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The Impact of Sacral Sensory Sparing in Motor Complete Spinal Cord Injury

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Abstract

Objective—To determine the effect of sensory sparing in motor complete persons with spinal cord injury (SCI) on completion of rehabilitation on neurologic, functional, and social outcomes reported at 1 year.

Design—Secondary analysis of longitudinal data collected by using prospective survey-based methods.

Setting—Data submitted to the National SCI Statistical Center Database.

Participants—Of persons (N=4106) enrolled in the model system with a motor complete injury (American Spinal Injury Association Impairment Scale [AIS] grade A or B) at the time of discharge between 1997 and 2007, a total of 2331 (56.8%) completed a 1-year follow-up interview (Form II) and 1284 (31.3%) had complete data for neurologic (eg, AIS grade, injury level) variables at 1 year.

Interventions—Not applicable.

Main Outcome Measures—AIS grade (A vs B) at 1 year, bladder management, hospitalizations, perceived health status, motor FIM items, Satisfaction With Life Scale, depressive symptoms, and social participation.

Results—Compared with persons with AIS grade A at discharge, persons with AIS grade B were less likely to require indwelling catheterization and be hospitalized and more likely to perceive better health, report greater functional independence (ie, self-care, sphincter control, mobility, locomotion), and report social participation in the first year postinjury. A greater portion of individuals with AIS grade B at discharge had improved neurologic recovery at 1 year postinjury than those with AIS grade A. Significant AIS group differences in 1-year outcomes related to

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physical health were maintained after excluding persons who improved to motor incomplete status for only bladder management and change in perceived health status. This recognition of differences between persons with motor complete injuries (AIS grade A vs B) has important ramifications for the field of SCI rehabilitation and research.

Keywords

Outcome assessment (health care); Paraplegia; Rehabilitation; Spinal cord injuries

Understanding the nature and extent of natural recovery after SCI is extremely important to developing a rehabilitation program, research studying new treatments, and discussion regarding prognosis with patients and their families. Although many methods are reported,^{1–18} outcomes are predicated mostly on performing an accurate examination according to the International Standards for Neurological Classification of SCI.¹⁹ The most important determinant of long-term prognosis is whether an injury is classified as neurologically complete or incomplete by using the AIS.

For long-term neurologic outcomes, the 72-hour to 1-week examination most commonly is used,^{20–24} although many previous reports used the 1-month postinjury examination^{25–28} because this correlated with the timing of rehabilitation facility admission in previous decades. Functional outcomes most often are defined for persons with a motor complete (AIS grades A, B) versus incomplete injury^{29–31}; only a few reported differences between individuals with a motor complete (AIS grade A vs B) injury in long-term medical, functional, or psychosocial outcomes.^{32,33} DeVivo³² reported no significant differences in discharge to a nursing home between persons with AIS grade A versus B, whereas Krause et al³³ found differences in long-term mortality. The purpose of this study was to determine the impact of sacral sensory sparing in persons with motor complete injuries at rehabilitation discharge (AIS grade A vs B) in outcomes reported at 1 year postinjury. Our hypothesis was that sacral sparing in motor complete SCI at discharge would offer physiologic and psychological benefits and thereby positively influence health and functioning over time.

METHODS

Sample

Data are from the NSCISC database. This sample included participants enrolled in 1997 to 2007 who were 16 years or older and classified as AIS grade A or B at discharge from rehabilitation (N=4106). Of this sample, 2331 participants (56.8%) completed a 1-year follow-up interview and 1284 (31.3%) had complete data for neurologic (eg, AIS grade, injury level) variables at 1 year. All centers participating in the NSCISC database had approval from their local institutional review boards, and the primary site had institutional review board approval to analyze the data.

Measures

Impairment (AIS) category, the primary explanatory variable in these analyses, measures the completeness of injury and was assessed at both discharge from rehabilitation and 1-year follow-up. Impairment categories were assessed dichotomously in all analyses (AIS grades A, B).

Injury characteristics included age and neurologic level of injury: tetraplegia (C1–8) and paraplegia (T1 and below). Participant characteristics included sex, race, education level, marital status, work status at time of injury, and discharge setting (ie, home or elsewhere).

Outcome measures included several indicators of health, physical functioning, and psychosocial functioning at 1 year. Bladder management is composed of 4 categories representing intermittent catheterization, indwelling catheter (Foley or suprapubic catheter), catheter-free/external method, or no method. Hospitalization was categorized as 1 (at least 1) or 0 (none). Perceived health status was assessed by using the SF-36 question: In general, would you say that your health is excellent, very good, good, fair, or poor? Responses for this measure were reverse coded for the analyses so that a higher score corresponded with better health. Changes in health status by using the SF-36 question, "Compared with 1 year ago, how would you rate your health in general now?" (much better, somewhat better, about the same, somewhat worse, much worse). This variable was reverse scored so that a higher score corresponded with positive change.

Functioning was measured by using the 13 motor FIM items that assess level of assistance with self-care (ie, eating, grooming, bathing, dressing, toileting), sphincter control, mobility, transfers, and locomotion. All items are scored on a scale of 1 to 7, with 1 representing total dependence and 7 indicating complete independence. The database also includes a calculated total score, which is measured continuously and ranges from 13 to 91. For the analyses, we divided the summated total FIM score by the total number of items, yielding a categorical measure that was comparable to the individual item response categories. Our initial inspection of FIM variables showed that some FIM categories were endorsed more frequently than others. Stineman et al³⁴ suggested that the modified and total independence categories be collapsed to improve category distributions, whereas other sources³⁵ suggested that a 4-category FIM was the best approach to simplifying FIM scores. For this analysis, we compared the relative merits of 6- versus 7-category FIM scores. Preliminary analyses showed that the 2 versions of FIM variables did not differ in internal consistency and reliability ($\alpha=.96$ for both versions) or pattern of results observed in multivariate analyses described later. These comparisons also suggested that the 6- versus 7-category version of these variables produced more parsimonious results in the final multivariate models. Therefore, each analytic FIM measure was composed of 6 categories in which higher score corresponds with less assistance and greater independence (eg, 1 = total assistance, 6 = independence).

Psychosocial functioning at follow-up was assessed by using the 5-item Diener Satisfaction With Life Scale.³⁶ Each item is scored on a 7-point Likert-type scale in which higher score indicates higher satisfaction. Depressive symptoms were measured dichotomously (0 = no syndrome, 1 = depressive syndrome) by using participant responses to the 9-item Patient Health Questionnaire.³⁷ Social participation was assessed by using the CHART.³⁸ Total scores on each domain assess the degree to which individuals are able to fulfill social roles, with a maximum score of 100 indicating normal functioning for an able-bodied individual. Preliminary univariate analysis of each domain indicated that the scores had considerably skewed distributions, necessitating the creation of categorical measures from raw scores for the analyses. A score of 100 was the most frequently occurring score on each domain and represents 1 category, whereas scores less than 100 were assigned cutoff values based on tertile scores. The final 4 categories used for each domain range from 0 to 3 (ie, low, moderate, high, normal participation).

Analysis

The analytic goal of this investigation was to assess whether participants' impairment (AIS grade) at the time of rehabilitation discharge predicted 1-year outcomes. Given the use of longitudinal data and potential for loss to follow-up, an attrition analysis was conducted to assess differences in sample characteristics between discharge and 1 year (table 1). Measurement of the outcome variables as described resulted in the use of several statistical methods for the analysis of categorical and non-normal data.³⁹ Logistic regression was used

to analyze binary outcomes (ie, hospitalization, depressive symptoms), multinomial regression was used for unordered categorical outcomes (ie, bladder management), and ordered logits were used for ordered response variables (eg, health status, FIM score, Satisfaction With Life Scale score, CHART score).⁴⁰ For each outcome, we used a sequential modeling strategy, first assessing group differences by impairment category (AIS grade A vs B) and then adjusting for differences by injury level and several demographic covariates to remove important sources of confounding caused by changes in sample composition at follow-up. Finally, we tested for interactions between impairment category and injury level. Significant AIS group differences were gauged by using ORs and confidence intervals determined from each model, as well as changes to the likelihood ratio test in all adjusted models. All analyses were conducted using Stata/SE, Version 10.0.^a

RESULTS

Sample Characteristics and Outcomes

Table 1 lists injury and demographic characteristics for persons classified as AIS grade A or B at discharge (average, 97d post-SCI) from rehabilitation (N=4106). The sample was predominantly men, young, and AIS grade A at discharge, and more than 80% were discharged to home. Of this sample, 2331 participants (56.8%) were interviewed at 1 year. This group did not differ significantly by injury characteristics compared with the overall group at discharge. Participants of minority backgrounds ($\chi^2_4=26.58$ $P<.001$), those who did not complete high school ($\chi^2_2=27.18$; $P<.001$), those who reported not working before the injury ($\chi^2_1=5.21$; $P<.05$), and those who were not discharged to home ($\chi^2_1=32.60$; $P<.001$) were less likely to be followed up at 1 year. Of participants interviewed at 1 year, 57.6% had complete neurologic data (eg, AIS grade, injury level; N=1284). Statistical power concerns for the analysis were limited because of the large sample; however, there was some concern about loss of power due to attrition at 1 year, missing neurologic data, and AIS grade conversion. Power calculations for logistic regression assuming $\alpha=.01$, power=.80, and 5 covariates indicated that N=1284 was a sufficient sample size to conduct multivariate logit models. Attrition analysis indicated a similar pattern of demographic characteristics for the final subgroup with complete data. In addition, this group was younger when injured ($t=4.86$; $P<.001$).

Distributions of AIS grades by injury level are listed in table 2. In separate bivariate analyses, we found that patients with AIS grade A were disproportionately represented in the paraplegic group for the full sample, the follow-up sample, and the final sample with complete data (results not shown). For people with tetraplegia, bivariate tests of group differences by injury level (ie, C1–4, C5, C6, C7, C8) yielded no significant differences in the likelihood of having AIS grade A vs AIS grade B (see table 2). Finally, a separate analysis of demographic differences by AIS grade (not shown) indicated that for the follow-up sample (N=2331), persons with AIS grade A complete injuries (vs B) were significantly less likely to have completed high school and less likely to be women than participants with AIS grade B injuries. For the follow-up sample with complete data, persons with AIS grade A complete injuries (vs B) were significantly less likely to be women. Demographic differences in sample composition at follow-up were taken into account, along with injury level, in the final analyses.

Distributions of 1-year outcome variables assessed for the analyses are listed in table 3. The intermittent catheterization method was the most common bladder management program at 1 year postdischarge. Approximately 60% of the sample reported at least 1 hospitalization

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postdischarge. Most participants perceived their health status as good or better, and most perceived a positive change in health status compared with 1 year ago. Distributions of individual FIM item scores varied according to functioning area. Most of the sample reported functional independence for self-care items. For the remaining items, the total assistance and independent categories were the most frequently reported. The sample commonly expressed dissatisfaction with life at 1 year. Approximately 20% of participants were symptomatic for depression. For participation, most of the sample (60.5%) reported “normal” social integration.

Discharge Impairment (AIS) Group Differences in 1-Year Outcomes

The ORs/relative risk ratios and SEs comparing individuals with AIS grade A with AIS grade B (the omitted reference group) at discharge across 1-year outcomes (N=2331) are listed in column I of table 4. Results for each model have been adjusted for systematic differences by injury type (ie, paraplegia, tetraplegia) and demographic characteristics (ie, sex, education) between the AIS groups observed in bivariate analyses. Sacral sparing was associated with differences in method of bladder management. Persons with AIS grade A were more likely to report using an invasive bladder management program and less likely to report no method in comparison to a catheter-free/external-method program. In a separate post hoc analysis (not shown), we observed that approximately 22% of persons with AIS grade A tetraplegia reported using an indwelling catheter versus 15% with AIS grade B tetraplegia. Similarly, 13.5% of persons with AIS grade A paraplegia used an indwelling catheter versus 8% with AIS grade B. There were no differences across different levels of tetraplegia. Persons with AIS grade A at discharge from rehabilitation were significantly more likely to be hospitalized during the year postinjury (OR, 1.30; SE, .14; $P<.05$), suggesting that AIS grade predicts the likelihood of subsequent hospitalization over and above injury level. Specifically, for persons with tetraplegia, 47.5% with AIS grade A versus 43.8% with AIS grade B were hospitalized, and for persons with paraplegia, 37.8% versus 28.1% (AIS grade A vs B). The odds of a patient perceiving their health as excellent at 1 year (vs very good, good, fair, poor) were 23% lower for persons with AIS grade A versus B.

Significant differences by impairment group also were apparent across several FIM items. As listed in the first column of table 4, persons with AIS grade A (compared with AIS grade B) had lower odds of functioning independence across the self-care, sphincter control, transfers, and mobility items and total FIM scores. We tested for interaction effects between AIS group and injury type (tetraplegia vs paraplegia) for each FIM outcome and found evidence of a contingency for eating. Specifically, the difference between AIS grade A and B occurs in persons with tetraplegia, with persons with AIS grade A having 34% lower odds of eating independently compared with AIS grade B (model not tabled). Aside from this contingency, the observed pattern of results from these adjusted models suggests that persons with AIS grade A are at greater risk for poor functioning at 1 year postinjury than those with grade B irrespective of whether they have paraplegia or tetraplegia.

Although there was no difference between AIS grade A and B in emotional health and life satisfaction at 1 year, persons with AIS grade A were significantly less likely to report independence across several domains of social participation. As listed in the first column of table 4, persons with AIS grade A were 22% less likely to report physical independence, 25% less likely to report mobility independence, and 19% less likely to report occupational independence. However, for the mobility independence subscale, in the group with tetraplegia, persons with AIS grade A versus B were significantly less likely to report mobility independence at 1 year, whereas there were no significant differences in the group with paraplegia.

Change in Impairment (AIS grade) at 1 Year

Given that a portion of persons with SCI continue to have neurologic recovery after discharge from rehabilitation, we assessed change in impairment (AIS grade) between discharge and 1-year follow-up for participants who had complete neurologic data at 1 year (N=1284) (table 5). We found significant group differences between patients with AIS grade A and B at discharge in distributions across the impairment categories at 1 year ($\chi^2_4=590.50$; $P<.001$). Most patients with AIS grade A at discharge remained AIS grade A (~87%); however, nearly half the persons with AIS grade B had a change in impairment category; with most improving to incomplete motor status. As listed in table 6, we observed an overall significant difference in the likelihood of changing AIS grade between discharge and 1 year between persons with tetraplegia and paraplegia ($\chi^2_4=40.97$; $P=.000$), suggesting that overall, persons with tetraplegia had a greater likelihood of conversion after discharge.

One-Year Impairment (AIS) Group Differences in 1-Year Outcomes

Given the changes observed in AIS impairment from discharge to 1 year, we reassessed the multivariate models listed in table 4 after removing persons with neurologic status that was no longer motor complete from the analytic sample, decreasing the sample size to N=1109. For purposes of comparison, findings from these models are listed in column 2 of table 4; all models were adjusted for systematic differences between AIS grade A and B by injury level and sex observed for the follow-up sample with complete data in earlier bivariate analyses. Consistent with results reported based on AIS grade at discharge, those who were AIS grade A at 1 year were more likely to report using an invasive bladder management program than persons who were AIS grade B. Also, the group with 1-year AIS grade A was 27% less likely to report a positive change in health status compared with the group with 1-year AIS grade B. Results of tests of interactions between AIS group and injury level were nonsignificant. Unlike our previous analyses listed in column 1 of table 4, we observed no differences across functioning outcomes between 1-year impairment groups with the exception of toilet transfers, an area in which persons with AIS grade A were less likely to report independence.

DISCUSSION

Differences Between AIS Grades A and B

Based on these analyses, many medical, functional, and psychological outcome differences can be expected at 1 year based on discharge status from rehabilitation for persons with AIS grade A versus B, with relatively fewer differences in persons who remain motor complete at 1 year postinjury. Specifically, persons with a discharge classification of AIS grade A (vs AIS grade B) were more likely to have an indwelling catheter for bladder management, experience hospitalization during the first year, and have lower perceived health status and less likely to report functional independence in self-care, sphincter control, mobility, and locomotion (based on individual FIM items and total FIM score) and report social participation based on the CHART domains of physical independence, mobility, occupational independence, and social integration.

However, further analysis indicated that most differences between motor complete individuals (AIS grades A, B) were related to the neurologic recovery (ie, conversion of AIS status) that occurred during the time between rehabilitation discharge and follow up. At 1 year, persons with AIS grade A were still more likely to use invasive bladder management and less likely to perceive themselves as having excellent and improved health status. The initial differences observed between patients with grade A and those with grade B across several domains of motor functioning and social participation were rendered non-significant

when individuals who experienced additional motor recovery during 1 year were excluded from the final analysis. This suggests that individuals who transitioned from motor complete to incomplete status accounted for most of the functional and social gains over time initially observed for this sample.

To determine whether level of injury was the possible reason for bladder management or hospitalizations (ie, more persons with AIS grade A vs B who had higher level tetraplegia vs lower level of injury, thus accounting for these differences), further analysis was completed by specific level of injury for tetraplegia and no significant differences were found. It is not clear why persons with AIS grade B should be more independent in bladder management, although it is possible that bladder sensation may facilitate other mechanisms for bladder management such that indwelling catheterization may not be required or improve cues for bladder fullness, allowing emptying to occur at appropriate times.

For the difference in hospitalizations during the first year, further investigation is needed to understand why sensory sparing influences this outcome. It is possible that sensory sparing offers improved capabilities from a neurophysiologic perspective. Sensory sparing may offer improved sensation of the ischial tuberosities and sacrum, potentially decreasing pressure ulcer development. Improved bladder sensation and management, as discussed, may result in decreased risks for recurrent infection, dysreflexia, and other complications necessitating hospitalization. Similarly, improved sacral sensation may improve bowel function, potentially decreasing hospitalizations.

Neurologic/AIS Grade Changes

In this study, conversion of persons with AIS grade A to incomplete status from rehabilitation discharge to 1 year was 13%, with less than 10% converting to motor incomplete status. For those with AIS grade B, approximately one third of persons improved to motor incomplete status by 1 year. In 1999, Marino et al⁵ reported that 15.4% of persons admitted with a neurologically complete injury within 1 week of injury (using the Frankel scale and American Spinal Injury Association standards) converted to incomplete status by 1 year, with 2.3% progressing to AIS grade D. For persons with initial AIS grade B, they reported a change of 71.3% to motor incomplete status at 1 year. Two other studies^{26,27} using NSCISC data with a 1-month baseline examination reported complete (AIS grade A) to incomplete injuries (AIS grades B, C, D), with conversion rates ranging from 4% to 10%. Speiss et al¹ more recently reported a conversion rate of 30% from initial (within 2 weeks) AIS grade A to incomplete status with follow-up at 1 year. A recent review of the existing literature reported a conversion rate of 20% for persons with initial (3d–4wk) neurologic complete injuries (10% to AIS grade B, 10% to motor incomplete status).⁶ Our data are consistent considering method differences, including our use of (1) AIS status at the time of discharge from rehabilitation and changes that occurred during the first year postinjury and (2) only the newer version of the international standards for classification. Although the percentage of patients improving to motor incomplete status decreased relative to the initial (usually 1–4wk) examination, improvement after rehabilitation discharge to 1 year postinjury was still observed.

The circumstances and reliability of the early neurologic assessment also may affect reported conversion rates, and the utility of the early examination for persons with certain factors, such as concomitant brain injury and those requiring ventilator support, has been questioned.³ Because this study used AIS grades determined from discharge examinations, the influence of reliability of the examination is mitigated compared with earlier work.

Recognition of differences in persons with motor complete injuries (AIS grade A vs B) has important ramifications for the field of SCI rehabilitation and research. For research

performed in early postinjury, even at rehabilitation discharge, it is important to separate patients with motor complete injuries rather than just group them together. In addition, the presence or recovery of sacral sensation alone by rehabilitation discharge has positive implications for subsequent individual well-being and postinjury adjustment.

Study Limitations

Limitations of this retrospective review of NSCISC data included loss to follow up and bias posed by missing data. However, the percentage of 1-year follow-up data available in this report was similar to other reviews of SCI data.^{5,41} There were differences in the complete sample versus the sample that followed at 1 year in terms of ethnicity and working history, although preliminary multivariate analyses suggested that these differences in sample composition over time did not affect results. Other systematic differences in the sample were accounted for in the final adjusted models. We were not able to study bowel function given the detail available in the database, and this would be an important aspect to study in defining benefits of sacral sensory sparing. Last, we did not study the frequency or cause of hospitalizations. On initial analysis, there were few subjects with multiple admissions. Therefore, because of data sparseness, this information was not included.

CONCLUSIONS

One-year outcomes for persons discharged from rehabilitation with AIS grade B relative to AIS grade A were improved, including less likely to use indwelling catheterization as a bladder method; less likely to experience rehospitalization; improved perceived health status, functional independence in self-care, sphincter control, mobility, and locomotion (based on individual FIM items and total FIM score); and greater report of social participation. Neurologic impairment change (AIS conversion rates) from motor complete to incomplete status occurred from the time of rehabilitation discharge through 1 year. Functional and social improvements appeared to be secondary to the improved neurologic gains to motor incomplete status by 1 year. However, at 1 year, persons with AIS grade B still had less chance of using an indwelling catheter and reported greater change in health status. This recognition of differences between persons with motor complete injuries (AIS grade A vs B) has important ramifications for the field of SCI rehabilitation and research.

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List of Abbreviations

AIS	American Spinal Injury Association Impairment Scale
CHART	Craig Handicap Assessment and Reporting Technique
NSCISC	National Spinal Cord Injury Statistical Center
OR	odds ratio
SCI	spinal cord injury
SF-36	36-Item Short Form Health Survey

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Table 1

Distributions of Sample Characteristics at Discharge and Attrition

Characteristics	Discharge (N=4106)	1-year Follow-up	
		Completed (N=2,331)*	With Neurologic Data (N=1289)†
Injury characteristics			
AIS impairment (%)			
AIS grade A	79.4	79.2	78.8
AIS grade B	20.6	20.8	21.2
Injury level (%)			
Paraplegia (T1 and below)	53.2	54.5	54.0
Tetraplegia (C1–C8)	46.8	45.5	46.0
Age at injury (y)	34.3±14.6	33.3±13.5	32.7±12.9‡
Demographic characteristics			
Sex (%)			
Men	80.6	79.9	80.8
Women	19.4	20.1	19.2
Race (%)			
Non-Hispanic white	58.6	60.4‡	60.7‡
Black	25.9	25.0	26.6
Asian-Pacific Islander	2.0	1.3	1.0
Latino	12.5	12.6	11.4
Other	1.0	0.7	0.3
Education (%)			
<High school	25.2	21.8‡	22.7§
High school	56.6	58.1	57.4
Some college	18.2	20.1	19.9
Marital status (%)			
Single	54.7	54.1	54.4
Married	32.6	33.5	33.5
Divorced	8.7	9.1	8.9
Separated	2.2	2.0	2.2
Widowed	1.8	1.3	1.0
Work status at injury (%)			
Yes	61.4	63.9§	65.2//
No	38.6	36.1	34.8
Discharged home (%)			
Yes	86.4	91.0§	91.8‡
No	13.6	9.0	8.2

NOTE. Values expressed as % or mean ± SD.

* Chi-square test of proportions or *t* test of mean values was used to compare group differences between the baseline and follow-up samples.

[†] Chi-square test of proportions or *t* test of means was used to compare group differences between the groups with and without neurologic data at follow-up.

[‡] $P < .001$;

[§] $P < .05$;

^{//} $P < .01$.

Table 2

Distribution of AIS Impairment Status by Injury Level (%)

Injury Level (%)	Sample *					
	Discharge (N=4106)		Completed 1-y Follow-up (N=2331)		Complete 1-y Neurologic Data (N=1289)	
	AIS Grade A	AIS Grade B	AIS Grade A	AIS Grade B	AIS Grade A	AIS Grade B
C1-4	21.9	23.8	19.6	25.1	19.4	23.1
C5	10.7	16.4	10.1	16.4	10.5	17.7
C6	6.7	13.3	7.6	13.0	7.3	14.2
C7	2.5	4.8	2.9	4.6	3.2	4.6
C8	1.4	2.7	1.2	3.3	1.4	2.7
T1-6	23.5	10.3	24.0	11.0	24.2	11.5
T7 and below	33.3	28.7 [†]	34.6	26.6 [†]	34.0	26.2 [†]

*. Significance based on chi-square test of significance.

[†] $P < .001$.

Table 3

Distribution Percentages of 1-Year Outcomes

Outcome	Assistance					Independence		
	Total	Maximal	Moderate	Minimal	Supervised	Modified	Total	
Bladder management (%)		None	Indwelling	Catheter-Free/External	ICP			
		1.1	16.1	6.8	76.0			
Hospitalizations (%)		Yes	No					
		41.0	59.0					
Health status (%)		Poor	Fair	Good	Very Good	Excellent		
		4.9	16.5	39.0	25.3	14.3		
Change in health status (%)		Much Worse	Somewhat Worse	About the Same	Somewhat Better	Much Better		
		5.5	9.3	21.4	23.5	40.3		
FIM items (%)	Assistance					Independence		
	Total	Maximal	Moderate	Minimal	Supervised	Modified	Total	
Eating	10.7	1.5	1.7	2.2	12.9	7.6	63.5	
Grooming	15.7	3.2	3.5	3.5	5.3	7.4	61.4	
Bathing	25.0	6.6	7.4	6.0	5.1	13.3	36.6	
Dress upper	22.9	3.9	3.9	3.0	5.4	6.4	54.5	
Dress lower	37.8	3.8	4.5	4.5	3.1	6.5	39.8	
Toileting	40.0	3.9	3.2	3.6	2.4	11.7	35.2	
Bladder	36.2	2.1	2.6	3.0	4.3	39.6	12.2	
Bowel	40.4	2.6	2.7	3.2	4.3	32.7	14.2	
Bed transfers	29.4	3.8	3.6	4.3	4.2	22.1	32.6	
Toilet transfers	39.0	2.8	3.1	3.7	3.1	25.1	23.3	
Tub transfers	35.4	3.4	4.6	5.5	4.8	26.8	19.5	
Walking	12.4	0.9	0.7	1.3	3.5	76.3	4.9	
Stairs	86.1	3.1	2.9	1.1	0.4	5.2	1.2	
FIM total	26.0	10.7	10.4	8.4	16.0	36.2	6.3	
Satisfaction with life (%)	Assistance					Independence		
	Very Dissatisfied	Dissatisfied	Slightly Dissatisfied	Neither	Slightly Satisfied	Satisfied	Very Satisfied	
	8.5	18.3	19.5	19.1	14.1	10.1	10.6	
Depression (%)	No Syndrome	Syndrome						

	Very Dissatisfied	Dissatisfied	Slightly Dissatisfied	Neither	Slightly Satisfied	Satisfied	Very Satisfied
CHART (%)	78.7	21.3					
	Low	Moderate	High	Normal Function			
Physical Independence	24.6	25.3	23.2	26.9			
Mobility	27.2	25.8	24.5	22.6			
Occupational Independence	28.2	23.8	26.0	22.0			
Social Integration	13.4	13.3	12.8	60.5			

NOTE. N=2331.
Abbreviation: ICP, intermittent catheterization program.

Table 4

Adjusted ORs From Logit Models Testing for the Effects of AIS Impairment Status on Outcomes 1 Year Postrehabilitation

Variable	Model I [*]		Model II [†]	
	AIS Grade A (vs B) at Discharge (N=2331)		AIS Grade A (vs B) at 1y (N=1109)	
	OR (95% CI)	LR _{df} Test	OR (95% CI)	LR _{df} Test
Outcome at 1y				
Bladder program [‡]				
None	0.17 (0.07–0.44)	LR ₁₅ =153.09 [§]	0.24 (0.04–1.34)	LR ₇ =74.76 [§]
Indwelling	2.57 (1.06–4.10)		2.21 (1.11–4.39)	
ICP	1.63 (1.11–2.40)		1.94 (1.07–3.50)	
Hospitalization ^{//}	1.30 (1.05–1.60)	LR ₅ =35.01 [§]	1.23 (0.90–1.70)	LR ₃ =9.69 [¶]
Perceived health status [#]	0.77 (0.63–0.94)	LR ₅ =31.70 ^{//}	0.84 (0.62–1.14)	LR ₃ =2.45
Change in health status [#]	0.85 (0.70–1.05)	LR ₅ =19.34 ^{**}	0.73 (0.53–0.99)	LR ₃ =14.71 ^{**}
FIM: Eat [#]	0.70 (0.54–0.91)	LR ₅ =819.10 [§]	1.01 (0.62–1.34)	LR ₃ =455.17 [§]
FIM: Grooming [#]	0.62 (0.48–0.80)	LR ₅ =861.51 [§]	1.03 (0.63–1.36)	LR ₃ =491.46
FIM: Bathing [#]	0.66 (0.52–0.84)	LR ₅ =982.96 [§]	1.08 (0.81–1.63)	LR ₃ =543.52 [§]
FIM: Dressing upper body [#]	0.64 (0.50–0.83)	LR ₅ =1048.25 [§]	0.9 (0.61–1.30)	LR ₃ =561.46 [§]
FIM: Dressing lower body [#]	0.81 (0.63–1.04)	LR ₅ =1055.60 [§]	1.16 (0.75–1.62)	LR ₃ =583.56 [§]
FIM: Toileting [#]	0.73 (0.57–0.95)	LR ₅ =990.36 [§]	1.19 (0.80–1.77)	LR ₃ =558.27 [§]
FIM: Bladder management [#]	0.68 (0.53–0.87)	LR ₅ =808.87 [§]	1.04 (0.71–1.53)	LR ₃ =446.12 [§]
FIM: Bowel management [#]	0.63 (0.49–0.81)	LR ₅ =823.15 [§]	0.97 (0.67–1.42)	LR ₃ =449.58 [§]
FIM: Bed transfer [#]	0.56 (0.44–0.72)	LR ₅ =994.54 [§]	0.77 (0.53–1.13)	LR ₃ =548.11 [§]
FIM: Toilet transfer [#]	0.56 (0.43–0.72)	LR ₅ =855.68 [§]	0.66 (0.45–0.97)	LR ₃ =445.67 [§]
FIM: Tub transfer [#]	0.55 (0.43–0.70)	LR ₅ =903.31 [§]	0.78 (0.53–1.13)	LR ₃ =509.46 [§]
FIM: Walking [#]	0.87 (0.66–1.16)	LR ₅ =118.29 [§]	0.61 (0.36–1.03)	LR ₃ =60.57 [§]
FIM: Stairs [#]	0.58 (0.42–0.81)	LR ₅ =139.37 [§]	1.02 (0.57–1.82)	LR ₃ =74.24 [§]
FIM: Total [#]	0.59 (0.62–0.90)	LR ₅ =663.53 [§]	0.84 (0.64–1.11)	LR ₃ =393.27 [§]
Satisfaction with life [#]	1.00 (0.83–1.21)	LR ₅ =7.28	0.92 (0.69–1.23)	LR ₃ =1.20
Depressive syndrome [¶]	1.22 (0.88–1.69)	LR ₅ =14.5 [¶]	1.12 (0.69–1.81)	LR ₃ =1.07
CHART: Physical [#]	0.78 (0.63–0.95)	LR ₅ =465.51 [§]	0.92 (0.68–1.24)	LR ₃ =209.15 [§]
CHART: Mobility [#]	0.75 (0.62–0.92)	LR ₅ =160.92 [§]	0.83 (0.61–1.11)	LR ₃ =45.17 [§]
CHART: Occupational [#]	0.81 (0.66–0.98)	LR ₅ =178.91 [§]	0.80 (0.60–1.09)	LR ₃ =54.73 [§]
CHART: Social Integration [#]	0.82 (0.65–1.03)	LR ₅ =105.56 [§]	0.85 (0.60–1.19)	LR ₃ =2.2

Abbreviations: CI, confidence interval; ICP, intermittent catheterization program; LR, likelihood ratio.

* Column I models are adjusted for injury level, sex, and education.

† Column II models are adjusted for injury level and sex.

‡ Multinomial logistic model results expressed as relative risk ratios comparing to Catheter Free/External Catheterization (omitted reference category).

§ P .001.

// Logistic regression models comparing the odds of hospitalization with none (omitted reference category) and depressive syndrome to with none (omitted reference category).

¶ P .05.

Ordered logit models comparing the likelihood that a person with AIS grade A (vs B) will be observed in a higher category.

** P .01.

Table 5

Distributions of AIS Impairment Categories Grades at 1 Year

AIS Grade at Discharge	AIS Grade at 1y			
	A	B	C	D
A	878 (86.5)	57 (5.6)	36 (3.5)	42 (4.1)
B	34 (12.6)	140 (52.0)	62 (23.1)	31 (11.5)
Overall	912 (71.0)	197 (15.3)	98 (7.6)	73 (5.7)
				4 (0.3)*

NOTE. N=1284. Values expressed as N (%). Significance test based on chi-square test of proportions.

* $P<.001$.

Table 6

Change in AIS Status From Discharge to 1 Year by Level of Injury

Variable	AIS Grade A at Discharge		AIS Grade B at Discharge		
	1-y AIS Status		1-y AIS Status		
	No Change	B C, D, E	A, B	C, D, E	
Tetraplegia	361 (61.3)	31 (5.3)	30 (5.1)	111 (18.8)	56 (9.5)
Paraplegia	517 (74.4)	26 (3.7)	50 (7.2)	63 (9.1)	39 (5.6)
Overall	878 (68.4)	57 (4.4)	80 (6.2)	174 (13.6)	95 (7.4) *

NOTE. N=1284. Values expressed as N (%). Significance test based on chi-square test of proportions.

* $P<.001$.