0.8%). Other personal and injury characteristics are displayed in Table 1.

Male/female ratio was higher in the traumatic group (2.8:1) than in the non-traumatic group (1.2:1; $P < 0.001$). Mean age in the traumatic group was 43.4 (s.d. 16.7) years (range 13–86) versus 57.2 (s.d. 14.5) years (range 15–88) in the non-traumatic group ($P < 0.001$). Only 12 patients were below 18 years of age, because children with SCI are usually admitted to paediatric rehabilitation departments, which were not involved in this project.

Traumatic lesions were more frequently motor complete (52.3%) than non-traumatic lesions (25.9%; $P < 0.001$) and were more likely to result in tetraplegia (49.6 versus 24.2%; $P < 0.001$).

Length of stay

The mean and median times that elapsed between the onset of injury and admission to the rehabilitation centre were 52.8 (s.d. 54.6) days and 33 days (interquartile range 20–62), respectively. No significant difference was seen between patients with traumatic and non-traumatic SCI. Mean and median LOS at the rehabilitation centre were 183.3 (s.d. 134.1) and 155.5 days (interquartile range 77.0–255.8), respectively. LOS for different subgroups is displayed in Table 2. LOS was longer for patients with traumatic, motor complete and cervical lesions. Higher age was weakly associated with shorter LOS ($r = -0.13$; $P = 0.001$), while

Table 1 Personal and injury characteristics (*N* = 919)

	N	Traumatic (%)	Non-traumatic (%)	Total (%)	χ^2	P-value
Sex					35.2	0.000
Male	578	73.5	54.5	63.1		
Female	338	26.5	45.5	36.9		
ASIA Impairment Scale ^a					92.7	0.000
AIS A	227	37.2	15.1	25.2		
AIS B	115	15.1	10.8	12.8		
AIS C	235	26.5	25.7	26.1		
AIS D	324	21.2	48.4	36.0		
Level of injury ^a					61.8	0.000
Tetraplegia	316	49.6	24.2	35.8		
Paraplegia	567	50.4	75.8	64.2		
Neurological Classification ^a					135.0	0.000
Complete tetraplegia	111	22.9	4.0	12.7		
Incomplete tetraplegia	203	26.7	20.3	23.2		
Complete paraplegia	230	30.7	22.6	26.3		
Incomplete paraplegia	331	19.7	53.2	37.8		
Age at injury (years)					153.3	0.000
13–30	133	26.8	4.7	14.7		
30–45	193	29.0	15.0	21.4		
45–60	276	26.1	33.7	30.3		
60–75	240	14.1	36.8	26.5		
75+	64	3.9	9.8	7.1		

^aOn admission.

better functional status on admission was strongly associated with shorter LOS ($r = -0.51$; $P < 0.001$).

Functional outcome

Functional status scores on admission were 14.5 (s.d. 23.0) for patients with traumatic SCI and 32.0 (s.d. 27.9) for patients with non-traumatic SCI ($t = 10.0$; $P < 0.001$). Functional gain during admission was 46.9 (s.d. 30.1) for patients with traumatic SCI and 39.0 (s.d. 26.9) for patients with non-traumatic SCI ($t = -4.0$; $P < 0.001$).

Functional outcomes for different subgroups are displayed in Table 3. The maximum functional outcome score was obtained by 18.4% of all patients. Functional outcome was better for patients with non-traumatic, motor incomplete and paraplegic lesions. Moreover, it was strongly correlated with functional status on admission ($r = 0.55$; $P < 0.001$) and moderately correlated with LOS ($r = -0.33$; $P < 0.001$). No significant correlation was found between functional outcome and age ($r = 0.06$; $P = 0.085$).

Regression analyses

The regression model of LOS explained 32% of the variance of LOS. Having a poorer functional status on admission was the strongest determinant of a longer LOS. Other significant determinants were the conditions of having a motor complete, a tetraplegic and a traumatic lesion (Table 4). The regression model of functional outcome explained 42% of the variance. Having a motor incomplete lesion, a better functional status on admission, a paraplegic lesion and a younger age were determinants of better functional outcome

(Table 4). Aetiology was not an independent determinant of functional outcome.

Discussion

Patients with non-traumatic SCI formed a majority in the Dutch and Flemish SCI population and showed a more even gender distribution, a more advanced age and less severe lesion characteristics than the group of patients with traumatic SCI. This is the first study in which relationships of aetiology (traumatic versus non-traumatic) with LOS and functional outcome were tested using regression analyses. Aetiology was a weak independent determinant of LOS, but was not an independent determinant of functional outcome.

Traumatic versus non-traumatic SCI

In this study, 54.7% of patients with SCI had non-traumatic lesions, which is similar to the 52% found in an earlier retrospective Dutch study.⁷ Lower percentages were found in studies from Turkey (32.5%),² Italy (25%)⁸ and the United States (39%).⁹ This difference might be attributed to the low incidence of traumatic SCI in the Netherlands³ or to a greater readiness of specialized Dutch rehabilitation centres to admit patients with non-traumatic SCI compared to rehabilitation centres elsewhere. The differences between traumatic and non-traumatic SCI found in this study are in agreement with results from other studies.^{2,7–9}

Table 2 Length of stay (LOS, days) in inpatient rehabilitation in relation to all injury-related factors (N = 708)

Variables	N	Mean $\pm$ s.d.	Median	IQR	Statistic ^a	P-value
Sex					$t = 1.5$	0.127
Male	451	187.2 $\pm$ 129.7	163.0	79.0–264.0		
Female	257	175.2 $\pm$ 141.4	133.0	71.0–237.5		
Aetiology					$t = 9.0$	0.000
Traumatic	339	227.6 $\pm$ 105.2	207.0	116.0–307.0		
Non-traumatic	368	142.7 $\pm$ 110.5	109.5	63.0–199.8		
ASIA Impairment Scale ^b					$F = 65.5^c$	0.000
AIS A	194	247.7 $\pm$ 140.7	231.5	147.0–324.5		
AIS B	99	249.6 $\pm$ 139.6	226.0	153.0–329.0		
AIS C	184	179.3 $\pm$ 127.0	158.5	77.0–243.8		
AIS D	220	100.1 $\pm$ 70.6	79.0	53.0–129.0		
Level of injury ^b					$t = 5.3$	0.000
Tetraplegia	250	228.0 $\pm$ 154.1	210.5	89.5–324.5		
Paraplegia	434	159.5 $\pm$ 112.7	134.5	73.0–219.0		
Neurological Classification ^b					$F = 61.2^d$	0.000
Complete tetraplegia	94	322.2 $\pm$ 149.9	301.0	212.0–411.0		
Incomplete tetraplegia	154	170.7 $\pm$ 126.0	133.0	71.0–249.8		
Complete paraplegia	198	213.7 $\pm$ 121.1	205.5	122.5–287.3		
Incomplete paraplegia	232	114.3 $\pm$ 81.3	93.0	58.3–157.0		
Age at injury (years)					$F = 3.5^e$	0.007
13–30	113	206.0 $\pm$ 142.9	177.0	96.5–284.0		
30–45	158	210.3 $\pm$ 143.8	191.5	91.5–295.3		
45–60	207	176.9 $\pm$ 134.2	139.0	77.0–257.0		
60–75	171	164.2 $\pm$ 121.8	135.0	72.0–231.0		
75+	53	146.1 $\pm$ 99.4	118.0	70.0–211.0		

Abbreviations: s.d., standard deviation; IQR, interquartile range.

^aIndependent samples *t*-test (*t*) or one-way analysis of variance (*F*) (performed on log-transformed LOS).

^bOn admission.

^cA Bonferroni *post hoc* test revealed no significant difference between AIS A and AIS B. All other subgroups were significantly different from each other ($P < 0.001$).

^dA Bonferroni *post hoc* test revealed that all subgroups were significantly different from each other ($P < 0.001$).

^eA Bonferroni *post hoc* test revealed no significant differences between subgroups, except for '30–45' and '60–75' ($P < 0.047$).

Traumatic SCI

Characteristics of patients with traumatic SCI found in this study resemble those found in previous studies. The male/female ratio was slightly lower than that described in previous Dutch studies,^{3,7} but lies within the range of 2.5:1 to 5.8:1 reported in international studies.^{1,10} Mean age in this study was relatively high, but also within the range reported in the literature (31–50 years).^{1,10} The age and gender data of patients with traumatic SCI in our study seem to fit a trend of increasing age and increasing proportions of female patients.^{1,10,11}

In our study, almost half of the traumatic SCI group was comprised of tetraplegic patients, a proportion which lies within the broad range of 31–75% reported in the international literature.^{1,10} Over half of all traumatic lesions were motor complete (ASIA A or B), while 37.2% were complete (ASIA A). Recent literature reports 35.0–52.1% of traumatic lesions to be complete.^{1,10}

Non-traumatic SCI

Mean age in the non-traumatic group was 57.2 years, compared to 48–61 years in the literature.^{2,7–9,12,13} Percentages of women reported in the literature (36.6–58%)

also resembled our findings, as did those for paraplegia (63.6–82.5%) and incomplete lesions (68.6–91%).^{2,7–9,12,13}

The most common non-traumatic aetiologies in this study were vascular diseases, spinal degeneration and tumours (benign and malignant), which all accounted for over a quarter of non-traumatic lesions. Tumours and spinal degeneration were also a substantial category of non-traumatic SCI in other studies (20.1–36.4%^{2,8,9,12,13} and 18–29%,^{2,7,12,13} respectively). Lesions of vascular origin accounted for a smaller proportion in a study from Turkey (8%),² but for about a quarter of non-traumatic lesions in other publications.^{7,12,13} An inflammatory cause was found in 17.2% of the patients with SCI in our study, compared to 19.5% reported elsewhere.¹² Not all studies described the same categories of aetiologies, making it difficult to draw comparisons between different studies.

Length of stay

Length of stay reports in the literature show wide ranges. LOS in this study was longer than those reported in studies from the United States (mean 60.8 days),¹⁴ Australia (median 83 days),¹⁵ Italy (mean 143.1 for traumatic and 91.7 days for non-traumatic injuries)⁸ and a previous retrospective Dutch

study.⁷ It was more or less comparable to LOS in Israel¹⁶ and shorter than that reported in Japan.¹⁷ Another Dutch study reported much longer mean and median LOS, viz. 272.9 and 240 days respectively.¹⁸ However, persons with motor complete lesions were over-represented in that study.

Table 3 Functional outcome (0–100 score) in inpatient rehabilitation in relation to all injury-related factors (*N* = 843)

Variables	N	Mean $\pm$ s.d.	Statistic ^a	P-value
Sex			<i>t</i> = −0.8	0.436
Male	531	65.9 $\pm$ 32.0		
Female	312	67.7 $\pm$ 33.2		
Aetiology			<i>t</i> = −4.4	0.000
Traumatic	380	61.3 $\pm$ 33.8		
Non-traumatic	461	71.0 $\pm$ 30.7		
ASIA Impairment Scale ^b			<i>F</i> = 98.9 ^c	0.000
AIS A	205	46.5 $\pm$ 30.1		
AIS B	109	50.2 $\pm$ 32.2		
AIS C	212	66.1 $\pm$ 32.1		
AIS D	309	86.1 $\pm$ 20.5		
Level of injury ^b			<i>t</i> = −5.9	0.000
Tetraplegia	294	56.7 $\pm$ 38.2		
Paraplegia	528	71.7 $\pm$ 27.4		
Neurological Classification ^b			<i>F</i> = 112.0 ^d	0.000
Complete tetraplegia	99	27.3 $\pm$ 29.4		
Incomplete tetraplegia	194	72.0 $\pm$ 32.9		
Complete paraplegia	214	57.2 $\pm$ 26.7		
Incomplete paraplegia	310	81.8 $\pm$ 22.7		
Age at injury (years)			<i>F</i> = 1.5 ^e	0.215
13–30	119	66.7 $\pm$ 30.1		
30–45	184	68.1 $\pm$ 31.9		
45–60	256	69.6 $\pm$ 32.5		
60–75	217	63.1 $\pm$ 34.7		
75+	58	62.9 $\pm$ 29.2		

Abbreviation: s.d., standard deviation.

^aIndependent samples *t*-test (*t*) or one-way analysis of variance (*F*).

^bOn admission.

^cA Bonferroni *post hoc* test revealed no significant difference between AIS A and AIS B. All other subgroups were significantly different from each other (*P* < 0.001).

^dA Bonferroni *post hoc* test revealed that all subgroups were significantly different from each other (*P* < 0.001).

^eA Bonferroni *post hoc* test revealed no significant differences between subgroups.

LOS was longer for patients with traumatic SCI than for patients with non-traumatic SCI and aetiology was an independent predictor of LOS in the regression analysis. We found no other studies testing aetiology as a determinant of LOS. Part of this difference can be ascribed to the short LOS of patients with SCI secondary to a malignant tumour, for whom a special rehabilitation programme exists in most SCI centres.¹⁹ Further research is necessary to analyse the independent influence of aetiology on LOS.

The other determinants of LOS found in this study are in agreement with the findings in previous publications.^{14,18,20} The presence of secondary conditions may also have contributed to the variation of LOS, but this factor could not be examined in this study. In addition, different health-care systems and cultural differences might explain some of the variation in LOS found in the literature.¹⁸ For example, the reimbursement system in the Netherlands offers little pressure to restrict LOS.²¹

Functional outcome

Patients with traumatic SCI showed more improvement of functional status during inpatient rehabilitation than patients with non-traumatic SCI. However, patients with non-traumatic SCI showed better functional outcomes, and, because LOS was much shorter in this group, more functional gain for each day of admission. In the regression analysis, aetiology was not an independent determinant of functional outcome. The bivariate association of aetiology with functional outcome in this study can therefore be ascribed to differences between both groups regarding lesions characteristics, functional status on admission and age. Previous studies reporting relationships between aetiology and rehabilitation outcomes did not use multivariate analysis to control for demographic and injury characteristics.^{2,9} The independent influence of age on functional outcome may be based on a reduced ability to recover and the effect of co-morbidity in elderly patients.

Implications

Patients with non-traumatic SCI formed a majority in the Dutch and Flemish SCI population and the characteristics of this group differed clearly from those of the traumatic group. As some non-traumatic causes of SCI are age-related, such as

Table 4 Linear regression analysis of determinants of length of stay and functional outcome in inpatient rehabilitation (*N* = 708)

Independent value	Length of stay			Functional outcome		
	β	t-value	P-value	β	t-value	P-value
Age			NS	−0.202	−6.382	0.000
Gender (male)			NS			NS
Aetiology (traumatic)	0.109	3.075	0.002			NS
Level of injury (tetraplegia)	0.134	3.988	0.000	−0.207	−6.725	0.000
Completeness (motor complete)	0.228	6.150	0.000	−0.369	−10.271	0.000
Functional status on admission	−0.338	−9.037	0.000	0.362	10.454	0.000
Length of stay	NA					NS
Adjusted R^2 = 0.32 (<i>F</i> = 79.4; <i>P</i> < 0.001)				Adjusted R^2 = 0.42 (<i>F</i> = 117.9; <i>P</i> < 0.001)		

Abbreviations: NS, not significant; NA, not applicable.

vascular diseases, tumours and spinal degeneration, it is expected that the group of patients with non-traumatic SCI will grow in the future.²²

The acute management and rehabilitation of patients with non-traumatic SCI is conducted in a variety of different settings, and these patients often do not receive specialized SCI rehabilitation services.²² This study showed, however, that treatment of non-traumatic SCI in specialized rehabilitation centres may be at least as effective as treatment of traumatic SCI.

The group of patients with non-traumatic SCI consists of a diversity of aetiologies. Further research into aetiology-related differences in rehabilitation needs might reveal a need to develop more rehabilitation programmes that are tailored to the needs of specific subgroups of patients with SCI.¹⁹

This study finally showed that a registry of patients with SCI is useful to collect epidemiological information. Such data complements data from scientific studies that often concern selected groups. Addition of a standard for recording aetiology of non-traumatic SCI to the Core Data Set⁵ is recommended to facilitate international comparisons of traumatic and non-traumatic SCI.

Limitations

Although this was a multi-centre study, including a large patient group, it does not provide complete coverage of all patients with SCI admitted to clinical rehabilitation. One SCI specialized centre did not participate at all, and patients with SCI were treated in non-specialized rehabilitation centres as well. In addition, children with SCI are generally admitted to paediatric departments, which were not included in this registry. The registry was not tested on inter-rater reliability, but consistency of scoring was monitored repeatedly at meetings of the participating physicians. These discussions showed that the larger part of the form was easy to use, but that it took time to achieve a uniform scoring of secondary conditions. Therefore, these data were not used in this study, although information about the presence of secondary conditions would have contributed to the analyses of LOS and functional outcome.

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