Spinal Cord (2011) 49, 909–916

www.nature.com/sc

ORIGINAL ARTICLE

Comparison of patients managed in specialised spinal rehabilitation units with those managed in non-specialised rehabilitation units

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Study design: Prospective open cohort study.
Objective: Compare the demographic characteristics and rehabilitation outcomes for both non-traumatic SCI (NT-SCI) and traumatic SCI (T-SCI) patients admitted into either specialist spinal cord injury rehabilitation units (SCIRUs) or non-specialist rehabilitation units (NSRUs).
Setting: Rehabilitation units in Australia.
Methods: The Australasian Rehabilitation Outcomes Centre maintains a national database on inpatients admitted to most (130/145) public and private rehabilitation units in Australia. Patients were included if they had a diagnosis of spinal cord injury (SCI) and were discharged between 1 January 2006 and 31 December 2006. Patients were excluded if admitted for <7 days, only for assessment, or were a readmission following a previous SCI.
Results: There were 668 patients with confirmed SCI admitted (NT-SCI $n=361$, 54.0%; T-SCI $n=307$, 46.0%). NT-SCI patients were much less likely to be admitted into a specialist SCIRU (30.5%) compared with T-SCI patients (70.4%). For both NT-SCI and T-SCI patients, those admitted to a specialist SCIRU tended to be younger ($P=0.000$), have a longer length of stay in rehabilitation ($P=0.000$), and lower Functional Independence Measure (FIM) motor subscale score on admission ($P=0.000$) than those admitted to a NSRU. For NT-SCI patients, after adjusting for covariates, those admitted into specialist SCIRU had greater improvement in their FIM motor score during rehabilitation. This finding was not demonstrated in T-SCI patients.
Conclusions: There are differences in the characteristics of SCI patients admitted to SCIRU compared with NSRU. NT-SCI patients admitted to SCIRU have greater functional gain.
Sponsorship: This project was made possible by a major research grant from the Victorian Neurotrauma Initiative. A minor research grant was also provided by the Australasian Faculty of Rehabilitation Medicine 2007 Ipsen research scholarship. The authors would like to thank these organisations for their support. These organisations had no role in the design, analysis or preparation of this manuscript.
Spinal Cord (2011) **49**, 909–916; doi:10.1038/sc.2011.29; published online 5 April 2011

Keywords: spinal cord injury; non-traumatic spinal cord injury; outcomes; epidemiology; rehabilitation; specialisation

Introduction

Spinal cord injury (SCI) or damage requires optimal care to reduce the chance of secondary complications that can have an adverse impact on patient outcomes. Because of 'poorer results obtained when SCI patients were managed sporadically in small numbers in non-specialised departments'[1] it is now accepted best practice to treat acute traumatic SCI (T-SCI) patients in specialist Spinal Injury Units.[2,3] In some regions, there are specialist spinal cord injury rehabilitation units (SCIRUs) that focus on the rehabilitation of patients with SCI after the acute hospital phase has occurred elsewhere. Some specialist SCIRUs are formally linked with a Spinal Injury Units, while others are independent, but have informal ties to acute hospitals and non-specialist rehabilitation units (NSRUs) in their region.

A coordinated system of care for T-SCI reduces complications,[4–6] time from onset of SCI until admission into

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Received 27 November 2010; revised 18 February 2011; accepted 2 March 2011; published online 5 April 2011

rehabilitation,[7] length of stay (LOS),[8] costs[5,9] and improves the efficiency of rehabilitation,[7] when compared with alternative systems of health care delivery.

Although the incidence of non-traumatic SCI (NT-SCI) is reported to be higher than that of T-SCI,[10] in contrast to the management of T-SCI, the management of NT-SCI patients is more fragmented and much less co-ordinated. The consensus opinion from rehabilitation physicians strongly recommends that NT-SCI patients should have access to specialist SCI rehabilitation services.[11] Only a few studies that include NT-SCI patients have reported the outcomes for those patients who were not admitted to a specialist SCIRU.[12,13] None of these used a population-based study design. These studies are also limited by the relatively small number of NT-SCI patients in the study samples. These issues raise concerns about the potential for type-II error and a lack of generalisability because of selection bias.

This project planned to perform a prospective open cohort study using a population-based national database of rehabilitation inpatients to compare the demographic characteristics and rehabilitation outcomes for both NT-SCI and T-SCI patients admitted into either specialist SCIRU or NSRU.

Methods

Setting and participants

The Australasian Rehabilitation Outcome Centre (AROC) was established in 2002 as an initiative of the Australian rehabilitation sector that included providers, payers, regulators and consumers (http://chsd.uow.edu.au/aroc/). AROC maintains a national database on inpatients admitted to both public and private rehabilitation hospitals in Australia.[14,15] By 2006, the coverage included 130 of the 145 rehabilitation units in Australia. Six of the seven designated SCIRU in Australia submitted data to AROC in 2006. AROC uses separate impairment classification codes for T-SCI and NT-SCI.

In Australia, a major proportion of inpatient rehabilitation occurs in private, for-profit hospitals.[15] Private rehabilitation hospitals in Australia have a strong financial incentive to limit the LOS of patients with a neurological impairment to 4–5 weeks. This is because the private health insurers impose a major step-down in the daily reimbursement after this point. This restriction, however, does not apply to patients covered by workers compensation and motor vehicle accident schemes, where no such financial incentive is in place. Patients admitted to public rehabilitation units in Australia have no restrictions on their LOS by third parties. There are no private specialist SCIRU in Australia.

Data submitted to AROC is compiled according to a standard dataset of items. Data received by AROC is reviewed for any missing data, errors or inconsistencies. An audit report is then provided to each facility with the request that highlighted episodes be reviewed and amended if necessary. Revised results are resubmitted to AROC. The Functional Independence Measure (FIM)[16] is the most widely used, valid and reliable tool for measuring the severity of disability and rehabilitation outcomes, including SCI. It is one of the main outcome measures in the AROC dataset. Staff using the FIM are required to be appropriately trained in its' use and to sit a credentialing examination every 2 years. The above processes are designed to optimise the quality of the data in the AROC database.

Patients included in this study have been described previously as part of a larger cohort that compared T-SCI and NT-SCI patients admitted between 2002 and 2006.[17] Only patients discharged between 1 January 2006 and 31 December 2006 were included in this study. Patients were excluded if they were admitted for <7 days, admitted only for assessment, or were recorded as a readmission for management of late complications and not a recent onset SCI.

Variables

Demographic details and outcome information were extracted from the AROC dataset for patients with SCI. The demographic information included age on admission, gender, usual accommodation and living arrangements before admission. Clinical and outcome information included the level of injury (paraplegia vs tetraplegia), LOS in rehabilitation, accommodation and living arrangements after discharge, and the admission and discharge motor subscale of the FIM.

The accommodation location was classified as either private or 'other', because of the relatively small numbers in the other options (hostel, nursing home, community, boarding house, transitional care and so on). The living arrangements were classified as either alone, spouse, family with or without spouse and other. The cognitive subscale of the FIM was not included as an outcome measure because of the high-ceiling effect in T-SCI and in NT-SCI patients.[17,18]

Data quality

There were 1026 discharges with recent onset SCI reported from 94 of the 130 (74.3%) participating rehabilitation units in 2006. In a desire to ascertain the quality of the data and verify the classification of SCI diagnoses, it was planned to conduct a limited audit. All units who submitted reports on SCI patients to AROC for 2006 were asked to review their medical file notes for these patients. Units were requested to confirm the following: (1) that the patient had an admission for a new onset SCI, (2) whether the aetiology was T-SCI or NT-SCI and (3) the level and completeness of SCI according to the AROC classification codes (http://chsd.uow.edu.au/aroc/documents/aroc_mds_version3_impairment_codes.pdf). This request was repeated on three occasions over a 4-month period to try and optimise the response rate.

In total, 34 of the 94 (36.2%) units that admitted SCI patients responded to the audit request. These hospitals reviewed 766 (74.7%) of the reported SCI episodes. A total of 98 (9.5%) episodes had their impairment code changed from SCI to another code or were not a recent onset SCI, 30 (2.9%) were changed from TSCI to NTSCI and 51 (5.0%) were changed from NTSCI to TSCI. There were 221 (21.5%) changes in the coding for level or completeness of injury within the same aetiology group, most of which were not felt

to be of clinical significance. Only the confirmed episodes of recent onset SCI (with any amended changes) were included in the analysis present here. The non-responder episodes had approximately the same proportion of patients as those included in the study cohort regarding aetiology of SCI and setting of treatment.

Statistical methods

For both patients with T-SCI and NT-SCI, it was planned to compare the demographic characteristics and rehabilitation outcomes depending on the setting where patients received their rehabilitation. As it was perceived that SCI patients admitted to private rehabilitation hospitals may have different characteristics, for the reasons outlined above, it was planned to analyse the data separately for those admitted to a public or private NSRU, as well as specialist SCIRU.

Categorical outcomes (for example, gender, level of SCI) were analysed using the χ^2-test. The Mann–Whitney test was used to analyse differences in non-normally distributed data, such as age, LOS and FIM motor subscale scores.

Univariate analysis of variance (ANOVA) was performed separately for NT-SCI and T-SCI patients to determine whether the setting where patients received rehabilitation (specialist SCIRU, public NSRU or private NSRU) had an influence on either (a) the FIM motor change (between admission and discharge) or, (b) LOS, after controlling for the following covariates: age, gender, FIM motor admission, level of injury (paraplegia vs tetraplegia), premorbid living arrangements before SCI (home alone vs other) and discharge home. LOS was also included as a covariate in the FIM motor change analysis. All covariates were initially included in the analysis. For each analysis those covariates that had no significant influence on the model were removed. Where the model was found to be significant (at least one setting different to at least one other setting) pairwise multiple comparisons were made using the Least Significant Difference technique to determine which setting had the significant differences.

P values of <0.05 were deemed statistically significant. Any missing data were excluded from analysis relevant only to that field. The LOS and FIM results excluded those episodes where the patient died during inpatient rehabilitation. We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research.

Results

A total of 668 patients with confirmed SCI were discharged from participating units during the study period. Of these, 361 (54%) had a NT-SCI and 307 (46%) had a T-SCI. The number of patients admitted to the different settings, their demographic characteristics, LOS, and accommodation and living arrangements at admission and discharge are shown in Table 1. Although as a group most SCI patients were managed in a NSRU, there was a much greater median number of SCI patients per unit cared for in specialised SCIRU than in NSRU, for both NT-SCI and T-SCI patients. For both NT-SCI and T-SCI patients there were significant differences between the different settings of rehabilitation regarding the age of patients on admission, their living arrangements at admission and discharge, and their LOS in rehabilitation.

NT-SCI patients admitted to a specialist SCIRU tended to be significantly more disabled than those admitted to NSRU, as measured by the motor subscale of the FIM, and they had a greater change in the FIM motor subscale during their admission (Table 2). Likewise, T-SCI patients admitted into specialist SCIRU tended to be significantly more disabled than those admitted to NSRU. However, in contrast to NT-SCI patients, there were no differences in the FIM motor change during rehabilitation of SCI patients in either a SCIRU or NSRU (Table 3).

The ANOVA comparing the influence of the setting of rehabilitation on the LOS was significant for both NT-SCI ($F=12.207$, $P<0.000$) and T-SCI ($F=11.505$, $P<0.000$). The FIM motor subscale score on admission was the only covariate that remained significant in the ANOVA model for LOS for both NT-SCI ($\beta=-0.828$, $t=-6.212$, $P=0.000$) and T-SCI patients ($\beta=-1.084$, $t=-4.651$, $P=0.000$). For both groups of patients, after adjusting for the FIM motor subscale on admission, there were significant differences in the LOS between the different settings of rehabilitation. Pairwise multiple comparisons resulting from these models are shown in Table 4. Patients admitted to specialist SCIRU were found to have a significantly longer LOS than those in NSRU. There was no difference between NSRU patients, either in public or private hospitals.

The ANOVA comparing the influence of the setting of rehabilitation on the FIM motor change was significant for both NTSCI ($F=5.088$, $P=0.007$) and TSCI ($F=3.160$, $P=0.045$). Pairwise multiple comparisons resulting from these models are shown in Table 5. For NTSCI patients, the covariates that remained significant in the ANOVA model for FIM motor change was FIM motor score on admission ($\beta=10.881$, $t=3.404$, $P=0.001$) and discharge home ($\beta=-0.246$, $t=-3.682$, $P<0.000$). There was no significant difference between the two general settings (typical change in motor score of 13.0 for public NSRU and 14.5 in private NSRU), but there was generally a much greater improvement achieved by admission to a specialist SCIRU (change in motor score 21.3 points on the FIM motor subscale).

For TSCI patients, the covariates that remained significant in the ANOVA model for FIM motor change were paraplegia ($\beta=-12.671$, $t=-4.218$, $P<0.000$), discharge home ($\beta=22.908$, $t=6.552$, $P<0.000$) and FIM motor score on admission ($\beta=-0.529$, $t=-6.772$, $P<0.000$). Although the model was significant, there was no difference found between the settings. Typically, the change in FIM motor score was higher in a SCIRU than in the NSRUs.

Discussion

We have shown that most SCI patients in Australia are admitted to a NSRU, rather than a specialist SCIRU. There are

Table 1 Demographic characteristics, LOS, accommodation and living arrangements of SCI patients

	NT-SCI				*T-SCI*			
	SCIRU	*Public NSRU*	*Private NSRU*	P	*SCIRU*	*Public NSRU*	*Private NSRU*	P
Episodes	110	151	100		216	50	41	
Units	6	39	33		6	25	24	
Episode/unit median, (IQR)[a]	13.5, (10.8–30)	3, (2–6)	2, (1–3)	$Z=19.3$, $P=0.000$	41, (20.3–49.3)	2, (1–2)	1, (1–2)	$Z=19.1$, $P=0.000$
Age median (IQR)[a]	57.0, (45.0–68.3)	67.0, (52.0–77.0)	72.0, (59.0–81.0)	$Z=38.5$, $P=0.000$	42.0, (25.0–59.0)	58.0, (40.5–74.5)	71.0, (56.6–77.5)	$Z=45.8$, $P=0.000$
Males[b]	60.0%	49.7%	44.0%	$\chi^2=5.6$, $P=0.06$	85.6%	62.0%	56.1%	$\chi^2=26.2$, $P=0.000$
Premorbid accommodation[b,c,d]								
Private	93.4%	97.0%	98.9%	$\chi^2=9.6$, $P=0.2$	96.3%	100%	100%	$\chi^2=3.3$, $P=0.50$
Other (%)	6.5	3.0	1.1		3.7	0	0	
Premorbid living arrangements[b,e]								
Alone	21.6%	28.1%	35.6%	$\chi^2=36.9$, $P=0.000$	23.1%	25.0%	34.2%	$\chi^2=36.4$, $P=0.000$
Spouse (%)	26.1	52.8	47.8		21.0	53.1	52.6	
Family ± spouse (%)	48.9	19.1	14.4		47.9	18.7	13.2	
Other (%)	3.4	0	2.2		8.0	3.1	0	
LOS median (IQR)[a]	54.0, (23.0–85.0)	22.0, (13.0–42.0)	18.5, (12.0–31.8)	$Z=56.4$, $P=0.000$	88.5, (35.3–134.0)	27.5, (17.0–41.3)	20.0, (14.5–32.0)	$Z=77.6$, $P=0.000$
Discharge accommodation[b,c,f]								
Private	81.6%	83.5%	85.4%	$\chi^2=0.5$, $P=0.8$	77.2%	82.9%	77.8%	$\chi^2=0.5$, $P=0.8$
Other (%)	18.4	16.5	14.6		22.8	17.1	22.2	
Discharge living arrangements[b,g]								
Alone	22.5%	20.5%	32.4%	$\chi^2=18.2$, $P=0.006$	24.2%	26.1%	25.0%	$\chi^2=20.5$, $P=0.002$
Spouse (%)	31.0	51.3	49.3		24.2	52.2	40.6	
Family ± spouse (%)	43.6	25.7	14.1		47.6	17.4	18.8	
Other (%)	2.8	2.6	4.2		4.0	4.3	15.6	

Abbreviations: IQR, interquartile range; LOS, length of stay; NSRU, non-specialist rehabilitation unit; NT-SCI, non-traumatic spinal cord injury; SCIRU, spinal cord injury rehabilitation unit; T-SCI, traumatic spinal cord injury.

[a]Kruskal–Wallis test.

[b]χ^2-test.

[c]Accommodation other = hostel, nursing home, transitional living unit, other.

[d]Premorbid accommodation missing: NT-SCI $n=26$ (7.2%); T-SCI $n=6$ (2.0%).

[e]Premorbid living arrangements missing: NT-SCI $n=56$ (17.3%); T-SCI $n=37$ (12.6%).

[f]Discharge accommodation missing: NT-SCI $n=58$ (16.1%); T-SCI $n=69$ (22.5%).

[g]Discharge living arrangements missing: NT-SCI $n=33$ (13.0%); T-SCI $n=12$ (6.5%).

Table 2 Non-traumatic SCI FIM motor subscale by level of injury

	NT-SCI			
	Specialist SCIRU[a]	*Public NSRU*[b]	*Private NSRU*[c]	P
Total, n	109	147	98	
Admission m-FIM median (IQR)	39.0 (29.0–61.5)	48.0 (30.0–63.0)	61.0 (47.8–69.5)	$Z=20.8$, $P=0.000$
Discharge m-FIM median (IQR)	73.0 (44.5–82.5)	74.0 (49.0–82.0)	78.0 (60.3–84.0)	$Z=4.1$, $P=0.1$
Change m-FIM median (IQR)	18.0 (6.0–34.5)	15.0 (4.0–27.0)	12.0 (4.8–20.0)	$Z=6.9$, $P=0.03$
Paraplegia, n	67	50	31	
LOS median (IQR)	57.0 (29.0–87.0)	25.0 (14.0–58.0)	31.0 (19.0–63.0)	$Z=15.6$, $P=0.000$
Admission m-FIM median (IQR)	40.0 (30.0–58.0)	44.0 (29.0–62.5)	52.0 (27.0–62.0)	$Z=0.2$, $P=0.9$
Discharge m-FIM median (IQR)	72.0 (46.0–81.0)	54.0 (42.0–78.5)	70.0 (34.0–81.0)	$Z=3.2$, $P=0.2$
Change m-FIM median (IQR)	17.0 (5.0–33.0)	8.0 (0.0–20.0)	13.0 (2.5–23.0)	$Z=7.7$, $P=0.02$
Tetraplegia, n	32	21	10	
LOS median (IQR)	60.0 (20.3–84.8)	31.0 (18.0–48.5)	21.5 (10.8–44.8)	$Z=5.0$, $P=0.08$
Admission m-FIM median (IQR)	32.0 (24.0–44.0)	24.0 (18.0–40.0)	52.0 (27.0–62.0)	$Z=2.0$, $P=0.4$
Discharge m-FIM median (IQR)	66.0 (42.0–87.0)	43.0 (25.5–81.0)	61.0 (27.0–74.5)	$Z=3.7$, $P=0.2$
Change m-FIM median (IQR)	18.0 (6.0–40.0)	8.0 (0.0–35.0)	14.0 (3.8–30.5)	$Z=1.9$, $P=0.4$

Abbreviations: IQR, interquartile range; m-FIM, motor subscale Functional Independence Measure; NSRU, non-specialist rehabilitation unit; NT-SCI, non-traumatic spinal cord injury; SCIRU, spinal cord injury rehabilitation unit.
[a]Missing specific level of injury = 10.
[b]Missing specific level of injury = 76.
[c]Missing specific level of injury = 57.

Table 3 Traumatic SCI FIM motor subscale by level of injury

	T-SCI			
	Specialist SCIRU[a]	*Public NSRU*[b]	*Private NSRU*[c]	P
Total, n	213	46	36	
Admission m-FIM median (IQR)	32.0 (19.0–42.0)	36 (22.8–57.3)	52.5 (36.5–62.0)	$Z=23.5$, $P=0.000$
Discharge m-FIM median (IQR)	69.0 (33.0–80.0)	63.5 (35.3–79.3)	75.0 (60.0–81.5)	$Z=2.9$, $P=0.2$
Change m-FIM median (IQR)	18.5 (4.0–44.0)	13.5 (2.8–29)	16.0 (4.8–22.8)	$Z=3.6$, $P=0.2$
Paraplegia, n	91	15	10	
LOS median (IQR)	79.0 (38.0–118.0)	36.0 (22.0–65.0)	20.0 (14.8–32.0)	$Z=16.1$, $P=0.000$
Admission-m-FIM median (IQR)	37.0 (30.0–46.0)	36.0 (25.8–57.3)	48.5 (37.5–58.0)	$Z=2.3$, $P=0.3$
Discharge- m-FIM median (IQR)	76.0 (60.0–80.0)	79.0 (58.3–80.8)	64.0 (44.3–77.8)	$Z=2.6$, $P=0.3$
Change m-FIM median (IQR)	33.0 (11.0–44.0)	20.0 (8.0–45.5)	9.5 (0.5–24.0)	$Z=5.7$, $P=0.06$
Tetraplegia, n	116	9	5	
LOS median (IQR)	102.0 (42.3–147.8)	29.0 (20.0–49.5)	33.0 (8.0–54.0)	$Z=14.1$, $P=0.001$
Admission m-FIM median (IQR)	22.0 (15.5–33.0)	18.0 (13.0–28.0)	33.5 (19.5–64.0)	$Z=2.5$, $P=0.3$
Discharge m-FIM median (IQR)	39.0 (23.0–78.8)	21.0 (18.0–33.0)	52.0 (21.3–76.8)	$Z=3.9$, $P=0.1$
Change m-FIM median (IQR)	9.5 (1.0–47.5)	1.0 (0.0–12.0)	7.0 (1.8–24.3)	$Z=2.4$, $P=0.3$

Abbreviations: IQR, interquartile range; m-FIM, motor subscale Functional Independence Measure; NSRU, non-specialist rehabilitation unit; SCIRU, spinal cord injury rehabilitation unit; T-SCI, traumatic spinal cord injury.
[a]Missing specific level of injury = 6.
[b]Missing specific level of injury = 22.
[c]Missing specific level of injury = 21.

Table 4 Pairwise multiple comparisons from ANOVA comparing the influence of setting of rehabilitation on LOS

SCI	*Reference unit*	*Comparison unit*	*Mean difference, (95% CI)*[a]	*Standard error*	P-*value*
NT-SCI	Specialist SCIRU	NSRU public	26.3, (14.9–37.7)	5.8	0.000
		NSRU private	23.6, (9.9–37.4)	7.0	0.001
	NSRU public	NSRU private	−2.6, (−17.2–11.9)	7.4	0.721
T-SCI	Specialist SCIRU	NSRU public	58.7, (29.1–88.3)	15.0	0.000
		NSRU private	60.2, (21.5–98.9)	19.6	0.002
	NSRU public	NSRU private	1.5, (−45.5–48.4)	23.8	0.951

Abbreviations: ANOVA, analysis of variance; 95% CI, 95% confidence interval; LOS, length of stay; NSRU, non-specialist rehabilitation unit; NT-SCI, non-traumatic spinal cord injury; SCIRU, spinal cord injury rehabilitation unit; T-SCI, traumatic spinal cord injury.
[a]Mean difference is calculated by 'Reference unit' minus 'Comparison unit'.

Table 5 Pairwise multiple comparisons from ANOVA comparing the influence of setting of rehabilitation on FIM motor change

SCI	*Reference unit*	*Comparison unit*	*Mean difference, (95% CI)*[a]	*Standard error*	P-*value*
NT-SCI	Specialist SCIRU	NSRU public	8.3, (2.9–13.7)	2.8	0.003
		NSRU private	6.8, (0.4–13.2)	3.2	0.038
	NSRU public	NSRU private	−1.5, (−8.2–5.2)	3.4	0.656
N-TSI	Specialist SCIRU	NSRU public	8.6, (−0.7–17.9)	4.7	0.069
		NSRU private	11.4, (−0.6–23.4)	6.1	0.062
	NSRU public	NSRU private	2.8, (−11.7–17.3)	7.4	0.707

Abbreviations: ANOVA, analysis of variance; 95% CI, 95% confidence interval; FIM, Functional Independence Measure; NSRU, non-specialist rehabilitation unit; NT-SCI, non-traumatic spinal cord injury; SCIRU, spinal cord injury rehabilitation unit; T-SCI, traumatic spinal cord injury.
[a]Mean difference is calculated by 'Reference unit' minus 'Comparison unit'.

numerous significant differences in the demographic and clinical characteristics of patients admitted to the different settings of care. Patients admitted to a specialist SCIRU tended to be younger, have a longer LOS, be more disabled on admission, but have a greater change in the FIM motor subscale during their admission. After adjusting for significant co-variables, patients with NT-SCI admitted to specialist SCIRU had significantly better improvement in their functioning by discharge than patients admitted to NSRU. This result was not confirmed for T-SCI patients.

The finding that there were more patients with NT-SCI admitted to rehabilitation reinforces results from recent research in Australia,[10] and elsewhere,[19,20] that in developed countries the incidence of NT-SCI is greater than T-SCI. Our results also suggest that the Australian Spinal Cord Injury Register[21,22] does not capture all T-SCI patients in Australia. In 2006, there were 254 cases of T-SCI in the Register that would have met the inclusion criteria for our study (personal communication, Denzil O'Brian, Australian Spinal Cord Injury Register, 12 October 2010). This is much less than our confirmed number of T-SCI patients admitted to rehabilitation, and likely to be a great deal less than the actual number, given that there were almost 370 other SCI patients reported to AROC during the study period, but not included in the study.

The differences in patient demographic characteristics between the different settings of rehabilitation may reflect selection bias, with private and public NRSU preferentially admitting the less disabled patients. In contrast to a previous report that SCI patients in specialised settings of care tend to have a shorter LOS,[8] we found the opposite. We believe that the longer LOS for SCI patients admitted to specialist SCIRU in our study is probably related to factors that we did not include in our analysis, such as comorbidities, complications and the ASIA (American Spinal Injury Association) Impairment Scale (AIS).[23]

The finding that after adjusting for co-variates there was no influence for T-SCI patients in the FIM motor change from the setting of rehabilitation may have been due to the relatively small numbers of these patients admitted to NSRU. We feel that the benefit regarding FIM motor change for NT-SCI patients admitted to a specialist SCIRU is clinically important. Although there are no reports of what the minimal clinically significant change in FIM motor scores are for SCI patients, in stroke patients this has been reported to be 11 points.[24]

An important finding was that most acute SCI patients in Australia are managed in a NSRU. This is contrary to evidence that SCI patients have better outcomes when admitted to specialist SCIRU.[25] This has important implications for health system planning. A number of major health reforms are currently proposed for Australia, including a substantial increase to subacute hospital beds, particularly rehabilitation.[26] The results of this study suggest that one imperative of the health care reforms should be to improve access for SCI patients to the specialist rehabilitation that evidence-based medicine indicates that they deserve. This applies especially to patients with NT-SCI, who face a bias in accessing specialist SCIRU services that is difficult to justify.[11]

The strength of our project is that it is the first to use a population-based study design to explore the differences in outcomes for SCI patients managed in specialist or general rehabilitation settings. We also have included many more patients with NT-SCI than the previous studies that have examined this issue.[12,13]

It is difficult to know to what extent it is possible to generalise our results to other countries because of differences in health systems organisation and rehabilitation services offered, at both a specialist SCIRU and NSRU level. We feel that our results may apply to other developed countries that share many features of the hospital system in Australia, particularly Canada and the UK.

Limitations

The accuracy of the data submitted to AROC was not ideal. We feel, however, that as we included only data from units that verified key clinical variables, our results are robust. There were many patients for whom the level of SCI was not recorded, especially for patients from NSRU. This may have influenced the results of some analyses, especially the comparison of FIM change by level and the ANOVA analyses.

The changes to the impairment coding outlined in the data quality section are an issue that required explanation. Allocation of the impairment code is usually the responsibility of the rehabilitation clinician, although we know that this responsibility is often devolved to another member of the clinical team (nursing or allied health). All units that are members of AROC have received dataset training that includes how to allocate impairment codes. However,

it is acknowledged that the quality of coding can always be improved.

Unfortunately, it was not possible to include in our analyses a number of variables that could influence outcomes for SCI patients and which may explain some of our findings. At the time that this project was conducted AROC had only just commenced collection data on comorbidities and complications. Therefore, these items could not be included in the analysis. In addition, the completion of the AIS by contributing units was very poor, so this item was also not included in our analyses. We presume that this is due to varying protocols, and lack of staff training, especially in NSRU.

Furthermore, there are variables that are important SCI outcomes, which are not collected by AROC in their core dataset. These include outcomes such as bowel management, method of bladder management at discharge (for example, intermittent catheter vs indwelling catheter), and mode of mobility at discharge (wheelchair vs walking). Finally, there were about 360 patients with SCI reported to AROC who were not included in the analysis because the submitting organisation did not confirm their key clinical details. It may be that if these patients were included the results of our analyses would have been different.

We did not explore as part of this project what factors, if any, may have prolonged the stay in rehabilitation for certain patients. This is now a supplementary data item that some units are collecting information on. Neither did we collect data on the occurrence of surgery or acute hospital complications and how these may have influenced LOS. As is typical for all recent onset SCI patients in Australia, the SCI patients in this study would have received their acute hospital management in a range of different acute hospitals. In addition, there are no uniform standards of management of SCI for the rehabilitation units, both SCIRU and NSRU. These acute and rehabilitation hospitals that manage SCI patients would vary in their standards of treatment, which may have influenced patient outcomes in rehabilitation in ways we were not able to ascertain.

Future directions

As a result of the data quality component of this project described above, we have already implemented strategies to improve the reliability and quality of data collected by AROC. Guidelines have been developed for hospitals to improve the correct coding of patients with SCI. Efforts are also been made to encourage the hospitals contributing to AROC to improve the completeness of their data collection. A workshop on the AIS has been held recently for rehabilitation doctors in an effort to raise the expertise among clinicians in rehabilitation units in Australia, especially those not working in a specialist SCIRU. It is planned to hold these annually, at least for a number of years, to train as many staff as possible from NSRU in the AIS examination.

In the future, it is planned to repeat the analyses and comparisons presented in this project. It is hoped that this will be with a more accurate and comprehensive dataset. In particular, including the AIS, complications and comorbidity. This would give a more robust analysis that could further explore the differences in outcomes between SCI patients admitted to the different settings, with the anticipation of providing further evidence of the advantage to patients of being admitted to specialist SCIRU. It might also be possible to conduct a data-linkage project involving AROC and acute hospital databases to explore the impact of surgery and other aspects of acute hospital care on rehabilitation outcomes.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgements

The authors would like to thank the assistance of all the hospitals contributing data to AROC, and especially those who participated in the data quality review undertaken as part of this project. Some of the results described here were presented at the 49th International Spinal Cord Society Annual Scientific Meeting, Florence, Italy, 21–24 October 2009. This project was made possible by a major research grant from the Victorian Neurotrauma Initiative. A minor research grant was also provided by the Australasian Faculty of Rehabilitation Medicine 2007 Ipsen research scholarship. We thank these organizations for their support. These organizations had no role in the design, analysis or preparation of this paper.

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