The Influence of Age and Gender on Rehabilitation Outcomes in Nontraumatic Spinal Cord Injury

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Abstract

Study Design: Retrospective, 3-year case series.

Objective: To investigate the relationship between gender and age and a range variables in patients with nontraumatic spinal cord injury (SCI).

Setting: Tertiary medical unit specializing in rehabilitation of patients with nontraumatic SCI.

Method: Participants were a consecutive series of 70 adult inpatients with nontraumatic SCI undergoing initial rehabilitation. The variables of interest were demographic characteristics, clinical features, complications, mortality, length of stay (LOS), mobility, bladder and bowel continence, and Functional Independence Measure (FIM) scores.

Results: Men were younger than women, but the difference was not statistically significant (median 64 years vs 72.5 years, $P = 0.2$). There was no statistically significant relationship between age or gender and the following: American Spinal Injury Association grade, level of injury, many SCI complications, mortality, LOS, walking ability, bladder management, and fecal continence. The only SCI complication that was related to age was pressure ulcers (<65 years = 20% vs ≥ 65 years = 50%, $P = 0.04$). Patients discharged home were more likely to be younger ($P = 0.01$) and male ($P = 0.03$). There was a significant negative correlation between patients' age and the discharge Rasch-transformed FIM motor (Spearman's $\rho = -0.30$, $P = 0.015$) and cognitive (Spearman's $\rho = -0.25$, $P = 0.04$) subscores. There were no significant relationships between gender and FIM subscale scores.

Conclusions: Gender and age do not significantly influence most aspects of rehabilitation in patients with nontraumatic SCI. Age alone should not be used as a discriminator of ability to benefit from nontraumatic SCI rehabilitation.

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Key Words: Age factors; Sex distribution; Outcome assessment (health care); Rehabilitation; Spinal cord injuries, traumatic, nontraumatic; Functional independence measure

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INTRODUCTION

The demographic characteristics and pattern of neurological injury in patients with nontraumatic spinal cord injury (SCI) are different from those with traumatic SCI. Nontraumatic SCI tends to affect older adults, with a fairly even gender distribution (1–3). For example, a recent study reported that patients with nontraumatic SCI had a median age of 69 years (interquartile range [IQR] 58–77 years) and 46% were male (4). There were significant differences concerning the age of patients with different causes of nontraumatic SCI. Patients with tumor, degeneration, or vascular causes of nontraumatic SCI were older (median age range 66–74 years) than patients with nontraumatic SCI due to infection, inflam-

mation, or other causes (median age 55 years) (4). Nontraumatic SCI results in a pattern of injury that is usually incomplete and is more likely to cause paraplegia than tetraplegia (1,2,4,5).

Age and Spinal Cord Injury

It is possible for health care professionals to underestimate the rehabilitation potential of older adults (6,7). Therefore, studies that examine the influence of age on SCI rehabilitation outcomes are important. This way, the potential for ageism to limit the access of older patients with SCI to rehabilitation services can be countered by evidence.

Demographic changes in the coming decades will result in a significant increase in the older population. In the United States, for example, 13% of the population was aged 65 years or older in 2000, and it is predicted that this percentage will double over the next 30 years (8). This pattern of population aging is predicted to occur to a similar extent throughout the world (9). Because nontraumatic SCI is associated with older age, it is expected that both the incidence and the prevalence of nontraumatic SCI will increase significantly in the decades ahead. This has significant implications for the delivery of rehabilitation and support services to this group of patients.

Compared with younger patients, older patients with SCI have reduced functional reserves and greater comorbidity (10) and are more likely to have been physically disabled prior to SCI (11,12). Because of these factors, older patients with SCI have care needs that require specialized medical and nursing considerations during hospitalization (13) and optimal planning of their discharge destination and support services.

There are conflicting results in the literature about the influence of age on outcomes of traumatic SCI rehabilitation (11,12,14–16). A recent review highlighted that the variation in findings in previous studies may be related to methodological issues (17). These include small sample size, narrow age spectrum, inadequate use of statistical analysis, and not controlling for the interaction between injury characteristics and age. Some recent studies have better methodologies, including studies in which results were analyzed while controlling for level and severity of injury (18,19) or matching patients with traumatic SCI with those with nontraumatic SCI (3,20,21).

Previous studies of traumatic SCI have shown that age is a significant predictor of discharge to a nursing home (11,12,22). Discharging SCI patients to a nursing home reduces privacy, social interaction, quality of life, and opportunities for independence (23). Therefore, discharging a patient with SCI to a nursing home is always a last resort. Each health care system has different support services and social factors that influence discharge to a nursing home. This can limit the appropriateness of comparisons between health care

systems. Nevertheless, the consequences for individuals with nontraumatic SCI and their families are so important that it is still relevant to consider the proportion of patients discharged to a nursing home as an indirect measure of rehabilitation outcome and program evaluation.

Gender Issues

Numerous studies have been published that explore gender issues in traumatic SCI (24–31). These studies have reported no gender differences in the rehabilitation length of stay (LOS), charges, American Spinal Injury Association (ASIA) motor scores, disability, discharge to institutional care (26,31), and most of the common SCI complications (26,30,31).

Gender-related differences in the rehabilitation outcomes of 281 patients with traumatic and nontraumatic SCI have been evaluated, with patients matched for level of injury, ASIA grade, time from onset of SCI to admission, age, and etiology (31). No results, however, were reported regarding the influence of gender on outcome variables within the nontraumatic SCI sample. Among patients more than 1 year post traumatic SCI, women are more likely to require a paid attendant as a caregiver (24). Although it has been reported that female patients may have more natural neurological recovery than male patients, for a given level and completeness of traumatic SCI, male patients tend to perform better functionally (30). This is supported by large studies of the older population that have reported women to be more severely disabled (32), especially with mobility and self-care (33–35).

Purpose

There has been very little research concerning the influences of age or gender on the rehabilitation of patients with nontraumatic SCI. The aim of this study was to assess the influences of age and gender on a range of variables and rehabilitation outcomes after the onset of nontraumatic SCI. This study was conceived as an exploratory investigation into this area that would be hypothesis generating for future studies.

The primary objective of this study was to examine, in a group of inpatients undergoing their initial rehabilitation after the onset of nontraumatic SCI, the relationship between age and gender on the following: demographic characteristics, clinical features, SCI complications, and a range of outcome measures. The first study hypothesis was that older patients would have a longer LOS, more complications, and poorer outcomes in key areas of functioning, disability, and discharge destination. The second hypothesis was that male patients would have better outcomes on the above variables. A secondary objective was to investigate which factors have an influence on whether patients are discharged to a nursing home.

METHODS

Study Sample

The Spinal Rehabilitation Unit at Caulfield General Medical Centre, Victoria, Australia, provides specialist interdisciplinary rehabilitation, principally for adults with nontraumatic SCI living in Melbourne. Patients who live elsewhere in Victoria are also accepted. Patients are admitted into the program once they are medically stable after acute medical or surgical treatments for their nontraumatic SCI or any comorbid conditions. The state government funds the hospital, and patients are admitted from either public or private hospitals. No third party has influence over LOS or discharge destination. Patients remain in the unit while the team feels that they are able to benefit from rehabilitation.

The individuals with nontraumatic SCI in this study have been described previously regarding their demographic characteristics and complications (36), pressure ulcer patterns and prediction (37), and key functional outcomes and disabilities (4). The medical records were reviewed for all inpatients with nontraumatic SCI admitted to the Spinal Rehabilitation Unit from January 1, 1995, through December 31, 1997. The study sample contained 70 patients with nontraumatic SCI admitted for initial rehabilitation. Patients were excluded if they did not have a nontraumatic SCI or if they had a peripheral nerve lesion not associated with cauda equina injury or a myelopathy. Patients were also excluded if they were not admitted for their initial rehabilitation admission after the onset of nontraumatic SCI or their LOS was less than 7 days. The most common diagnoses were tumor (33%, $n = 23$), degenerative conditions causing cord compression (26%, $n = 18$), vascular conditions (14%, $n = 10$), and transverse myelitis (10%, $n = 7$). Eight patients died before discharge, and except for mortality data, these patients were excluded from the analysis of discharge outcomes.

Data Collection

Information concerning demographic characteristics, clinical features, and rehabilitation outcomes were extracted from patient medical records and entered into a database. The data were de-identified to maintain patient privacy. Individual patient consent was not obtained. The local ethics committee approved the study.

Measurements

The following demographic information was recorded: age, gender, and premorbid accommodation setting (home, other, nursing home). The clinical features studied were neurological level of injury, completeness of SCI at discharge, and common SCI complications that occurred during inpatient rehabilitation. The neurological level of injury was classified as either tetraplegia or paraplegia. The completeness of nontraumatic SCI was assessed according to the *International Standards for*

Neurological and Functional Classification of Spinal Cord Injury, using the version that was current at the time the study was conducted (38). The occurrence of any of the following SCI complications was noted: urinary tract infection, pressure ulcer ([PU] either present on admission or occurring during rehabilitation), pain, spasticity, pneumonia, psychological problems, or deep-venous thrombosis (DVT)/pulmonary embolism (PE). The diagnosis of complications was based on clinical features and relevant investigations, where necessary.

The rehabilitation outcomes were LOS, mortality, discharge accommodation setting, and selected measures of function and disability. Outcomes were dichotomised on the following measures of function: discharge formal and informal support services (none vs any), mobility status (walking >10 m with or without an aid vs wheelchair dependent), bladder voiding method (urinary catheter vs no catheter or intermittent catheter [IMC]), and fecal continence (continent with bowel program or on sensation vs incontinent at least once during week prior to discharge). The use of formal and informal support services provides information that reflects a patient's practical ability to function independently in the community after discharge. Formal supports were defined as the employment of personal care (visiting nurses, attendant carers) or domestic help (cleaning or meal preparation). Informal supports were nonpaid help from family or friends for personal care or domestic duties.

The patient's Functional Independence Measure (FIM) (39) scores within 72 hours of admission and discharge were recorded as a measure of disability. Rehabilitation team members were trained in the use of the FIM and had access to guidelines that assisted scoring. The FIM is an ordinal scale that has acceptable scalability only when separated into its 13-item motor and 5-item cognitive subscales (40,41). The FIM raw scores in the motor and cognitive subscales were transformed using a conversion chart that was based on a Rasch analysis (42) to a linear score on a 100-point scale with equal intervals so that assessment of change using parametric analysis could be performed.

Statistical Analysis

Initial database entry was performed using Excel 97 (Microsoft Corp, Redmond, WA). Statistical analysis was performed using Stata, intercooled version 6.0 for Windows (Stata Corp, College Station, TX). Descriptive statistics, including proportions and medians, were calculated for demographic characteristics, clinical features, and outcomes. The LOS followed a log normal distribution and was log transformed to facilitate the use of parametric methods of analysis.

The patients' age was analyzed as a continuous variable using nonparametric methods because it was not normally distributed. Spearmans' correlation was used to assess the relationship between age and other continuous

Figure 1. Age of patients at initial admission for nontraumatic spinal cord injury.

variables, such as LOS and FIM subscale scores. The Wilcoxon rank-sum test (Mann-Whitney) was used to determine the relationship between age and nominal variables, such as gender, level of SCI, complication occurrence, and dichotomous outcomes. The Kruskal-Wallis method of 1-way analysis of variance was used when determining the relationship between age and ASIA grade or level of injury.

If a statistically significant difference was found concerning the influence of age, then the analysis was repeated with patients divided into 2 age groups: those aged less than 65 years and those 65 years or older. Sixty-five years was chosen as the cut-off because it is commonly used for defining geriatric patients and it was also close to the median age of the patient sample. This secondary analysis was conducted to allow reporting of the outcome of interest in younger and older age groups. This comparison may be of practical use in clinical situations.

The influence of gender on categorical variables was analyzed using the χ^2 test. The influence of gender on continuous variables was analyzed using the 2-sample t test for normally distributed variables, such as log-LOS and Rasch motor FIM scores. For variables that were not normally distributed, such as age and Rasch cognition FIM scores, the Wilcoxon rank-sum test was used.

A selection of variables that were felt to be possible influences on discharge to nursing home were assessed for significance using bivariate analysis. The choice of variables was based on clinical experience and traumatic SCI literature. The following variables were dichotomized and analyzed using the χ^2 test: gender, previously living at home, previously receiving any formal or informal supports, combination of level of injury and ASIA grade (paraplegia-ASIA ABC, tetraplegia-ASIA ABC, and all ASIA D), nontransient SCI complications (PU, pain, spasticity, and psychological), mobility status, bladder voiding method, and fecal continence. Because of the small number of patients in the sample who were discharged

to a nursing home, it was not possible to perform a multivariate analysis to determine which variables had the most influence.

With 70 subjects in this sample, this study had an 80% power to detect a correlation coefficient between 2 continuous variables equal to 0.33. With a minimum of 32 subjects per gender group, this study had an 80% power to detect a difference equal to 70% of 1 standard deviation and an 80% power to detect a difference in proportions of 35%. In all analyses, P values of 0.05 or less were deemed statistically significant.

RESULTS

Demographic Characteristics

Nearly half (47%, $n = 33$) the patients were aged older than 65 years on admission, and only 11% ($n = 8$) were younger than 40 years. The distribution of patients' age was skewed to the right, with many older patients (Figure 1).

There was no relationship between the age of patients and their ASIA grade (Kruskal-Wallis $H = 2.8$, $P = 0.4$) or level of injury (Kruskal-Wallis $H = 2.2$, $P = 0.1$). There was no relationship between gender and the etiology of nontraumatic SCI ($\chi^2_3 = 1.4$, $P = 0.7$), ASIA grade ($\chi^2_3 = 5.0$, $P = 0.2$), or level of injury ($\chi^2_1 = 0.07$, $P = 0.8$).

There was no correlation between patients' age and their LOS in rehabilitation (Spearman's $\rho = -0.14$, $P = 0.24$). Although there was a trend for men to have a shorter LOS (geometric mean 51.5, median 60 days, IQR 28–141) compared with women (geometric mean 62.5, median 48.5, IQR 27.5–105.5), this difference was not significant (t test $t = 0.8$, $P = 0.4$).

Men (median age 64 years, IQR 57–73) tended to be younger than women (median 72.5 years, IQR 62–78), and this difference just failed to reach statistical significance (Wilcoxon rank-sum test $z = 1.9$, $P = 0.06$). The relationship between age and gender was also examined by logistical regression to determine whether controlling for level and ASIA grade changed the relationship, and no significant interaction was found ($P = 0.2$). There were significantly ($\chi^2_1 = 7.7$, $P = 0.006$) more women (58%) living alone prior to their SCI compared with men (25%).

Complications and Outcomes

The only SCI complication in which there was a significant influence of age was the development of PU (Table 1). Among patients younger than age 65 years, 20% ($n = 6$) had a PU, whereas among those 65 years and over, 50% ($n = 20$) had a PU. There was no influence of gender on the occurrence of common SCI complications. There was no correlation between the total number of SCI complications that occurred during rehabilitation and the patient's age (Spearman's $\rho = 0.04$, $P = 0.7$) or gender (Wilcoxon rank-sum test, $z = 1.8$, $P = 0.07$).

Table 1. Relationships Between Age, Gender, and Spinal Cord Injury Complications

Complication	Patients	Age Influence z^*	Gender Influence		$\chi^{2\dagger}$
			Male (n = 32)	Female (n = 38)	
Urinary Tract Infection	46% (n = 32)	-0.1, $P = 0.9$	38%	53%	1.6, $P = 0.2$
Pressure Ulcer	37% (n = 26)	-2.1, $P = 0.04$	34%	39%	0.2, $P = 0.7$
Pain	23% (n = 16)	0.8, $P = 0.4$	25%	21%	0.2, $P = 0.7$
Spasticity	13% (n = 9)	0.9, $P = 0.4$	16%	11%	0.4, $P = 0.5$
Pneumonia	7% (n = 5)	-0.4, $P = 0.7$	3%	11%	1.4, $P = 0.2$
Psychological	7% (n = 5)	0.05, $P = 0.9$	3%	11%	1.4, $P = 0.2$
DVT/PE	3% (n = 2)	0.1, $P = 0.9$	3%	3%	0.0, $P = 0.9$

DVT/PE = deep-venous thrombosis or pulmonary embolism.

*Wilcoxon rank-sum test.

†Chi-squared test, $df = 1$.

The relationships between both the age and the gender of patients and key rehabilitation outcomes are shown in Table 2. There were statistically significant relationships between age and the following: not being discharged home after rehabilitation, formal supports needed for patients discharged home, and no informal supports needed for patients discharged home. There was a statistically significant negative correlation between the patient's age and the following: Rasch FIM mean motor subscale score at discharge, the Rasch FIM mean motor gain during rehabilitation, and the Rasch FIM median cognitive subscale score at discharge (Table 3). There was no relationship between gender and any of the Rasch FIM subscale scores.

Nursing Home Discharge

The analysis of key variables that were believed to influence discharge to a nursing home is shown in Table 4. The following variables were associated with discharge to a nursing home after inpatient rehabilitation: female; unable to walk >10 m; urinary catheter; fecal incontinence; ASIA A, B, or C grade of SCI; more complications; having a pressure ulcer; and lower FIM motor and cognitive subscale scores on admission and discharge.

DISCUSSION

Demographic Characteristics

Among patients with traumatic SCI, male patients tend to be younger than female patients (11,30). One study reported that men were, on average, 2 years younger than women, and this difference was statistically significant (30). In this sample of patients with nontraumatic SCI, male patients tended to be younger than female patients. The difference between the median ages was 8.5 years; however, this was not statistically significant.

The lack of a statistically significant relationship between age and gender in this sample of patients with nontraumatic SCI, even after adjusting for level and ASIA

grade, justified presenting the age results without adjustment for gender and visa versa.

Length of Stay

There are conflicting results in the literature concerning the influence of age on SCI rehabilitation LOS. A recent study of traumatic and nontraumatic SCI that matched 130 patients for etiology, time from onset, and injury characteristics reported that older patients tend to have a shorter LOS (3). Other studies, however, have found the opposite, with older patients having a longer LOS. These studies involved unmatched traumatic SCI patients (43) and traumatic SCI patients matched to control for level and ASIA grade (19). In contrast with the above, other studies have found that age was not a predictor of LOS after traumatic SCI. This has been reported in a retrospective study of 866 patients (11), in a study that performed multivariate analysis of factors influencing LOS in 358 patients (12), and in a study of 375 patients with tetraplegia matched to control for the effects of level and ASIA grade (18).

In this study of nontraumatic SCI, patients' age was not found to influence the rehabilitation LOS. There are numerous factors that can influence rehabilitation LOS in nontraumatic SCI patients (4), including comorbid medical conditions, health care system factors, and community supports. There are methodological problems that make LOS comparisons between different papers difficult (4).

Patients in this study who were transferred to a nursing home had a significantly longer LOS compared with those discharged elsewhere. Typically, patients would spend only a few weeks waiting for a nursing home bed because of access to interim nursing home accommodation. Therefore, the finding of a significantly longer LOS in those patients transferred to a nursing home probably reflects the severity of patients' disabilities and attempts to improve their functioning. Previous studies in unmatched (30,44) and matched [(level, ASIA grade, and age) (26) (level, ASIA grade, age, and time

Table 2. Relationships Between Age, Gender, and Nontraumatic Spinal Cord Injury Outcomes

Outcome	Patients	Age		Gender	
		Median (IQR)	$z^{\dagger}$	Male (n)	Female (n)
Walking*					$\chi^2_{ }$
Unaided or aided >10 m indoors	58% (n = 36)	65 (43.5–76)	1.5, $P = 0.13$	73% (22)	44% (14)
Wheelchair	42% (n = 26)	71 (60–78)		27% (8)	56% (18)
Urinary catheter*					
In situ	37% (n = 23)	69 (62–74)	–0.51, $P = 0.61$	33% (10)	41% (13)
IMC or none	62% (n = 39)	68.5 (44–78)		67% (20)	59% (19)
Fecal continence*					
Controlled continence	95% (n = 59)	68.5 (57–76)	–1.3, $P = 0.19$	97% (29)	94% (30)
Incontinent	5% (n = 3)	79 (62–85)		3% (1)	6% (2)
Discharge*					
Home	76% (n = 47)	65 (48–74)	2.6, $P = 0.01^{\dagger }$	93% (28)	63% (20)
Not home	24% (n = 15)	74.5 (66–79)		7% (2)	37% (12)
Mortality					
Died	11% (n = 8)	74.5 (61.5–76)	–0.76, $P = 0.45$	6% (2)	16% (6)
Discharged alive	89% (n = 62)	69 (57–77)		94% (30)	84% (32)
Discharge home supports [†]					
Formal support	73% (n = 37)	71 (62–78)	–3.6, $P < 0.001^{**}$	75% (18)	89% (24)
No formal supports	27% (n = 14)	40.5 (28.5–64)		25% (6)	11% (3)
Informal supports	71% (n = 36)	69 (60–76)	–2.4, $P = 0.02^{\dagger\dagger}$	67% (20)	71% (15)
No informal support	29% (n = 15)	43.5 (34–69)		33% (10)	29% (6)

IQR = interquartile range; IMC = intermittent catheterization.

*Excluding patients who died.

[†]Excluding patients transferred to hostel, retirement village, or nursing home.[‡]Wilcoxon rank-sum test.^{||}Chi-squared test, $df = 1$.[¶]Not discharged home: ≥ 65 years 77%, $n = 17$ vs < 65 years 23%, $n = 5$.^{**}Formal supports: ≥ 65 years 66%, $n = 31$ vs < 65 years 34%, $n = 16$; no formal supports: ≥ 65 years 17%, $n = 2$ vs < 65 years 83%, $n = 10$.^{††}No informal supports: ≥ 65 years 29%, $n = 4$ vs < 65 years 71%, $n = 10$.

Table 3. Relationships Between Age, Gender, and Rasch Functional Independent Measure (FIM) Scores

Rasch FIM Subscale	Age (Correlation)		Gender		
	Spearman's ρ	P	Male	Female	
Motor Admission	0.001	0.99	40.8*	38.6*	$t = -0.5, P = 0.6$
Motor Discharge [†]	-0.30	0.015	60.8*	56.8*	$t = -1.6, P = 0.1$
Motor Gain	-0.26	0.05 [¶]	20.0*	18.2*	$t = -1.5, P = 0.1$
Cognitive Admission	-0.20	0.11	100 [‡]	87 [‡]	$z = -0.5, P = 0.7$
Cognitive Discharge [†]	-0.25	0.04**	100 [‡]	100 [‡]	$z = -0.7, P = 0.5$

*Mean FIM score.

[†]Excluding patients who died.

[‡]Median FIM score.

^{||}Rasch FIM mean motor subscale score at discharge: <65 years = 63.6 vs ≥ 65 years = 54.6.

[¶]Rasch FIM mean motor gain during rehabilitation: <65 years = 20.5 vs ≥ 65 years = 14.7.

**Rasch FIM median cognitive subscale score at discharge: <65 years = 100 vs ≥ 65 years = 77.

from SCI onset to admission) (31)] samples have not found any significant influence of gender on rehabilitation LOS. This finding has not been previously reported with nontraumatic SCI patients.

The time elapsed waiting for a nursing home was not subtracted from the LOS because it was not always accurately recorded. Also, many patients discharged home also spent time after completing their rehabilitation program waiting for home modifications, equipment purchases, or carer availability and training, and the LOS for these patients was not reduced to reflect these delays. The presentation of the actual LOS rather than a modified LOS reduced to adjust for unnecessary time in hospital reflects the pragmatics of rehabilitation practice in the unit.

Level and Completeness of Nontraumatic Spinal Cord Injury

Previous studies of traumatic SCI have reported a higher incidence of tetraplegia and more incomplete lesions among older patients (11,15). These findings most likely reflect central cord syndrome's tendency to occur in older patients after falls. By contrast, there was no relationship between age and the level or completeness of SCI in this sample of patients with nontraumatic SCI.

Previous matched studies of traumatic SCI patients (26) and a sample consisting of both traumatic and nontraumatic SCI patients (31) have not found any significant influence of gender on ASIA motor scores, but female patients were reported to be more likely to have an ASIA C SCI (31). An unmatched study found that women had greater motor score increases between admission and 1-year review but no significant change in ASIA grade (30). The present study did not find an influence of gender on the ASIA grade at discharge from rehabilitation in patients with nontraumatic SCI.

Complications

A study of 866 patients with traumatic SCI examined the influence of age on outcomes and reported that older

patients were more likely to develop pneumonia, gastrointestinal hemorrhage, PE, and renal calculi (11). Another study, however, of 62 patients with traumatic SCI reported no differences regarding numerous complications, including urinary tract infection, PUs, spasticity, pneumonia, or DVT/PE (12). In a study of traumatic SCI patients at their first annual review, pain interference was found to be the only complication that was significantly associated with age, but no relationship was found between age and pain at discharge (45).

A matched study of traumatic and nontraumatic SCI patients found no influence of age on complications present at admission (3). There was, however, a higher incidence of complications in older patients during rehabilitation due to more frequent respiratory problems in patients with traumatic SCI. In the present study, the occurrence of PUs was the only complication associated with age.

Previous studies have reported some gender-related differences in the occurrence of SCI complications. One study of traumatic SCI reported that men were more likely to develop PUs and DVT, but there was no association with pneumonia, autonomic hyperreflexia, and PE (26). Another study of traumatic SCI reported men are more likely to develop PE, but there were no differences for DVT or pneumonia (30). A matched study in patients with traumatic and nontraumatic SCI reported no influence of gender on complications, but the types of complications studied were not specified (31). Studies of specific SCI complications have not shown an association between gender and the occurrence of depression (25) or pain in patients more than 1 year post traumatic SCI (29).

Bowel Control

Most (95%, $n = 59$) patients in this study were discharged with controlled fecal continence, and this was not influenced by age or gender. The controlled continence group included patients who were able to open their

Table 4. Analysis of Variables Influencing Discharge to a Nursing Home

Variable	Discharged to a Nursing Home (18%, n = 11)	Not Discharged to a Nursing Home (82%, n = 51)	
Gender			$\chi^2_1 5.4, P = 0.02$
Male	6% (n = 2)	94% (n = 29)	
Female	29% (n = 9)	71% (n = 22)	
Age (median), IQR	73, 66–80	66.5, 54–76	$z = -1.8, P = 0.08^*$
Premorbid home alone			$\chi^2_1 = 1.5, P = 0.2$
Yes	24% (n = 7)	76% (n = 22)	
No	12% (n = 4)	88% (n = 29)	
Premorbid formal supports			$\chi^2_1 = 0.8 P = 0.4$
Yes	27% (n = 3)	73% (n = 8)	
No	16% (n = 8)	84% (n = 43)	
Premorbid informal supports			$\chi^2_1 = 0.5 P = 0.5$
Yes	24% (n = 4)	77% (n = 13)	
No	16% (n = 7)	84% (n = 38)	
Walking >10 m			$\chi^2_1 = 14.2, P < 0.001$
Yes	3% (n = 1)	97% (n = 36)	
No	40% (n = 10)	60% (n = 15)	
Catheter			$\chi^2_1 = 11.5, P = 0.001$
Yes	39% (n = 9)	61% (n = 14)	
No	5% (n = 2)	95% (n = 37)	
Fecal incontinence			$\chi^2_1 = 14.6, P < 0.001$
Yes	100% (n = 3)	0% (n = 0)	
No	13% (n = 8)	87% (n = 51)	
Level-ASIA			$\chi^2_1 = 7.8, P = 0.02$
Paraplegia-ABC	38% (n = 5)	62% (n = 8)	
Tetraplegia-ABC	40% (n = 2)	60% (n = 3)	
All D	9% (n = 4)	91% (n = 40)	
Etiology			$\chi^2_1 = 2.1, P = 0.6$
Tumor	22% (n = 4)	78% (n = 14)	
Degenerative	11% (n=2)	89% (n = 15)	
Vascular	30% (n = 3)	70% (n = 7)	
Other	12% (n = 2)	88% (n = 15)	
Complications (median)	2	1	$z = -2.0, P = 0.05^*$
Pressure ulcer			$\chi^2_1 = 5.3, P = 0.02$
Yes	33% (n = 7)	67% (n = 14)	
No	10% (n = 4)	90% (n = 37)	
Pain		8	$\chi^2_1 = 0.11, P = 0.9$
Yes	17% (n = 2)	3% (n = 10)	
No	18% (n = 9)	82% (n = 41)	
Spasticity			$\chi^2_1 = 0.63, P = 0.4$
Yes	29% (n = 2)	71% (n = 5)	
No	16% (n = 9)	84% (n = 46)	
Psychological			$\chi^2_1 = 0.15, P = 0.7$
Yes	25% (n = 1)	75% (n = 3)	
No	18% (n = 10)	82% (n = 48)	

Table 4. Continued

Variable	Discharged to a Nursing Home (18%, n = 11)	Not Discharged to a Nursing Home (82%, n = 51)	
LOS (Geometric mean, 95%CI)	103.0, 59.0–179.9	52.2, 39.3–69.2	$t = -2.1, P = 0.04^{\dagger}$
Rasch FIM motor admission (mean, SD)	27.3, 14.5	44.3, 13.5	$t = 3.6, P < 0.001^{\dagger}$
Rasch FIM motor discharge (mean, SD)	42.1, 7.5	62.2, 14.5	$t = 4.2, P < 0.001^{\dagger}$
Rasch FIM cognition admission (median, IQR)	65, 57–87	100, 77–100	$z = 2.7, P = 0.008^*$
Rasch FIM cognition discharge (median, IQR)	65, 57–87	100, 77–100	$z = 3.1, P = 0.002^*$

IQR = interquartile range.

*Wilcoxon rank-sum test.

$\dagger$ Student's t test.

bowels on sensation, as well as those requiring the use of aperients and/or suppositories. This was irrespective of whether patients were able to administer the suppositories independently. If patients are unable to insert suppositories independently, then this can be done by the visiting home nursing service 3 times a week. Patients requiring this service are established on this routine prior to discharge. A study involving traumatic and non-traumatic SCI patients reported that older patients were more likely to have poorer bowel functioning (3), but there is no influence of gender on autonomy in bowel management (31). Achieving controlled continence, however, was not specified, and autonomy was not clearly defined.

Bladder Management

Most (62%, $n = 39$) patients in this study were discharged without an indwelling catheter (IDC), and this was not associated with age. Others, however, have reported that older traumatic and nontraumatic SCI patients are more likely to have an IDC (3). A previous study of traumatic SCI patients also reported that older patients have higher rates of IDC at discharge, and those with an IDC were more likely to be discharged to a nursing home (12).

The bladder management in 26 patients with tetraplegia with unspecified etiologies of SCI and aged older than 60 years at the time of their SCI reported that 50% (10/20) of men were catheter free, 1 was performing IMCs, and 9 had an IDC (46). Four female patients were catheter free, and 2 were performing IMCs. No comparison was made with patients younger than 60 years regarding their bladder management strategies. The authors stated that the management of neurogenic bladder in elderly SCI patients is more challenging. The reasons given for this opinion were (a) decreased ability of the elderly to cope with a new situation; (b) pre-existing conditions that interfere with micturition, such as prostate hypertrophy and cystocoele; (c) delayed and weak detrusor reflex; and (d) the belief among doctors and nurses that continuous IDC drainage is a safe and comfortable solution for this group of patients.

The clinical experience at Caulfield General Medical Centre supports the first 3 of the authors' assertions referred to above, although large cystoceles that interfere with IMCs are extremely rare and significant prostatic enlargement is amenable to surgery. In the spinal unit's experience, planning and organizational difficulties in patients that make learning to perform an IMC impractical are not uncommon. Additional reasons noted for patients not being able to manage IMCs are problems with vision and upper limb dexterity, especially related to arthritis.

The practice of the spinal unit, however, does not reflect the opinion of the authors referred to above about assumptions of risks associated with an IDC. The aim of the unit concerning bladder management is to always try and avoid an IDC. Using a patient-centered approach, education of patients allows them to make an informed decision on the best option for the management of their neurogenic bladder. Many patients indicate a preference to accept the increased risks associated with having an IDC. There are numerous practical advantages of having an IDC and not performing IMCs, including reduced energy demands and fatigue associated with frequent transfers and practical issues related to toilet access in the wider community. In addition, many nursing homes do not have the resources to perform routine IMCs on patients. An IDC allows patients to be dry and to avoid the increased risk of PUs associated with urinary incontinence.

A recent study reported no influence of gender on bladder management strategy (31), whereas earlier studies reported that women with traumatic SCI are more likely to use an IDC and men are more likely to use condom drainage (24,47). There were no gender differences in this study of nontraumatic SCI regarding bladder management strategies.

Mobility

At discharge, most (58%, $n = 36$) patients in this study were walking at least 10 m, with or without a gait aid, and age did not have an influence on being able to walk.

This contrasts with studies of patients with traumatic SCI that have found otherwise. A study of the recovery of ambulation in patients with incomplete tetraplegia due to traumatic SCI found that age had a significant influence on being able to walk at least 50 feet at discharge after rehabilitation (48). Patients younger than 50 years of age with an ASIA C SCI on admission were more than twice as likely as those who were more than age 50 years to be able to walk at discharge. A study on the recovery of function after traumatic SCI resulting in central cord syndrome likewise found that younger patients were more likely to regain walking (16). A matched study of patients with traumatic and non-traumatic SCI also found that younger patients were more likely to regain walking ability (3).

A matched study examining gender-related differences in rehabilitation of patients with SCI reported no gender differences in mobility using the Rivermead Mobility Index or the Walking Index for SCI (31). This study did not find any gender-related differences in mobility outcomes for nontraumatic SCI patients.

Disability

Previous studies have reported conflicting results concerning the influence of age on disability after SCI rehabilitation. An early study of traumatic SCI reported that older patients do not have more disability on admission or discharge, compared with younger patients (15). A recent study of 6,128 patients at least 1 year post traumatic SCI reported that older age was associated with worse self-reported disability, life satisfaction, and overall handicap. After controlling for demographic and medical characteristics, however, the amount of variance that was attributed to age was relatively small (45).

Numerous studies, however, have reported that older age does have an adverse impact on disability after SCI. A study that controlled for the level and completeness of SCI in 2,169 patients with traumatic paraplegia found that age was associated with disability (43). The study reported that despite older patients' having a higher motor index score on admission and no significant difference regarding their motor index change scores compared with younger patients, that older patients had lower FIM scores, both on admission and discharge. A study of 1,074 traumatic SCI patients matched for age, level and completeness of injury reported that there was no significant difference in FIM motor scores on admission, but at discharge younger patients had significantly higher scores (26). Two studies that matched patients with traumatic and nontraumatic SCI on their level and ASIA grade have also examined the influence of age on disability (3,20). It was reported that patients with traumatic SCI had a greater improvement in disability than patients with nontraumatic SCI during inpatient rehabilitation, when measured by FIM motor scores (20). Patients older than 50 years were reported to have less improvement in disability during rehabilitation and more

severe disability at discharge, as measured by the Barthel Index (3), but there was no influence of age on admission disability. A study of traumatic and nontraumatic SCI involving patients matched for level and ASIA grade reported that patients younger than 60 years had less disability at discharge, as measured by the FIM, and a greater improvement during rehabilitation (19).

Previous studies in traumatic SCI (26) and a matched sample of traumatic and nontraumatic SCI patients (31) have shown that there is no influence of gender on disability after SCI measured using the Barthel Index (31) or FIM scores (26). A study of 14,433 patients from the Model Spinal Cord Injury Systems examined the effects of gender on recovery after traumatic SCI (30). It was reported that there were some statistically significant gender differences in disability. For those with complete SCI, men tended to have higher FIM motor scores at discharge. In patients with incomplete SCI, however, there were no differences, except in 1 subgroup in which women had significantly greater improvement. By 1 year post injury, however, in most comparisons there were no differences. The study, however, analyzed results using the raw FIM scores and not the Rasch-transformed FIM scores, which may have influenced the findings. In addition, it was not reported whether the FIM differences were functionally significant. The present study of nontraumatic SCI patients did not find any gender influences on the Rasch-converted FIM scores.

Nursing Home Discharge

In this study the following variables were associated with discharge to a nursing home after inpatient rehabilitation: female, unable to walk >10 m, urinary catheter, fecal incontinence, complete SCI, more complications, having a pressure ulcer, and lower FIM motor and cognitive subscale scores on admission and discharge. It was not possible to determine which variables were the most important because of the small sample size.

Many studies of traumatic SCI have reported that age is a significant predictor of discharge to nursing home (11,12,18,22,43). Other factors that have been reported to influence nursing home discharge include having an IDC, being unmarried, and having tetraplegia (22). Some authors, however, have not found a relationship between age and nursing home discharge in SCI patients (19). In a study of traumatic and nontraumatic SCI in which patients were matched for neurological level and ASIA grade, there was no report of any significant effect of age on discharge to a nursing home (20). This present study found that age did not have a significant influence on discharge of patients with nontraumatic SCI to nursing homes.

Previous studies have not reported any gender differences concerning discharge to nursing home after SCI (26,31). This present study, by contrast, found that there were significantly more women who required nursing home care. This may be because women tended

to be older and live alone prior to their nontraumatic SCI, compared with men, who are more likely to have a spouse to care for them.

The FIM cognition subscale has a strong ceiling effect in nontraumatic SCI, with most patients attaining the maximum score at both admission and discharge (4). This limits the utility of the cognition subscale because it lacks sensitivity in detecting meaningful change. In this study the admission and discharge FIM cognition subscale scores were significantly lower in patients who were discharged to a nursing home. Therefore, the FIM cognition subscale score may be useful in identifying which patients are more likely to require nursing home placement.

Methodology Issues

Most studies that examine the influence of age on SCI outcomes have divided patients into age groups. Previous studies have used the following ages as cut-offs for what they considered to be an older or elderly patient with SCI: 50 years (3,16,21,48), 55 years (12,49), 60 years (15,19,20) and 65 years (18). In addition, some studies have separated patients into groupings with 3 (18,19,26), 4 (15), 5 (11), 6 (22), 7 (45), and 11 (43) age ranges. The studies referred to above used parametric statistics for ordinal variables, whereas this study did not follow this approach because converting continuous data to ordinal groups and using parametric statistical tests to analyze the results lead to numerous concerns and is not recommended for statistical analysis (50). The concerns include the following: loss of power, increased chance of false-negative results, underestimating the variation in outcomes between groups, and an increased chance of concealing a nonlinear relationship between variables.

Study Implications

The methodological issues highlighted above suggest that SCI research needs to improve the approaches to analyzing the age of patients. To facilitate comparisons between different studies, there is a need for uniform agreement about what is considered an older or elderly person with SCI. Whether the same age is used as cut-off for both traumatic and nontraumatic SCI or whether different ages are used also needs to be decided.

It is suggested that the same cut-off age be used for both traumatic and nontraumatic SCI to make valid comparisons between groups. In this case, a decision on the age cut-off will need to consider the very different patterns of distribution regarding the typical age of patients at the onset of traumatic and nontraumatic SCI. It is suggested that these issues are important enough to be decided upon by a process that has an international approach, with relevant SCI rehabilitation organizations, and also involves the editors of the major peer-reviewed SCI and rehabilitation journals.

Because this present study showed that older nontraumatic SCI patients had comparable outcomes to

younger patients, there is a need to ensure that the training of rehabilitation and acute health care professionals acknowledges the rehabilitation potential of older patients with nontraumatic SCI. This applies especially to the decision about whether to refer for rehabilitation after the onset of nontraumatic SCI. It is suggested that whenever there is any uncertainty about the appropriateness of referring a patient with nontraumatic SCI for rehabilitation, the decision should ideally be deferred to a clinician experienced in the rehabilitation of these patients.

Further studies are needed involving nontraumatic SCI patients on the influences of age and gender on the variables studied in this paper to address the limitations due to the small sample size, which are discussed below. Additional studies are needed to explore further the factors influencing discharge of patients to a nursing home after nontraumatic SCI. In particular, studies are needed to examine whether the admission FIM cognition subscale score could be helpful in identifying which patients with nontraumatic SCI are more likely to require nursing home placement. Although not the subject of this paper, it is apparent that there is a need for longitudinal studies on nontraumatic SCI concerning life expectancy and the effect of aging on functioning, as has been done for traumatic SCI (27,28,51–53).

Based on clinical plausibility and the omission of longitudinal studies from the present study, it is suggested that future studies of age and gender in nontraumatic SCI include caregiver availability and comorbid disease severity as variables influencing discharge destination.

Study Limitations

The present study has some limitations. As with all retrospective studies, inaccuracies due to incorrect or incomplete documentation may occur in patients' medical files. In addition, the number of subjects in this study is relatively small, which increased the chances of type-II errors occurring.

The assessment of the relationship between mortality and age in this study is limited. This study only included patients with nontraumatic SCI who survived acute hospital admission and were admitted into the rehabilitation unit. A formal study of the influence of age and other factors influencing survival after nontraumatic SCI would need to include all patients admitted into acute hospitals with nontraumatic SCI and those that developed nontraumatic SCI while in an acute hospital.

This study is based on data that are almost 10 years old. It is believed, however, that these data are still relevant and useful because this is the first study to explore the issues of age and gender in nontraumatic SCI to the detail reported here. In addition, it is the author's clinical impression that little has changed in the local health care system to appreciably alter the results reported.

Because these results reflect the practice and referral pattern of only 1 center, the generalizability of the findings is limited. Patients with nontraumatic SCI who are not admitted to the spinal unit would include the following: patients with a very mild nontraumatic SCI who recover quickly at the acute hospital and do not need inpatient rehabilitation; patients who die at the acute hospital; those who have a poor prognosis for rehabilitation and are transferred directly to a nursing home, hospice, or palliative care unit; and those patients who are managed at other institutions.

CONCLUSION

In adults with nontraumatic SCI, most outcomes are not influenced by patients' advancing age or their gender. Older patients were more likely to be women, develop a PU, require more support services after discharge or need nursing home placement, and have lower FIM motor and cognitive subscale scores at discharge. Age alone should not be used as a discriminator of ability to benefit from nontraumatic SCI rehabilitation.

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REFERENCES

- McKinley WO, Seel RT, Hardman JT. Nontraumatic spinal cord injury: incidence, epidemiology, and functional outcome. *Arch Phys Med Rehabil*. 1999;80:619–623.
- Celani MG, Spizzichino L, Ricci S, Zampolini M, Franceschini M. for the retrospective study group on SCI. Spinal cord injury in Italy: a multicenter retrospective study. *Arch Phys Med Rehabil*. 2001;82:589–596.
- Scivoletto G, Morganti B, Ditunno P, Ditunno JF, Molinari M. Effects on age on spinal cord lesion patients' rehabilitation. *Spinal Cord*. 2003;41:457–464.
- New PW. Functional outcomes and disability after nontraumatic spinal cord injury rehabilitation: results from a retrospective study. *Arch Phys Med Rehabil*. 2005;86:250–261.
- Schönherr MC, Groothoff JW, Mulder GA, Eisma WH. Rehabilitation of patients with spinal lesions in The Netherlands: an epidemiological study. *Spinal Cord*. 1996;34:679–683.
- Benedict RC, Ganikos ML. Coming to terms with ageism in rehabilitation. *J Rehabil*. 1981;47:10–18.
- Hesse KA, Champion EW, Karamouz N. Attitudinal stumbling blocks to geriatric rehabilitation. *J Am Geriatr Soc*. 1984;32:747–750.
- Federal Interagency Forum on Aging Related Statistics. Older Americans 2000: key indicators of wellbeing. Washington, DC: US Government Printing Office; 2000.
- Report of the Second World Assembly on Ageing. Madrid, April 8–12, 2002. A/CONF.197/9. Sales No. E.02.IV.4. United Nations. New York, 2002. Available at: <http://www.un.org/ageing/documents.htm>. Accessed November 21, 2006.
- Rochon PA, Katz JN, Morrow LA, et al. Comorbid illness is associated with survival and length of hospital stay in patients with chronic disability: a prospective comparison of three comorbidity indices. *Med Care*. 1996;34:1093–1101.
- DeVivo MJ, Kartus PL, Rutt RD, Stover SL, Fine PR. The influence of age at time of spinal cord injury on rehabilitation outcome. *Arch Neurol*. 1990;47:687–691.
- Roth EJ, Lovell L, Heinemann AW, Lee MY, Yarkony GM. The older adult with a spinal cord injury. *Paraplegia*. 1992;30:520–526.
- Villanueva NE. Spinal cord injury in the elderly. *Crit Care Nurs Clin North Am*. 2000;12:509–519.
- Watson N. Pattern of spinal cord injury in the elderly. *Paraplegia*. 1976;14:36–40.
- Yarkony GM, Roth EJ, Heinemann AW, Lovell LL. Spinal cord injury rehabilitation outcome: the impact of age. *J Clin Epidemiol*. 1988;41:173–177.
- Penrod LE, Hegde SK, Ditunno JF Jr. Age effect on prognosis for functional recovery in acute, traumatic central cord syndrome. *Arch Phys Med Rehabil*. 1990;71:963–968.
- McKinley W, Cifu D, Seel R, et al. Age-related outcomes in persons with spinal cord injury: a summary paper. *Neuro-rehabilitation*. 2003;18:83–90.
- Cifu DX, Seel RT, Kreutzer JS, McKinley WO. A multicenter investigation of lengths of stay, hospital charges, and outcomes for a matched tetraplegia sample. *Arch Phys Med Rehabil*. 1999;80:733–740.
- Seel RT, Huang ME, Cifu DX, Kolakowsky-Hayner SA, McKinley WO. Age-related differences in length of stays, hospitalization costs, and outcomes for an injury-matched sample of adults with paraplegia. *J Spinal Cord Med*. 2001;24:241–250.
- McKinley WO, Seel RT, Gadi RK, Tewksbury MA. Nontraumatic vs. traumatic spinal cord injury: a rehabilitation outcome comparison. *Am J Phys Med Rehabil*. 2001;80:693–699.
- Scivoletto G, Morganti B, Molinari M. Neurological recovery of spinal cord injury in Italy. *Arch Phys Med Rehabil*. 2004;85:485–489.
- DeVivo MJ. Discharge disposition from model spinal cord injury care system rehabilitation programs. *Arch Phys Med Rehabil*. 1999;80:785–790.
- Dijkers MP, Adela MB, Gans BM, Gordon WA. The aftermath of spinal cord injury. In: Stover S, DeLisa J, Whiteneck G, eds. *Spinal Cord Injury: Clinical Outcomes From the Model Systems*. Gaithersburg, MD: Aspen Publishers; 1995:185–212.
- Shackelford M, Farley T, Vines CL. A comparison of women and men with spinal cord injury. *Spinal Cord*. 1998;36:337–339.
- Krause JS, Kemp B, Coker J. Depression after spinal cord injury: relation to gender, ethnicity, aging, and socioeco-

- nomnic indicators. *Arch Phys Med Rehabil.* 2000;81:1099–1109.
26. Greenwald BD, Seel RT, Cifu DX, Shah AN. Gender-related differences in acute rehabilitation lengths of stay, charges, and functional outcomes for a matched sample with spinal cord injury: a multicenter investigation. *Arch Phys Med Rehabil.* 2001;82:1181–1187.
 27. McColl MA, Charlifue SW, Glass C, Lawson N, Savic G. Aging, gender, and spinal cord injury. *Arch Phys Med Rehabil.* 2004;85:363–367.
 28. Krause JS, Broderick L. Outcomes after spinal cord injury: comparisons as a function of gender and race and ethnicity. *Arch Phys Med Rehabil.* 2004;85:355–362.
 29. Cardenas DD, Bryce TN, Shem K, Richards JS, Elhefni H. Gender and minority differences in the pain experience of people with spinal cord injury. *Arch Phys Med Rehabil.* 2004;85:1774–1781.
 30. Sipski ML, Jackson AB, Gómez-Marín O, Estores I, Stein A. Effects of gender on neurologic and functional recovery after spinal cord injury. *Arch Phys Med Rehabil.* 2004;85:1826–1836.
 31. Scivoletto G, Morganti B. Sex-related differences of rehabilitation outcomes of spinal cord lesion patients. *Clinical Rehabil.* 2004;18:709–713.
 32. Disability, ageing and carers, Australia: summary of findings. 2003. Catalogue no 4430.0. Australian Bureau of Statistics, Canberra, 2004. Available at: <http://www.abs.gov.au/Ausstats/abs@.nsf/mf/4430.0>. Accessed November 21, 2006.
 33. Penning MJ, Strain LA. Gender differences in disability, assistance, and subjective well-being in later life. *J Gerontol.* 1994;49:S202–S208.
 34. Arber S, Cooper H. Gender differences in health in later life: the new paradox? *Soc Sci Med.* 1999;48:61–76.
 35. Jagger C, Arthur AJ, Spiers NA, Clarke M. Patterns of onset of disability in activities of daily living with age. *J Am Geriatr Soc.* 2001;49:404–409.
 36. New PW, Rawicki HB, Bailey MJ. Nontraumatic spinal cord injury: demographic characteristics and complications. *Arch Phys Med Rehabil.* 2002;83:996–1001.
 37. New PW, Rawicki HB, Bailey MJ. Nontraumatic spinal cord injury rehabilitation: pressure ulcer patterns, prediction, and impact. *Arch Phys Med Rehabil.* 2004;85:87–93.
 38. Maynard FM, Bracken MB, Creasey G, et al. International Standards for Neurological and Functional Classification of Spinal Cord Injury. *Spinal Cord.* 1997;35:266–274.
 39. Guide for the Uniform Data Set for Medical Rehabilitation (including the FIM instrument), version 5.1. Buffalo, NY: State University of New York at Buffalo; 1997.
 40. Linacre JM, Heinemann AW, Wright BD, Granger CV, Hamilton BB. The Functional Independence Measure as a measure of disability. Research Report 91–01. Chicago, IL: Rehabilitation Services Evaluation Unit, Rehabilitation Institute of Chicago; 1991.
 41. Heinemann AW, Linacre JM, Wright BD, Hamilton BB, Granger CV. Relationships between impairment and physical disability as measured by the Functional Independence Measure. *Arch Phys Med Rehabil.* 1993;74:566–573.
 42. Heinemann AW, Hamilton BB, Granger CV, et al. Rating scale analysis of functional assessment measures: National Institute on Disability and Rehabilitation Research. Final Report; 1991.
 43. Cifu DX, Huang ME, Kolakowsky-Hayner SA, Seel RT. Age, outcome and rehabilitation costs after paraplegia caused by traumatic injury of the thoracic spinal cord, conus medullaris and cauda equina. *J Neurotrauma.* 1999;16:805–815.
 44. Eastwood EA, Hagglund KJ, Ragnarsson KT, Gordon WA, Marino RJ. Medical rehabilitation length of stay and outcomes for persons with traumatic spinal cord injury 1990–1997. *Arch Phys Med Rehabil.* 1999;80:1457–1463.
 45. Putzke JD, Barrett JJ, Richards JS, DeVivo MJ. Age and spinal cord injury: an emphasis on outcomes among the elderly. *J Spinal Cord Med.* 2003;26:37–44.
 46. Madersbacher G, Oberwalder M. The elderly para- and tetraplegic: special aspects of the urological care. *Paraplegia.* 1987;25:318–323.
 47. Jackson AB, DeVivo MJ. Urological long-term follow-up in women with spinal cord injuries. *Arch Phys Med Rehabil.* 1992;73:1029–1035.
 48. Burns SP, Golding DG, Rolle WA Jr, Graziani V, Ditunno JF Jr. Recovery of ambulation in motor-incomplete tetraplegia. *Arch Phys Med Rehabil.* 1997;78:1169–1172.
 49. Kennedy P, Evans MJ, Berry C, Mullin J. Comparative analysis of goal achievement during rehabilitation for older and younger adults with spinal cord injury. *Spinal Cord.* 2003;41:44–52.
 50. Altman DG, Royston P. The cost of dichotomising continuous variables. *BMJ.* 2006;332:1080.
 51. Liem NR, McColl MA, King W, Smith KM. Aging with a spinal cord injury: factors associated with the need for more help with activities of daily living. *Arch Phys Med Rehabil.* 2004;85:1567–1577.
 52. Kemp BJ, Adkins RH, Thompson L. Aging with a spinal cord injury: what recent research shows. *Top Spinal Cord Inj Rehabil.* 2004;10:175–197.
 53. Capoor J, Stein AB. Aging with spinal cord injury. *Phys Med Rehabil Clin N Am.* 2005;16:129–161.