Research Article

Implementation and initial outcomes of a spinal cord injury home care program at a large veterans affairs medical center

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Objectives: Describe an interdisciplinary spinal cord injury home care program (SCIHCP), sample demographics for the veteran participants, and initial impact of SCIHCP on health care utilization and mortality.

Design: Retrospective review.

Setting: SCIHCP of the Spinal Cord Injury Center, VA North Texas Health Care System (VANTHCS).

Participants: Patients with SCI/D enrolled in the SCIHCP during January 6, 2006 through January 9, 2012, whose injury occurred at least one year prior to enrollment (n = 125).

Main Outcome Measures: VANTHCS hospital admissions, length of stay (LOS), and emergency department (ED) visits evaluated one year before and one year after SCIHCP enrollment; mortality evaluated one-year post-enrollment.

Results: There were no significant changes in number of ED visits, number of hospital admissions, or LOS over time. More home care visits and more mental health comorbidities predicted more hospital admissions. Older patients and those with more mental health comorbidities were more likely to experience increases in LOS. These prediction models were significant after adjusting for injury level, age, race, time since SCI, and number of medical comorbidities. More home care visits were associated with lower likelihood of mortality post-enrollment.

Conclusions: Inpatient and ED utilization did not change one year after enrollment, but more SCIHCP visits predicted more hospital admissions and lower likelihood of mortality in the post-evaluation year. The support, education, and care continuity SCIHCP generates might be related to increased inpatient access and lower mortality rate. Veterans with increased mental health comorbidities used inpatient services more, and might need additional support.

Keywords: Spinal cord injuries, Spinal cord diseases, Home care services, Emergency medical services, Hospitalization, Organizational case studies, Retrospective studies, United States Department of Veterans Affairs, Length of stay, Home care services hospitals, Veterans

Introduction

Prevalence and cost to system

The prevalence of spinal cord injuries and disorders (SCI/D) among veterans, and the cost to Veterans Health Administration (VHA) for managing SCI/D, is significant. VHA estimates that as of FY16, 9.05 million veterans enrolled in the VA Health Care System.¹ The Spinal Cord Injury System of Care within Veterans Health Administration treats over 22,000 veterans with SCI/D.² The average recurring

annual health care cost for a sample of veterans with varying levels of spinal cord injury in fiscal year (FY) 2005 was \$21,450 per veteran, and half of those costs were related to inpatient care.³

Utilization patterns for samples of non-veterans with SCI/D indicate persons with SCI/D utilize more health care services and incur more healthcare costs than non-veterans without SCI/D.⁴ Compared to the matched controls, a sample of persons with SCI/D in Canada were found to have more contact with physicians, be admitted to the hospital more, and spend more days in the hospital with a higher incidence of urinary tract infections, pressure ulcers, pneumonia, and depression.⁴ Persons

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with complete spinal cord injury incurred significantly more cost both in the first year after injury, as well as subsequent years.⁵ Comorbid conditions related to SCI/D, such as hypertension, pressure ulcers and urinary tract infections, contribute to this long-term management difficulty.⁵ Higher degree of impairment and discharge status other than to home have been found to be related to increased health care utilization in the year after inpatient rehabilitation.⁶ In order to address high health care utilization and related comorbid conditions of veterans with SCI/D, VHA directed SCI centers throughout the VA system to provide home care through sub-specialty SCI providers.⁷ SCI home care teams throughout the VA system provide care to veterans in their homes in order to prevent escalation of comorbid conditions and subsequent emergency department (ED) visits or hospitalizations.

Mitigating costs of post-SCI care

SCI Home Care Service is one of many viable options to mitigate complications and health care cost for veterans with SCI/D. In the past decade, VHA's Spinal Cord Injury System of Care has provided many programs with the potential to mitigate increased health care utilization and costs for veterans with SCI/D, including comprehensive lifetime SCI specialty care, peer support, caregiver support, respite care programs, and the Spinal Cord Injury Home Care Program. Veterans Health Administration SCI home care services are outlined in detail by Veterans Health Administration Handbook 1176.01, section 9f.⁷ SCI home care services involve the main goal of providing caregiver support and training, help in managing any daily paid caregivers, and attention from nurses and providers while in the home.

The benefits of SCI home care services may include identifying medical complications early on and solving those problems in the home when possible, decreasing ED visits and unplanned hospitalizations, assisting veterans with SCI in managing medical needs while living at home, and supporting them in staying connected to their families and communities. The goals of SCI home care are clearly defined in the VHA Handbook 1176.01, and there is a need to develop peer-reviewed data to support what veterans and providers participating in SCI home care have reported anecdotally during the last decade.

Paucity of peer-reviewed, SCI/D-Specific Home Care Program evaluation data

Although there is a paucity of specific information from VHA and the private sector about home care for persons with SCI/D, VHA has been a leader in

developing comprehensive home care services for persons with chronic health conditions as they age. SCI home care program (SCIHCP) services as they have been implemented thus far have drawn from VHA's long-standing home care model. VHA initiated home based primary care (HBPC) in 1972 in order to provide interdisciplinary care to veterans in the home in hopes of preventing unnecessary hospitalizations and nursing home placements.^{8,9} A history of HBPC's origins presented by Cooper *et al.*¹⁰ quotes the HBPC directive,

“...the continuous provision of services that involve ongoing monitoring, routine comprehensive assessment, coordination of care, prevention or early detection of worsening condition, and timely interventions delivered throughout the protracted course of chronic disease. This is in contrast to the episodic care that is provided only at intervals of disease presentation or exacerbation ...”

Cooper *et al.*¹⁰ also notes there is a corresponding national HBPC database similar to other national registries, from which outcomes (e.g. decrease in hospital LOS) have been evaluated. These outcomes indicate overall HBPC's effectiveness.

HBPC has served as a model for SCIHCP. Both programs aim to care for veterans with illnesses for the duration of the veteran's life, regardless of whether or not the veteran has the potential for medical/physical improvement.¹⁰ That said, there are important distinctions between HBPC and SCIHCP. SCIHCP differs from HBPC because the focus is on providing highly-coordinated care for veterans with SCI/D who have difficulty leaving their home. A dedicated interdisciplinary team, in coordination with the veteran's primary care provider, cares for veterans with SCI/D in the inpatient, outpatient and home care setting. SCIHCP aims to optimize a veteran's relationship with the SCI Center provider team and utilizes care coordination and patient/caregiver education as primary drivers of good patient outcomes.

Another important distinction between HBPC and SCIHCP is that the SCIHCP treatment model incorporates caregiver education and coordination assistance. Schulz *et al.*¹¹ indicated that an important component of health care for persons with SCI/D includes helping the caregiver in managing the medical and functional needs of their care recipient. SCIHCP goes beyond the traditional problem-focused care centered on symptoms and SCI-related comorbidities. Paid and unpaid caregiver support adds to the high cost of

living with SCI/D and also results in significant physical and psychological caregiver burden.^{11,12} SCIHCP provides specific support to both veterans with SCI/D and persons serving as caregivers.^{13,14} For example, SCIHCP staff provide education, coordination and support to paid caregivers who provide daily or almost-daily care for pressure sores, bowel and bladder management, and other needs common to managing SCI/D over the lifetime. Serving as a primary caregiver for a person with SCI/D, and perhaps additionally training and managing other paid caregivers, can be a stressful and sometimes overwhelming task. SCIHCP services differ from most HBPC services in the amount of time and effort aimed at supporting paid and unpaid caregivers and including them as part of the comprehensive health-care team needed to optimize health and avoid complications for veterans with SCI/D.

HBPC outcomes available as initial SCIHCP benchmarks

With differing treatment strategies from SCIHCP, HBPC remains a helpful model to begin investigating SCIHCP outcomes. HBPC outcomes are very promising with respect to patient health outcomes, and these findings suggest that patients with SCI/D who receive a specialized home care program may also expect similar benefits. One study has evaluated VHA HBPC outcomes, including mortality and utilization patterns. Chang *et al.*'s¹⁵ study, "Impact of a Home-Based Primary Care Program in an Urban Veterans Affairs Medical Center," serves as a model for the present study in terms of approaching assessment of VHA home care services to determine caseload characteristics and initial outcomes. The investigators defined the program in terms of staffing, average visits, and caseload demographics. They found that, compared to veterans' pre-HBPC rates, ED visits decreased 18.5% (non-significant trend), hospitalizations significantly decreased 43.7%, and hospital length of stay significantly decreased 49.9%. The post-HBPC mortality rate was 17%. They concluded that their HBPC program had a positive impact on utilization outcomes.

The present study expands on Chang *et al.*'s¹⁵ findings by focusing on veterans with SCI/D who receive a specialized type of home care services which differ from HBPC. The SCI Home Care program addresses specific, long-term concerns for veterans with SCI/D, including optimizing veterans' health and connection to family and community; preventing escalation of SCI/D-related complications via caregiver education and support; and attempting to minimize lifetime ED and inpatient utilization.

The present study is aimed at describing the SCI home care program (SCIHCP), demographics of the veterans who participate, and one-year utilization impact and mortality. The hypotheses include:

- 1) Changes in Utilization after SCIHCP Enrollment: SCIHCP participants will show a decrease in rates of hospital admissions, hospital length of stay (LOS), and emergency department (ED) visits when comparing rates during 365 days pre-SCIHCP and 365 days post-SCIHCP time frames.
- 2) Association between pre-existing comorbidities, functional impairment, utilization, and mortality: veterans participating in SCIHCP with more functional impairment will show more utilization improvement when comparing hospital admissions, hospital LOS, and ED visit rates during 365 days pre-SCIHCP and 365 days post-SCIHCP time frames. More SCIHCP utilization will result in decreased likelihood of mortality during the 365 day post-SCIHCP time frame.

Method

Study population: The initial study population included all 180 veterans with SCI who were enrolled in the VA North Texas Health Care System (VANTHCS) SCI home care program (SCIHCP) from its inception in 2006 through 2012. The SCIHCP caseload grew at a higher rate in the later years of this span. Approximately 750 other veterans with SCI served at VANTHCS during this time period did not receive SCI home care services, and were not included in this study.

SCI home care program (SCIHCP) inclusion & discharge criteria: Beginning in 2006, SCIHCP utilized criteria described in VHA Handbook 1176.01, Section 9f,⁷ by formalizing an SCI home care program (SCIHCP). From 2002 until 2006, several nurses made home visits but performed services that differed from the SCIHCP. In 2006, SCI Center leaders formalized the VANTHCS SCIHCP inclusion criteria using the following items from the VHA Handbook 1176.01⁷:

- Patient lived within 100 miles of VANTHCS (although if living in excess of 100 miles, unless the SCI Chief made an exception)
- Patient must have had a medical need for skilled services in the home
- Lived in a home that was physically suitable or adaptable for daily care to be provided at home, or patient lived in a nursing home
- Patient and identified caregiver(s) must have been able and willing to participate in SCI Home Care treatment planning and services

VHA Handbook 1176.01, Section 9f,⁷ also specifies SCI home care discharge criteria:

- Patient achieved care plan goals and no longer needs SCI home care services
- Patient was admitted to the medical center for an extended stay of more than 15 days
- Patient requested termination
- Patient and/or family refused to cooperate with SCI home care team, resulting in an inability to provide safe and/or effective services

SCI home care program (SCIHCP) description: Veterans with SCI/D were referred to the SCIHCP based on the above eligibility criteria. Veterans received a comprehensive assessment annually by physicians at the SCI Center and received at least one annual in-home visit by the SCIHCP physician. Veterans enrolled in SCIHCP receive monthly visits from a registered nurse from the SCIHCP team, as well as annual and as-needed visits from the SCIHCP social worker. The veteran and SCIHCP team may decide on frequency of visits based on mutually-established, veteran-centered health goals and veteran preferences. Patient cases are routinely reviewed by a SCI Center interdisciplinary team. The visits are usually scheduled monthly, and focus on caregiver education, training and support; coordination of paid and unpaid care providers; evaluation and management of potential and existing chronic comorbid conditions; coordination of VA and non-VA care; and strengthening communication with matrixed SCI center provider team members.

SCI home care caseload information at VANTHCS indicated that once patients were admitted, the services might be discontinued for one of the above-listed discharge reasons, and subsequently the patients could become in need of and eligible for the services again within months. While formal admission and discharge data was not obtained in the present study, the number of SCIHCP visits were captured, even if the patient was discharged from the SCIHCP for a brief period of time and re-admitted to the program during the same year.

SCI home care program (SCIHCP) study inclusion/exclusion criteria: The patients enrolled into the SCIHCP during the study period included 180 patients who met the programmatic inclusion criteria above. For the purposes of the present study, 9 patients with multiple sclerosis (MS) were excluded, as were 46 patients whose spinal cord injury or disorder onset date was less than 365 days prior to the home care start date. The onset date criterion was selected to allow time for patients included in the study to stabilize after initial injury. The remaining 125 patients receiving SCIHCP services had

SCI/D onset more than 365 days before the home care start date, and were not diagnosed with MS.

Data collection: The VANTHCS IRB approved a waiver of informed consent and approval to obtain chart review data for all of the original 180 veterans who received home care services from 2006 to 2012 at VANTHCS. The data collection form used for the chart review included patient characteristic information at SCIHCP enrollment, and health care utilization information from the 365 days prior to each patient's SCIHCP enrollment date. The SCIHCP enrollment date was defined as the first SCIHCP visit in the home by a SCIHCP registered nurse. ED visit data did not include urgent care visits patients might have made to the SCI Center outpatient clinic during daily walk-in appointment opportunities.

Sources of data: Information was obtained via chart review of the Computerized Patient Record System (CPRS), which consists of the veterans' historical medical records. Data from the VISN 17 Corporate Data Warehouse was also obtained using structured query language (SQL).

Statistical analyses

Continuous parameters are reported as mean $\pm$ standard deviation, and discrete parameters are reported as N and percent (%). Continuous dependent variables were tested for normality with the Shapiro-Wilk test. The health utilization variables (emergency department visits, hospital admissions, and hospital length of stay) were tested for differences over time with Wilcoxon signed-rank tests. Spearman rank-order correlation coefficients were computed to examine the association between the number of home care visits received and changes over time in health utilization. Mann-Whitney U tests were computed to examine the differences in functional impairment groups on changes over time in health utilization. The three utilization outcomes were subsequently recoded into ordinal variables due to the substantial and significant non-normality of the frequency distributions. These new ordinal outcomes were submitted to ordinal regression analyses to identify predictors of changes over time in emergency department visits, hospital admissions, and hospital length of stay. Multiple logistic regression analysis was performed to identify predictors of mortality in the year following the first home care visit. Analyses were performed using SAS 9.2 for Linux and SPSS 22.0 for Windows. The study alpha was set to 0.05.

Results

The majority of the study sample ($n = 125$) were male (96.8%), and the mean age was 63 ± 12.5 years (Table 1). Over 49% were married, followed by divorced (32.8%), never married (6.4%) and widowed (8.0%). Most were white/Caucasian (64.8%), followed by African-American (28.8%); 6.4% of the veterans had an unknown race/ethnicity. The mean number of years since the spinal cord injury was 18.2 years ($SD = 14$). One-fourth of the sample received social security disability income (24.8%), and 32.0% of the sample received social security income. Almost half of the study sample received VA service-connected benefits (47.2%), and 46.4% received non service-connected benefits.

Almost one-third of the sample had paraplegia (31.2%), 12.0% were classified as high (C1-4) tetraplegia, and 24.8% were classified as low (C5-8) tetraplegia. The American Spinal Injury Association (ASIA) uses an international classification rating system, the ASIA Impairment Scale (AIS) to categorize spinal cord injuries in terms of the amount of sensation and motor strength.¹⁶

The majority of subjects were classified as being “complete” on the ASIA scale, meaning no motor strength or sensation (AIS A; 35.2%), followed by Incomplete - Low Muscle Strength (AIS C; 20.0%), Motor Incomplete - High Muscle Strength (AIS D; 19.2%), Motor Sensory Incomplete (AIS B; 9.6%), and Normal (AIS E; 3.2%; 12.8% of the sample’s ASIA levels were unknown).

The SCI etiology for the majority of the sample was vehicular (30.1%), followed by other non-traumatic (21.2%), fall (12.4%), violence (9.7%), and sports

Table 1 Patient demographics ($n = 125$).

Mean Age (range 21 - 92)	63.0 (12.5)
Male	121 (96.8%)
Hispanic or Latino	2 (1.6%)
Race	
White or Caucasian	81 (64.8%)
Black/African-American	36 (28.8%)
Unknown	8 (6.4%)
Residence	
Living in the community	98 (78.4%)
Community nursing home	15 (12.0%)
VA nursing home	2 (1.6%)
Medicare home health	1 (0.8%)
Distance from VA (miles; range 1 - 151)	38.0 (31.0)
Receives VA Service-Connected Disability	51 (40.8%)
Receives VA Non Service-Connected Disability	58 (46.4%)
Receives SSDI Income	31 (24.8%)
Injury Category	
High tetra	15 (12.0%)
Low tetra	31 (24.8%)
Paraplegia	39 (31.2%)
ASIA D	23 (18.4%)
Unknown	14 (11.2%)

Table 2 Patient comorbidities ($n = 125$).

Hypertension	65.5%
Pressure ulcer	63.8%
Urinary tract infection	60.0%
Spasticity	57.4%
Chronic pain	54.3%
Depression	32.8%
Diabetes mellitus	30.2%
DVT/Pulmonary embolism	22.4%
Spinal canal stenosis	21.6%
Calculus in kidney or ureter	20.7%
Heart disease	19.1%
Substance abuse	12.9%
Cervical spondylosis	12.9%
Degenerative joint disease	12.1%
Anxiety	9.5%
Syringomyelia	8.6%
Traumatic Brain Injury	8.6%
COPD	7.8%
Heterotopic ossification	7.8%
Dementia	7.0%
PTSD	6.0%
Bipolar disorder	3.4%
Schizophrenia	3.4%
Insomnia	2.6%
Substance dependence	1.7%
Ankylosing spondylitis	0.9%

activity (8.8%). As shown in Table 2, the most common co-morbid diagnosis was hypertension (65.5%), followed by pressure ulcer (63.8%), urinary tract infection (60.0%), spasticity (57.4%), and chronic pain (54.3%). The mortality rate during the year after the first home care visit was 6.4%.

Hypothesis 1: Changes in utilization after SCIHC enrollment

The mean number of home care visits for the enrollees was 7.2 (range 1 - 24; SD 4.4). As shown in Table 3, Shapiro-Wilk tests of normality revealed that the frequency distributions for number of home care visits, number of pre-home care emergency department visits, number of post-home care emergency department visits, number of pre-home care hospital admissions, number of post-home care hospital admissions, pre-

Table 3 Utilization variables: One year Pre-SCIHC versus one year Post-SCIHC ($n = 125$).

	Total Number	Mean	SD	Median
Number of Pre ED Visits	61	0.49	1.29	0
Number of Post ED Visits	55	0.44	1.64	0
Number of Pre Hospitalizations	158	1.26	1.28	1
Number of Post Hospitalizations	160	1.28	1.68	1
Pre Hospitalization Length of Stay	2732	21.86	44.90	3
Post Hospitalization Length of Stay	2252	18.02	41.52	0

home care hospitalization length of stay, and post-home care hospitalization length of stay significantly deviated from normality ($P < 0.001$).

There were no significant changes in the number of emergency department visits over time ($z = 0.83$, $P = 0.41$) nor number of hospitalizations ($z = 0.28$, $P = 0.78$). There were no significant changes in the length of hospital stays from pre to post-intervention ($z = 1.14$, $P = 0.25$).

Hypothesis 2: Association between pre-existing comorbidities, functional impairment, utilization, and mortality

The following analyses explore the association between pre-existing conditions and health outcomes at one-year post SCI home care program enrollment. The first set of analyses examine whether pre-existing functional impairment may predict changes in utilization. The second set of analyses examines the association between pre-existing functional impairment, related comorbidities and utilization at one-year post enrollment.

Association between pre-existing functional impairment and overall changes in utilization

Injury category was recoded as either having a higher level of functional impairment (defined as high tetraplegia or low tetraplegia) or a lower level of functional impairment (paraplegia or ASIA). These categories were compared on the residualized change scores for ED visits, hospital admissions, and length of stay. Mann-Whitney U tests revealed no significant differences between the two groups on changes over time in ED visits, hospital admissions, or length of stay.

Ordinal regression was performed to further explore the association between functional impairment, patient characteristics, and reductions in utilization over time. Three new ordinal utilization outcome variables were

created to represent change over time. Each new outcome variable had three levels: decrease in utilization over time, no change over time, and increase in utilization over time. Predictors were injury level (high versus low functional impairment), age, race, total number of home care visits, total number of mental health comorbidities, total number of physical comorbidities, and injury duration (in days).

Ordinal regression on change in visits to the ED revealed no significant model predictors. Ordinal regression on change in unplanned hospital admissions using the negative log-log function (to reflect a positively skewed distribution) revealed a significant model (Nagelkerke $R^2 = 0.134$). The number of home care visits and the number of mental health comorbidities significantly predicted change in hospital admissions over time, even after adjusting for injury level, age, race, number of days elapsed since injury, and number of medical comorbidities. As shown in Table 4, more home care visits (OR = 1.07, $P = 0.023$) and more mental health comorbidities (OR = 1.29, $P = 0.025$) were associated with increases in hospital admissions.

Ordinal regression on change in days spent in the hospital using the negative log-log function (to reflect a positively skewed distribution) revealed a significant model (Nagelkerke $R^2 = 0.16$). Age and number of mental health comorbidities significantly predicted change in hospital lengths of stay over time, even after adjusting for injury level, race, number of days elapsed since injury, number of home care visits, and number of medical comorbidities. Older age (OR = 1.03, $P = 0.023$) and more mental health comorbidities (OR = 1.36, $P = 0.01$) were associated with increases in hospital lengths of stay.

Multiple logistic regression on mortality revealed a significant model (Nagelkerke $R^2 = 0.51$). Age and number of home care visits significantly predicted mortality in the year following the first home care visit, even

Table 4 Ordinal regression results for changes in ED visits and hospital admissions (n = 125).

	Hospital Admissions			Length of Stay		
	Adjusted Odds Ratio	P	95% CI	Adjusted Odds Ratio	P	95% CI
Age	1.01	0.366	0.988 - 1.033	1.03	0.023	1.004 - 1.05
White, non-minority race	0.93	0.800	0.539 - 1.611	1.17	0.601	0.651 - 2.098
Number Home Care Visits ^a	1.07	0.029	1.007 - 1.129	1.04	0.163	0.983 - 1.105
Injury Duration ^a	1.00	0.973	0.791 - 1.255	1.04	0.745	0.818 - 1.324
Medical Comorbidities	0.92	0.244	0.801 - 1.059	0.91	0.192	0.787 - 1.049
Mental Health Comorbidities	1.29	0.025	1.033 - 1.618	1.36	0.010	1.075 - 1.716
Injury Level ^b	0.79	0.379	0.475 - 1.328	0.85	0.562	0.499 - 1.459

^aVariable transformed into quartiles to adjust for non-normal frequency distribution.

^bHigh functional impairment was the reference category to low functional impairment in the models.

after adjusting for injury level, race, number of days elapsed since injury, number of mental health comorbidities, and number of medical comorbidities. Older age (OR = 1.09, $P = 0.05$) was associated with a greater likelihood of mortality during the post-year study period. More home care visits (OR = 0.32, $P = 0.04$) were associated with a decreased likelihood of mortality during the post-year study period.

Discussion

Evaluation of 125 veterans with spinal cord injury and disorders (SCI/D) enrolled in a spinal cord injury home care program (SCIHCP) between 2006 and 2012 resulted in no significant changes in ED visits, hospital admissions, or hospital length of stay. Further analyses indicated that veterans with SCI/D did not differ in utilization outcomes based on level of injury and functional impairment. However, receiving more home care visits and having more mental health comorbidities were associated with increases in hospital admissions. Being older and having more mental health comorbidities were associated with increases in hospital length of stay. Increased age predicted a higher likelihood of mortality, while increased number of home care visits was associated with a lower likelihood of mortality.

The present study expands upon Chang *et al.*'s¹⁵ findings by examining a similar home care program specifically designed for veterans with SCI/D. The increased hospital admissions associated with SCIHCP are in contrast with Chang *et al.*'s¹⁵ evaluation of VA home based primary care (HBPC), in which there was a significant decrease in admissions and length of stay. However, while the mortality rate observed by Chang *et al.*¹⁵ was 17%, the present study's mortality rate was only 6.4%, and more SCIHCP visits were associated with lower mortality. The lack of statistically significant relationship between SCIHCP and ED utilization was consistent with Chang *et al.*¹⁵ Though Chang *et al.*¹⁵ did not examine the relationship between age and utilization outcomes and mortality, the present study did show that older veterans tended to stay in the hospital longer and have increased likelihood of mortality, which would be expected given age-related decline. The SCIHCP incorporates monthly visits to veterans' homes where registered nurses and social workers with specialized knowledge of SCI/D support veterans with SCI/D and their caregivers (both paid and unpaid). More frequent, customized and proactive support for veterans with SCI/D in the form of SCIHCP services might assist in patients getting care they need, possibly sooner, resulting in higher inpatient utilization and lower mortality.

Spinal cord injuries and disorders are typically associated with a significant list of related chronic conditions, only some of which can be completely prevented. The strength in the SCIHCP may not lie in preventing certain conditions and hospitalizations altogether; rather, the SCIHCP provides critical communication and familiarity with the veterans with SCI/D. While increases medical comorbidities were not associated with increased inpatient utilization, having more mental health comorbidities was associated with increased inpatient utilization (both admissions and length of stay). It is possible that patients with increased mental health comorbidities need more support in managing medical issues that can eventually result in hospitalization.

Limitations

The present study is limited by the retrospective design and its sample consisting of only veterans referred to the SCIHCP. The current evaluation does not employ a control comparison of outcomes for veterans with SCI/D not enrolled in the SCIHCP. Veterans with SCI/D were not randomly assigned to the SCIHCP; instead, they were referred to the SCIHCP by their SCI center providers based on the inclusion criteria set forth by the VHA National SCI Program Office. This may bias outcomes in a few ways. SCIHCP enrollees might have been chosen because of a degree of health-related stability needed to actually live at home and engage in the program. Alternatively, SCIHCP enrollees may have been referred because they had a relatively greater number of health issues. Private health care utilization, while likely of lower frequency than VA SCI Center utilization, was not obtained and included in the present evaluation. It may be possible that the combined utilization of both VA and non-VA emergency room and hospitalizations did change following enrollment, but the current study failed to capture the change due to the exclusion of private healthcare utilization information. VA SCI outpatient clinic utilization was not available for this manuscript and will be obtained for future VA SCIHCP studies. While study inclusion criteria required SCI onset date to be more than 365 days prior to SCIHCP start date, it is possible that CDW-extracted inpatient utilization data could have included some inpatient rehabilitation bed days of care, contributing to higher pre-SCIHCP inpatient utilization. Lastly, these results may not be generalizable to a larger population of patients without SCI/D and non-veterans. The SCIHCP for veterans with SCI/D is unique in its interdisciplinary structure, caregiver support, life-long care, and coordination of care focus.

It may be difficult outside the VHA SCI system of care to replicate a similar environment where patients receive life-long care from one interdisciplinary team providing acute inpatient care, outpatient care, and in-home care.

Future directions

Future research should further examine whether the SCIHCP intervention amount is related to important utilization and health outcomes such as ED visits, hospitalizations, hospital length of stay (LOS), comorbid conditions, and mortality. Prediction models should include, but not be limited to, variables such as mental health and medical comorbidities, age, duration of SCI/D, level of injury and function. Because VHA is ethically unable to withhold SCIHCP services at this time, researchers might consider using a case-matched control design to more powerfully evaluate utilization changes over time for veterans receiving SCIHCP and veterans not receiving SCIHCP. Furthermore, there are many reasons veterans with SCI/D and their providers mutually decide to plan a hospital admission (e.g. respite, inpatient annual exam). A more detailed analysis of differences between planned and unplanned hospitalizations may allow for greater understanding of the SCIHCP efficacy. Because a major component of the SCIHCP is in part designed to support caregivers, examination of caregiver burden, health and well-being should also be incorporated in future studies.

Conclusion

Preliminary analysis of the spinal cord injury home care program (SCIHCP) shows that more SCIHCP visits were associated with a higher total hospital length of stay, but lower likelihood of mortality. Veterans receiving SCIHCP services who have more mental health comorbidities might need additional support through home care and other services. Broadly speaking, this program allows for a continuity of care for patients for whom travelling to receive regular outpatient care is a barrier and might be associated with reduced mortality for some participants during the intervention time frame.

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