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Original Article

Length of stay in hospital following spinal cord lesions in Israel

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Study Design: Retrospective cohort study.
Objective: To monitor length of stay (LOS) in a specialist spinal cord lesion (SCL) department in Israel, evaluate factors that affect it, and assess its association with other outcome measures.
Setting: Loewenstein Rehabilitation Hospital, Raanana, Israel.
Methods: In all, 1367 SCL patients treated between 1962 and 2000, and a group of 44 patients admitted between 1996 and 2002 were recruited. LOS, factors that affect it, and Spinal Cord Independence Measure second version (SCIM-II) gain and efficiency were measured. Data were collected from hospital charts and from the Population Registry of the Israel Ministry of Internal Affairs. LOS associations were analyzed with ANOVA, ANCOVA, Pearson's χ^2 test, Pearson's correlation, and Cox proportional hazard model.
Results: The mean LOS was 239 days for traumatic SCL (SD = 168) and 106 days for non-traumatic SCL (SD = 137). SCL etiology, SCL severity, and decade of admission to rehabilitation, were associated with the LOS ($P<0.001$). SCIM II gain correlated with LOS in the first 70 days after admission ($r=0.81$–0.82; $P<0.001$). In some patients, longer LOS was associated with a considerable increase in ability, through 5–8 months from admission.
Conclusions: LOS of patients with SCL in Israel is within the customary LOS range in Europe. Longer LOS in a specialist SCL department may be positively associated with improved rehabilitation outcome. Further study is required to determine the LOS that allows optimal achievements.
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Keywords: length of stay; spinal cord lesions; SCIM; etiology; Frankel grade

Introduction

Caregivers in rehabilitation systems are frequently involved in decisions concerning the discharge date of patients with spinal cord lesions (SCL). As economical factors are increasingly influencing clinical considerations, these decisions often become a source of conflict. The discharge date, and implicitly the length of stay (LOS) during the first hospitalization, may have an impact both on the outcome following SCL and on the cost of care. Shorter LOS, desirable from the economic point of view, may diminish patient achievement. Longer LOS may be associated with FIM motor score improvement and efficiency (change over time).[1–3]

This conflict may be aggravated by the expected increase in the elderly population in the Western world, which is likely to result in an increase in nontraumatic SCL (NTSCL).[4]

To identify SCL patients at high risk of extended LOS, allow physicians to treat them more aggressively, and permit families, as well as sponsors, to estimate the costs of long-term care, some authors have developed models for the prediction of SCL patients' LOS. These models were successful in predicting LOS in many of the examined patients, using factors that may influence the LOS such as age at lesion onset[4,5], lesion etiology, number of days to rehabilitation admission, number of pressure ulcers, medical complications, level of lesion, Frankel or ASIA grade of lesion, and sponsor of initial hospitalization.[4–9]

Although these factors could be used to predict LOS in the departments in which they were examined, LOS differed in reports from various places. Average values were in the following ranges: 20–74 days in the USA,[2,3,9,10] 56–61 in Australia,[4] 91–143 in Italy,[6] 150 in

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Bangladesh,[11] 154 in the Netherlands,[12] 198–222 in Spain,[13] and 149–285 in Denmark.[14]

This study was designed to monitor LOS and examine its relationship with the factors that can affect it and with rehabilitation outcomes in a relatively large SCL population in Israel.

Methods

The participants in the study, SCL patients admitted to Loewenstein Rehabilitation Hospital, consisted of two groups: a main group of 1367 patients for the study of LOS and factors that can affect it, and a smaller group of 44 patients for the study of the relationship of LOS with ability and rehabilitation outcomes. The main group included two subgroups: 1117 patients with NTSCL and 250 patients with traumatic SCL (TSCL). Data for all patients were obtained from hospital charts. Data collection for TSCL patients was performed in 1998 and included only patients treated between 1962 and 1992. Data collection for NTSCL patients was performed in 2001 and included only patients treated between 1962 and 2000. Data collection for the second group was performed at the end of 2002, and included patients treated between 1996 and 2002. All SCL patients whose files and relevant data were found during each collection period were included.

All patients had a first, longer admission, after which many were readmitted for shorter periods for complementary treatment, care of complications, or check-up examinations. The average time to first admission to Loewenstein Hospital was 59 days after injury in the patients with TSCL, and 51 months after the earliest event related to SCL in the hospital records in the patients with NTSCL. The first admission of the few patients who contracted NTSCL from birth was not in their childhood, but when the need for comprehensive rehabilitation was identified during adulthood.

The mean age at lesion onset was 47.1 years (SD = 16.8, range = 0–82 years) for patients with NTSCL, and 34.5 (SD = 15.3, range = 6–83 years) for patients with TSCL. The male:female ratio was 1.2:1 for NTSCL and 3.3:1 for TSCL.

NTSCL etiology was degenerative spine disease in 40% of cases, multiple sclerosis (MS) in 21.0%, tumor in 20% (meningioma 9%, ependymoma 2%, astrocytoma 1.3%, shwannoma, hemangioma and others 7.7%), myelitis (myelopathy of unknown origin) in 7%, infection in 4% (mainly Tuberculosis and *Staphylococcus aureus*), and others in 8%. The MS patients were usually neurologically stable during rehabilitation, although occasionally improvement or deterioration was observed during hospitalization. The cause of TSCL was a road accident in 33% of cases, work accident in 27%, fall from a height (of unknown reason) in 17%, suicide attempt in 13%, and other (gunshot, stabbing, sports-related accidents) in 10%.

The cervical spinal cord was affected in NTSCL in 32% and in TSCL in 37% of the lesions; the thoracic in 44% in NTSCL and 32% in TSCL; and the lumbosacral in 24% in NTSCL and 31% in TSCL.

At the first admission, 22% (16% of the NTSCL and 46% of the TSCL) had complete or almost complete lesions (Frankel grade A or B); 44% had Frankel grade C (45% of the NTSCL and 40% of the TSCL); and 34% had Frankel grade D (39% of the NTSCL and 14% D of the TSCL). In all, 16% of the patients were treated at Loewenstein Hospital between 1961 and 1970, 20% between 1971 and 1980, 28% between 1981 and 1990, and 35% between 1991 and 2000. Demographic and clinical data were collected by reviewing the hospital charts. Mortality data were collected from the Population Registry of the Israel Ministry of Internal Affairs.

The association of the LOS with etiology and decade of admission was analyzed with ANOVA. LOS associations with gender, SCL severity and level, and attribution to TSCL or NTSCL were examined using ANCOVA, with age as a covariate. All analyses were performed after a square root transformation was performed on LOS to approach a normal LOS distribution. The associations between gender and attribution to TSCL or NTSCL, and between decade of lesion onset and association with male or female gender, TSCL or NTSCL, and the various Frankel grades were analyzed with Pearson's χ^2 test. The impact of LOS on the risk of mortality was estimated using the Cox proportional hazard model.[15] The severity of neurological deficit below the spinal cord level of injury was graded according to Frankel.[16]

In the second, smaller group, there were 27 male and 17 female patients; 25 had TSCL and 19 NTSCL, and the mean age at admission was 45.2 years (SD = 19.8, range = 18–78 years).[17] The cervical spinal cord was affected in 37% of the NTSCL and in 24% of the TSCL cases, the thoracic in 37% of the NTSCL and 44% of the TSCL cases, and the lumbosacral in 26% of the NTSCL and 32% of the TSCL cases. At the first admission, 18% (5% of the NTSCL and 28% of the TSCL) had complete or almost complete lesions (Frankel grade A or B); 21% had Frankel grade C (27% of the NTSCL and 16% of the TSCL); and 61% had Frankel grade D (68% of the NTSCL and 56% of the TSCL).

The second version of the Spinal Cord Independence Measure (SCIM-II) score, proven to be a valid and reliable measure of disability in SCL patients, represents the functional ability of patients in this group.[18] The outcome measures examined for relationship with LOS include *SCIM-II gain* (defined as the difference between the SCIM-II score during the week before discharge and the SCIM-II score at the first week of admission = $SCIM_2 - SCIM_1$), *SCIM-II efficiency* (SCIM-II gain over time = $[SCIM_2 - SCIM_1]$/LOS), *relative SCIM-II gain* (the ratio of SCIM-II gain and SCIM-II at discharge = $[SCIM_2 - SCIM_1]/SCIM_2$), and *relative SCIM-II efficiency* (the ratio of SCIM-II efficiency and SCIM-II at discharge = $[SCIM_2 - SCIM_1]/SCIM_2$/LOS).

The associations of LOS with SCIM II and with its gain and efficiency were analyzed with ANOVA and with Pearson's correlation.

Three LOS groups were defined: short (mean LOS $\leqslant$70 days), medium (mean LOS 71–120 days), and long (mean LOS $>$120 days).

The Bonferroni correction was employed to explore multiple associations with LOS; *P*-values <0.002 were considered statistically significant. Data were analyzed by SPSS for Windows, version 11 (SPSS Inc., USA).

Results

The mean LOS was 239 days for patients with TSCL (SD = 168) and 106 days for patients with NTSCL (SD = 137).

Factors affecting LOS

SCL etiology, SCL severity, and decade of admission to rehabilitation were significantly associated with LOS.

SCL etiology Controlling for age, gender, SCL level, and Frankel grade, LOS was significantly longer in patients with TSCL than in patients with NTSCL ($P<0.001$). In patients with NTSCL, LOS was long in cases of myelitis, infection, or vascular lesion, medium in cases of degenerative spine disease or tumor, and short in cases of multiple sclerosis (Table 1). In all, 57–73% of degenerative spine disease, infection, or myelitis appeared in men, while 58–61% of tumors and multiple sclerosis appeared in women ($P<0.001$).

Table 1 LOS and various SCL etiologies

Etiology	N	*Mean LOS days (SD)*
Multiple sclerosis	235	70 (44)
Degenerative spine disease	441	102 (185)
Tumor	222	115 (96)
Infection	49	127 (88)
Myelitis	74	158 (133)
Trauma	250	239 (168)

LOS = length of stay during the first rehabilitation hospitalization. N = number of patients in each etiological group. SD = Standard deviation

SCL severity Controlling for age, gender, attribution to TSCL or NTSCL, and SCL level, LOS was longer in patients with Frankel grades A, B, and C (Table 2). Frankel grades A, B, and C had a mean LOS of 156 days (SD = 128), versus 79 days (SD = 179) of grade D ($P<0.001$).

Decade of admission to rehabilitation LOS was reduced significantly over the last few decades (Table 3), irrespective of age at lesion onset or attribution to TSCL or NTSCL ($P<0.001$). The decrease in LOS over the decades showed an interaction with the attribution to TSCL or NTSCL; this interaction, however, did not reach statistical significance after the Bonferroni correction ($P<0.05$). In patients with TSCL, LOS decreased between the 1960s and 1970s, and a further decrease could be noticed in the second half of the 1990s. In patients with NTSCL, LOS increased between the 1960s and 1970s, and has been generally decreasing since then (Table 3). More recent decades of admission are associated with higher frequencies of NTSCL versus TSCL, higher versus lower Frankel grades, and female versus male gender ($P<0.001$).

Gender Male patient LOS values (mean = 147 days, SD = 183) were higher than female patient LOS values (mean = 105 days, SD = 82). However, this difference did reach statistical significance ($P<0.02$) after controlling for age, attribution to TSCL or NTSCL, Frankel grade, and SCL level, and employing the Bonferroni correction.

SCL level The overall effect of SCL level on LOS, controlling for age, gender, attribution to TSCL or NTSCL, and Frankel grade, did not reach statistical significance ($P=0.092$). No significant interactions were found with the effect of SCL level on LOS. However, for Frankel grades A, B, or C, LOS values were lower in cases of lumbosacral SCL than in cases of cervical or thoracic SCL, while for Frankel grade D, LOS values were higher in cases of cervical SCL than in cases of thoracic or lumbosacral SCL (Table 4). The interaction between the effect of SCL level on LOS and Frankel grade did not reach statistical significance after the Bonferroni correction ($P<0.03$).

Table 2 LOS and severity of SCL

Frankel grade	*TSCL*		*NTSCL*	
	N	*Mean LOS days (SD)*	N	*Mean LOS days (SD)*
A	74	267 (182)	32	231 (128)
B	42	340 (213)	146	153 (108)
C	100	203 (130)	506	112 (77)
D	34	156 (96)	433	73 (183)

LOS = length of stay during the first rehabilitation hospitalization. N = number of patients in each etiological group. SD = Standard deviation. SCL = spinal cord lesion. TSCL = traumatic SCL. NTSCL = nontraumatic SCL

Table 3 LOS and the time of admission to rehabilitation

Years	*TSCL*		*NTSCL*	
	N	*Mean LOS days (SD)*	N	*Mean LOS days (SD)*
1961–1970	84	265 (183)	136	107 (85)
1971–1980	68	210 (137)	210	124 (90)
1981–1990	79	210 (116)	305	115 (222)
1991–2000	19[a]	231 (108)	466	91 (81)
1996–2002[b]	25	102 (59)	19	106 (51)

LOS = length of stay during the first rehabilitation hospitalization. N = number of patients in each etiological group. SD = Standard deviation. SCL = spinal cord lesion. TSCL = traumatic SCL. NTSCL = nontraumatic SCL
[a]The TSCL included in the 1991–2000 decade were admitted during 1991 and 1992
[b]The LOS between 1996 and 2002 is in the smaller group of 44 patients, which does not include all the NTSCL patients admitted during that period

Table 4 LOS and SCL level in SCL with different Frankel grades

SCL level	*Frankel grade A,B, or C*		*Frankel grade D*	
	N	*Mean LOS days (SD)*	N	*Mean LOS days (SD)*
Cervical	277	161 (152)	163	102 (292)
Thoracic	422	161 (124)	153	64 (48)
Lumbosacral	200	138 (95)	149	70 (64)

LOS = length of stay during the first rehabilitation hospitalization. N = number of patients in each etiological group. SD = Standard deviation. SCL = spinal cord lesion

Age had no significant effect on LOS ($P = 0.08$)
$SCIM_1$ (SCIM-II score in the first week of admission) was lower (mean = 38.9 days, SD = 19.9) when LOS was long (> 120 days), and higher (mean = 40.29, SD = 20.3, and mean = 47.9, SD = 21.8) when LOS was medium (71–120 days) or short (⩽70 days). This negative association did not reach statistical significance after the Bonferroni correction ($P < 0.03$). When LOS was short, $SCIM_1$ had a negative correlation with LOS, which almost reached statistical significance after the Bonferroni correction ($r = -0.73$, $P < 0.003$; Figure 1). A significant correlation could not be demonstrated for medium or long LOS periods. The mean values of $SCIM_2$ (SCIM-II score during the week before discharge) were also lower (mean = 63.2 days, SD = 17.9) when LOS was long, and higher (mean = 64, SD = 23.9, and mean = 76.5, SD = 13.9) when LOS was medium or short. However, these differences are nonsignificant, and $SCIM_2$ did not correlate with LOS in any LOS group.

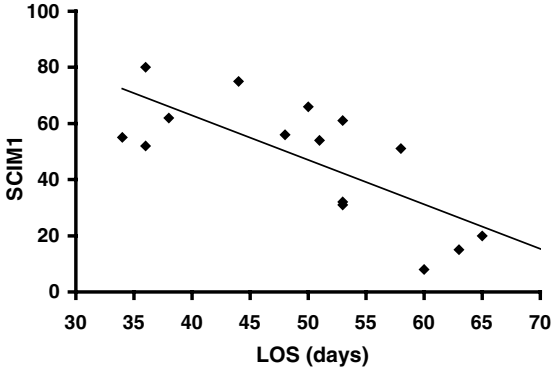

Figure 1 LOS and disability. The correlation between SCIM-II at admission ($SCIM_1$) and LOS when LOS < 70 days ($r = -0.73$, $P < 0.003$)

LOS relationship with other outcomes
Survival was not associated with LOS in patients with TSCL ($P = 0.97$). In patients with NTSCL, however, after controlling for age, the mortality risk increased by 1.002 for each additional day of hospitalization ($P < 0.001$).

SCIM-II gain and *relative SCIM-II gain* were positively correlated with LOS, when LOS was short (⩽70 days) ($r = 0.81$–0.82, $P < 0.001$). Correlations were calculated after exclusion of the deviant high SCIM-II gain following a short rehabilitation in one patient. *SCIM-II efficiency and relative SCIM-II efficiency* also tended to correlate positively with LOS, but this correlation was found to be nonsignificant after the Bonferroni correction ($r = 0.61$–0.72, $P < 0.03$; Figure 2). When LOS was medium (71–120 days), or long (> 120 days), no clear correlation could be demonstrated between LOS and SCIM-II gain or efficiency. Nevertheless, patients with LOS of 120–150 days achieved considerable SCIM-II gains (Figure 3).

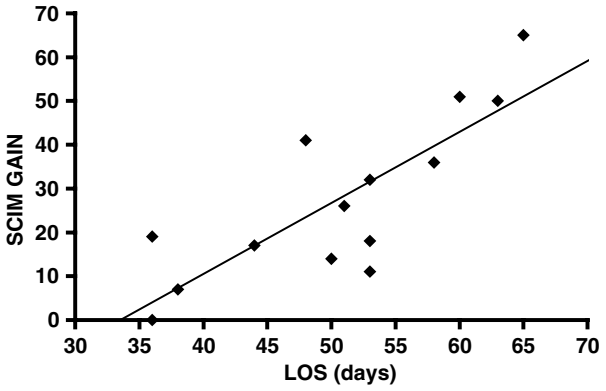

Figure 2 Functional change when LOS < 70 days. The correlation between SCIM gain and LOS ($r = 0.81$, $P < 0.001$)

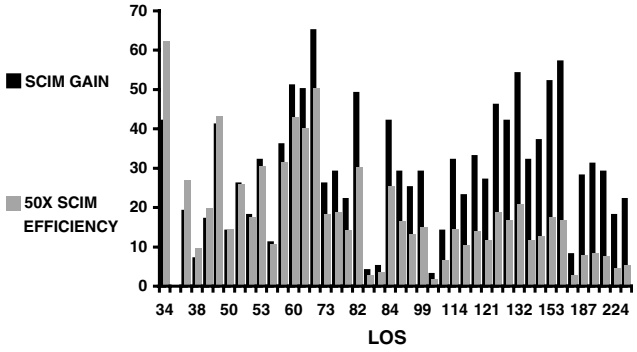

Figure 3 LOS and functional change. The relationship between LOS and SCIM gain and efficiency. SCIM efficiency values were multiplied by 50 for display

Discussion

The LOS for Israeli patients with SCL screened in this study is within the range presented in European publications, and is much longer than LOS in American studies.[2–4,6,9–14] LOS for the population described in this study became shorter over the years, as in the American population.[9] Given that European publications were earlier than their American and Australian counterparts (1975–1994 versus 1990–1999), the longer LOS in Europe and Israel may partly reflect the decade of admission.

Other factors also affect LOS significantly. The study found significant associations of LOS with some SCL etiologies and lower Frankel grades (which stand for more extensive SCL), and a tendency for longer LOS with lower initial SCIM-II scores, consistent with other studies.[4–6] These factors may reflect severe clinical conditions that slow functional improvement, require a longer time to achieve certain outcomes, and thereby prolong LOS. These and other factors that may aggravate the clinical condition have been used in models developed to predict LOS.[4–9] However, the predictive ability of these models is confined to the sites in which they were examined, and the models failed to predict LOS in many SCL patients.[4,5] This is because severe medical conditions may also act to shorten LOS in certain cases and because additional factors may affect LOS. A severe medical condition may shorten LOS by limiting the chances of functional improvement to a degree that eliminates the justification for further inpatient rehabilitation. Among the additional factors that may affect LOS are delays in patient psychological adaptation, housing adaptation, or organizing to provide proper medical care in the community, lack of institutional room for those who need it, or payment arrangements that discourage discharge.

The increasing need to cut expenses in all medical systems reduces the impact of these factors on LOS. Instead, LOS is increasingly influenced by the requirement to minimize costs. The balance between the desire for optimal clinical achievements and the financial considerations may be different in various places, according to local economic and social policies.

Survival is probably not affected by LOS. The increase in mortality risk with NTSCL and longer LOS probably reflects the older age and severe condition of the patients at risk.

The LOS may affect functional achievements that can be determined by the gain or efficiency of an ability measure. Longer LOS was associated with higher FIM gain and efficiency in American studies of SCL patients with short ($\leqslant$70 days) LOS.[1–3] Similarly, LOS correlated positively with SCIM gain and tended to correlate with SCIM efficiency in the present study in patients with LOS shorter than 70 days. Functional gain and efficiency with LOS longer than 70 days were not described in previous publications and showed no significant correlation with LOS in this study. However, considerable SCIM gains were achieved in the present study with LOS longer than 120 days, a characteristic of patients with greater disability (Figure 3).

The association of these outcome measures with LOS indicates that longer rehabilitation is associated with improved functional outcomes in the first 70 days after admission. For some patients, in particular those who are initially more disabled, longer LOS may be associated with improved functional outcomes through 5–8 months from admission (Figure 3). These associations of LOS with functional achievements, together with the earlier demonstration of the superiority of functional outcomes following specialist spinal cord injury management over nonspecialist management,[18] probably justify longer hospitalization of certain patients in a specialist SCL department. However, neither the present nor previous studies have indicated the LOS range associated with optimal achievements, and further investigation, with larger samples, is required to determine the optimal LOS range.

Future investigation should include examination of the effect of the time from admission on achievements recorded after specific periods of hospitalization in the specialist spinal cord department. It should also include a comparison of the achievements recorded at various times after admission of patients who were in the

specialist spinal cord department for the entire periods and those who were discharged earlier.

In the present study, LOS was affected by the decade of admission to rehabilitation, and was longer in TSCL than in NTSCL, even when controlling for Frankel grade and other affecting factors. In a previous study, LOS of patients with TSCL was longer than that of patients with NTSCL who were admitted with similar FIM scores and who had similar FIM efficiency.[3] These seem to indicate that considerations of the severity of the patient's condition or rehabilitation efficiency may influence LOS less than reference to factors that may be related to SCL etiology or the admission decade. Such factors can be the caregivers' notions about the prognosis of certain SCL etiologies or economic influence on medical policy.

To conclude, LOS of patients with spinal cord lesions in Israel is within the customary LOS range in Europe. It is affected mainly by the severity of the SCL and by factors that characterize the SCL etiology. Longer LOS is associated with improved functional outcomes. Further research is required to determine the LOS that allows optimal functional achievements.

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