Research Article

Healthcare utilization following spinal cord injury: Objective findings from a regional hospital registry

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Objective: The purpose was to describe the prevalence and characteristics of healthcare utilization among individuals with spinal cord injury (SCI) from a Level I trauma center.
Design: Retrospective data analysis utilizing a local acute trauma registry for initial hospitalization and merged with the Dallas-Fort Worth Hospital Council registry to obtain subsequent health care utilization in the first post-injury year.
Setting: Dallas, TX, USA.
Participants: Six hundred and sixty four patients were admitted with an acute traumatic SCI from January 2003 through June 2014 to a Level I trauma center. Fifty five patients that expired during initial hospitalization and 18 patients with unspecified SCI (defined by ICD-9 with no etiology or level of injury specified) were not included in the analysis, leaving a final sample of 591.
Outcome Measures: Data included demographic and clinical characteristics, charges, and healthcare utilization.
Results: Mean age was 46.1 years (±18.9 years), the majority of patients were male (74%), and Caucasian (58%). Of the 591 patients, 345 (58%) had additional inpatient or emergency healthcare utilization accounting for 769 additional visits (median of 3 visits per person). Of the 769 encounters, 534 (69%) were inpatient and 235 (31%) were emergency visits not resulting in an admission. The most prevalent ICD-9 codes listed were pressure ulcer, neurogenic bowel, neurogenic bladder, urinary tract infection, fluid electrolyte imbalance, hypertension, and tobacco use.
Conclusion: Individuals with SCI experience high levels of healthcare utilization which are costly and may be preventable. Increasing our understanding of the prevalence and causes for healthcare utilization after acute SCI is important to target preventive strategies.

Keywords: Spinal cord injury, Healthcare utilization, Trauma

Introduction

Re-hospitalizations are used as an indicator of the hospital quality for the patient and are associated with increased morbidity and costs for the healthcare system.[1–5] Examining healthcare utilization is important in order to monitor the quality of care as well as controlling costs for both hospital healthcare systems and federal agencies.[2,6] Re-hospitalization and emergency department healthcare encounters are quality indicators specifically that identify possible unnecessary medical expenses or sub-optimal quality of care.[2] Consequently, healthcare providers are presented with a challenge to decrease the length of stay (LOS) and reduce the rate of re-hospitalizations.[1]

Individuals with spinal cord injury (SCI) use a disproportionate amount of health services and incur greater cost when compared to the general population.[7–10] Specifically, rates of re-hospitalization in individuals with SCI post-rehabilitation have been previously studied and are higher than the general population.[1,8] For example, studies using data from the National

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Institute of Disability, Independent Living, and Rehabilitation Research sponsored SCI Model Systems database report rates of re-hospitalization that range between 19 and 57% in the first-year post-SCI.[1,7,8,11] This increased utilization is due to complex medical and social needs that last across a lifespan, such as increased risk of pressure ulcers, urinary tract infections, respiratory infections, cardiovascular disease, pain, and psychosocial conditions.[7,11] Determinants of re-hospitalizations following SCI include level and completeness of injuries, indwelling catheters, lower functional independence measure scores at acute-rehabilitation discharge, and lower socioeconomic factors (*e.g.* lower educational attainment and family income).[1,10,12,13] Additionally, individuals with SCI are less likely to receive preventative care due to physical barriers such as transportation and accessible equipment causing increased emergency room utilization and re-hospitalization.[9,10]

While several studies have examined re-hospitalization rates following SCI, results have been limited to single institutions, SCI Model Systems data (which include only inpatient rehabilitation data and self-reported re-hospitalization at follow-up encounters), or are part of universal healthcare databases outside of the United States.[1,8,10,14,15] Therefore, the purpose of this study is to describe the prevalence and characteristics of healthcare utilization across time among individuals with SCI that were originally admitted to a Level I trauma center. Objective utilization data were extracted from a regional hospital registry from January 2003 to July 2014 and patients' utilization across time is reported.

Methods

Procedure

Institutional Review Board approval was obtained to ensure that all procedures were ethical and in compliance with organizational requirements. A retrospective, cross-sectional design was utilized to include patients treated for traumatic SCI between January 2003 and July 2014 at a large urban Level I trauma center in the Southwest United States.

Trauma registry data from the patients' initial hospitalization for their SCI were merged with data from the regional hospital registry (Dallas-Fort Worth Hospital Council [DFWHC] Database). The trauma center admits approximately 2500 trauma patients annually, and information about each patient including demographic, diagnosis, and hospital stay was extracted from trauma registry. The DFWHC database includes hospital discharge data (including demographic, diagnosis, procedural, billing, and hospital stay information) from 88 member institutions (105 hospitals) in a large metropolitan area. The DFWHC provides a service for North Texas hospitals which are required to report quality metrics to the state. These combined data allowed us to track individuals' healthcare utilization overtime regardless of which hospital system where they utilized healthcare services, following their initial admit to the Level I trauma center. The registry includes data from 96% of hospitals in the region which covers more than 15,000 square/miles and includes over 10 million patients and 45 million hospital encounters.[16,17] The DFWHC categorizes hospital visits as inpatient or emergency visits. Inpatient visits include those that require overnight admission. Emergency visits do not require overnight admission and may include emergency department services and urgent care services. Acute care hospital utilization data from individuals with SCI that were admitted to our trauma center were extracted from the DFWHC Database and included in the analysis.

Participants

Six hundred and sixty four patients with traumatic SCI were identified from the Level I trauma center based on International Classification of Disease Version 9 (ICD-9) codes at onset of injury and were admitted between January 2003 and June 2014. Fifty five of these patients were excluded because they passed away during initial hospitalization yielding a total of 609 patients. An additional 18 patients with an unspecified SCI diagnosis, defined by ICD-9, with no etiology or level of injury specified, were removed leaving a final sample of 591 patients with tetraplegia or paraplegia.

Data

Trauma registry data included demographic information (including sex, race, ethnicity, and insurance status) and clinical information (including LOS, total charges, cause of injury, and discharge status) from the initial onset trauma hospital admission. Trauma registry data were merged with DFWHC registry data. DFWHC registry data included subsequent healthcare utilization after initial trauma hospitalization and included LOS (inpatient encounters only), total charges, admission type (inpatient or emergency), specialization, and ICD-9 codes. Patients were divided by the level of injury (paraplegic and tetraplegic) based on their ICD-9 code at the trauma admission. All utilization data were aggregated over one year following the individuals' first admission to the trauma acute care setting after their SCI.

Frequency of ICD-9 codes was tabulated using the general category, and digits after the dot separator were not initially included. After the top ten ICD-9 categories were tabulated, the digits after the dot separator were added to the top ICD-9 codes to tabulate the most frequently used subcategory for each ICD-9 code. The most frequent diagnosis codes were summarized with all healthcare encounters after initial trauma hospitalization as the denominator.

Statistical analysis

All data were summarized using standard descriptive statistics. Mean and standard deviation were used to describe age. The other quantitative variables, LOS and chargers, were skewed to the right, and thus summarized with medians and interquartile ranges. Counts and percentages were used for all qualitative variables.

Results

The mean age of patients upon admission to the trauma center following their SCI was 46.1 ± 18.9 years. Patients were mostly male (74%) and white (58%). Private insurance status was equal to uninsured status, 40% and 40%, respectively (see Table 1). Similar trends were seen after separating between tetraplegic and paraplegic. Three hundred and sixty two patients (61%) were identified as tetraplegic and 229 (39%) as paraplegic.

Table 2 summarizes the clinical information for patients during their initial hospitalization after SCI injury. The median LOS in the trauma setting for all patients was 9 days, which was similar between individuals with tetraplegia and paraplegia. Charges, the primary trauma causes of injury, and discharge status from trauma care are also summarized in Table 2.

Table 1 Summary of the demographic information for SCI patients.

Demographics	*N* = 591	Tetraplegic (*N* = 362)	Paraplegic (*N* = 229)
Age	46.1 ± 18.9	50.3 ± 18.5	39.4 ± 17.4
Male Sex	436 (74%)	261 (72%)	175 (76%)
Race			
White	343 (58%)	204 (56%)	139 (61%)
Black	145 (25%)	95 (26%)	50 (22%)
Asian	6 (1%)	3 (1%)	3 (1%)
Other	97 (16%)	60 (17%)	37 (16%)
Hispanic ethnicity	88 (15%)	48 (13%)	40 (17%)
Insurance			
Private	239 (40%)	146 (40%)	93 (41%)
Medicaid	34 (5%)	23 (7%)	11 (5%)
Medicare	90 (15%)	73 (20%)	17 (7%)
Uninsured	239 (40%)	120 (33%)	108 (47%)

Of the 591 SCI admissions to the trauma center between 2003 and 2014, 345 (58%) had additional inpatient or emergency healthcare utilization in the DFW area over the first year after their initial hospitalization. Of the 345 with additional utilization, there were 769 additional inpatient or emergency encounters captured with a median of 3 additional encounters per person (interquartile range: 2–6) and maximum of 22. Of the 769 encounters, 442 (57%) of the encounters were for individuals with tetraplegia, and 327 (43%) of the encounters were for those with paraplegia.

Of the 769 encounters, 534 (69%) were inpatient encounters and 235 (31%) were emergency encounters not resulting in admission. A summary of the types of services for inpatient and emergency utilization visits after their initial hospitalization post-injury is provided in Tables 3 and 4, respectively. The median LOS for inpatient re-hospitalizations was 11 days, and 35% of those patients who were re-hospitalized were seen by rehabilitation specialists and 21% by internists.

In Tables 5 and 6, the most prevalent ICD-9 codes are listed for inpatient and emergency encounters, respectively. The most frequent diagnosis codes for inpatient hospitalization readmission in individuals with tetraplegia were chronic ulcer of the skin (47%), disorders of fluid electrolyte and acid–base balance (43%), functional digestive disorders not elsewhere classified (39%), and essential hypertension (38%). The most frequent diagnosis codes for inpatient hospitalization in individuals with paraplegia were chronic ulcer of the skin (51%), functional digestive disorders not elsewhere classified (48%), and other disorders of the bladder (43%). The most frequent diagnosis codes for emergency visits among individuals with tetraplegia were nondependent abuse of drugs (38%), of which 63% were tobacco use disorder and essential hypertension (30%). Similarly, the most frequent diagnosis codes for emergency visits among individuals with paraplegia were nondependent abuse of drugs (32%), of which 78% were tobacco use disorder and essential hypertension (26%).

Discussion

While several studies have examined healthcare utilization following SCI,[1,8–15,18–20] this dataset is unique because it captures utilization across multiple healthcare systems in a large area and extracts more objective information from claims sources as opposed to self-reported measures. As a result, there are several interesting similarities and differences in findings. For example, the demographic representation of our sample is consistent with that from SCI Model System data,[6,21] despite the

Table 2 Summary of clinical information for SCI patients at the trauma admission.

Clinical information	All (*N* = 591)	Tetraplegic (*N* = 362)	Paraplegic (*N* = 229)
LOS, median (Q1, Q3)	9 (5, 18)	9 (5, 18)	10 (6, 17)
Total charges (thousands)	76.3 (35.9, 142.1)	69.5 (33.0, 133.3)	92.6 (42.2, 146.7)
Cause of injury			
Motor vehicle/cycle collision	218 (37%)	141 (39%)	77 (34%)
Fall	200 (34%)	143 (40%)	57 (25%)
Gunshot wound/aggravated assault/stab	96 (16%)	26 (7%)	70 (30%)
Other	77 (13%)	52 (14%)	25 (11%)
Discharge status			
Rehabilitation	259 (44%)	146 (41%)	113 (49%)
Home	221 (37%)	137 (38%)	84 (37%)
Skilled nursing facility	48 (8%)	34 (9%)	14 (6%)
Long-term care	19 (3%)	15 (4%)	4 (2%)
Other	44 (8%)	30 (8%)	14 (6%)

fact that patients in the current sample were from an acute trauma setting as opposed to the inpatient rehabilitation setting. Fifty eight percentage of SCI subjects had additional healthcare utilization within the first year after discharge from the acute onset. This rate of utilization is slightly higher than that described in previous self-report, rehabilitation-based studies which showed a 19–57% incidence of additional healthcare utilization.[1,8,10,12,14,15,18–20] While current results do not identify why this pattern of utilization occurred, previous literature suggests that an individuals' barriers to healthcare (*e.g.* lack of insurance coverage or transportation) may play a significant role.[9,13,22] Additionally, self-reported data are subject to recall bias, thus administrative data may be more accurate.

Table 3 Summary of inpatient admitted encounters for SCI patients after their initial visit.

	All (*N* = 534)	Tetraplegic (*N* = 336)	Paraplegic (*N* = 198)
LOS	11 (4, 28)	10 (4, 26.5)	14 (6, 29)
Admit type			
Elective	288 (54%)	182 (54%)	106 (54%)
Medical emergency	161 (30%)	95 (28%)	66 (33%)
Trauma	4 (1%)	3 (1%)	1 (0.5%)
Urgent	81 (15%)	56 (17%)	25 (13%)
Specialization			
Physical Medicine & Rehabilitation	188 (35%)	108 (32%)	80 (40%)
Internal Medicine	112 (21%)	84 (25%)	28 (14%)
Hospitalist	46 (9%)	34 (10%)	12 (6%)
Trauma Surgery	18 (4%)	9 (3%)	9 (5%)
Specialist	17 (3%)	13 (4%)	4 (2%)
Orthopedic Surgery of the Spine	13 (3%)	12 (4%)	1 (0.5%)
Orthopedic Surgery	10 (2%)	7 (2%)	3 (2%)
Pulmonary Disease	7 (1%)	5 (1%)	2 (1%)
Other	61 (11%)	27 (8%)	34 (17%)
Not listed	62 (12%)	37 (11%)	26 (13%)

Differences in charges for the initial onset acute hospitalization were found in the current sample, *i.e.* individuals with paraplegia had higher charges than individuals with tetraplegia. This may be due to our sample population coming from an acute trauma setting, thus patients with less severe injury who do not require inpatient rehabilitation are included. It is important to note that our dataset is limited because a breakdown of American Spinal Injury Association Impairment Scale (AIS) category (*i.e.* completeness of injury) is not available. As a result, there may be more AIS D individuals with tetraplegia that are ambulatory in our sample who may have intact bowel and bladder function when compared to individuals with paraplegia, thus contributing to decreased charges and subsequent health complications. Additionally, there may have been other trauma associated with their SCI (*e.g.* patient with paraplegia with bleeding from gunshot wound) or funding limitations (*e.g.* uninsured with delayed discharge) that could have impacted charges.

The reasons for utilization, based on identification of ICD-9 codes, were consistent with the previous literature as individuals with tetraplegia and paraplegia were most frequently readmitted for genitourinary, skin breakdown, and gastrointestinal symptoms.[1,8,10,11,14,15,18–20] While respiratory symptoms have been found to be a

Table 4 Summary of non-admitted emergency visits for SCI patients after their initial visit.

	All (*N* = 235)	Tetraplegic (*N* = 106)	Paraplegic (*N* = 129)
Specialization			
Emergency Medicine	133 (57%)	61 (58%)	72 (56%)
Internal Medicine	16 (7%)	8 (8%)	8 (6%)
Other	6 (3%)	1 (1%)	5 (4%)
Not listed	80 (34%)	36 (34%)	44 (34%)

Table 5 Top associated ICD-9 codes for inpatient visits after initial hospitalization among individuals with tetraplegia and paraplegia.*

Tetraplegic		Paraplegic	
1. Chronic ulcer of skin (707)	157 (47%)	1. Chronic ulcer of skin (707)	101 (51%)
Pressure ulcer, lower back (707.03)	50 (32%)	Pressure ulcer, lower back (707.03)	38 (38%)
2. Disorders of fluid electrolyte and acid–base balance (276)	145 (43%)	2. Functional digestive disorders not elsewhere classified (564)	95 (48%)
Hypopotassemia (276.8)	45 (31%)	Neurogenic bowel (564.81)	73 (77%)
3. Functional digestive disorders not elsewhere classified (564)	130 (39%)	3. Other disorders of bladder (596)	85 (43%)
Neurogenic bowel (564.81)	99 (76%)	Neurogenic bladder NOS (596.54)	79 (93%)
4. Essential hypertension (401)	127 (38%)	4. Disorders of fluid electrolyte and acid–base balance (276)	62 (31%)
Unspecified essential hypertension (401.9)	113 (89%)	Hyposmolality and/or hyponatremia (276.1)	21 (34%)
5. Other disorders of urethra and urinary tract (599)	122 (36%)	5. Late effects of injuries to the nervous system (907)	61 (31%)
Urinary tract infection site not specified (599.0)	110 (90%)	Late effect of spinal cord injury (907.2)	53 (87%)
6. Other disorders of bladder (596)	112 (33%)	6. Essential hypertension (401)	59 (30%)
Neurogenic bladder NOS (596.54)	110 (98%)	Unspecified essential hypertension (401.9)	57 (97%)
7. General Symptoms (780)	97 (29%)	7. Other disorders of urethra and urinary tract (599)	58 (29%)
Other convulsions (780.39)	16 (16%)	Urinary tract infection, site not specified (599.0)	55 (95%)
8. Late effects of injuries to the nervous system (907)	95 (28%)	8. Nondependent abuse of drugs (305)	57 (29%)
Late effect of spinal cord injury (907.2)	78 (82%)	Tobacco use disorder (305.1)	33 (58%)
9. Nondependent abuse of drugs (305)	90 (27%)	9. Other and unspecified anemias (285)	51 (26%)
Tobacco use disorder (305.1)	51 (57%)	Anemia, unspecified (285.9)	28 (55%)

*ICD-9 codes listed were associated diagnostic codes and may not be the primary diagnosis for admission.

frequent cause for re-hospitalization in the previous literature,[1,8,10,11,15,20] it was not included in the top ten reasons for utilization in our data which may possibly be due to more incomplete levels of injury per AIS among our sample. Disorders of fluid electrolyte and acid–base balance, hypertension, and tobacco use were also frequently diagnosed among our sample and were not reported in the previous literature. This level of specificity may be due to the fact that we collected ICD-9 codes versus being based on the self-report. It is important to restate that data were collected using the frequency of ICD-9 diagnosis and may not be the primary admitting diagnosis for individuals. Thus, ICD-9 codes such as tobacco use disorder and essential hypertension are associated with subsequent healthcare utilization visits.

Table 6 Top associated ICD-9 codes for emergency visits after initial hospitalization among individuals with tetraplegia and paraplegia.*

Tetraplegic		Paraplegic	
1. Nondependent abuse of drugs (305)	40 (38%)	1. Nondependent abuse of drugs (305)	41 (32%)
Tobacco use disorder (305.1)	25 (63%)	Tobacco use disorder (305.1)	32 (78%)
2. Essential hypertension (401)	32 (30%)	2. Essential hypertension (401)	33 (26%)
Unspecified essential hypertension (401.9)	32 (100%)	Unspecified essential hypertension (401.9)	33 (100%)
3. Symptoms involving respiratory system and other chest symptoms (786)	19 (18%)	3. Other symptoms abdomen and pelvis (789)	30 (23%)
Chest pain, unspecified (786.50)	4 (21%)	Abdominal pain, unspecified site (789.00)	13 (43%)
4. Diabetes mellitus (250)	17 (16%)	4. Other and unspecified disorders of back (724)	29 (23%)
Diabetes mellitus without mention of complication (250.00)	16 (94%)	Backache, unspecified (724.5)	13 (45%)
5. General symptoms (780)	17 (16%)	5. Symptoms involving respiratory system and other chest symptoms (786)	21 (16%)
Dizziness and giddiness (780.4)	5 (29%)	Chest pain, unspecified (786.50)	8 (38%)
6. Other disorders of urethra and urinary tract (599)	13 (12%)	6. Chronic ulcer of skin (707)	19 (15%)
Urinary tract infection, site not specified (599.0)	12 (92%)	Pressure ulcer, heel (707.07)	4 (21%)
7. Other disorders of cervical region (723)	13 (12%)	7. Other disorders of urethra and urinary tract (599)	18 (14%)
Cervicalgia (723.1)	11 (85%)	Urinary tract infection, site not specified (599.0)	15 (83%)
8. Other and unspecified disorders of back (724)	9 (9%)	8. Symptoms involving digestive system (787)	16 (12%)
Lumbago (724.2)	5 (56%)	Nausea and vomiting (787.01)	7 (44%)
9. Other disorders of soft tissues (729)	9 (9%)	9. Pain (338)	15 (12%)
Pain in limb (729.5)	5 (56%)	Other chronic pain (338.29)	8 (53%)

*ICD-9 codes listed were associated diagnostic codes and may not be the primary diagnosis at emergency visit.

Limitations

It is important to recognize several limitations with our data and interpretation. First, data for people served at the trauma center but who lived outside the catchment area was unavailable, so trends for a subgroup of the sample cannot be analysed. Thus, living outside the catchment area may be one of the reasons why 25% of the sample had no data for additional healthcare utilization. Other reasons for no additional utilization may include being healthy post-SCI or expiring. Ultimately, the actual utilization rate may be higher if we had data for people living outside the registry catchment. Additionally, we were unable to stratify patients based on their injury severity due to a lack of AIS scores. This limited our ability to analyse the relationship between severity and discharge disposition from the trauma setting and subsequent healthcare utilization. Furthermore, the DFWHC database collects administrative hospital claims data, so it is difficult to identify if utilization is planned or unplanned or if the primary reason for hospital visit was related to the SCI or another premorbid condition. Another common limitation with large datasets like this is the inability to control and check the data that were submitted. To address this, future efforts should focus on collecting specific objective information of SCI characteristics, such as AIS score, which could be merged with self-reported longitudinal data, *e.g.* SCI Model Systems data.

Future directions

Based on our results and existing literature, there are several opportunities for future research. For example, efforts should focus on the breakdown of utilization between individuals with tetraplegia and paraplegia based on AIS so that we can more accurately compare utilization based on the severity of injury. Additionally, it will be important to examine the characteristics (*e.g.* insurance status, race, discharge disposition) of those individuals who have the highest utilization, *i.e.* super-utilizers and those that are readmitted within 30 days so that preventative measures (*e.g.* telehealth) can be put in place. As many of the most prevalent reasons for healthcare utilization in our sample are preventable conditions (*e.g.* urinary tract infections, pressure ulcers, bowel impaction), it is imperative to identify high-risk patients and target interventions. Finally, trends in utilization across the lifespan should be examined to identify whether the needs of individuals with SCI change over time.

Conclusion

Using large, multicenter data such as the DFWHC registry is critical to better understand healthcare utilization post-SCI in an evolving healthcare climate where reduced re-hospitalization, LOS, and cost are important quality metrics. Of concern is the high rate of healthcare utilization for the current sample observed within the first-year post-SCI. This emphasizes the need for further analysis of large, objective datasets as well as targeted interventions to reduce utilization, improve access to outpatient services to prevent inpatient re-hospitalization, and improve identification and management of SCI-related issues.

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