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Original Article

Patterns of morbidity and rehospitalisation following spinal cord injury

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Study design: Longitudinal, descriptive design.
Objectives: The aim of this study was to investigate the frequency, cause and duration of rehospitalisations in individuals with spinal cord injury (SCI) living in the community.
Setting: Australian spinal cord injury unit in collaboration with State Health Department.
Methods: A data set was created by linking records from the NSW Department of Health Inpatient Statistics Collection between 1989–1990 and 1999–2000 with data from the Royal North Shore Hospital (RNSH) Spinal Cord Injuries Database using probabilistic record linkage techniques. Records excluded were nontraumatic injuries, age <16 years, spinal column injury without neurological deficit, full recovery (ASIA Grade E) and index admission not at RNSH. Descriptive statistics and time to readmission using survival analysis, stratified by ASIA impairment grade, were calculated.
Results: Over the 10-year period, 253 persons (58.6%) required one or more spinal-related readmissions, accounting for 977 rehospitalisations and 15,127 bed-days (average length of stay (ALOS) 15.5 days; median 5 days). The most frequent causes for rehospitalisation were genitourinary (24.1% of readmissions), gastrointestinal (11.0%), further rehabilitation (11.0%), skin-related (8.9%), musculoskeletal (8.6%) and psychiatric disorders (6.8%). Pressure sores accounted for only 6.6% of all readmissions, however, contributed a disproportionate number of bed-days (27.9%), with an ALOS of 65.9 (median 49) days and over 50% of readmissions (33 out of 64) occurred in only nine individuals aged under 30 years. Age, level and completeness of neurological impairment, all influenced differential rates of readmission depending on the type of complication. Overall rehospitalisation rates were high in the first 4 years after initial treatment episode, averaging 0.64 readmissions (12.6 bed-days) per person at risk in the first year and fluctuating between 0.52 and 0.61 readmissions (5.1–8.3 bed-days) per person at risk per year between the second to fourth years, before trending downwards to reach 0.35 readmissions (2.0 bed-days) as 10th year approaches. Time to readmission was influenced by degree of impairment, with significantly fewer people readmitted for ASIA D (43.2%) versus ASIA A, B and C (55.2–67.0%) impairments ($P<0.0001$). The mean duration to first readmission was 46 months overall, however, differed significantly between persons with ASIA A–C impairments (26–36 months) and ASIA D impairment (60 months).
Conclusion: Identifying rates, causes and patterns of morbidity is important for future resource allocation and targeting preventative measures. For instance, the late complication of pressure sores in a small subgroup of young males, consuming disproportionately large resources, warrants further research to better understand the complex psychosocial and environmental factors involved and to develop effective countermeasures.
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Keywords: spinal cord injury; morbidity; health complications; hospital readmission

Introduction

Spinal cord injury (SCI) results not only in a devastating change to a person's physical functioning and independence, but predisposes the individual to various secondary medical complications throughout life, which may interfere with health and well-being, social activity,

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productive employment and quality of life. Early rehospitalisation rates have been shown to be high in persons with SCI, particularly during the first year after discharge, thereafter declining over the next 5–10 years[1,2] before increasing again later in life.[3–5] Reasons frequently cited for readmission to hospital in people with SCI include urinary tract infection, pneumonia, gastrointestinal problems, pressure sores, pain and spasticity.[3,5,6–10]

Some authors have also highlighted the high costs associated with rehospitalisation after SCI, with costs averaging in excess of USD$7500 per readmission over the first year after discharge and USD$5000 annually thereafter,[11,12] with costs 6–8 times greater in persons with tetraplegia and ASIA impairment grades A-C (USD$10,000-$15,000) than in persons with either paraplegia and ASIA impairment grades A–C or all ASIA grade D lesions (USD$1700–$1850).[12] In addition, health care costs and utilisation of services due to medical complications have been shown to increase with age and duration postinjury.[13]

Researchers have developed models to predict risk of rehospitalisation based on various factors such as level and severity of neurological impairment, time since injury, age, sex, race, marital status and employment, although with a significant amount of variance in regression models remaining unexplained.[1,6,7,14] Most previous studies have been cross-sectional in design,[1,6–10] sometimes based on retrospective medical records or self-administered survey, relatively short follow-up periods or small nonrepresentative samples, and where longitudinal and of long duration still limited by missing data for patients not readmitted to hospitals within a particular system.[2] It could be argued that cross-sectional studies and even longitudinal studies with high attrition rates may be biased by high morbidity rates in those persons with SCI who are more poorly adjusted or more severely impaired with loss to follow-up of less severely impaired and more mobile individuals.

Research questions for this present study included: (1) What are the common secondary causes for rehospitalisation following acute SCI? (2) Does the level and degree of neurological impairment influence frequency, duration and cause of readmission for SCI-related conditions? (3) How do the patterns and rates of rehospitalisation for SCI-related reasons vary over time following acute SCI?

Methods

Sources of data

Approval for this study was obtained from the NSW Health Department Ethics Committee. Using probabilistic record linkage software, data from the NSW Inpatient Statistics Collection (ISC) for the financial years 1989–1990 to 1999–2000 were linked with data from the Spinal Injury Unit at Royal North Shore Hospital in Sydney.

The ISC includes records for all hospital separations (discharges, transfers and deaths) from all NSW public and private hospitals and day procedure centres, except for some smaller private hospitals prior to July 1992 for which only a known sample of admissions was available. ISC records consist of a range of demographic data items (eg date of birth, residential address, language spoken at home and country of birth), administrative items (eg admission and separation dates) and coded information (eg reason for admission, significant co-morbidities and complications, and procedures performed during the admission). The ISC data do not contain names nor is there a unique patient identifier to enable the identification of individuals.

Data from the Spinal Cord Injuries Database (SCID) consist of records of all patients who were admitted with an SCI to Royal North Shore Hospital. Data consist of patient details (eg name, date of birth, residential address, country of birth, occupation and level of education), administrative items (eg date of index admission and discharge date of index admission), details of death (eg date of death, primary cause of death and secondary cause of death) and some clinical information (eg cause of injury, ASIA impairment grade, indicator of injury to chest, abdomen or limb, and some psychiatric illness indicators). SCID was previously matched with National Death Index data to obtain complete information on deaths.

Record linkage

Two files were created, the first contained records from the ISC for financial year 1989–1990 to 1999–2000 and the second file comprised records of patients in the SCID database. A file of ISC records was prepared consisting of ICD-9-CM and ICD-10-AM codes relating to spinal injury and conditions known to cause morbidity following SCI (eg urinary tract infection, pyelonephritis, epididymo-orchitis, renal tract calculi, hydronephrosis, hydroureter, chronic renal failure and impairment, calculus of lower urinary tract, decubitus ulcer, osteomyelitis, pneumonia, sleep apnoea, pseudobowel obstruction, anal fissure and fistula, haemorrhoids, autonomic dysreflexia, pulmonary emboli, DVT, lower limb cellulitis, syringomyelia, mental disorder, neuropathic pain, mechanical back or neck pain, pathologic fracture, tendonitis/bursitis, carpal tunnel syndrome, complication of internal device, etc) and surgical procedures (eg cystoscopy, sphincterotomy, lithopaxy, cystostomy, lithotripsy, lithotomy, ileocystoplasty, haemorrhoidectomy, shunt of spinal theca, wound debridement, skin graft, pedicle graft or flaps, suture of skin and subcutaneous tissue, reduction of fracture for long bones, and hand/forearm tendon transfer surgery, etc). ISC data prepared for the record linkage totalled 5,597,541 records.

A total of 455 records from SCID were made available for the record linkage and the data excluded nontraumatic injuries, aged <16 years, spinal column injury without neurological deficit, ASIA grade E and

index admission not at RNSH. The records were for patients injured from 1989 onwards. Records from the two files were matched using the probabilistic linkage software Automatch (Automatch Version 4.01 (software), MatchWare Technologies, Burtonsville, MA, USA, 1997). Matching variables were date of birth, residential address, postcode, hospital and sex.

Analyses

For this study, a hospital admission was defined as any continuous period of hospitalisation, including periods of time spent in different hospitals. It was possible to match 98% of records from SCID to ISC records. The remaining eight patient records could not be matched with any ISC data. Of the unmatched records, there were three patients who died during their initial treatment episode in 1990 and 1991. One patient had no deficit and was taken out of the study. Thus, the final linked data set contains seven unmatched Spinal Unit records and 2817 ISC records for the matched Spinal Unit records.

We classified the linked records into two categories – an initial treatment episode (consisting of first admission for the injury including rehabilitation and transfers to another hospital on the same day or next day) and readmission episodes (transfers to another hospital on the same day or next day were considered as one record).

There were 16 patients in the linked data set who died during the initial treatment episode. These cases and the seven unlinked cases were excluded from the denominator used in the analyses, leaving hospital admission records for 432 patients who had survived an initial treatment episode for analysis.

Analysis was carried out using the SAS software (SAS Institute. The SAS System for Windows Version 8.02. Cary, NC: SAS Institute, 2001). The analyses consisted mainly of descriptive statistics. Rehospitalisation rates were based on the above 432 patients, who comprised the number of persons at risk. In addition, time to readmission was analysed using survival analysis, specifically the Kaplan–Meier estimator of the survivorship function and was stratified by ASIA grade for spinal injury-related readmissions. Differences in the readmission rates for strata were tested using log-rank statistic.

Results

Demographics

The 432 subjects in this study were predominantly males, with a mean age of 37.8 ± 17.4 years and over 40% under the age of 30 years. Tetraplegia was slightly more common than paraplegia, with almost half of the group sustaining complete (ASIA grade A) lesions, while another 30% had very incomplete (ASIA grade D) neurological impairments (Table 1). External causes of injury were mainly motor vehicle accidents (42.1%), falls (23.2%) and diving/sports injuries (9.7%).

Table 1 Subject demographics and injury details

Category	*Number (%)*
Gender	
Male	338 (78.2)
Female	94 (21.8)
Age (years)	
16–29	188 (43.5)
30–44	125 (28.9)
45–59	61 (14.1)
60 years and over	58 (13.4)
Lesion level	
Tetraplegia	229 (53.0%)
Paraplegia	199 (46.1%)
Unclassified	4 (0.9%)
Impairment	
ASIA A	206 (47.7%)
ASIA B	27 (6.2%)
ASIA C	67 (15.5%)
ASIA D	132 (30.6%)

Number of readmissions between 1990–1991 and 1999–2000

From an entire group of 432 persons, 12 months or more postinjury, 253 individuals (58.6%) required rehospitalisation for a spinal-related cause on at least one occasion during the 10-year study period, comprising a total of 977 readmissions. Another 44 persons (10.2%) were admitted to hospital for nonspinal-related causes, but excluded from the analysis. In comparison to the nonreadmitted group (including persons readmitted with a nonspinal-related condition), the group readmitted with a spinal-related condition was similar in age with a slight shift towards older ages and had a relatively higher proportion of males and people born in Australia rather than other country of origin. The major difference, however, between the groups was a substantially increased proportion of persons with complete (ASIA grade A) impairment (54.9 versus 37.4%) and more persons with C5–8 tetraplegia in the spinal-related readmission group. Spinal-related readmissions totalled 15,127 bed-days, with an average length of stay (ALOS) of 15.5 days (median 5 days) and a range from 1 to 318 days. The frequency distribution for spinal-related readmissions among the entire group is illustrated in Figure 1, with the number of readmissions, persons, ALOS, range and total bed-days summarised by age group in Table 2.

Causes of readmission

Causes of readmission to hospital are categorised in Table 3. Rehospitalisation most frequently related to complications of the genitourinary system, comprising almost one-quarter of readmissions and 15.0% of

bed-days. Among all categories urinary tract infection (UTI) was the single most common cause (9.2% of total readmissions in 14.4% of persons).

Within the group of genitourinary-related readmissions, after UTI the next most common conditions in descending order of frequency were: other nonspecific disorders of bladder, lower urinary tract calculus, epididymo-orchitis, urinary retention, urethral stricture/false passage and haematuria. Renal/upper tract calculi were uncommon, with pyelonephritis, hydronephrosis/ureter, renal failure, urethritis, prostatitis and neoplasms rare. Cystoscopy was the most frequent procedure performed (96 procedures in 74 persons), followed by extracorporeal shock-wave lithotripsy (23 procedures) and suprapubic cystostomy (19 procedures); however, the procedures were not commonly the primary cause of the readmission.

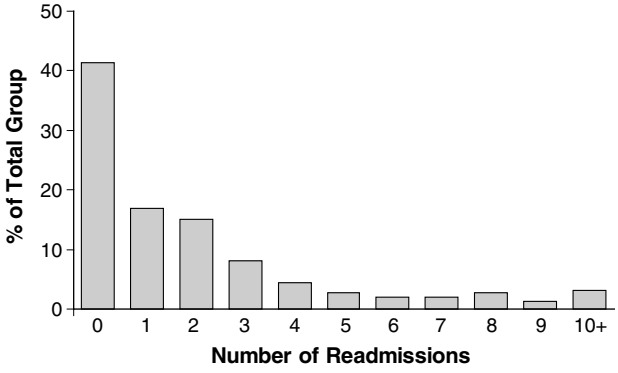

Figure 1 Frequency-distribution of spinal-related readmissions

Rehospitalisations for gastrointestinal (GIT)-related causes most frequently involved pseudobowel obstruction or treatment of haemorrhoids, accounting for 3.2 and 2.8% of all readmissions in 5.8 and 5.6% of persons, respectively. Almost half of the readmissions for pseudobowel obstruction occurred in persons 60 years and older with an ALOS of 5.1 (median 2) days. Readmissions for GIT haemorrhage, oesophagitis, gastric ulcer, cholecystitis/lithiasis and anal fissure/fistula or anorectal abscess, abdominal pain, nausea, vomiting and flatulence made up the remainder. Sigmoidoscopy/colonoscopy and haemorrhoidectomy were procedures performed most frequently.

Pressure areas, while causing only 6.6% of rehospitalisations, contributed a disproportionately large number of 4219 bed-days (27.9% of total). Interestingly, more than half (33 out of 64) of these readmissions occurred in the 16–29-year age group, where five individuals with paraplegia accounted for 24 readmissions between them. This very high recurrence rate was not seen in any other age group. Pressure areas requiring rehospitalisation occurred more commonly in persons with paraplegia than tetraplegia under the age of 45 years, while the reverse was found in the two older age groups. Length of stay was found to be 24 days

Table 2 Summary of the number of readmissions, persons, average length of stay (ALOS), range and total bed-days by age group

	Age group (years)				
	16–29	*30–44*	*45–59*	*60+*	*Total*
Readmissions	294	264	180	239	977
Persons (% of age group)	98 (52.1%)	77 (61.6%)	38 (62.3%)	27 (46.6%)	253 (58.6%)
Total bed-days	5442	3881	3143	2661	15127
ALOS (median) in days	18.5 (6)	14.7 (5)	17.5 (6)	11.1 (1)	15.5 (5)
LOS range in days	1–241	1–210	1–233	1–318	1–318

Table 3 Causes of readmission categorised by organ system

Organ System	*Readmissions (%)*	*Persons (%)*	*Total Bed-days*	*ALOS (median)*
Genitourinary	235 (24.1)	125 (28.9)	2248	9.6 (3)
Gastrointestinal	107 (11.0)	69 (16.0)	589	5.5 (1)
Skin	87 (8.9)	40 (9.3)	4432	50.9 (28)
Musculoskeletal	84 (8.6)	60 (13.9)	860	10.2 (4)
Neurological	30 (3.1)	18 (4.2)	775	25.8 (8)
Respiratory	44 (4.5)	28 (6.5)	632	14.4 (7)
Cardiovascular	47 (4.8)	40 (9.3)	879	18.7 (6)
Endocrine	7 (0.7)	5 (1.2)	68	9.7 (8)
Psychiatric	66 (6.8)	37 (8.6)	802	12.2 (4)
Other	270 (27.6)	96 (22.2)	3830	14.2 (5)
Total	977 (100)	253 (58.6)	15127	15.5 (5)

longer on an average in persons with tetraplegia than paraplegia (80.7 versus 56.5 days), with most pressure areas occurring in individuals with ASIA A neurological impairment (54 out of 64 readmissions). The majority underwent surgical debridement (66.7% of persons), with 12 advancement/rotation flap repairs performed (18.8% of pressure area-related readmissions). Other skin-related causes of readmission included cellulitis and burns.

Musculoskeletal complaints accounted for 8.6% readmissions (in 13.9% of persons) and relatively fewer bed-days (5.7%). Causes included orthopaedic management or complications, mechanical back or neck pain, pathologic fractures, tendonitis/bursitis, sprains and strains, and spasticity. Similarly, neurological reasons for readmission accounted for only a small number of readmissions (3.1%) and bed-days (5.1%), with primary diagnoses including syringomyelia, neuropathic pain, carpal tunnel syndrome/mononeuritis and complications with implanted devices. Additionally, intrathecal testing was performed on 26 occasions for assessment and possible management of intractable spasticity and/or pain.

Although relatively uncommon overall, most cardiovascular-related readmissions resulted either from deep venous thrombosis/pulmonary emboli (2.3% of total readmissions in 4.4% of persons) or autonomic dysreflexia (1.4% of readmissions in 2.3% of persons). Pneumonia accounted for the majority of respiratory system-related readmissions (3.4% of readmissions in 5.8% of persons), occurring almost exclusively in persons with tetraplegia (only one out of 25 persons with paraplegia). ALOS for pneumonia was 11.7 (median 7) days overall, however, several days shorter for younger age groups, with ALOS between 5.2 and 6.6 (median 5–7) days. Psychiatric disorders were not an uncommon cause of rehospitalisation, resulting in 6.8% of readmissions and 5.3% of total bed-days. Within this group, substance use disorders were most common (27.3%), followed by psychoses (24.2%), overdose (10.6%), mood and adjustment disorders (each 9.1%).

Of the remainder classified under 'Other', readmission for rehabilitation was the most frequent primary code, accounting for 107 rehospitalisations (11.0% of total) and 2514 bed-days (16.6% of total) with an ALOS of 23.5 days (median 12 days). The most common reasons found for these readmissions upon review of secondary diagnosis codes were musculoskeletal disorders requiring functional review, equipment prescription, fitting and supply (eg wheelchair), bladder assessment and retraining (eg intermittent self-catheterisation) or bowel management, occupational therapy, particularly for hand contracture management or post-tendon transfer surgery, orthosis-assisted gait training and pain management. Respite accounted for a further 27 readmissions in 13 persons (11 with tetraplegia) and 461 bed-days. The most frequent secondary codes of the rest of this subgrouping were genitourinary and musculoskeletal.

Effect of age and neurological level on readmission rates & bed occupancy

Figure 2, showing percentages of persons and total bed-days in each age group, demonstrates a disproportionately greater bed occupancy for persons in the two older groups (45 years and over). Figure 3 illustrates the relationship between age and readmission rates for four common causes, with the total number of readmissions for each separate complication expressed as a percentage. It is evident that a large proportion of readmissions related to UTI and pressure sores occurred in the youngest age group, whereas those for pseudobowel obstruction were most common in the oldest group. However, when complication rates were described as a percentage of persons affected within each group, no age effect was found for UTI, but a 3–4-fold increase in pseudobowel obstruction and pneumonia was noted in the two older compared to younger groups. Figure 4 illustrates the point that the rate of readmission for a certain cause will be differentially influenced by neurological level. In the case of the four common complications shown in Figure 4, episodes of rehospitalisation for UTI, pseudobowel obstruction and pneumonia

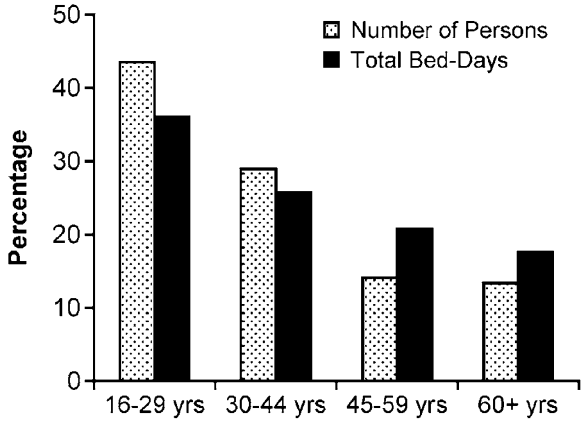

Figure 2 Proportion of persons readmitted and total bed-days by age group

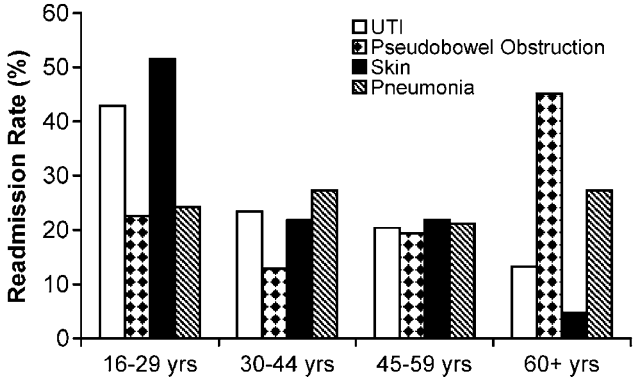

Figure 3 Rates of readmission for common complications by age group

occurred more frequently in persons with tetraplegia, the latter almost exclusively so, while the opposite was true for pressure sore readmissions.

Survival analysis

Figure 5 shows the time to spinal-related readmission stratified by degree of neurological impairment, with significantly fewer readmissions for ASIA D (43.2%) versus ASIA A, B and C (55.2–67.0%) impairments (logrank test = 26.7628 with 3 df, $P < 0.0001$). The mean duration to first readmission ($\pm$SE) for all spinal-related readmissions was 45.6 ± 2.2 months overall; however, when analysed for different neurological impairments, it was found to be 35.9 ± 3.1, 25.9 ± 5.0, 36.3 ± 4.1 and 59.6 ± 3.6 months for ASIA A–D groups, respectively.

Rates of readmissions to specialist SCI units

Admissions to specialist SCI units (acute and rehabilitation) comprised less than half of all readmissions (43.8%) in 192 (75.9%) persons, but accounted for a greater number of bed-days (55.9%) with longer ALOS (20.6 days in acute unit and 16.2 days in rehabilitation unit versus 12.1 days in nonspecialist hospitals).

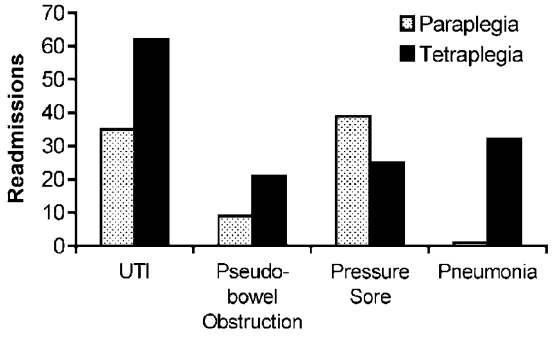

Figure 4 Rates of readmission for common complications by impairment group

Discussion

Results of this current study support the findings of previous researchers,[1,2,6,7] with similar rates of rehospitalisation following community resettlement after SCI. The majority (almost 60%) of the present cohort required readmission on at least one occasion for a spinal-related cause during the 10-year study period, with a minority ($\sim$10%) readmitted five times or more. Davidoff *et al*[7] reported that 39% of patients with acute SCI were readmitted at least once during the first year after discharge from initial rehabilitation with the mean LOS per readmission being 11.9 days. The present study found an overall rehospitalisation rate in the first 12 months after discharge of 0.64 readmissions (12.6 bed-days) per person at risk and an ALOS of 19.7 (median 6) days. ALOS was significantly longer for those with less incomplete (ASIA A, B and C) impairments (22.2–17.0 days) compared to more incomplete (ASIA D) impairments (11.3 days).

Previous researchers[1,2] have demonstrated that rehospitalisation and bed occupancy rates declined rapidly over the first 5–10 years following SCI, with a 13% decline in rehospitalisation rates for each successive year postinjury over the 6-year period reported in one study.[1] By comparison, in the current study while overall rehospitalisation (and bed occupancy) rates trended downwards over time, relatively high rates persisted for several years after discharge before subsequently decreasing (Figure 6). This was most notable in the ASIA A group where in the first postdischarge year the readmission rate was 0.84 readmissions (18.6 bed-days) per person at risk, fluctuating over next 3 years between 0.74 and 0.94 readmissions (8.4–14.6 bed-days) per person at risk per year. Readmission (and bed occupancy) rates were approximately 3–4 times lower in the ASIA D group and remained more stable over time at

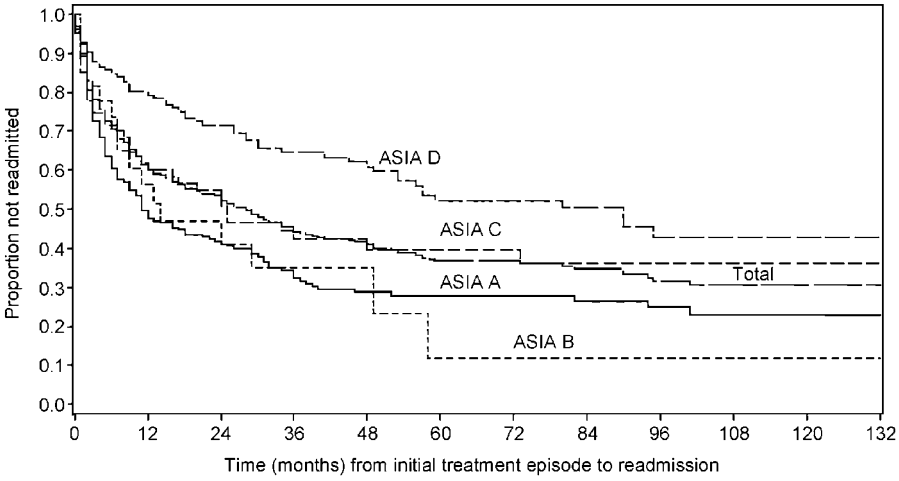

Figure 5 Survival analysis of time to first readmission stratified by degree of impairment

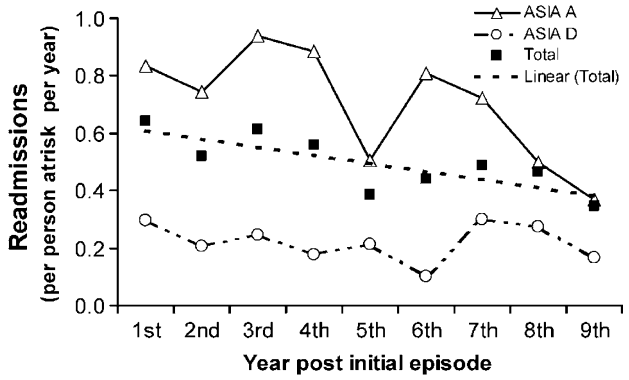

Figure 6 Rehospitalisation rates (readmissions per person at risk per year) over time for ASIA A and ASIA D subgroups, and all impairments combined

around 0.2–0.3 readmissions (2–3 bed-days) per person at risk per year. When nearing 10 years after acute admission, the observed average rehospitalisation rate of ~0.4 readmissions per person at risk per year was similar to that reported by Savic *et al*[5] in persons with SCI for more than 20 years.[5] However, despite a general reduction over time, disproportionately high readmission rates were persistently seen in a relatively small percentage of persons with SCI. A similar pattern was recently reported in the Tetrafigap study,[10] where a small subgroup of persons were hospitalised more frequently and for longer duration than the overall population (median of three readmissions over 11.2 years), which has been attributed to increased impairment, lower educational level and poorer socioeconomic status, as well as probably poorer adjustment. Samsa *et al*[2] have previously observed that later high-intensity health service utilisation (6–10 years after injury) was predicted to some extent by the number of days a person was rehospitalised during the first 5 years after injury.

Interestingly, the relative frequency of rehospitalisation for the different causes in the current study over a 10-year period after injury were generally quite similar to those reported by Savic *et al*[5] in a population-based sample of people with chronic SCI for more than 20 years duration. The main differences were a reduction by approximately half in genito-urinary (24 versus 40%) and skin-related (9 versus 17%) readmissions, although similarly high and disproportionate bed occupancy rates for the latter were noted (approximately 30% of all bed days). In an earlier community sample, Meyers *et al*[6] had identified a similar readmission rate for rehabilitation (eg for wheelchair assessments) to that found in the current study (16 versus 11%). Notably, Whiteneck *et al*[3] described a number of conditions encountered most commonly in younger patients and early after injury, including seizures and central nervous system disorders, urinary retention and hydronephrosis, spasticity and contractures, superficial wounds, injuries and suicides, while some other illnesses were found to be more related to age than chronicity of SCI. A recent large multicentre survey of 1668 persons with tetraplegia revealed that urinary tract complications and pressure sores were reported more commonly in those with complete lesions, whereas contractures and pain were more frequent in persons with incomplete lesions.[10]

Urinary tract infection was the single most common cause for readmission, with an increased rehospitalisation rate for persons with tetraplegia most likely related to type of bladder management, where persons managed with a permanent indwelling catheter have been reported to be approximately twice as likely to experience urinary complications compared to other methods.[1,9] Gastrointestinal problems are common after SCI, with incidence known to be related to completeness of lesion and duration since injury.[15] The present study also highlights the effect that older age has on bowel function, with almost 50% of readmissions for pseudo-bowel obstruction occurring in the 60 years and older age group. Similarly, pneumonia was shown to be associated with higher level (tetraplegia) and more complete lesions, as well as an increased incidence with age.

Pressure sores are of major concern, not only because of demonstrated significant impact on activity, employment, interpersonal relationships and overall emotional well-being,[16] but also because of the very disproportionate bed occupancy and resource utilisation associated with them. Pressure sores are known to be a common problem in people with SCI, with later rates reported between 23 and 33% per year.[3,8,16–18] Current results are consistent with data from the Model systems in the USA showing an early incidence of between 7.9 and 8.9% pressure ulcers at 1- and 2-year follow-up examination with an average of 1.6 ulcers per patient with ulcer/s.[18] Similarly, Krause[16] found 10% out of more than 1000 community subjects with SCI reported undergoing plastic surgery in previous 2-year period, with 7% of sample reporting needing to reduce their sitting time by 9 weeks or more. In that study, individuals with tetraplegia and complete lesions were more likely to suffer skin breakdown.[16] In the present study, while this was found to be true for older persons, most readmissions for pressure sores, with high recurrence rates, occurred in a small group of young males with paraplegia.

This particular problem warrants special attention to identify the personal characteristics of these recidivists and potential risk factors, as well as to better understand whether this form of behaviour may represent parasuicide. Krause[16] demonstrated a strong correlation between skin problems and poorer adjustment, however, could not attribute cause or effect and therefore recommended future studies should investigate the role of behavioural risk factors, both positive preventative behaviours, such as regular weight shift and skin checks and the presence of self-destructive behaviours, such as smoking, alcohol abuse and risk-taking. Heinemann and Hawkins[19] showed a relationship between risk of substance abuse and developing pressure sores, even in those with a history of drinking problems who remained

abstinent after injury, suggesting this may relate to poorer coping skills, diminished social support and being more vulnerable to depression, consequently failing to exercise due diligence in self-care and nutrition. Not surprisingly, use of illicit drugs or alcohol after injury and misuse of prescription medication has been shown to predict subsequent UTI and ulcers.[19] Fuhrer *et al*[17] reported different determinants governing the initial development of a pressure sore (eg extent of paralysis) and those responsible for progression in ulcer severity (eg ethnicity). The latter may well relate to socioeconomic and educational disadvantage.[10] Some authors[10,20] have also suggested a link between unemployment and risk of rehospitalisation for pressure sores.

Previous authors have tried to develop a readmission risk profile for individuals with SCI based on level and severity of neurological impairment, with limited success. It appears that psychosocial factors are likely to play at least as great a role as impairment and functional capacity. Factors shown to be associated with increased likelihood of rehospitalisation include lack of tertiary education, indwelling catheter, motor complete injuries, dependence in self-care, and dependence in ambulation.[1] Samsa *et al*[2] showed both injury level and completeness affected the likelihood of rehospitalisation. Similarly, the present study also demonstrated a strong effect of impairment on risk of rehospitalisation, with significantly reduced time to readmission for more complete lesions (average of 2–3 years for ASIA A–C impairments versus 5 years for ASIA D) and increased likelihood of readmission for certain conditions with tetraplegia (eg pneumonia, UTI and pseudobowel obstruction).

Samsa *et al*[2] have recommended that prevention efforts should target those persons with previous high utilisation. Davidoff *et al*[7] found patients with potentially preventable readmissions such as pressure sores, urinary tract infection, pulmonary infection and burns (34% of all readmissions over the first year) had the longest initial rehabilitation stays, independent of ASIA class, possibly reflecting higher lesion level, more complex injuries or greater difficulty learning essential skills. Their contention that learning capacity may be an important contributing factor was based on finding that lower education level increased risk of readmission,[7] as well as earlier reporting a trend toward impaired cognitive performance in areas of attention, and short- and long-term verbal recall in people with SCI readmitted with a potentially preventable complication within 6 months of initial discharge.[21]

These previous studies highlight that while initial inpatient rehabilitation certainly must emphasise education, in order to minimise the occurrence of preventable secondary health complications, it is also essential to identify atrisk individuals and provide targeted follow-up and ongoing education after discharge for persons with SCI and their carers. This could perhaps best be achieved by development of networks with local health-care providers, possibly via telemedicine, to provide education, ongoing support and better surveillance using standard checklists, in addition to a system of routine follow-up by specialised spinal outpatient and outreach services. In addition, there may be opportunities to improve efficiency and resource utilisation in the future through novel initiatives such as developing shared care arrangements with general practitioners locally, particularly in the early identification and management of pressure areas.

The current study was longitudinal, examining readmissions in a cohort of individuals with traumatic SCI to all hospitals, in both the public and private sector, across the state over a 10-year period. Some of the limitations in previous studies, such as cross-sectional designs,[1,6,14] inability to separate planned and unplanned hospitalisations, reliably distinguish between rehospitalisation for medical causes only and absence of nonsystem admission data[2] or missing data resulting from drop outs due to death,[1,18] were overcome in the present study. Demographic and impairment records from the linked Spinal Unit database were very accurate, having been collected and entered prospectively. However, there were some limitations with the current study that may have led to underestimation of the incidence of conditions causing rehospitalisation, namely: the degree of loss to follow-up is not known, but is likely to be small; for some records the only disease code available was of the spinal deficit rather than the condition that led to readmission; the study examined only primary diagnoses – additional diagnoses were not examined; and unlike a prospective study with predetermined fields, valuable information, for instance about methods of bladder management or psychosocial variables, including aspects of coping, lifestyle and adjustment to disability, were not available. Finally, the present study records all spinal-related inpatient readmissions, but does not capture outpatient or local doctor attendances.

Conclusion

Frequent or prolonged rehospitalisation significantly impacts on employability, socialisation and overall quality of life for people with SCI. This study showed that the most frequent causes of readmission in this population are genitourinary, gastrointestinal, skin and musculoskeletal related. The most costly, in terms of bed-occupancy, were skin-related. This information is valuable to health-care providers, consumers and administrators alike, allowing more considered planning of service models and facilities with projections of future care requirements and resource allocation necessary for both the treatment and prevention of secondary complications after SCI. This assumes even greater relevance when the increasing prevalence and ageing nature of the spinal cord injured population is taken into consideration.

Finally, more comprehensive longitudinal studies with follow-up over the life span of the population with SCI are needed before we truly understand the impact of

unplanned complications on quality of life, how and when to intervene and which prevention strategies are best. In particular, there is a need to identify psychological and behavioural risk factors for problematic conditions such as skin breakdown after SCI and more clearly elucidate the interaction of personal, injury-related, psychosocial and environmental factors, which would provide the basis for developing better preventative strategies.

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