Early Versus Delayed Inpatient Spinal Cord Injury Rehabilitation: An Italian Study

Giorgio Scivoletto, MD, Barbara Morganti, PT, Marco Molinari, MD, PhD

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Objective: To examine what effect the injury-to-rehabilitation interval has on the outcome of spinal cord injury (SCI) rehabilitation.

Design: Retrospective study.

Setting: Spinal unit of a large rehabilitation hospital.

Participants: Consecutive admissions were divided into groups according to age, sex, and American Spinal Injury Association impairment grade and neurologic level of injury. The patients were matched for these variables and divided into groups according to the interval from injury to admission into acute rehabilitation. This approach resulted in 150 patients with SCI grouped into 50 comparison subgroupings.

Interventions: Three comparison groups—short (<30d), medium (31–60d), and long (>60d) time to admission (TTA)—were evaluated for rehabilitation outcomes.

Main Outcome Measures: Barthel Index, Rivermead Mobility Index, Walking Index for Spinal Cord Injury, and motor scores at admission and discharge were examined. The changes and efficiencies were evaluated.

Results: The 3 groups were comparable for all medical and demographic characteristics as well as neurologic recovery. The 3 subgroups differed significantly in activity of daily living outcomes, with the short TTA group exhibiting higher Barthel Index raw discharge scores, score increases, and score efficiencies.

Conclusions: Early rehabilitation seems to be a relevant prognostic factor of functional outcome. Rehabilitation intervention in patients with SCI should begin as soon as possible, in a specialized setting, because delay may adversely affect functional recovery.

Key Words: Rehabilitation; Spinal cord injuries; Treatment outcome.

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SEVERAL STUDIES ON spinal cord injury (SCI) recovery have been conducted to evaluate the role of medical, personal, and demographic variables in functional outcome. Age and degree of disability at admission have been identified as strong prognostic factors influencing rehabilitation programs and amount of recovery. Although the relation between age and outcomes (with increasing age being associated with worse outcomes) is very well known in SCI patients,[1] only few data are reported about the effect of either precocious or delayed rehabilitation.[2,3]

It is crucial to determine when to begin rehabilitation: a considerable amount of neurologic recovery usually occurs within the first few months after SCI, although some amelioration may occur later. Despite this knowledge, only 1 study[2] has examined the importance of time-to-admission interval (TTA): a short interval, with rehabilitation beginning quickly after the lesion, has been recognized as a relevant favorable prognostic factor. However, TTA varies greatly in different countries. Because TTA depends on the clinical course of the acute phase and the number of beds available in rehabilitation wards, outcome studies should be adapted to each situation. In some cases, admission to a rehabilitation ward is delayed because of the patient's comorbidities, and rehabilitation can be started only after the patient's medical condition has stabilized. The aim of the present study was to evaluate the specific influence of TTA on rehabilitation outcomes in consecutive SCI inpatients after age, lesion characteristics, and disability matching was completed, to rule out the influence of factors recognized as strongly prognostic. In particular, we compared rehabilitation results across homogeneous subgroups of patients who were admitted for rehabilitation of SCI sequelae and separated according to the period when they started specific rehabilitation.

METHODS

We retrospectively evaluated the charts of spinal cord lesion inpatient survivors admitted to our Spinal Unit between January 1997 and December 2001. Admission of SCI patients to our free-standing rehabilitation facility is based on their ability to participate actively in rehabilitation activities and to tolerate intense therapeutic interventions. Within our system of care, we have a paucity of beds in relation to the demand for services and thus have a waiting list for admission. Admissions are controlled by administration, according to a prioritizing scheme. Thus, we find that some of our patients are discharged from the acute care setting to home before they receive formalized acute rehabilitation services. Most of these patients received conventional home care physical therapy (PT) services while awaiting hospital admission. No patient included in this study had been admitted to acute inpatient rehabilitation in the past. Whenever a patient was discharged or transferred for more than 3 weeks, the readmission was considered a second admission and the patient was excluded.

The rehabilitation plan was based on practical skills characteristic of activities of daily living (ADLs). Individual PT was performed for 60 minutes twice a day, 5 days a week, and a single 60-minute treatment on Saturday. All patients also underwent water therapy (45min twice weekly) and occupational therapy (45min 3d/wk). All rehabilitation treatment began within 24 hours of admission. If necessary, patients had access to individual training for breathing, bowel, and bladder dysfunction. PT continued throughout the hospital stay.

From the Spinal Cord Unit, IRCCS Foundation S. Lucia, Rome (Scivoletto, Morganti, Molinari); and Institute of Neurology, Catholic University, Rome (Molinari), Italy.

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Reprint requests to Giorgio Scivoletto, MD, Spinal Cord Unit, IRCCS Fondazione S. Lucia, Via Ardeatina 306, 00179 Rome, Italy, e-mail: *g.scivoletto@hsantalucia.it*.

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Matching Procedure

For outcomes evaluation, we used a block-design, matching procedure to control for the covariant effects that injury characteristics, sex, and age may have on TTA effects. We selected 4 matching variables: neurologic level of injury (3 levels: cervical, thoracic, lumbar), American Spinal Injury Association (ASIA) impairment grades[4] (2 levels: grades A, B, C vs grade D), age (2 categories: <50y, >50y), and sex. Each patient was identified by an ASIA impairment grade, lesion level, age, and sex, and the patients were categorized according to time from lesion. Patients were selected from each TTA group to create matched triads on the basis of their ASIA grade, lesion level, age, and sex. When multiple young and old patients were identified within the same classification, the patients were randomly matched until no more triads could be created. Patients without exact ASIA grade, lesion level, age, and sex counterparts were excluded. Each triad consisted of 1 patient with a short TTA (admitted within 30d of the acute event), 1 patient with a medium TTA (admission range, 31–60d), and 1 patient with a long TTA (admission over 60d). This matching procedure produced 24 blocks (6 injury type groups × 2 age groups × 2 sex groups). Overall, 150 patients were selected, thus creating 50 triads. The threshold value of 30 days after SCI as the cutoff point for early intervention was chosen according to the mean time interval before admission to our hospital, as already published.[1] The choice of age 50 years, although arbitrary, was made on the basis of previous reports,[5-7] which indicated that although geriatric patients are generally defined as persons age 65 years or older, those 50 years or older were considered as "older adults." The choice of comparing ASIA grades A, B, and C versus grade D was made on the basis of the original Frankel classification, which distinguished patients who have no motor power or no functional motor power in their muscles (grades A, B, C) from those who have functional muscles (grade D) and from which the ASIA classification is derived. Further, the Model Spinal Cord Injury Systems data showed that grade A, B, and C functional recovery differs significantly from that of grade D.[8]

Measures

In addition to TTA, we collected injury variables (etiology, associated injury, medical complications, surgical intervention) and data on length of stay (LOS) as inpatients in the rehabilitation facility. At admission to and discharge from rehabilitation, patients were submitted to a neurologic examination and their scores were recorded for the Barthel Index, Rivermead Mobility Index (RMI), and walking Index for SCI (WISCI).

Neurologic examination. Neurologic examination was performed according to ASIA standards,[4] with evaluation using the ASIA Impairment Scale (AIS) (right and left motor and sensory levels and motor scores). Neurologic recovery was defined on the basis of improvement of motor scores and ASIA impairment grade.

Barthel Index. Barthel Index[9] scores, according to standard protocols, range from 0 to 100 and were assigned at admission and discharge; higher scores denote greater levels of independence. Barthel Index subsets were also noted to identify areas of daily living more prone to be influenced by age. Barthel Index scores were derived directly from the charts.

Rivermead Mobility Index. The RMI[10] is a 15-item mobility scale. The first 3 items of the scale evaluate patients' bed mobility and transfers, whereas the other 12 items assess patients' walking; the scores go from 0 (unable to perform task) to 15 (full autonomy in bed motility, walking, and running). RMI scores were derived directly from the charts.

Table 1: Group Composition

Grade	Under 50y (n)		Over 50y (n)	
	M	F	M	F
Cervical A, B, C	4	0	4	2
Cervical D	0	0	0	0
Thoracic A, B, C	7	4	12	5
Thoracic D	1	1	1	1
Lumbar A, B, C	5	2	0	0
Lumbar D	0	0	1	0

Abbreviations: F, female; M, male.

Walking Index For Spinal Cord Injury. The WISCI[11] is a new 0- to 20-level scale that evaluates walking based on the need of physical assistance, braces, and devices. The levels go from 0 (client unable to walk) to 20 (client walking without braces and/or devices and without physical assistance for at least 10m). WISCI scores were retrospectively derived from medical chart records. The same researcher (BM) assigned the WISCI score based on the description of walking derived from the records.

Change and efficiency scores. Calculations for changes in motor, Barthel Index, and RMI scores were based on the difference between scores at rehabilitation discharge and scores at admission. Motor, Barthel Index, and RMI scores' efficiency were calculated by dividing changes by LOS.

Statistical Analysis

Descriptive values, expressed as mean ± standard deviation (SD), were supplied for all continuous clinical data. Continuous clinical data were analyzed with the Kruskal-Wallis test for nonparametric data. The chi-square test was applied to assess contingency differences. Differences were significant at P less than .05.

RESULTS

The final sample included 150 patients (mean age, 48.3±18.7y; mean TTA, 56.7±46d; mean LOS, 112.4±69.3d). Patients were divided into 3 age- and disability-matched subgroups of 50 patients. In all cases of patients in the medium or long TTA groups, delay in admission was caused by organizational problems (waiting list because a bed was not immediately available in the rehabilitation ward) and not by medical factors. During their stay in the acute care hospital, all patients were treated daily by physiotherapists to avoid secondary complications such as contractures or pressure ulcers. Some patients in the medium TTA group and all in the long TTA group were discharged from the acute care hospital and admitted to the rehabilitation hospital from home, where they had received a nonstandardized routine of range of motion and nonspecific exercises in the interim. The composition of the triads is shown in table 1.

Table 2 presents demographic, medical, neurologic, and functional findings of the 3 subgroups. At admission, no significant difference was found among the 3 subgroups for any demographic parameter (age, etiology, associated lesion, surgical intervention). Severity of SCI was similar among subgroups: the number of ASIA grade A, B, C, and D patients was evenly distributed in the 3 cohorts, and both the motor scores and functional scales scores at admission were comparable (tables 2, 3).

Because of death or emergency transfer, 7 patients (4.6%) did not complete treatment. Nevertheless, the 3 subgroups did not differ significantly in percentage of dropouts (3 in the short

Table 2: Demographic and Medical Characteristics of the Sample

Characteristics	Entire Group	Short TTA	Medium TTA	Long TTA	*P*
Etiology (traumatic/nontraumatic) (n)	64/86	21/29	22/28	21/29	.84
Complications at admission (n)	8	3	2	3	.64
Surgical intervention (n)	107	37	34	36	.82*; .5†; .66‡
Age (y)	48.3±18.7	47.2±19.8	47.3±17.8	49.3±17.1	.96
TTA (d)	56.7±46	20.3±9.1	42.9±11.3	113.9±48.5	<.001
LOS (d)	112.4±69.3	100.6±64.2	1118.2±89.4	120.3±72.4	.15
Scores at admission					
Motor	62.6±21.9	66.3±24.7	65.1±22.6	64.3±20.4	.86
Barthel Index	24.5±20.8	21.3±17.2	24.1±19.2	24.6±20.4	.84
RMI	1.1±1.7	0.9±1.6	1.1±2	0.9±1.8	.67
WISCI	1.3±3.5	0.6±2.8	1.6±4	1±2.9	.35

NOTE: Values are n or mean ± SD.
*Short vs long.
†Short vs medium.
‡Medium vs long.

TTA group, 2 in the medium TTA group, 2 in the long TTA group).

Table 3 shows the relations between ASIA impairments at admission and discharge in the 3 subgroups; in total, 18 patients in the short TTA group showed neurologic improvement versus 18 in the medium TTA and 14 in the long TTA group (*P*=not significant).

As shown in table 4, the 3 subgroups differed significantly in ADL outcomes, evaluated by using the Barthel Index, with the short TTA group showing a higher Barthel Index score at discharge and higher Barthel Index score increase and efficiency. Global mobility at discharge (evaluated with RMI) also was better in the short TTA group.

DISCUSSION

Our results underscore the importance of timing as a specific prognostic factor in rehabilitation results and confirm that early specific rehabilitation treatment is associated with greater improvement in ADLs than delayed treatment. The best functional recovery occurs during the early weeks of treatment after the event, and effectiveness of SCI rehabilitation gradually decreases after the first weeks of treatment. This finding is of particular importance in Italy where admission to rehabilitation facilities is often delayed because of bed unavailability: Celani et al,[3] in their multicenter retrospective study, found an average TTA of 55 days for traumatic SCI and 167 days for nontraumatic SCI and reported that, in all cases, TTA exceeded 30 days. In our 2003 retrospective survey,[1] mean TTA was 57 days. Similar data are reported in other countries of the Mediterranean area.[12]

Table 3: Neurologic Recovery

Initial AIS grade	Final AIS				
Short TTA					
	A	B	C	D	E
A	13	0	1	0	0
B	0	5	0	2	0
C	0	0	9	15	0
D	0	0	0	5	0
Medium TTA					
	A	B	C	D	E
A	13	0	1	1	0
B	0	3	1	1	0
C	0	0	12	14	0
D	0	0	0	4	1
Long TTA					
	A	B	C	D	E
A	13	0	1	0	0
B	0	2	0	0	0
C	0	0	16	13	0
D	0	0	0	5	0

In our series, the decreased effectiveness in the long TTA subgroups was presumably related to delayed start of specific rehabilitation treatment. In fact, the 3 subgroups of patients differed only in delays in receiving specific rehabilitation. The patients in the 3 subgroups were not only matched for age and disability but were also homogeneous for medical and neurologic findings; admission scores of the various scales were comparable too.

We chose to categorize patients by age because of the well-documented effects of age on rehabilitation outcomes: in a recent matching comparison,[1] we showed that older adults (>50y) have significantly worse outcomes and their autonomy in ADLs was rated as being between incapacity to perform the activities and the need of moderate assistance. We did not categorize patients by SCI etiology. McKinley et al,[13] when comparing a matched cohort of traumatic and nontraumatic subjects controlled for neurologic level and AIS, found that patients with nontraumatic SCI could achieve functional outcomes similar to those attained by persons with traumatic ones. With regard to rehabilitation, the same inpatient rehabilitation treatment was carried out for all 3 subgroups. Although most patients underwent a low-intensity rehabilitation program while they were waiting for rehabilitation admission, no patient received a specific multidisciplinary rehabilitation treatment before admission to the rehabilitation hospital. As has been reported,[14] the different rehabilitation results were probably caused by the more efficacious action and different therapeutic plans of specific multidisciplinary treatments performed in the rehabilitation ward on very recent SCI sequelae. The goals of inpatient treatment specific to SCI were to reduce disabilities in ADLs and other SCI-related consequences by using techniques not available at home. Intensity of treatment is clearly greater in the hospital ward than at home. Similar conclusions have been reported by Heinemann[15] and De Vivo[16] and colleagues who also emphasized the benefits of early admission to rehabilitation facility.

Our data are consistent with those of Sumida et al,[2] who showed that patients with very early intervention after an acute

Table 4: Outcomes Comparison

	Entire Group	Short TTA	Medium TTA	Long TTA	*P*
Barthel Index					
At discharge	63.3±308	72.2±21.9	65.1±31.2	56.4±3	.006
Increase	40.2±26.3	51±21	40.4±25.1	32.5±27.6	.003
Efficiency	0.5±0.4	0.8±0.9	0.45±0.4	0.4±0.3	.03*; <.001†
RMI					
At discharge	5.4±4.7	6.6±4.6	5.5±39	4.8±4.4	.03
Increase	4.5±4.1	5.7±3.9	4.3±4.3	3.9±3.9	.001
Efficiency	0.08±0.04	0.08±0.08	0.06±0.05	0.05±0.04	.04
WISCI					
At discharge	7.4±8.3	8.2±8	6.7±8.1	6.3±8.1	.63
Increase	6.5±7.9	6.7±7.7	6.6±8.4	5.8±7.9	.95
Efficiency	0.08±0.13	0.1±0.1	0.07±0.09	0.07±0.4	.76
Motor scores					
At discharge	74.1±23.8	70±23.6	72.1±24	71.6±24.5	.81
Increase	11.7±7.5	6.1±9.3	7.1±8.8	6.5±6.8	.91
Efficiency	0.15±0.5	0.17±0.4	0.12±0.2	0.08±0.1	.4

NOTE. Values are mean ± SD. Significant *P* values refer to short versus long TTA comparison, except when specifically noted.
*Short versus medium TTA.
†Short versus long TTA.

SCI event have better outcomes. Our methods differed from Sumida's in respect to timing. The Sumida cohort was divided into an early rehabilitation group (<2wk from injury) and a delayed rehabilitation group (2wk to ≥6mo postinjury). Probably because of this division, the 2 groups differed significantly in percentage of neurologic recovery, with 30 of 60 patients of the early rehabilitation group improving their ASIA impairment versus 7 of 63 of the delayed rehabilitation group. Thus, in the Sumida cohort, outcomes differences between the early and the delayed rehabilitation groups (FIM gain, FIM efficiency) could be because of the difference of neurologic recovery. In contrast, our series evaluated patients who were admitted within a maximum of 6 months postinjury and all 3 groups showed no significance in neurologic recovery. Thus, we can assume that the differences of ADL outcomes really depend on intervention timing.

Study Limitations

One could criticize our study methodology because of the uneven distribution of ASIA grade A, B, and C patients, which may have confounded the recovery and rehabilitation success. Several studies[1,13] performed by using this kind of division, also without an equal distribution of the various ASIA impairment grades, showed no difference of recovery.

Better outcomes could be related to longer LOS in the short TTA subgroup, but, in our series, this is not true: the short TTA patients not only showed shorter LOS, but they also showed higher Barthel Index efficiency. Italian health policy permits a more prolonged LOS than that reported in the United States. Because our guidelines are to discharge patients when they reach the maximum independence possible or when their Barthel Index and RMI scores plateau (same scores in 2 different evaluations with an interval of 20–30 days), we believe that the better outcomes of patients in the short TTA group are caused by the effects of early intervention.

The necessity of beginning rehabilitation treatment as soon as possible to obtain better rehabilitation results implies a potential risk of clinical emergencies because in some cases the medical conditions in the first days after SCI are not yet stabilized. Even if these medical complications increase the costs of rehabilitation and cause distress to patients and their relatives, we believe that the potential for a more favorable outcome in patients with short TTA counterbalances the increased risk of dropouts. Carefully evaluating each patient's medical condition before admitting him/her to a rehabilitation ward may reduce, but not eliminate, the risk of new clinical events.

The lack of a control group comprised of SCI patients without any treatment may reduce the power of our results. Spontaneous recovery of brain and spinal cord function after acute SCI might overlap with recovery attributable to rehabilitation. Available evidence suggests that SCI rehabilitation is effective, even if at present we cannot easily differentiate between the influence of specific treatment and the natural recovery process. To our knowledge, no studies of the course of post-SCI recovery in the absence of any intervention have been done. Almost all studies of "natural history" occur in settings (eg, nursing care) that include rehabilitative activities. Moreover, it would be ethically and practically difficult to conduct a randomized trial.

CONCLUSIONS

Early initiation of SCI-specific rehabilitation is an independent and relative prognostic factor for functional recovery. A delay in starting this intervention may greatly influence the patients' ultimate recovery; therefore, even if the patient's clinical status has not been entirely stabilized, an SCI-specific therapy program should be started early in the clinical course.

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