Cost of Treating Pressure Ulcers for Veterans with Spinal Cord Injury

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Veterans comprise almost 17% of the 250,000 persons with spinal cord injury/disorder (SCI/D) in the United States. Pressure ulcers are common complications of SCI/D. We compared annual health care utilization and costs between veterans with and without pressure ulcers in the Veterans Health Administration (VHA). Veterans with pressure ulcers had more total inpatient days on average (61.00 vs 9.19; $P < .001$) and higher total health care costs ($100,935 vs $27,914; $P < .001$) due primarily to higher inpatient costs ($91,341 vs $13,754; $P < .05$). Our results highlight the need to identify patients at risk for pressure ulcers who could benefit from targeted skin care management interventions. **Key words:** *health care cost, hospitalization, pressure ulcer, spinal cord injury/disorder, veteran*

There are approximately 250,000 persons with spinal cord injury/disorder (SCI/D) in the United States and an estimated 11,000 new injuries per year.[1] Pressure ulcers are common, serious complications of SCI/D[2,3] with annual incidence rates ranging from 20% to 31% and prevalence rates ranging from 10% to 30% in patients with SCI.[3,4] Pressure ulcers may disrupt rehabilitation and adversely affect overall quality of life,[3,5-8] frequently resulting in hospitalization.[2] If a pressure ulcer is severe (eg, stage III/IV), it can result in further disability, decreased mobility, loss of independence, the need for surgical interventions, and potentially fatal infections.[3,6,9] It has been estimated that the cost of care for pressure ulcers is about $1.2 to $1.3 billion annually for patients with SCI/D in the United States.[3]

Veterans make up almost 17% of the SCI population,[10] and SCI/D is the most costly medical condition for veterans ($34,551 per person annually in 2008 dollars).[11] Interdisciplinary teams at 24 Regional SCI/D Centers located in Department of Veterans Affairs (VA) medical centers deliver primary care, acute rehabilitation, disability management, ongoing rehabilitation, and long-term care for veterans with SCI/D. To inform the work of clinicians at these centers and the decision making of policymakers regarding the burden of illness that pressure ulcers pose for the health care system, the objective of this study was to compare the annual health care utilization and costs of veterans with and without pressure ulcers in the Veterans Health Administration (VHA).

Methods

Study design

We conducted a retrospective analysis of veterans diagnosed with SCI/D who received care at a VA health care facility. To examine health care utilization and costs associated with incident pressure ulcers, we first determined which patients

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had a pressure ulcer diagnosis in fiscal year (FY) 2007 (ie, October 1, 2006, through September 30, 2007) but no pressure ulcer diagnosis in FY 2006. We then described those patients' health care utilization and costs during the 12-month period following the date of their first pressure ulcer diagnosis in FY 2007 (ie, their "index date" for this study). We included all patients who were diagnosed with a pressure ulcer in FY 2007 regardless of whether they were diagnosed and treated in inpatient or outpatient settings. Patients without pressure ulcers in FY 2007 who developed a pressure ulcer in FY 2008 were excluded from this study. For patients without pressure ulcers in FY 2006 through FY 2008, we examined health care utilization and costs during FY 2008. For these patients, their index date was the beginning of FY 2008 (October 1, 2007). We restricted our analyses to veterans in our cohort who were alive at the index date.

Data sources

Data for this study came from national VA data sources. We used the cohort of veterans with SCI/D created by the VA Allocation Resource Center (ARC), which maintains an ongoing registry of veterans with SCI/D that is used to allocate resources to VA medical centers. Health care utilization was obtained from the Medical SAS Inpatient and Outpatient Datasets extracted from the National Patient Care Database, which captures inpatient and outpatient utilization from the electronic record system of local VA medical centers,[12,13] and from VA Fee Basis files,[14] which capture claims for non-VA services paid for by the VA. Health care costs were obtained from the VA Decision Support System (DSS) National Data Extracts (NDE), which contain cost estimates of VA care derived from an activity-based cost allocation system.[15] Pharmacy data were obtained from the DSS Pharmacy NDEs, which capture medications dispensed from the electronic record systems of VA medical centers.[16]

Patients

To be included in our study cohort, veterans must have had an inpatient *International Classification of Diseases, 9th Revision* (*ICD-9*) code listed below and additional utilization of either an SCI/D outpatient center or hospitalization in an SCI/D center bed section. The codes include: 806.0-806.9 (fracture of vertebral column with SCI), 907.2-907.3 (late effects of SCI), 952.00-952.9 (SCI without evidence of spinal bone injury), 953.0-953.9 (injury to nerve root and spinal plexus), and 344.xx (paraplegia and quadriplegia not otherwise specified [NOS]).

We identified pressure ulcers based on the *ICD-9* diagnostic codes in the Medical SAS Inpatient or Outpatient Datasets or in the VA Fee Basis Files (ie, 707.0x). The result was the formation of 2 patient groups for this study: patients with incident pressure ulcers during FY 2007 and patients without pressure ulcers during FY 2007.

Health care utilization and costs

Outpatient utilization was categorized as primary care, mental health care, specialty care, and other outpatient care (such as ancillary care, home care, etc) based on clinic codes in the VA Medical SAS Outpatient Datasets. We examined the number of outpatient encounters that veterans had for each of these categories of care. Because veterans may visit more than one clinic while they are at a VA facility, they may have had more than one encounter per facility visit. Outpatient pharmacy use was categorized as chronic medications, defined as those for which a patient received more than one 30-day supply, and acute medications, defined as those medications for which a patient received no more than one 30-day supply. Inpatient utilization included the total number of hospital days for short-term medical/surgical, SCI, psychiatric, rehabilitation, and long-term care, based on time spent in that care unit (ie, VA bed section), and days of non-VA care financed by VA from the VA Fee Basis databases.

We examined the direct costs of patient care from the VA's (ie, the payer/provider's) perspective; our cost estimates reflect VA's expenditures for care of these patients. Costs for outpatient care, outpatient pharmacy, and inpatient care were obtained from VA DSS NDEs.[15] The DSS extracts information from the VA's accounting and payroll system and combines it with workload information from

patient care and administrative departments to produce cost estimates.[15] These databases contain estimates of personnel costs, including physicians, nurses, technicians, and other staff, as well as costs of supplies and other administrative/overhead expenses of inpatient stays and outpatient encounters. Pharmacy costs in DSS NDEs include the purchase price of the medication as well as dispensing and administrative/overhead costs.[16] Costs of non-VA hospitalizations financed by VA were obtained from the VA Fee Basis databases.[14] We examined annual total costs per patient, which consisted of total outpatient (primary care, specialty care, mental health care, and other costs), total outpatient pharmacy (chronic and acute medication costs), and total inpatient costs. All costs were adjusted to 2008 dollars using the Consumer Price Index.

Patient characteristics

Health care utilization and costs were adjusted for patient demographic, clinical, and other factors in multivariable models described below. Demographic characteristics of patients including age, race, ethnicity, and marital status were obtained from the VA Medical SAS Inpatient and Outpatient Datasets.[12,13] Comorbid conditions were determined from diagnoses in VA databases during the 12-month period prior to the index date. History of depression was based on diagnosis codes from FY 1999 to FY 2008.

Injury characteristics of veterans including level (tetraplegia, paraplegia) and duration of injury (0-10, 10-20, >20 years) were obtained from the VA Spinal Cord Dysfunction (SCD) Registry. SCI/D etiology was classified as traumatic (eg, vehicular, fall, act of violence, sports injury or other-traumatic), non-traumatic (eg, arthritic disease of the spine, poliomyelitis, tumor, infection or abscess, and other-disease), or both traumatic and nontraumatic based on SCD Registry information supplemented with *ICD-9* codes in the Medical SAS datasets if registry data were missing.

We used the residential zip code of each veteran to obtain associated geographic data including the average household income in each patient's zip code from the 2000 US census.[17] Travel time in minutes between zip code of residence and the nearest VA facility was calculated using geographic information system software (Network Analyst) that is available from the Environmental Science Research Institute in Redlands, California (ArcGIS 9.3). Utilization and cost information during the 12-month period prior to the index date were gathered from national VA databases.

Analysis

Bivariate and multivariable analyses were conducted using SAS version 9.1 (SAS Institute, Cary, North Carolina) and STATA SE version 11.0 (StataCorp LP, College Station, Texas). For bivariate analyses, characteristics prior to the index date were compared between patients with or without pressure ulcers using *t* tests or chi-square tests.

Differences in the health care utilization and costs between patients with or without pressure ulcers during the 12-month period following the index date were analyzed using bootstrapping approaches to account for the non-normal distribution of utilization and cost data. We used bias-corrected accelerated nonparametric bootstrapping procedures to estimate 95% confidence intervals (95% CIs).[18] We investigated statistical significance of the differences in means by examining whether the 95% CIs included 0. To conduct the bootstrap analyses, a series of 1,000 random samples were drawn, with replacement, from the data, and then the difference in means was recomputed after each resampling. The difference in means from these 1,000 resamplings were sorted and then used to estimate upper and lower bounds of the 95% CI.

To investigate the association of pressure ulcers with total hospital days and total costs, we used multivariable regression analyses, controlling for veteran's demographic, clinical, and other factors described previously. Because the number of hospital days in the 12-month period after the index date were non-negative integers, we used zero-inflated negative binomial (ZINB) count models for our multivariable analysis. The ZINB model is a count data model that allows for overdispersion where the conditional variance exceeds the conditional mean, and it adjusts for the portion of patients who would have no

hospitalization regardless of the values of the independent variables. Model specification tests indicated that the ZINB model was the most appropriate count model.[19,20] To examine the association between pressure ulcers and total direct health care costs after controlling for other factors, we used generalized linear models (GLM).[21] The GLM used includes a distribution function that describes the expected distribution of the costs and a link function that describes the scale on which the variables in the model are related to costs.[22] We used gamma distribution with a log link based on results from a modified Park test and a Box-Cox test.[23-25]

Results

Patients

Of the 10,977 patients who met our inclusion criteria, 11% had an incident pressure ulcer in FY 2007 (**Table 1**). Patients with incident pressure ulcers were more likely to have had a traumatic injury, an injury for >20 years, a hospitalization in the prior year, more outpatient visits in the prior year, and diabetes (**Table 1**).

Health care utilization

Patients with pressure ulcers had significantly more health care utilization during the 12-month period following the index date than patients without pressure ulcers. After controlling for factors in the multivariable ZINB model, patients with pressure ulcers averaged nearly 52 more total inpatient days (61.00 vs 9.19) than patients without pressure ulcers (P <.001) (**Tables 2** and **4**). The greater number of hospital days for patients with pressure ulcers was due primarily to more days in SCI care units (nearly 36 more days) and in long-term care (nearly 11 more days) (P < .05). Patients with incident pressure ulcers also had more outpatient encounters than patients without pressure ulcers during this time period (**Table 2**). Patients with pressure ulcers had nearly 8 more outpatient encounters with specialists (18.94 vs 11.39; P <.05) and nearly 13 more encounters for other outpatient services (52.34 vs 39.80; P <.05) than those without pressure ulcers.

Other factors associated with fewer total inpatient days from the ZINB model included having paraplegia rather than tetraplegia (5 fewer days), having an injury longer than 10 years (>3 fewer days), having more outpatient visits during the 12-month period prior to the index date (0.07 fewer days as outpatient encounters increased), and having a longer travel time to the nearest VA facility (0.06 fewer days as minutes to a VA facility increased) (P <.001). Factors associated with more total inpatient days included older age (0.34 more days as age increased), hospitalization in the 12-month period before the index date (18 more days), and a history of depression (nearly 5 more days) (P <.001) (**Table 4**).

Health care costs

Health care costs for those with pressure ulcers were higher during the 12-month period following the index date than for those without pressure ulcers. After adjusting for covariates in GLM analyses, total health care costs were $73,021 higher for patients with an incident pressure ulcer ($100,935 vs $27,914; P <0.001) (**Tables 3** and **4**; **Figure 1**). These higher total costs were due primarily to higher total inpatient costs for patients with pressure ulcers ($91,341 vs $13,754; P <.05). The largest category of inpatient costs was for care received in an SCI unit. This care was over 10 times higher ($51,901) for patients with versus without pressure ulcers ($56,895 vs $4,994; P <.05). Moreover, total outpatient costs during the 12-month period after the index date were also $8,559 higher for patients with pressure ulcers ($19,844 vs $11,829; P <.05), with the largest expenditure for care from a specialist. Total outpatient pharmacy costs were also $781 higher for patients with pressure ulcers ($2,394 vs 1,613; P <.05).

Other factors associated with lower total costs from the GLM analysis included being married ($4,248 lower), having paraplegia rather than tetraplegia ($10,166 lower), and having greater travel time to nearest VA ($142 lower as minutes to a VA facility increased) (P <.05). Factors associated with higher total health care costs included hospitalization in the 12-month period before the index date ($21,901 higher), more

Table 1. Characteristics of veterans with and without pressure ulcers

Characteristics	With pressure ulcers (n=1,220)	Without pressure ulcers (n=9,757)	*P*
Race			
Black	267 (21.9%)	1,912 (19.6%)	.059
White	926 (75.9%)	7,621 (78.1%)	.080
Other	27 (2.2%)	224 (2.3%)	.855
Hispanic	69 (5.7%)	577 (5.6%)	.940
Gender			
Male	1,195 (98.0%)	9,465 (97.1%)	.064
Female	25 (2.1%)	292 (2.9%)	
Marital status			
Married	523 (42.9%)	4,334 (44.4%)	.304
Age, years	59.4 (13.6)	59.4 (13.5)	.893
Level of SCI/D injury			
Tetraplegia	478 (39.2)	3,845 (39.4%)	<.0001
Paraplegia	735 (60.2%)	5,109 (52.4%)	
Unknown	7 (0.6%)	803 (8.2%)	
SCI/D etiology			
Traumatic	865 (70.9%)	5,497 (56.3%)	<.0001
Nontraumatic	201 (16.5%)	2,309 (23.7%)	
Both[a]	45 (3.7%)	669 (6.9%)	
Unknown	109 (8.9%)	1,282 (13.1%)	
Duration of injury			
0-10 yrs	349 (28.6%)	2,293 (23.5%)	<.0001
10-20 yrs	198 (16.2%)	1,614 (16.6%)	
>20 yrs	455 (37.3%)	2,569 (26.3%)	
Unknown	218 (17.9%)	3,281 (33.6%)	
Travel time to nearest VA, minutes	52.2 (45.8)	59.4 (50.7)	<.0001
Hospitalized in prior year	832 (68.2%)	3,185 (32.6%)	<.0001
No. of outpatient visits in prior year	44.9 (37.4)	43.6 (33.5)	.253
Average household income in zip code, $	51,491.4 (19072.4)	50,295.3 (17512.6)	.037
COPD	98 (8.0%)	808 (8.3%)	.766
History of depression	528 (43.3%)	4,165 (42.7%)	.694
Diabetes	253 (20.7%)	1,496 (15.3%)	<.0001

Note: Values are shown as n (%) or mean (*SD*). SCI/D = spinal cord injury/disorder; VA = Veterans Affairs; COPD = chronic obstructive pulmonary disorder.

[a]Both traumatic and non-traumatic diagnoses were present.

outpatient visits in the year prior to the index date ($97 higher as outpatient encounters increased), and comorbidities (>$5,000 higher) ($P$ <.05) (**Table 4**).

Discussion

In a large cohort of veterans with SCI/D, incident pressure ulcers were associated with higher total health care costs and hospitalizations over a 12-month period for patients with pressure ulcers than patients without them. After adjusting for patient demographic, clinical, and other characteristics, total annual health care costs per patient were $73,021 higher for patients with pressure ulcers ($100,935 vs $27,914) and annual hospitalizations were nearly 52 days longer (61.00 vs 9.19 days).

This study highlights the burden of illness of SCI/D for both patients and the health care system and demonstrates the larger additional burden of illness if these patients develop a pressure ulcer. Prior studies have examined the costs of veterans with SCI/D[11,26,27]; however, less is known about the impact of pressure ulcers on veterans with SCI/D. In a previous study of veterans with SCI/D, average inpatient and outpatient costs for a sample of 675 patients were $23,647 in 2008 dollars.[26] Because

Table 2. Health care utilization among veterans with and without pressure ulcers

	With pressure ulcers (n=1,220)	Without pressure ulcers (n=9,757)	
	Mean Median (IQR)	Mean Median (IQR)	Difference (95% CI)[a]
Outpatient care, no. of encounters			
Primary care	4.08 2 (0-5)	3.41 2 (0-4)	0.67 (0.28 to 1.07)
Mental health	1.85 0 (0-1)	2.23 0 (0-1)	-0.38 (-0.92 to 0.43)
Specialty care	18.94 14 (6-25)	11.39 8 (2-16)	7.56 (6.43 to 8.76)
Other outpatient	52.34 46 (21-73.5)	39.80 34 (15-57)	12.54 (10.16 to 15.16)
Outpatient pharmacy[b]			
Chronic medications	68.56 54 (17-106)	69.52 55 (16-103)	-0.96 (-4.62 to 2.62)
Acute medications	2.78 1 (0-4)	2.25 1 (0-3)	0.53 (0.30 to 0.85)
Inpatient care, no. of days			
Medical/surgical	5.53 0 (0-5)	1.03 0 (0-0)	4.50 (3.78 to 5.64)
Rehabilitation	0.51 0 (0-0)	0.07 0 (0-0)	0.43 (0.14 to 0.92)
SCI	39.16 0 (0-43)	3.28 0 (0-0)	35.88 (31.93 to 39.98)
Mental health	0.17 0 (0-0)	0.44 0 (0-0)	-0.27 (-0.44 to 0.02)
ICU	1.88 0 (0-0)	0.22 0 (0-0)	1.66 (1.24 to 2.50)
Long-term care	15.83 0 (0-0)	5.24 0 (0-0)	10.59 (7.61 to 14.23)
Other care	0.45 0 (0-0)	0.27 0 (0-0)	0.18 (-0.06 to 0.44)
Total VA hospital days	55.81 15 (0-75)	5.39 0 (0-1)	50.42 (45.88 to 55.74)
Non-VA hospital	5.02 0 (0-0)	2.87 0 (0-0)	2.15 (0.80 to 4.54)
Total hospital days[c]	61.00 17 (0-82)	9.19 0 (0-1)	51.80 (44.12 to 59.49)

Note: IQR = interquartile range; SCI = spinal cord injury; ICU = intensive care unit; VA = Veterans Affairs.

[a]CI for the difference in utilization for patients with pressure ulcers minus utilization for patients without pressure ulcers.

[b]Outpatient medications are the number of 30-day supplies for medications that patients received during the 12-month period after the index date. Chronic medications were defined as those for which a patient received more than one 30-day supply. Acute medications were defined as those medications for which a patient received no more than one 30-day supply.

[c]Mean total hospital days were adjusted with zero-inflated negative binomial models including covariates in Table 4.

Table 3. Health care costs among veterans with and without pressure ulcers

	With pressure ulcers (n=1,220)	Without pressure ulcers (n=9,757)	
	Mean Median (IQR)	Mean Median (IQR)	Difference (95% CI)[a]
Outpatient care, $			
Primary care	1,149 367 (0-1,190)	914 361 (0-1,005)	235 (108 to 394)
Mental health	298 0 (0-7)	424 0 (0-40)	-126 (-205 to 7)
Specialty care	9,343 5,353 (1,746-11,327)	5,176 2,669 (534-6,634)	4,167(3,310 to 5,029)
Other outpatient	9,055 5,043 (2,180-10,811)	5,316 2,780 (1,044-5,965)	3,739 (3,049 to 4,760)
Total outpatient	19,844 13,170 (6,143-25,928)	11,829 7,553 (2,996-15,366)	8,015 (6,683 to 9,415)
Outpatient medications,[b] $			
Chronic medications	2,230 880 (244-2,076)	1,503 708 (171-1,767)	727 (390 to 1,678)
Acute medications	164 23 (0-90)	109 1 (0-56)	54 (10 to 125)
Total pharmacy	2,394 949 (280-2,256)	1,613 762 (195, 1,871)	781 (406 to 1,656)
Inpatient care, $			
Medical/surgical	10,479 0 (0-9,821)	2,072 0 (0-0)	8,407 (7,208 to 10,265)
Rehabilitation	929 0 (0-0)	149 0 (0-0)	781 (235 to 1,862)
SCI	56,895 0 (0-62,018)	4,994 0 (0-0)	51,901 (45,600 to 58,407)
Mental health	245 0 (0-0)	442 0 (0-0)	-197 (-407 to 488)
ICU	7,836 0 (0-0)	1,046 0 (0-0)	6,789 (4,867 to 10,073)
Long-term care	11,334 0 (0-0)	3,791 0 (0-0)	7,543 (5,522 to 10,047)
Other care	1,065 54 (0-727)	325 0 (0-0)	741 (523 to 1,177)
Non-VA	2,557 0 (0-0)	935 0 (0-0)	1,622 (1,069 to 2,428)
Total inpatient	91,341 29,788 (0-121,841)	13,754 0 (0-4,278)	77,587 (69,009 to 85,355)
Total costs,[c] $	100,935 57,623 (21,714-155,810)	27,195 11,579 (4,467-26,525)	73,021 (64,236 to 81,806)

Note: IQR = interquartile range; SCI = spinal cord injury; ICU = intensive care unit; VA = Veterans Affairs.

[a]CI for the difference in utilization for patients with pressure ulcers minus utilization for patients without pressure ulcers.

[b]Outpatient medications are the number of 30-day supplies for medications that patients received during the 12-month period after the index date. Chronic medications were defined as those for which a patient received more than one 30-day supply. Acute medications were defined as those medications for which a patient received no more than one 30-day supply.

[c]Mean total hospital days were adjusted with zero-inflated negative binomial models including covariates in Table 4.

Table 4. Factors associated with total inpatient days and total health care costs per year in patients with and without pressure ulcers

	Change in inpatient days (95% CI)	*P*	Change in total healthcare costs ($) (95% CI)	*P*
Pressure ulcer status	51.80 (44.12 to 59.49)	<.001	73,021 (64,236 to 81,806)	<.001
Race				
Non-Black[a]				
Black	1.51 (-0.85 to 3.88)	.21	2,512 (-1,437 to 6,460)	.212
Ethnicity				
Non-Hispanic[a]				
Hispanic	2.78 (-1.32 to 6.87)	.184	6,183 (-368 to 12,734)	.064
Gender				
Female[a]				
Male	-6.02 (-13.11 to 1.08)	.097	-5,670 (-16,642 to 5,302)	.311
Marital status				
Not married[a]				
Married	-2.86 (-4.62 to -1.09)	.002	-4,248 (-7,051 to -1,445)	.003
Age, years	0.34 (0.27 to 0.42)	<.001	275 (143 to 408)	<.001
Level of SCI/D injury				
Tetraplegia[a]				
Paraplegia	-5.45 (-7.48 to -3.41)	<.001	-10,166 (-13,479 to -6,853)	<.001
Unknown	-9.09 (-12.46 to -5.71)	<.001	-22,583 (-26,662 to -18,505)	<.001
SCI/D etiology				
Traumatic[a]				
Non-traumatic	1.40 (-0.97 to 3.76)	.247	2,061 (-1,741 to 5,863)	.288
Both[b]	0.97 (-2.52 to 4.46)	.586	2,036 (-4,437 to 8,509)	.538
Unknown	7.50 (-2.53 to 12.48)	.003	2,628 (-3,491 to 8,746)	.400
Duration of injury				
0-10 years[a]				
10-20 years	-5.37 (-7.82 to -2.92)	<.001	-10,636 (-14,805 to -6,467)	<.001
>20 years	-3.78 (-6.20 to -1.35)	.002	-2,491 (-7,310 to 2,327)	.311
Unknown	1.23 (-1.88 to 4.33)	.439	-7,890 (-12,790 to -2,990)	.002
Travel time to the nearest VA facility, minutes	-0.06 (-0.08 to -0.04)	<.001	-142 (-170 to -114)	<.001
Hospitalized in prior year	18.34 (16.30 to 20.37)	<.001	21,901 (19,181 to 24,622)	<.001
Outpatient visits in prior year	-0.07 (-0.09 to -0.05)	<.001	97 (58 to 137)	<.001
Average household income from zip per $10,000	-0.18 (-071 to 0.35)	.515	964 (-116 to 2,045)	.08
COPD	1.72 (-1.29 to 4.73)	.264	5,482 (1,094 to 9,871)	.014
Depression	4.78 (2.93 to 6.62)	<.001	7,159 (4,336 to 9,983)	<.001
Diabetes	1.06 (-1.30 to 3.42)	.379	7,184 (3,710 to 10,658)	<.001

Note: SCI/D = spinal cord injury/disorder; VA = Veterans Affairs; COPD = chronic obstructive pulmonary disease

[a]Reference category.

[b]Both traumatic and non-traumatic diagnoses were present.

veterans who had more than 40 days of bed rest were excluded from the French et al study, many patients with pressure ulcers were excluded. In studies examining 29 common chronic conditions treated in VA, Yu et al found that treating veterans with SCI/D cost approximately $34,000 annually per patient[27] and that for veterans 65 years of age or older the annual treatment costs were over $38,000,[11] both in 2008 dollars. Of the 29 chronic conditions examined, the annual treatment cost of SCI/D was the highest. Renal failure had the next highest treatment cost per patient at over $29,000 per year

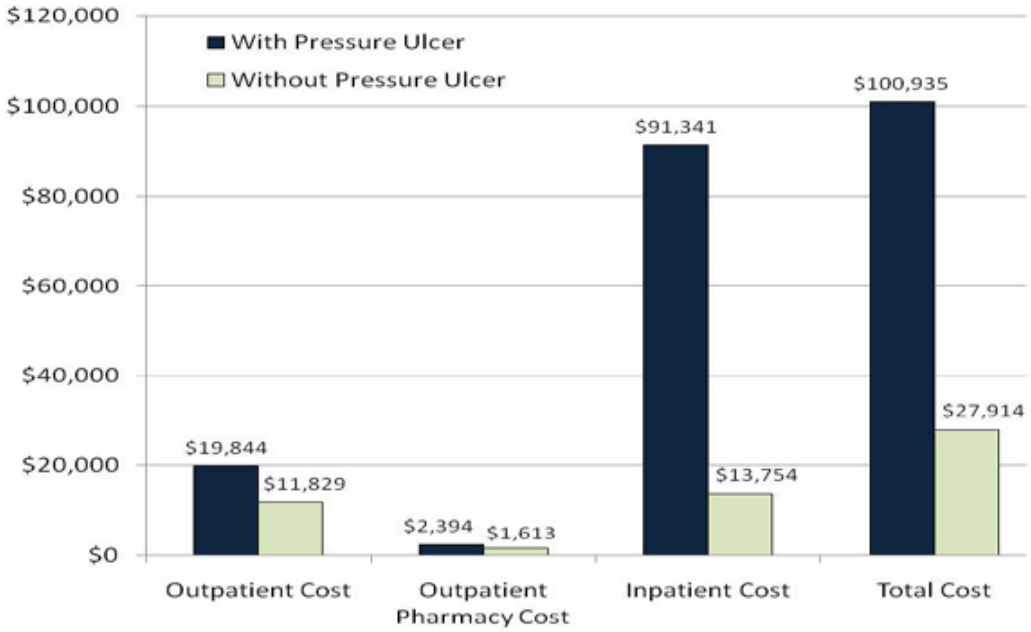

Figure 1. Cost of care per year for veterans with and without pressure ulcers.

followed by dementia at over $25,000 per year in 2008 dollars. Both of these studies have shown that patients with SCI/D have high annual treatment costs; however, neither specifically examined the subset of veterans with pressure ulcers.

Our estimates of the annual costs of patients without pressure ulcers were comparable to annual treatment costs of veterans with SCI/D that have been reported elsewhere.[26,27] Additionally, our findings indicate that annual treatment costs were over 260% higher in the presence of a pressure ulcer among SCI/D patients compared to SCI patients without pressure ulcers. Moreover, the high costs that are associated with an incident pressure ulcer are just one measure of associated illness burden. Pressure ulcers also substantially impact health-related quality of life[28] and increase morbidity and mortality.[3,6,9] In light of these points, developing an evidence base for effective strategies to improve pressure ulcer prevention and treatment should be high priorities for VA.

Our results suggest that VA's SCI/D system of care could benefit from efficient ways to promote early identification and treatment of new skin problems. In this study, veterans with SCI/D who had pressure ulcers averaged $73,021 more in annual treatment costs than veterans without pressure ulcers. This represents over $89 million in total additional costs to the health care system. If interventions to prevent pressure ulcers could be developed that cost approximately $8,000 or less per patient to implement (ie, $89 million divided by 10,997), these interventions might ultimately be cost saving to VA.

By conceptualizing pressure ulcer prevention as an ongoing chronic care self-management activity for persons with SCI/D, steps might be taken before high-cost acute events and other complications occur. For example, patients and/or their informal caregivers could be encouraged to provide routine skin care updates to providers or to report any potential skin problems at the earliest possible opportunity, when immediate intervention by a clinician could positively alter the trajectory of pressure ulcer development and, ultimately, health outcomes. Moreover, increasing access to

specialty care through patient-facing technologies (eg, home telehealth applications, personal health record systems) may be a promising approach to extend current resources and further develop a focus on prevention.

Limitations

There are several limitations to this study. First, although we were able to measure the level of injury (paraplegia vs tetraplegia), we were unable to adjust for the completeness of injury as indicated by the International Standards for Neurological Classification of SCI scores due to the substantial portion (>85%) of patients with missing information in our data. Moreover, 7% of patients had an "unknown" level of injury, which was associated with significantly lower total health care costs. We have speculated that the missing level of injury and lower total costs may indicate that these patients are not utilizing VA care as often as other groups. We were also unable to adjust for characteristics of the pressure ulcer itself (number of ulcers, severity, etc). For patients with greater severity of an ulcer (ie, stage I to stage IV), cost, utilization, and mortality risk are also greater. Our results demonstrate, however, that even when early stage (I and II) ulcers are included in the analyses, there is a substantial cost difference between veterans with and without incident pressure ulcers. A second limitation is that only direct VA costs are measured. Because veterans may have other insurance options, such as through Medicare or Medicaid, that might result in non-VA health care use, future studies of Medicare and Medicaid utilization and costs by veterans with SCI will be useful. Moreover, although costs of home-based primary care provided by VA and bowel attendant care covered by VA were included in the cost estimates, non-VA home care and attendant care may also be important for this population but were not measured in this study. Attendant care is the single biggest cost category in the long-term care of persons with SCI,[29] and pressure ulcers will likely increase the need for home care. There is limited research on home care, attendant care, and indirect costs (eg, lost wages, lost productivity) for veterans with SCI/D with pressure ulcers, so additional research would provide important information about the burden of this condition in these areas. Fourth, these costs estimates may not be generalizable to other health care settings because of the differences in how pressure ulcers are managed as well as how costs are measured in other health care systems. Even though veterans with SCI might be admitted to a VA hospital for a pressure ulcer, non-veterans with SCI might be more likely to be admitted to a nursing home if they develop a pressure ulcer. Despite limitations in generalizability to the larger SCI population, this study does provide a vivid picture of the burden pressure ulcers can cause in a health care system in terms of utilization and costs. Fifth, given the cross-sectional design of our analyses, the results presented here must be viewed as associative rather than strictly causal. It is possible that individuals hospitalized or in long-term care for another problem subsequently developed pressure ulcers, which were not responsible for the initial health care use. Additionally, we could have overestimated the real costs of pressure ulcer treatment, because veterans may be admitted for multiple reasons, and pressure ulcer is one of the concurrent diagnoses. Further research would be necessary to disentangle such effects. Finally, this study captured a year's worth of data on incident pressure ulcers. Very long healing times and recurrent pressure ulcers are common in this population, suggesting that costs of treating pressure ulcers are likely higher than we report in our analysis.

Despite these limitations, this study highlights the importance of identifying patients with SCI/D who could be targeted for interventions to decrease the burden of illness associated with pressure ulcers. This is an important step toward developing a better understanding of the costs of care for veterans with SCI/D in the VA and toward being able to develop a more refined research agenda that can help clinicians and policymakers with developing, testing, and implementing more cost-effective treatments for prevention and treatment of pressure ulcers in SCI/D. The VA SCI Quality Enhancement Research Initiative (SCI QUERI), which was established to improve the health and quality of life for veterans with SCI/D by promoting and implementing evidence-

based practice, is currently working on projects to improve outcomes by developing and testing a tool to measure wound healing and developing a risk assessment tool to identify patients at greatest risk for pressure ulcer development. Investigators with the SCI QUERI are also evaluating patient self-management programs to decrease pressure ulcer risk. Interventions focused on prevention and early treatment are likely to be the best strategies to reduce health care costs and improve health outcomes in veterans with SCI/D. These initiatives are important steps toward containing the costs of pressure ulcers and ultimately to addressing the overall burden that they pose to veterans, providers, and the health care system.

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