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Factors associated with VHA costs of care for first 12 months after first stroke

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Abstract—We examined the use patterns and costs of care for a validated stroke cohort (*n* = 172) from 13 Department of Veterans Affairs (VA) medical centers 1 year poststroke. Decision Support System (DSS) cost and use data (inpatient and outpatient) are profiled. We provide preliminary information about the costs associated with inpatient and outpatient care and explore the relationship between the cost of stroke care, location of service (inpatient and outpatient), and patient functional outcomes. Data on both clinical and sociodemographic characteristics were abstracted from the medical record and merged with VA DSS cost data from each patient's first year poststroke. Descriptive statistics assessed patterns in treatment costs. We found that DSS costs varied as expected across key indicators, including function, health status, discharge location, and the number of comorbidities. These findings provide broad support for the use of DSS cost data in studies of VA stroke care.

Key words: acute stroke care, Decision Support System, FIM, Modified Rankin Scale, rehabilitation care, stroke, stroke costs, Stroke Impact Scale, subacute stroke care, VA.

INTRODUCTION

Stroke is the second most frequent cause of death and the most common cause of invalidity in adults worldwide [1], as well as the leading cause of long-term disability in the United States [2]. More than 700,000 Americans experience a new or recurrent stroke each year [3]. The estimated direct costs exceeded $31 billion in 2003 [4]. Stroke-related diseases cost the Veterans Health Administration (VHA) at least $1 billion each year [5]. This figure is expected to increase significantly in the next 20 years as more veterans reach an age at which stroke is more likely to occur [6–7]. This article examined the use patterns and costs of care of a validated VHA stroke cohort (*n* = 172) over a 1-year period. Decision Support System (DSS) cost and use data (inpatient and outpatient) were profiled for the cohort. From a policy perspective, it is important to differentiate the costs associated with inpatient and outpatient care and to consider the relationship between the type of setting (inpatient vs outpatient), characteristics of the stroke, and patient functional outcomes. Accurate, detailed assessments of the costs of stroke care are needed to help policy makers allocate scarce healthcare resources. We analyzed the relationship between cost of

Abbreviations: AITC = Austin Information Technology Center, DSS = Decision Support System, FIM = Functional Independence Measure, GLM = general linear model, MRS = Modified Rankin Scale, NDE = National Data Extracts, SD = standard deviation, SF-36V = 36-item Short Form Health Survey for Veterans, SIS = Stroke Impact Scale, VA = Department of Veterans Affairs, VHA = Veterans Health Administration, VISN = Veterans Integrated Service Network.

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stroke care to the VHA, location of service (inpatient and outpatient), stroke characteristics, and patient functional outcomes by using the Modified Rankin Scale (MRS), a global disability measure [8–12], and the Functional Independence Measure (FIM) [13].

REVIEW OF LITERATURE

Several studies report the cost of poststroke care. Matchar and Duncan examined Medicare claims data to gain insight into the costs of stroke care 90 days poststroke [14]. A little more than half (57%) of the costs of stroke were represented by direct medical costs (e.g., hospitalization, nursing home care, physicians' fees, and medical equipment). The remaining 43 percent consisted of indirect costs from lost wages. The average cost of stroke care during the first 90 days after stroke was $15,000 (1991 dollars). Lee et al. used a 20 percent sample of the 1991 national Medicare claims data to examine stroke costs during the initial 6 months poststroke [15]. The researchers found that the average total per patient cost of care for the first 6 months poststroke was $18,626, with 60 percent of the poststroke expense incurred in acute care settings. Freburger explored the costs of poststroke care by using the 1996 University Health System Consortium Clinical Database [16]. The mean total direct cost associated with stroke care was $9,146 per patient, and the mean direct physical therapy charge for acute care was $527 per patient. Further, physical therapy use was significantly associated with the cost of poststroke care.

Within the Department of Veterans Affairs (VA) system, however, little is known about the costs incurred for stroke care. Various methods of examining the costs of stroke care in the VHA have been discussed, including the advantages, disadvantages, and assumptions associated with each of five methods: direct assessment of costs, list costing, estimations using regression analysis, average cost data based on Health Economics Resource Center data, and DSS National Data Extracts (NDE) data [17]. DSS costs are based on actual resource consumption (not charges or payments) in both direct patient care cost centers (e.g., inpatient wards) and indirect cost centers (e.g., housekeeping). DSS uses a system of intermediate product accounts to allocate costs incurred in indirect work centers to direct patient care cost centers where attribution to individual patients is possible. This allocation is based on a number of mechanisms, including physical measurements (e.g., square footage) and relative value units specific to DSS. Recently, DSS costs have become the basis for development of the VHA budget and have gained increasing credibility as the DSS cost accounting system has been developed and refined.

Validation of VHA DSS-NDE data is still necessary, however, for at least two reasons: (1) DSS remains a relatively new tool available to researchers and (2) incomplete reporting can pose serious challenges to the validity of extracts [17–18]. Also, one should note that DSS only captures VA-specific cost and use and does not include any non-VA healthcare consumed by our sample. This limitation of our study was unavoidable and limited the perspective of our analyses to the VA as opposed to total societal costs and use.

METHODS

Subjects

The subjects for this research were recruited as part of a larger clinical survey designed to compare telephone versus mail administration of the Stroke Impact Scale (SIS), a 59-item instrument assessing eight dimensions of patient health and the overall burden of stroke [19]. Thirteen VA medical centers participated in this retrospective/prospective study. Potential stroke patients were identified by International Classification of Diseases-9th Revision diagnosis codes that have been shown to be highly sensitive to stroke capture [20]. The larger clinical study was approved by human subject committees at all participating VA sites of care.

Patient Selection and Variable Definitions

A trained research coordinator reviewed electronic medical records (VHA VISTA [Veterans Health Information Systems and Technology Architecture]) to validate the stroke diagnosis either by clinical or imaging diagnosis. Stroke patients who survived their index hospitalization were randomly assigned to one of two survey methods for SIS administration: mail or telephone. A letter of introduction and a consent form were mailed to each survey recipient. Following informed consent, patients were surveyed (by either mail or telephone) with the SIS at 12 weeks poststroke. At 16 weeks poststroke, all patients were resurveyed (by telephone only) with the FIM [13] and the 36-item Short Form Health Survey for

Veterans (SF-36V) [21]. The following information was abstracted from the medical record: age, sex, race, marital status, next of kin, provider specialty, stroke diagnosis source, stroke type and location, functional status at discharge, history of prior stroke, prior functional status, prior neurological symptoms, cognitive impairment on discharge, and pre- and poststroke MRSs.

Modified Rankin Scale—Derived Functional Measure

The MRS is scored along a continuum ranging from 0 to 6, with 0 representing "no symptoms at all" and 6 indicating "death" [22]. A person whose score is a 1 may have symptoms but no significant disability and be able to carry out all usual duties and activities. Similarly, a score of 2 indicates "slight disability" and the person is usually unable to carry out all previous activities but can look after his or her own affairs without assistance. A score of 3 indicates "moderate disability" and the person requires some help but is able to walk without assistance. A score of 4 indicates "moderately severe disability" and the person is unable to walk without assistance and cannot attend to his or her own bodily needs without assistance. A score of 5 indicates "severe disability" and the person is usually bedridden and incontinent and requires constant nursing care and attention.

Study Subgroup Variables

The FIM, an 18-item instrument with two domains, motor (13 items) and cognition (5 items), is the most widely used instrument in the United States to measure activities of daily living function in all rehabilitation populations [13]. The FIM has been adopted by the VHA as the standard for functional measurement; has been mandated for use in VA patients with stroke, amputation, and traumatic brain injury; and forms the basis for the VA-wide Functional Status Outcomes Database that is integrated nationally within the Computerized Patient Record System and housed at the Austin Information Technology Center (AITC). The SF-36V is a veteran-specific adaptation of the 36-item Short Form, developed as part of the Medical Outcomes Study, and is perhaps the most commonly used measure of health-related quality of life [21]. The instrument has 36 items in eight domains and has a physical and mental summary scale.

From the DSS-NDE cost files located at the AITC, VA cost data were obtained for VHA use and costs only (i.e., no out-of-system use was measured). All inpatient and outpatient cost data associated with each unique patient identifier were collected from the index stroke admission through 12 months (based on the hospital admission date for the index stroke). Patients who died during the 12-month period were excluded from the descriptive analyses. Descriptive statistics were generated using SAS, version 8.2 (SAS Institute Inc; Cary, North Carolina). Statistical tests (*t*-tests and *F*-tests) were run on all cost comparisons for continuous and categorical variables thought to be associated with costs. Costs were aggregated for two time periods: (1) a 3-month period from stroke onset to SIS evaluation and (2) from 3 months poststroke (SIS evaluation) to 12 months poststroke. Costs for total, inpatient, and outpatient services were aggregated as well. Small sample sizes in some categories limit our ability to draw conclusions and require that results be interpreted with caution.

RESULTS

Screening of medical records yielded 458 patients with a valid diagnosis of stroke. Two-hundred thirty-five of the patients (51%) completed the SIS evaluation by telephone or mail. Forty-nine participating patients were dropped from the study according to institutional review board rules because consent forms were not returned or were incomplete (no witness signature). The study sample consisted of 186 validated stroke patients, representing 41 percent of the surveyed sample. All patients received treatment for stroke from May 2001 through September 2002 in 13 VA medical centers with an average bed capacity of 275 (standard deviation [SD] = 175) and a range of 60–688 beds. **Table 1** is a comparison of the 186 complete responders and the 272 validated stroke patients who either did not respond to the survey or were dropped because of invalid consents. A *t*-test was used to compare responders and nonresponders on continuous variables (age) and the chi-square statistic was used for categorical variables (all remaining comparisons). Two baseline characteristics were statistically different between the groups: the responders were more often married (60% vs 42%, respectively) and had fewer cognitive deficits at acute care discharge (16% vs 30%, respectively) than nonresponders. These two characteristic differences are likely causal in relationship to survey response and should be expected in survey studies of older and potentially more impaired populations.

Table 1.
Baseline characteristics of survey responders and nonresponders. Data shown as No. (%), unless otherwise indicated.

Variable	Responders (*n* = 186)	Nonresponders (*n* = 272)	*p*-Value
Age (mean ± standard deviation)	68.4 ± 11.0	67.8 ± 12.0	0.74
Female	1 (0.5)	7 (1.5)	0.10
Race/Ethnicity			0.12
White	128 (69)	167 (61)	
Black	24 (13)	51 (19)	
Hispanic	1 (0.5)	5 (2)	
Asian	8 (4)	2 (1)	
Other	1 (0.4)	12 (4)	
Missing	24 (13)	35 (13)	
Marital Status			0.001
Married	107 (60)	109 (42)	
Divorced/Separated	23 (13)	67 (26)	
Widowed	15 (8)	34 (13)	
Never Married	11 (6)	16 (6)	
Missing	22 (12)	35 (13)	
Ischemic Stroke (%)	93.5	94.1	0.65
Prestroke Modified Rankin Scale Score			0.87
0 = No symptoms at all	94 (51)	138 (51)	
1 = Symptoms, no significant disability	37 (20)	47 (17)	
2 = Slight disability	23 (12)	33 (12)	
3 = Moderate disability	9 (5)	21 (8)	
4 = Moderately severe disability	6 (3)	12 (4)	
5 = Severe disability	1 (1)	1 (0)	
Missing	16 (9)	20 (7)	
Previously Resided in Community	180 (97)	249 (92)	0.07
Prior Stroke	69 (26)	77 (35)	0.61
Prior Neurological Symptoms	30 (11)	42 (18)	0.13
Poststroke Modified Rankin Scale Score			0.36
0 = No symptoms at all	8 (4)	14 (5)	
1 = Symptoms, no significant disability	37 (20)	50 (18)	
2 = Slight disability	40 (22)	40 (15)	
3 = Moderate disability	51 (27)	73 (27)	
4 = Moderately severe disability	37 (20)	63 (23)	
5 = Severe disability	7 (4)	20 (7)	
Missing	6 (3)	12 (4)	
Cognitive Deficit at Discharge	30 (16)	82 (30)	0.002
Aphasia	34 (18)	52 (19)	0.34

Source: Data extracted from Department of Veterans Affairs (VA) Decision Support System as merged with VA medical SAS data sets.

Prior studies on the stroke cohort used in this study focused on the effect of SIS administration mode and on the construct validity of the SIS [23–24]. Findings from the article on SIS administration mode included (1) mail nonresponders were more likely to have had severe strokes, have cognitive deficits, and be unmarried; (2) telephone responders and nonresponders were not different; (3) mail and telephone responders were not different, and the SIS score distribution did not indicate the presence of mode effects; (4) telephone mode of administration yielded a higher response rate; (5) test-retest reliability was good to excellent for seven SIS domains in the mail group (0.77–0.99), except social participation (0.62); and (6) test-retest reliability was excellent in the telephone group

(0.90–0.99), except emotion (0.68) [23]. For additional details on the study methodology and results, see Duncan and colleagues [23] and Kwon and colleagues [24]. In general, these findings support both the broad consistency of the SIS across modes of administration and the use of these data for the current exploratory research.

Tables 2–**5** contain the 186 validated stroke patients in the original sample less the 14 patients who died during the follow-up period, resulting in an analytic sample of 172 for all cost and use analyses. **Table 2** provides aggregate cost data and use by admission period (time 0–3 months poststroke and time 4–12 months poststroke) and delivery setting (inpatient and outpatient). Nearly 66 percent of the mean total inpatient and outpatient costs were accrued for patients in time 0–3 months ($15,375). While the majority of stroke costs were associated with inpatient care occurring 0–3 months poststroke ($12,547), about 33 percent of the mean total costs resulted from care received on an outpatient basis ($2,829 in time 0–3 months plus $5,710 for time 4–12 months). Finally, the study sample distributions were skewed right, as noted by the higher mean costs than median costs, as expected when studying healthcare costs.

Median costs in **Table 3** are broken down into clinical categories such as stroke type and location, comorbidities, stroke severity (MRS), and bed section at discharge. Variation is observed across all inpatient, outpatient, and total cost categories as well as by stroke type and location. Most notable among the cost variations are the graduated increases in costs with each incremental increase in the number of comorbidities and stroke disability increases (MRS), especially the MRS unit increase from 2 to 3. A general linear model (GLM) (univariate Proc GLM) indicated that outpatient costs in time 4–12 months were significantly greater for stroke patients who had more comorbid health conditions (p = 0.04). Similarly, the

Table 2.
Mean and median inpatient and outpatient costs and use 0–12 mo after first stroke.

Variable	*n*	Sum	Mean	Median	Standard Deviation
Inpatient					
Cost ($)					
Time 0–3 mo	172	2,158,072	12,547	7,085	15,253
Time 4–12 mo	172	737,239	4,286	0*	11,883
Days (No.)					
Time 0–3 mo	172	2,492	14	7	25
Time 4–12 mo	172	769	4	0*	15
Outpatient					
Cost ($)					
Time 0–3 mo	172	486,505	2,829	2,159	2,414
Time 4–12 mo	172	982,173	5,710	4,049	5,268
Day Visits† (No.)					
Time 0–3 mo	172	1,309	8	7	5
Time 4–12 mo	172	3,013	18	14	18
Clinic Stops‡ (No.)	169	2,482	14	12	10
Time 0–3 mo	169	4,882	29	21	27
Time 4–12 mo					
Inpatient & Outpatient Costs ($)					
Total Time 0–3 mo	172	2,644,577	15,375	10,063	15,273
Total Time 4–12 mo	172	1,719,412	9,997	5,101	13,840
Grand Total 12 mo	172	4,363,989	25,372	18,374	22,450

Source: Data extracted from Department of Veterans Affairs (VA) Decision Support System as merged with VA medical SAS data sets.
*Value of zero indicates that more than half our sample had no hospitalizations in months 4–12.
†Veterans Health Administration defines "day visits" as visit to VA facility on any given day.
‡During a "Day Visit," the patient may visit one or more outpatient department(s). Visits to one or more outpatient clinics during a "Day Visit" are defined as "Clinic Stops."

Table 3.
Median inpatient and outpatient costs by clinical characteristics, discharge bed section, and survival status.

Variable	*n*	Time 0–3 Mo Costs ($)		Time 4–12 Mo Costs ($)		Grand Total Costs ($)
		Inpatient	Total	Outpatient	Total	
Stroke Type						
Ischemic	163	7,236	10,527	4,220	5,138	18,349
Hemorrhagic	9	4,437	8,603	3,529	3,578	18,399
Stroke Location						
Right Hemisphere	57	7,922	10,010	4,082	5,727	19,218
Left Hemisphere	68	6,389	9,268	4,332	5,915	19,113
Brain stem	26	7,404	10,696	3,136	4,150	15,824
Cerebellar	7	7,852	16,215	4,253	4,253	25,244
Bilateral	3	21,555	21,889	1,355	1,355	23,244
No. Elixhauser Comorbidities						
0	25	4,988	7,290	3,084	4,471	14,174
1	59	7,247	11,439	4,122	5,344	16,497
2	48	7,082	10,513	4,049	4,269	19,044
3	30	8,571	12,001	4,619	5,446	23,218
4	9	9,017	11,265	5,602	6,243	21,475
5	1	32,095	36,287	8,812	14,543	50,830
Poststroke Modified Rankin Scale Score						
0 = No symptoms at all	8	5,014	7,044	4,108	4,321	14,901
1 = Symptoms, no significant disability	35	4,025	6,159	3,433	5,727	12,637
2 = Slight disability	39	5,767	7,885	3,414	3,994	12,751
3 = Moderate disability	48	8,249	11,723	5,329	6,811	23,218
4 = Moderately severe disability	34	19,197	22,156	4,231	5,154	30,971
5 = Severe disability	2	17,097	18,670	5,795	9,958	28,628
Discharge Bed section						
Neurology	65	6,145	9,633	4,325	6,044	17,220
General Medicine	77	7,922	11,955	3,656	4,471	18,399
Intermediate Medicine (subacute hospital bed)	20	6,839	8,430	4,162	4,790	14,097

Source: Data extracted from Department of Veterans Affairs (VA) Decision Support System as merged with VA medical SAS data sets.

MRS at discharge was related to inpatient costs in time 0–3 months ($p < 0.001$), all costs in time 0–3 months ($p < 0.001$), and total inpatient and outpatient costs ($p < 0.001$). Higher MRS at discharge corresponded to higher inpatient costs.

Table 4 lists median costs broken down by the Veterans Integrated Service Network (VISN) structure and site(s) within each VISN, patient discharge location, and facility characteristics. Median costs varied considerably across VISNs, with sites in VISNs 12, 17, and 23 ranging about 55 percent higher than the lowest total cost category (VISN 8), although these comparisons are limited by the small sample sizes in these VISNs. A GLM (univariate Proc GLM) indicated that the cost of care associated with inpatient days and total patient costs was significantly greater for patients who discharged to an acute care hospital or nursing home as opposed to remaining in the community (e.g., at home) ($p < 0.001$). Further, the number of outpatient visits in time 4–12 months was significantly higher for stroke patients in facilities with more than 200 beds ($p = 0.04$). The results only address VHA use and costs, and out-of-system use is not measured.

Table 5 displays median costs by patient age group and patient function as measured by the SF-36V and FIM. A GLM (univariate Proc GLM) revealed that age appears to be related to greater costs associated with inpatient days ($p = 0.03$). Median costs for the entire

Table 4.
Median costs by Veterans Integrated Service Network (VISN), patient discharge location, and facility characteristics.

Variable	*n*	Time 0–3 Mo Costs ($)		Time 4–12 Mo Costs ($)		Grand Total Costs ($)
		Inpatient	Total	Outpatient	Total	
VISN/Facility						
VISN 1 (1 site)	7	5,471	13,917	4,286	4,286	16,497
VISN 4 (1 site)	4	6,850	9,684	3,242	3,242	14,097
VISN 8 (1 site)	12	5,790	7,414	2,368	2,368	10,356
VISN 9 (1 site)	2	11,480	14,723	7,404	8,847	23,570
VISN 10 (1 site)	10	4,485	7,391	3,772	3,772	11,169
VISN 12 (1 site)	15	10,497	16,080	6,950	10,649	23,598
VISN 15 (3 sites)	64	7,074	9,562	3,105	3,641	15,272
VISN 16 (1 site)	12	6,245	7,874	4,141	6,024	17,490
VISN 17 (1 site)	31	11,011	13,259	4,250	5,862	23,244
VISN 18 (1 site)	3	6,358	9,061	2,807	2,807	14,126
VISN 23 (1 site)	12	5,956	9,979	12,858	13,531	23,598
Discharge Location						
Community/AMA	146	6,162	9,073	4,049	5,194	15,958
Other Acute Care Hospital	4	23,736	25,201	4,585	7,574	30,614
Nursing Home	22	20,358	24,144	3,955	4,541	30,130
Facility Size						
<200 Beds	81	5,620	8,233	3,625	4,253	14,174
>200 Beds	91	8,369	11,955	4,250	6,044	20,229
		Time 0–3 Mo Inpatient Days		Time 4–12 Mo Outpatient Visits		
Use by Facility Size						
Days/Visits (Median)						
<200 Beds	81	7		11		—
>200 Beds	91	8		17		—
Cost/Day/Visit ($)						
<200 Beds	81	1,022		326		—
>200 Beds	91	990		309		—

Source: Data extracted from Department of Veterans Affairs (VA) Decision Support System as merged with VA medical SAS data sets.
AMA = against medical advice.

12-month period may exhibit this trend best. The cost of stroke care is the greatest for patients who are in the youngest (35–44 years) and the oldest (85+ years) age categories. However, the small sample sizes for these age categories limit our ability to draw conclusions and suggest the need for further investigation. Median FIM motor scores measured at 3 months poststroke appear to have the strongest association with stroke costs. Increased median costs are graduated across the quartiles of motor function and appear monotonic. Median inpatient costs at time 0–3 months are 2.4 times higher among patients with FIM motor scores in the lowest quartile than among patients with FIM motor scores in the highest quartile.

Median costs across the quartiles of the SF-36V follow a similar but not identical pattern. Results of a GLM (univariate Proc GLM) indicated significantly higher inpatient costs (time 0–3 months and total costs time 0–3 months; both $p < 0.001$), outpatient costs (time 4–12 months; $p = 0.03$), and total costs ($p < 0.001$) for stroke patients with greater functional limitations as measured by the FIM ($p < 0.001$). Stroke patients who had lower scores on the SF-36V physical functioning subscale had significantly greater costs associated with inpatient days ($p = 0.01$). Increased stroke costs may be associated with increasing stroke impact in later years, increased comorbidities as seen in **Table 3**, or a combination of the two.

Table 5.
Median costs by patient age and function.

Variable	*n*	Time 0–3 Mo Costs ($)		Time 4–12 Mo Costs ($)		Grand Total Costs ($)
		Inpatient	Total	Outpatient	Total	
Age Group						
35–44	2	26,084	28,143	2,052	2,052	30,196
45–54	23	6,803	8,417	4,122	5,805	14,442
55–64	35	6,358	9,335	4,253	4,471	18,349
65–74	53	7,047	10,209	3,701	5,178	18,112
75–84	56	9,017	11,784	4,082	5,576	19,385
85+	3	21,384	22,042	828	828	22,042
Most and Least Impaired						
FIM Motor						
Lowest Two Quartiles	71	11,885	13,462	5,315	6,962	24,446
Highest Two Quartiles	76	5,018	7,500	3,254	3,602	13,265
SF-36V Physical Dimension						
Lowest Two Quartiles	69	9,017	11,265	4,325	5,344	19,385
Highest Two Quartiles	79	5,476	8,233	3,887	4,286	15,676

Source: Data extracted from Department of Veterans Affairs (VA) Decision Support System as merged with VA medical SAS data sets.
FIM = Functional Independence Measure, SF-36V= 36-item Short Form Health Survey for Veterans.

The **Figure** displays the median costs for inpatient care (time 0–3 months), outpatient care (time 4–12 months), and total care (time 0–12 months) across deciles of the SIS physical dimension at 3 months post-stroke. Higher SIS scores reflect improved patient health and lower stroke burden. We inserted trend (regression) lines for each variable using Microsoft Excel software (Microsoft Corporation; Redmond, Washington). For 171 valid physical dimension scores, the mean score was 59, median 62, SD 26, minimum 1.3, and maximum 100 (higher SIS scores indicate better functioning). Each regression line has a substantial negative slope, although the outpatient slope is difficult to see as a result of the larger scale needed for inpatient care. The actual decrease for outpatient median costs from the first decile to the last decile was from $5,251 to $2,581, representing a 51 percent reduction. Inpatient median costs decreased from $9,196 to $3,670 (60% reduction) across the deciles, and total median costs decreased from $23,706 to $15,676 (34% reduction).

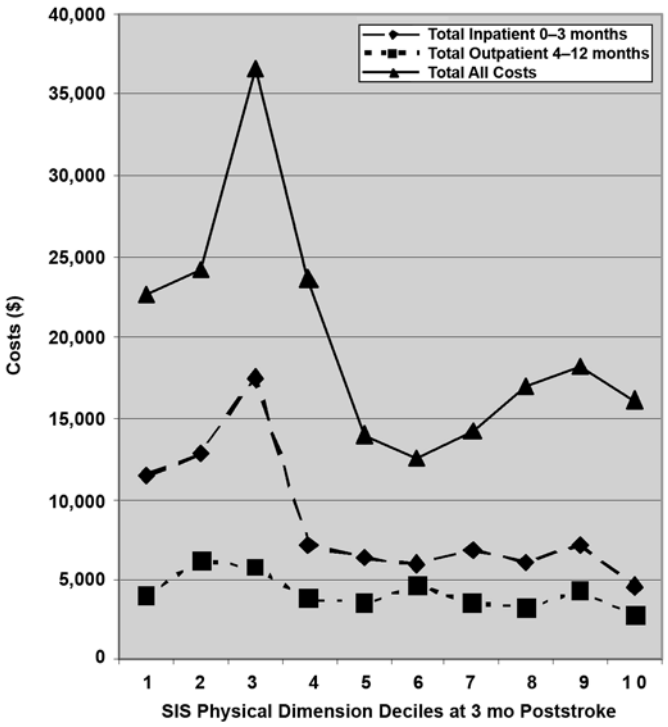

Figure.
Median inpatient, outpatient, and total cost sums by Stroke Impact Scale (SIS) physical deciles 3 months poststroke, with calculated trend (regression) lines. *Source:* Data extracted from Department of Veterans Affairs (VA) Decision Support System as merged with VA medical SAS data sets.

DISCUSSION

The present article reports several important findings. First, since stroke can manifest along a continuum of severity, one would expect to identify variation in median costs across these categories. DSS costs do

indeed vary with function (as indicated by the FIM), health and disability status (assessed using the SF-36V and MRS, respectively), and the number of comorbidities. Second, variation in median costs by discharge location was also observed in the expected direction. The patients discharged to both nursing homes and other acute settings were typically the most severely affected patients with the highest costs. Third, although the majority of stroke costs are still accrued from inpatient admissions in time 0–3 months poststroke, about 33 percent of the total annual costs occur on an outpatient basis. Fourth, there appears to be substantial variation in median patient-specific costs by facility. Such variation is likely caused by differences in factors such as case-mix, severity, teaching status, quality of care, geographic wage differences, scale economies, and efficiency. Future work is necessary to measure the relative contributions of such factors to the observed differences.

Documenting the costs associated with patient care in all care settings and considering the relationship with patient functional outcomes are important. Future research should examine the relationship between costs and functional outcomes by using a larger cohort and multivariate modeling techniques to better estimate the relationship between rehabilitation unit type, costs, and functional outcomes and health status, while controlling for covariates such as patient characteristics, baseline functional and health status, and facility characteristics (e.g., facility size, bed capacity).

STUDY LIMITATIONS

This study relied on a limited sample of VHA stroke patients from a previous study investigating the effects of the mode of SIS administration. As such, the sample was not selected specifically for the study of costs and some systematic differences (marital status and cognition) between the analytic and overall samples were noted. Moreover, this descriptive study did not control for the myriad of factors that influence costs, and hence, the results presented here should be viewed as preliminary. In addition, the results only address VHA use and costs; out-of-system use was not measured. This out-of-system use is likely to be significant for veterans with other sources of care and coverage (e.g., veterans enrolled in Medicare). Finally, the small sample size in some stratified categories should be noted and the results interpreted with caution.

CONCLUSIONS

Several conclusions can be drawn from the present article. Our examination of inpatient- and outpatient-use figures found in the data suggest that DSS costs correlate well with expected use patterns 3 and 12 months poststroke. For example, higher costs were reported for patients who had greater impairments, had longer inpatient stays, had more outpatient visits, and were discharged to nursing homes. Thus, our results are clinically intuitive and consistent with other studies examining the costs of stroke care among VA (and non-VA) patients, lending credence to the use of DSS in cost studies. A significant variation in median patient costs by facility was documented, suggesting that the factors driving such variations need to be identified and their relative contributions measured. Finally, examination of a validated stroke cohort for a full 12-months indicates that about a third of the costs of care in the VHA over a 12-month period occur on an outpatient basis. These data provide a first look at VHA costs for stroke care. Future studies could extend these results with a sample that is larger and national in scope.

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