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Duration and functional outcome of spinal cord injury rehabilitation in the Netherlands

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Abstract—This study describes the length of stay (LOS) and functional outcome of spinal cord injury (SCI) in the Netherlands and its determinants. Data of 157 patients from eight rehabilitation centers were available. Mean age was 40.0 years and 76.4% were traumatic injuries, 39.8% had tetraplegia, and 69.9% had a motor complete SCI. Median LOS was 240 days (interquartile range 164–322). Median motor Functional Independence Measure (FIM) scores at discharge were 37.3 for persons with complete tetraplegia and 69.7 for persons with complete paraplegia. Level and completeness of injury, bed rest because of pressure sores, and LOS were predictors of motor FIM scores. Duration of SCI rehabilitation in the Netherlands is long compared with the literature. Functional outcome appears slightly better in persons with complete tetraplegia, but not in persons with complete paraplegia when compared with data from the United States. International studies are necessary to reveal strengths and weaknesses of SCI rehabilitation systems in different countries.

Key words: activity limitation, bed rest, clinical rehabilitation, FIM, length of stay, paraplegia, rehabilitation outcome, secondary complications, tetraplegia, wheelchair-dependent.

INTRODUCTION

Spinal cord injury (SCI) is a devastating condition that requires intensive and specialized clinical rehabilitation. SCI occurs often at a young age, and life expectancy of persons with SCI has increased in recent decades, although it is still lower than the life expectancy of the general population [1]. Nevertheless, most people suffering from SCI can now be expected to live for many years. Rehabilitation should "add life to years" by facilitating people with SCI as much as possible to function independently and to create conditions for social reintegration [2]. Evidence of the benefits of medical rehabilitation is documented typically by the reduction in disability of persons receiving inpatient rehabilitation and by length of stay (LOS). Functional outcome, or gain in functional ability during rehabilitation, reflects the effectiveness of clinical rehabilitation, and LOS is often used as a measure of its efficiency. To date, little is known about the effectiveness and efficiency of medical rehabilitation.

Abbreviations: ADL = activity of daily living, ASIA = American Spinal Injury Association, FIM = Functional Independence Measure, IQR = interquartile range, LOS = length of stay, SCI = spinal cord injury, SD = standard deviation, UDSMR = Uniform Data System for Medical Rehabilitation, UTI = urinary tract infection.

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Most studies have been done in the United States using data from the National Model Spinal Cord Injury Systems Database [3–5]. This database allows comparisons of an institution's performance to that of other similar facilities or analyses of trends in a certain time period. Such comparisons on an international scale have not been made yet, but available studies show that mean LOS in inpatient rehabilitation may vary from 60 days in the United States [4] up to 267 days in Japan [6]. It is unknown whether these differences reflect caseload differences, system differences (for example, variations in the moment of transfer from acute care to the rehabilitation facility), or differences in effectiveness or efficiency of medical rehabilitation. Variation in functional outcome and LOS within one facility or system has been related to severity of injury, degree of disability at admission, age, and other demographic variables and various complications [4–8]. However, these predictors unlikely fully explain the differences seen in LOS and outcome between facilities and systems. Comparative research of LOS, treatment regimes, and outcomes might reveal strengths and weaknesses of rehabilitation in various countries and cultures. Currently, international comparisons are hardly possible because of a lack of data from different countries.

This study describes LOS and functional outcome of SCI rehabilitation in the Netherlands and examines relationships between personal and injury characteristics on LOS and functional outcome.

METHODS

Subjects

The present study was part of the Dutch research program "physical strain, work capacity, and mechanisms of restoration of mobility in the rehabilitation of persons with spinal cord injuries."* In this prospective cohort study, individuals with SCI were followed during primary inpatient rehabilitation. Eight rehabilitation centers with a specialty in SCI rehabilitation took part in the study. Subjects were eligible to enter the project if they had an acute SCI; were between 18 and 65 years of age; were classified as A, B, C, or D on the American Spinal Injury Association (ASIA) Impairment Scale; and were expected to remain wheelchair-dependent (at least for long distances). These inclusion criteria were chosen because the main target of the research program was the recovery of physical capacity, as measured by a wheelchair treadmill test. For people who no longer use a wheelchair, this test is invalid, and in older people, the recovery of physical capacity is often different because of their age and frequent comorbidity. Exclusion criteria included SCI due to malignant tumor, progressive disease, known cardiovascular disease or psychiatric problems, and enough command of the Dutch language to understand the goal of the study and the testing methods. All subjects gave informed consent, and the medical ethics committees of all participating institutes approved all tests and protocols.

Procedures

Measurements were performed at the start of functional rehabilitation (defined as the moment that a person can sit for 3 to 4 hours), 3 months after the start of functional rehabilitation, and at discharge. The second measurement was performed only if the period of inpatient functional rehabilitation took longer than 3 months.

Instruments

Length of Stay

The duration of hospitalization is defined as the period between the onset of SCI and the day of admission to the rehabilitation center. This period can safely be assumed to be the period of hospitalization since, in the Netherlands, discharge to a nursing home or the patient's home to await inpatient rehabilitation is extremely rare. LOS in inpatient rehabilitation is defined as the period between first admission and final discharge in the rehabilitation center. The period of admission was divided into a period between admission and the start of functional rehabilitation, called acute rehabilitation, and a period of functional rehabilitation. The start of functional rehabilitation was defined as the moment that the person can sit in a wheelchair for 3 to 4 hours. We were not able to track all readmissions to an acute-care hospital during rehabilitation, and the influence of readmissions on the LOS was therefore ignored.

Lesion Characteristics

The physicians in each center assessed lesion characteristics at the start of functional rehabilitation and at discharge according to the International Standards for Neurological Classification of Spinal Cord Injury [9]: the ASIA Impairment Scale classifications A and B were defined as motor complete, C and D as motor incomplete,

* www.fbw.vu.nl/onderzoek/A4zon/ZONenglish

and neurological lesion levels below T1 were defined as paraplegia, while lesion levels at or above T1 were defined as tetraplegia.

Secondary Complications

The rehabilitation physicians registered, based on their medical files, at fixed moments (start of functional rehabilitation, 3 months later, and at discharge) whether subjects had suffered from pressure sores, urinary tract infections (UTIs), or respiratory tract infections during the previous period. They also registered, if applicable, the number of days that subjects were confined to bed because of these complications.

Activity Limitations

The level of independence in activities of daily living (ADLs) was assessed with the use of the motor score of the Functional Independence Measure (FIM) [10]. The FIM motor score consists of 13 items on the domains self-care (6), continence (2), transfers (3), and locomotion (2). Each item is scored on a 7-point scale, with 7 indicating complete independence, 6 modified independence (extra time or a device needed), and 5 or lower the need of assistance in varying degrees (from 5, supervision, down to 1, total dependence). The interrater reliability, validity, and responsiveness of the FIM are well-established [11]. The FIM is part of the U.S. Uniform Data System for Medical Rehabilitation (UDSMR) [10] and is worldwide the most often used measure for this goal. However, its use in routine registration of rehabilitation centers in Europe has been limited to a few countries [12]. A Dutch version of the FIM was developed for this study and pretested regarding feasibility of the scoring system, and all research assistants and physicians were given 1 day of training by an accredited FIM-trainer of UDSMR. During the study, we discussed the way the FIM was scored and a few ambiguities in the scoring guidelines in quarterly meetings with the research team and the raters to optimize the reliability of the FIM rating.

Statistical Analyses

We used FIM scores in two ways: (1) as a measure of functional outcome and (2) to perform statistical analyses. In addition, the percentages of persons who were independent on each of the four FIM domains were described. Such figures help clinicians determine the degree to which the goals of medical rehabilitation (making people independent) are met. To be rated as independent on a certain FIM domain, a person has to score a 6 or 7 on all items (each item) within that domain.

Since both LOS and the FIM scores at discharge showed a strongly skewed distribution, we used nonparametric statistics to describe the distributions of these scores and to test differences between groups: Mann-Whitney *Z*-test for differences between two groups and Kruskall-Wallis chi-square for differences between more than two groups. In addition, means and standard deviations (SDs) were displayed to facilitate comparisons with other studies. To enable post hoc comparisons (Bonferroni procedure) and linear regression analyses, we used 10 log transformations of LOS and FIM scores. These transformed scores showed a fairly normal distribution (Kolmogorov-Smirnov test; $p = 0.204$ and $p = 0.579$, respectively).

We performed two regression analyses, one for LOS and one for functional outcome, to examine the influence of all injury-related factors together. First, all variables were entered together. Next, a "Backward" procedure was performed with the use of the SPSS default criterion $P_{out} = 0.10$. Because both models showed comparable results, only those of the "Enter" procedures are given in this paper. The multiple regression (MR) correlation and the adjusted percentage of explained variance (Adj. R^2) reflect the accuracy of the prediction by these regression models.

RESULTS

Respondents

This study is part of an ongoing cohort study. Between August 2000 and July 2003, 205 persons with SCI were included. Data of 157 patients, who were already discharged from clinical rehabilitation and for whom the neurological and FIM data were available, were available at the time of this study. Mean age of the subjects was 40.0 ± 14.1 SD. Most were men (73.9%) and 83.4 percent were employed before the SCI. The SCI was of traumatic origin in 76.4 percent of all subjects (traffic accident 32.5%, fall 17.2%, sports 12.1%, occupational 7.6%, assault 1.2%, and other traumatic 5.1%).

At the start of functional rehabilitation, 39.8 percent had tetraplegia and 69.9 percent had a motor complete SCI. At patient discharge, these figures were 36.9 percent and 62.4 percent, respectively. The relationship between type of injury at admission and at discharge is displayed in **Table 1**, showing that type of injury remained fairly stable during inpatient rehabilitation.

The occurrence of pressure sores, UTIs, and pulmonary infections during admission of patients in the rehabilitation center was registered. The results are summarized in **Table 2**, with the phases of acute and of functional rehabilitation split.

From **Table 2**, one can see that most days of bed rest were caused by the occurrence of pressure sores: nearly half of all patients had one or more pressure sores, nearly one-third had one or more episodes of bed rest because of pressure sores, and the median patient stayed in bed for 20 days. Many patients were admitted with existing pressure sores, explaining why this shorter period had as many episodes of pressure sores as the much longer period of functional rehabilitation. UTIs were more common, but had fewer consequences; only a minority of these patients had to stay in bed, and the period was limited to 1 week for most of them. Pulmonary infections were relatively rare and were seen more often in patients with tetraplegia than in patients with paraplegia. Bed rest during the entire period of inpatient rehabilitation because of pulmonary infections was mostly seen in persons with complete tetraplegia (22.0%). Bed rest because of UTIs was mostly seen in persons with complete injuries (29.3% in tetraplegia and 23.5% in paraplegia). Bed rest because of pressure sores was seen in all four groups, although more in persons with tetraplegia (41.5%) than in persons with incomplete paraplegia (19.2%).

Length of Stay

Table 3 shows the LOS in the acute-care hospital and in the rehabilitation center, with the rehabilitation center period split between admission and start of functional rehabilitation and between functional rehabilitation until discharge from inpatient rehabilitation.

From **Table 3**, one can see that many patients were in inpatient rehabilitation for long time periods with large variations in length of all phases. The "median" SCI

Table 1.
Type of injury at start of functional rehabilitation and at discharge (*N* = 156).

Discharge	Complete Tetraplegia at Admission	Incomplete Tetraplegia at Admission	Complete Paraplegia at Admission	Incomplete Tetraplegia at Admission	All Patients at Admission
Complete Tetraplegia	27	11	3	0	41
Incomplete Tetraplegia	3	16	0	2	21
Complete Paraplegia	0	0	57	11	68
Incomplete Paraplegia	0	1	7	18	26
All Patients at Discharge	30	28	67	31	156

Table 2.
Occurrence and bed rest caused by pressure sores, urinary tract infections, and pulmonary infections during inpatient rehabilitation (*N* = 157).

Inpatient Rehabilitation	Occurrence of Complication No. (%)	Bed Rest Complication No. (%)	Mean ± SD Days of Bed Rest*	Median Days of Bed Rest*	Interquartile Range*
Acute Rehabilitation					
Pressure Sores	56 (35.9)	27 (17.2)	37.2 ± 49.1	19	10–57
Urinary Tract Infections	73 (46.8)	13 (8.3)	8.5 ± 16.0	2	1–9
Pulmonary Infections	12 (7.7)	10 (8.0)	8.7 ± 10.0	5	4–10
Functional Rehabilitation					
Pressure Sores	58 (36,9)	32 (20.4)	25.8 ± 35.8	15	6–30
Urinary Tract Infections	94 (59,9)	17 (10.8)	5.9 ± 5.0	4	3–7
Pulmonary Infections	17 (10.8)	10 (6.4)	6.6 ± 4.9	4	4–9
Total Admission: Discharge					
Pressure Sores	77 (49.0)	47 (29.9)	38.1 ± 51.7	20	8–42
Urinary Tract Infections	113 (72.0)	27 (17.2)	7.8 ± 12.2	4	2–7
Pulmonary Infections	25 (15.9)	16 (10.8)	9.5 ± 9.7	5	4–12

*Only patients with bed rest SD = standard deviation patient spent the first 31 days in the hospital and was then transferred to the rehabilitation center, with an additional month to become mobilized in the wheelchair, followed by a functional rehabilitation period of 6.5 months. The total period of hospitalization and rehabilitation for this "median" patient was nearly 8.5 months. The "average" patient stayed longer in the hospital and rehabilitation: about 10.5 months. Mean LOS figures however were dominated by a few patients who stayed in the hospital and rehabilitation center up to more than 2 years.

Predictors of Length of Stay

Table 4 gives the duration of rehabilitation (acute and functional together) for different subgroups related to age, gender, etiology, type of injury, and the occurrence of secondary complications. No difference was found regarding

Table 3.
Length of stay (days) in acute-care hospital and of inpatient rehabilitation (*N* = 157).

Facility	Mean ± SD	Median	IQR	Minimum	Maximum
Hospital	48.6 ± 51.4	31	19–55	1	281
Inpatient Rehabilitation	272.9 ± 148.7	240	164–322	79	808
Acute	48.8 ± 45.2	35	23–59.5	4	309
Functional Rehabilitation	224.5 ± 135.9	191	128.8–276.0	32	731

SD = standard deviation IQR = interquartile range

Table 4.
Length of stay in inpatient rehabilitation related to age, gender, type of injury, and occurrence of secondary complications.

Variables	*N*	Mean ± SD	Median	IQR	*p*-Value*
Age					
<40	74	279.1 ± 149.3	259.5	171–359	0.619
40	81	267.2 ± 148.9	254.5	163–294	
Gender					
Male	114	277.8 ± 156.1	240.0	164–317	0.686
Female	41	259.3 ± 129.3	226.0	161–341	
Etiology					
Traumatic	118	274.8 ± 150.0	243.0	164–323	0.791
Nontraumatic	37	266.6 ± 146.4	226.0	164–293	
Type of Injury at T1					
Complete Tetraplegia	39	385.4 ± 170.3	360.0	274–483	0.000
Incomplete Tetraplegia	21	269.0 ± 148.6	244.0	167–308	
Complete Paraplegia	68	214.0 ± 89.0	191.0	151–272	
Incomplete Paraplegia	21	262.0 ± 157.7	219.5	145–337	
Bed Rest All Complications					
No	86	234.2 ± 124.5	194.0	148–280	0.000
Yes	69	321.1 ± 162.8	280.0	197–400	
Bed Rest Pressure Sores					
No	104	258.6 ± 149.8	204.0	150–293	0.010
Yes	51	301.9 ± 143.6	272.0	212–353	
Bed Rest Urinary Tract Infection					
No	127	261.7 ± 145.8	225.0	156–307	0.089
Yes	28	322.6 ± 154.4	272.5	203–398	
Bed Rest Pulmonary Infection					
No	139	261.3 ± 146.8	225.0	156–293	0.001
Yes	16	373.2 ± 130.0	369.0	251–454	

*Nonparametric testing (Mann-Whitney or Kruskall-Wallis) SD = standard deviation IQR = interquartile range duration of inpatient rehabilitation between men and women, between persons younger or older than 40 years of age, and between persons with traumatic or with nontraumatic injuries. The Spearman correlation between age and LOS was also not significant r_S (r_{Spearman}) (–0.02; p = 0.831). However, as expected, clear differences regarding type of injury and occurrence of complications were seen. Persons with complete tetraplegia stayed longest in the rehabilitation center (median 360 days), against median 191 days for persons with complete paraplegia. The difference between the group with complete tetraplegia and all other groups was statistically significant; differences between the other three groups were not significant. The occurrence of complications resulted in a considerably longer stay in the rehabilitation center: from median 194 up to 280 days. The difference was largest for persons with pulmonary infections, although this difference is "biased" because pulmonary infections occur mostly in persons with tetraplegia. The correlation between the total number of days of bed rest and LOS was 0.33, $p < 0.001$.

We performed a regression analysis to examine the influence of all injury-related factors together. Since age, gender, and etiology showed no significant relationships with LOS, these variables were not included in this regression analysis. Type of injury was represented by its constituting variables (tetraplegia/paraplegia and motor-complete/motor-incomplete injury) as predictors. **Table 5** shows the results.

The regression model was highly significant (F = 6.98; $p < 0.001$), but explained only a minor part of the variance of LOS (21%). Level of injury was the strongest predictor of LOS. Surprisingly, having a complete injury at admission and having had bed rest because of pressure sores were not independent predictors of LOS.

Functional Outcome

The distribution of FIM scores at discharge from clinical rehabilitation is displayed in **Figure 1**. A clear clustering of FIM scores at the higher end of the scale (good functional outcome) can be seen, although the maximum score (91) was not reached. The highest score obtained was 90 by two patients. The skewed distribution of FIM scores was reflected in a relatively low mean score of 64.7 ± 20.9 SD and a large difference between this mean and the median score of 74.0 (interquartile range [IQR] 49.0–79.5).

LOS was strongly correlated r_S (r_{Spearman}) (–0.61; p < 0.001) to functional outcome, indicating that patients who stayed longer showed worse outcome. Because of complications, bed rest and type of injury were also clearly related to functional outcome (**Table 6** and **Figure 2**). Demographic variables and etiology were not significantly related to functional outcome; therefore, these figures are not displayed in **Table 6**.

As expected, patients with complete tetraplegia showed poorer outcomes than the other groups, and the best outcome was seen in patients with incomplete paraplegia. Patients with incomplete tetraplegia showed largest within-group differences in outcome. Post hoc analyses showed that, except between the groups with incomplete tetraplegia and with complete paraplegia, all differences in FIM motor scores between the four types of injury were significant. Finally, bed rest caused by complications was associated with poorer outcome at discharge, and the largest median difference was seen for bed rest because of pulmonary complications.

Table 7 displays the percentage of persons with SCI who were independent on different FIM domains at discharge. In this table, someone is called independent for a certain FIM domain if he or she scores a 6 or 7 on all FIM items within that domain (**Table 7**).

As can be seen from **Table 7**, persons with complete tetraplegia were, for the most part, still dependent on help

Table 5.
Linear regression analysis of determinants of length of stay in inpatient rehabilitation (N = 157).*

Independent Variable	β	*t*-Value	*p*-Value
Level of Injury	0.33	4.37	0.000
Completeness Injury	0.02	0.3	0.760
Bed Rest Pressure Sores	0.07	0.92	0.360
Bed Rest Urinary Tract Infections	0.14	1.77	0.079
Bed Rest Pulmonary Infection	0.17	2.26	0.025

*Note: Only the final model is displayed.
Multiple regression coefficient = 0.48; adjusted percentage of explained variance: Adj. R^2 = 0.21

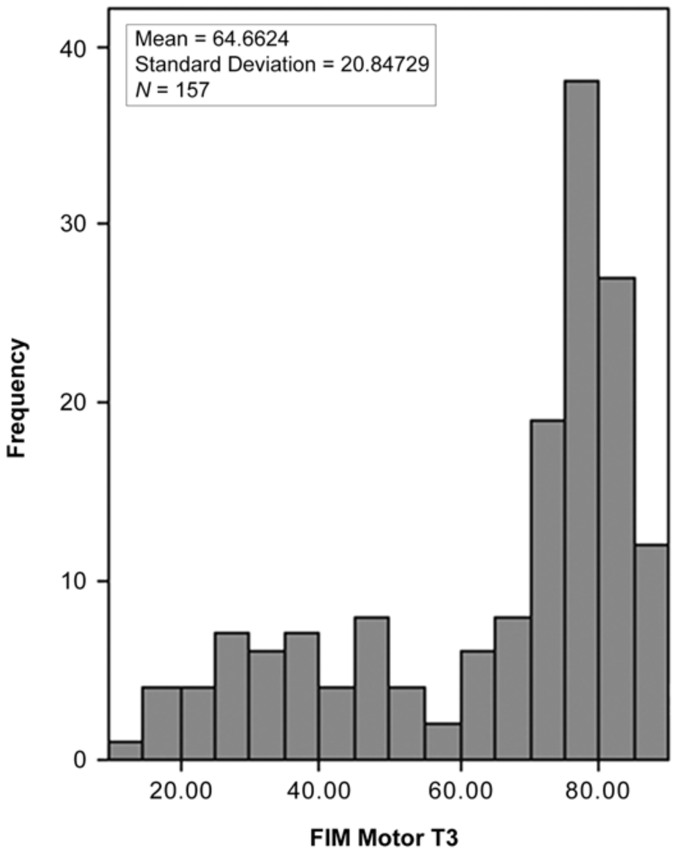

Figure 1.
Distribution of Functional Independence Measure (FIM) scores at discharge from clinical rehabilitation.

from others in all FIM domains. The highest levels of independence were for the items eating/drinking (35.4%), personal care (43.3%), and moving around (96.6% independent in wheelchair) (not shown in table). About half of all persons with incomplete tetraplegia (46.4%–67.9%) were independent on the four FIM domains (**Table 7**). Inspection of the items revealed that the percentage of persons being independent was within a close range of 64.2 and 71.5 percent on all items, except for washing (57.1%), dressing lower body (46.4%), and negotiating stairs (46.4%). Of this group, 32.1 percent were able to walk independently. Persons with complete paraplegia were usually independent in self-care. Toileting was the most difficult item (72% independent). All were able to move around in a wheelchair independently, but only 4.4 percent were able to negotiate stairs independently. Finally, persons with incomplete paraplegia were nearly all independent, except for negotiating stairs (35.5% independent) and controlling bladder and bowel. Of this group, 36.7 percent were able to walk independently.

To examine the joint influence of injury characteristics, bed rest because of complications, and LOS, we performed a linear regression analysis (**Table 8**). Nearly half of the variance of functional outcome was explained. LOS was the strongest predictor of outcome, indicating that, controlled for the influence of severity of injury, persons with longer LOS showed worse outcome at discharge. Having tetraplegia, a complete injury, and bed rest because of pressure sores were also independently associated with worse functional outcome of clinical rehabilitation.

DISCUSSION

The median and mean duration of inpatient rehabilitation in this study was 240 days and 273 days, respectively. Two earlier studies in the Netherlands showed strongly deviating results. Schonherr et al. reported a much shorter mean duration of rehabilitation of 154 days in a retrospective study in one rehabilitation center in 1982 to 1993 (*N* = 293) [13]. However, this study included only 27 percent of patients with complete injuries, and mean LOS of persons with complete cervical injuries was 296 days. Post et al. found a longer mean duration of hospital and rehabilitation together of 11.6 ± 7.6 months in a study of 318 persons with SCI who were admitted to one of eight rehabilitation centers in the years 1986 to 1992 [14].

Reported mean LOS in the international literature varies between 60 ± 38.7 days in the United States [4] up to a mean LOS of 267 ± 171.6 days in Japan for patients who were admitted to the rehabilitation center between 2 weeks and 6 months after the onset of SCI [6]. In other countries, mean LOS has been reported of mean 88 days in Greece [15], median 83 days (IQR 35–139) in Australia [16], median 92 days in Québec [17], mean 143 to 164 ± 89.1 days in Italy [18–19], 217 days in Norway [19], and finally in Israel mean 239 ± 168 for traumatic and 106 ± 137 days for nontraumatic injuries [20].

This means that LOS in the Netherlands is comparable with that in Japan and, to a lesser degree, Israel, but considerably longer than in many other countries. Part of this difference may be due to our selected study group. Our study included persons who were expected to become wheelchair users, thus excluding persons with

Table 6.
Functional Independence Measure scores at discharge from clinical rehabilitation by type of injury and bed rest due to occurrence of complications (N = 157).

Variable	*N*	Mean ± SD	Median	IQR	*p*-Value*
Complete Tetraplegia	30	37.3 ± 15.9	35.5	26.0–49.5	$p < 0.001$
Incomplete Tetraplegia	28	65.1 ± 24.7	78.0	37.3–84.0	
Complete Paraplegia	68	69.7 ± 13.2	75.0	64.8–77.0	
Incomplete Paraplegia	31	79.6 ± 6.2	81.0	76.0–84.0	
Bed Rest, All Complications					
No	87	71.6 ± 16.1	76.0	70.0–82.0	$p < 0.001$
Yes	70	56.0 ± 22.8	61.5	37.8–76.0	
Bed Rest, Pressure Sores					
No	106	69.0 ± 17.4	76.0	67.0–82.0	$p < 0.001$
Yes	51	54.0 ± 23.3	55.0	30.0–76.0	
Bed Rest, Urinary Tract Infection					
No	128	66.8 ± 19.9	76.0	55.5–81.0	$p = 0.003$
Yes	29	55.2 ± 22.5	62.0	37.5–75.5	
Bed Rest, Pulmonary Infection					
No	141	67.0 ± 20.0	76.0	60.0–80.5	$p < 0.001$
Yes	16	43.8 ± 16.5	44.0	29.8–54.0	

*Kruskall-Wallis chi-square or Mann-Whitney *Z*-test IQR = interquartile range

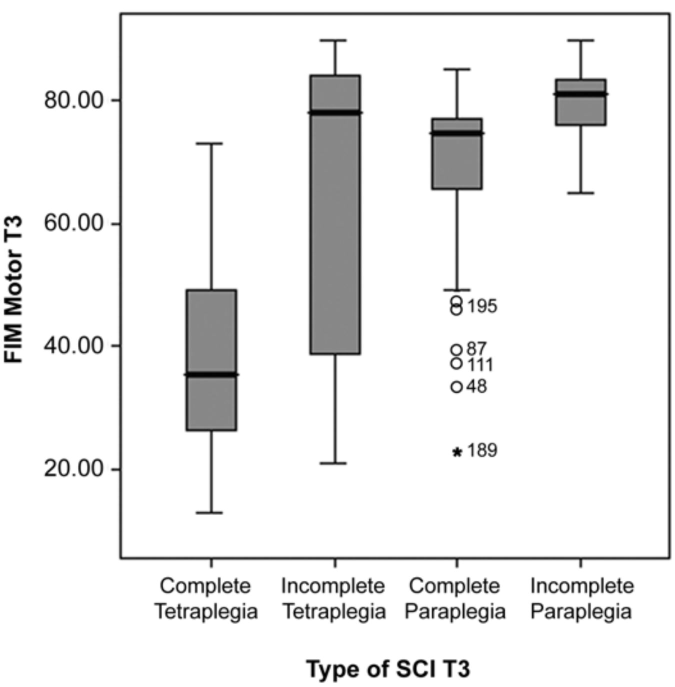

Figure 2.
Functional Independence Measure (FIM) scores by type of injury at discharge from clinical rehabilitation (N = 157). *Patient number. SCI = spinal cord injury.

good neurological recovery and probably short LOS. In addition, geriatric persons who were expected to be discharged to a nursing home after a short period of rehabilitation were excluded from our study. Finally, readmissions to the acute-care hospital may have influenced the number of days in inpatient rehabilitation, but this was not recorded in our study. However, most likely, system and cultural differences were also an influence. In the Netherlands, the reimbursement system offers relatively little pressure to restrict LOS, neither to the rehabilitation center nor to the person.

Predictors of Length of Stay

The incidence of pressure sores and pulmonary infections is comparable with the figures of pressure sores requiring intervention and pulmonary complications reported for the UDSMR [21]. Level of injury and occurrence of bed rest because of UTIs and pulmonary infections were determinants of LOS. Winslow et al. also found an impact of respiratory complications on LOS [22]. Eastwood et al. found admission FIM to be the most important predictor of LOS ($\beta = -0.43$) [4], a higher FIM related to shorter LOS. They did not examine the occurrence of complications, but found a relationship with bladder management and with various demographic variables (age,

Table 7.
Percentage of persons with spinal cord injury being independent on different Functional Independence Measure (FIM) domains at discharge from clinical rehabilitation (N = 157).

Lesion Level	FIM Self-Care	FIM Continence	FIM Transfers	FIM Locomotion
Complete Tetraplegia	3.3	6.7	13.3	3.3
Incomplete Tetraplegia	46.4	57.1	67.9	46.4
Complete Paraplegia	67.6	38.2	69.1	4.4
Incomplete Paraplegia	83.9	58.1	93.5	32.3

Table 8.
Linear regression analysis of determinants of functional outcome of persons with spinal cord injury at discharge clinical rehabilitation (N = 157).

Independent Variable	β	*t*-Value	*p*-Value
Level of Injury	–0.25	3.81	0.000
Completeness Injury	–0.32	4.96	0.000
Bed Rest Pressure Sores	–0.19	3.09	0.002
Bed Rest Urinary Tract Infections	–0.03	0.47	0.637
Bed Rest Pulmonary Infections	–0.09	1.48	0.142
Length of Stay	–0.35	5.37	0.000

Multiple regression correlation = 0.72; adjusted percentage of explained variance: Adj. R^2 = 0.49

education, marriage, minority status, retirement status at admission). However, the β coefficients of most demographic variables were very low (–0.03/–0.07). Bode and Heinemann found initial functional status to be the main predictor of LOS [8], with patients with greater disability having longer LOS. These results agree with our results. In addition, similar to the findings of our study, Greenwald et al. did not find gender differences in LOS studying an age-matched sample [23]. Age was found to be a significant predictor of LOS in several studies [4,24]. That age was not relevant in our study might again be explained by the exclusion of people over age 65.

Functional Outcome

Comparing our figures with those of other studies is difficult because the composition of the patient group regarding type of injury will strongly influence the average FIM scores and because hardly any studies reported FIM scores split by level of injury and ASIA Impairment Scale. The best possible comparison was with Hall et al. [5], from whose tables we computed a mean FIM score of 32.2 for persons with complete tetraplegia and 69.4 for persons with complete paraplegia. In our study, these FIM scores were 37.3 ± 15.9 and 69.7 ± 13.3, respectively, indicating that discharge FIM scores were somewhat higher for persons with complete tetraplegia but were not different for persons with paraplegia. Thus, rehabilitation in the Netherlands apparently is not very efficient, taking more time but not resulting in substantially better outcomes. Further study will be necessary to relate LOS/functional outcome to possible differences in the system, such as intensity of therapy, the use or nonuse of particular interventions, or cultural differences. Differences in FIM scores (or any other scores) as applied in different countries must however be treated with caution. The raters in this study were given 1 day of training organized by UDSMR. Nevertheless, cross-cultural differences in interpreting FIM items or differences due to translation problems cannot dismissed. Furthermore, the FIM suffers from a lack of sensitivity to change [25–27]. Streppel and Van Harten concluded that the Dutch FIM because of its ceiling effect cannot be used to measure outcome in stroke patients in inpatient rehabilitation [28]. At least in some countries, rehabilitation goals exist that may justify continuation of rehabilitation that cannot be measured by the FIM; for example, enlarging maximum walking distance or improving wheelchair skills so that one can negotiate curbs. Therefore, more sensitive measures, such as the Wheelchair Skills Test [29] or the Walking Index of Spinal Cord Injury [25], should be used in addition to the FIM for the outcome of rehabilitation to be fully appreciated.

Length of Stay and Outcome

Theoretically, discharge should occur when a patient's functional and educational gains begin to plateau [4]. Research has shown that in the United States, LOS has become too short, the reduction from 74 to 60 days between 1990 and 1998 being accompanied with an increase in hospital readmissions and discharge to nursing homes instead of discharge to the community [4]. According to Ronen et al., a prolonged stay in a specialized center may be positively associated with an improved rehabilitation outcome measured by the Spinal Cord Independence Measure [20]. Elsewhere, we reported improvement of wheelchair skills after the first 3 months of functional rehabilitation [30], a period that is longer than the mean total period of inpatient rehabilitation in several countries [4,16–17]. However, discharge also may be delayed because people have to wait for completion of domestic adaptations or delivery of assistive devices. In an earlier study, we found that one-third of all persons with SCI said that their discharge from the rehabilitation center had been unnecessarily delayed, with a median duration of 15.5 weeks because they had to wait for another house or for adaptation of their current house [14]. This kind of inefficiency should be corrected as soon as possible, because a long stay in an institution not only results in higher costs of rehabilitation but may also result in hospitalization and hamper social reintegration.

CONCLUSION

LOS of first inpatient rehabilitation in the Netherlands is long compared with many other countries. One cannot possibly conclude whether or not this long LOS is justified by better functional outcomes. Prospective international comparative studies using sensitive measures are needed for better insight in the optimal LOS for patients with various types of SCI.

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