Stroke and Preventable Hospitalization: Who Is Most At Risk?

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A retrospective study assessed how many poststroke patients are hospitalized and why—plus the sociodemographic and clinical characteristics that increased their odds of preventable hospitalization.

Stroke is the third most common hospital discharge diagnosis within the VHA, and about 80,000 VHA patients are stroke survivors. Each year, about 11,000 veterans are hospitalized within the system with a newly acquired stroke, costing the VHA more than $274 million for acute, postacute, and 6 months follow-up stroke care.[1-4] These stroke patients provide a unique cohort for the study of preventable hospitalization because they are at risk of admission for another stroke or for one of the variety of comorbid conditions that are prevalent in this population. Yet no study report has systematically examined this issue—a gap this study is intended to fill. Our objectives were twofold: to define 12-month poststroke preventable hospitalization use by a national sample of VHA enrollees with acute stroke and to assess whether the odds of being subject to a preventable hospitalization can be explained by observed differences in stroke pa-

tients' sociodemographic and clinical characteristics. Our findings can lead the way to enhancing patients' secondary stroke prevention, improving comorbidity monitoring, and increasing access to timely and effective ambulatory poststroke care to reduce preventable hospitalization and to decrease VHA health care costs.

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BACKGROUND

Preventable hospitalization refers to a patient's use of inpatient care for select medical conditions commonly known as ambulatory care sensitive conditions (ACSCs), or avoidable or preventable conditions.[5-8] Because hospitalizations for ACSCs are thought to be preventable if patients have access to timely, effective, and needed ambulatory care that will delay disease onset or proactively manage a chronic condition, rates of preventable hospitalization can serve as a strong indicator of the level of ac-

cessibility and care quality of a health care program.[9]

Both the Agency for Healthcare Research and Quality (AHRQ) and the Institute of Medicine have defined ACSCs.[10,11] Each organization lists 14 categories of ACSCs, 8 of which they have in common: angina, asthma, chronic obstructive pulmonary disease, congestive heart failure, dehydration, hypertension, kidney/urinary tract infections, and pneumonia. For this study, we used the Institute of Medicine list, which also includes diabetes, gastroenteritis, grand mal status and epileptic convulsions, hypoglycemia, severe ear-nose-throat infections, and cellulitis, because its categories are more relevant to our study patients than those of the AHRQ and are commonly used in related studies or reports.[5-7,12]

We also added recurrent ischemic stroke to the Institute of Medicine

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Table 1. Conditions associated with preventable hospitalization[a]

Condition	ICD-9 code
Angina	411.1, 411.8, or 413
Asthma	493, 493.0, 493.01, 493.1, 493.2, or 493.9
Cellulitis	263, 264, 681, 682, 682.0, 682.9, 683, or 686
Chronic obstructive pulmonary disease	466, 491, 491.1, 491.20, 491.21, 491.8, 492, 492.0, 492.8, 494, or 496
Congestive heart failure	402.01, 402.11, 402.91, 428, 428.0, 428.1, 428.9, or 518.4
Dehydration	276.5
Diabetes	250.0–250.3, 250.8–250.10, 250.12, 250.13, 250.20, 250.22, 250.23, 250.30, 250.32, 250.33, 250.90, 250.92, or 250.93
Gastroenteritis	558.9
Grand mal status and epileptic convulsions	345.0–345.9, or 780.3
Hypertension	401.0, 401.9, 402.00, 402.10, or 402.90
Hypoglycemia	251.2
Kidney/urinary tract infections	590, 590.2, 590.9, 590.10, 590.11, 599.0, or 599.9
Pneumonia	481, 482.2, 482.3, 482.9, 483, 483.0, 485, or 486
Severe ear, nose, throat infections	382, 382.1–382.9, 382.00–382.02, 462, 463, 464, 465, or 472.1
Ischemic strokes[b]	433, 434, 435, or 436

ICD-9 = *International Classification of Diseases, Ninth Revision*. [a]According to list compiled by the Institute of Medicine. [b]Added to the Institute of Medicine list by the authors.

list because recently published stroke care guidelines from the American Heart Association and the American Stroke Association (AHA/ASA) state that recurrence of ischemic stroke can be prevented if patients are appropriately screened for risk factors (including hypertension, diabetes, lipids, and blood clots) during initial stroke management and if these conditions are controlled effectively after initial stroke onset (Table 1).[13,14] In other words, like other potentially preventable conditions, recurrent ischemic stroke can be avoided if patients have access to timely and appropriate health care and education programs following an initial stroke.

Though no previous studies have focused exclusively on patients with stroke, several investigations have assessed the relationship between preventable hospitalization use and contributing risk factors. These studies have found that preventable hospitalization is associated with older patient age, low income and lack of health insurance, poor access to primary care providers, patient perception that access to care is poor, and patients' health seeking behavior (such as seeking medical care later in the course of their disease).[5–7,9,15]

Within the VHA system, several studies have examined potentially preventable hospitalization and its associated risk factors. A recent study on racial disparities in preventable hospitalization among community dwelling veterans with dementia, for example, reported that African Americans were more likely to be hospitalized for diabetes and hypertension than their white counterparts (adjusted odds ratio = 1.8; $P < .01$).[16] In a separate study on geographic variations in utilization rates within the VHA system, significant variation across the system was demonstrated in hospitalization for 8 preventable conditions. These conditions included chronic obstructive pulmonary disease, pneumonia, congestive heart failure, angina, diabetes, chronic renal failure, bipolar disorder, and major depression.[17]

METHODS
For this retrospective observational study, we identified 7,224 VHA patients who were diagnosed with acute stroke. These patients had at least 1 inpatient stay with a primary

Table 2. Frequency of preventable hospitalization by condition				
Condition	**No. of hospitalizations**			**Total hospitalizations, No. (%)**
	1	**2**	**≥ 3**	
Ischemic stroke	265	17	4	312 (30)
Congestive heart failure	101	21	6	167 (16)
Kidney/urinary tract infection	130	11	4	165 (16)
Pneumonia	132	5	2	148 (14)
Chronic obstructive pulmonary disease	56	5	3	77 (7)
Dehydration	50	4	0	58 (6)
Hypertension	42	2	1	49 (5)
Angina	19	1	0	21 (2)
Diabetes	12	1	0	14 (1)
Gastroenteritis	11	0	0	11 (1)
Hypoglycemia	4	0	0	4 (0)
Cellulitis	2	0	0	2 (0)
Grand mal status and epileptic convulsion	2	0	0	2 (0)
Asthma	0	0	0	0 (0)
Severe ear, nose, throat infection	0	0	0	0 (0)

admission or discharge diagnosis that met criteria for a high specificity algorithm using *International Classification of Diseases, Ninth Revision* (ICD)-9 codes, as recorded in VHA national medical inpatient dat bases between 2001 and 2002.[18] All study patients survived the initial 12 months following their index stroke hospitalization and had an index inpatient stay of fewer than 365 days.

The study's main dependent variable was whether the patient had a preventable hospitalization during the 12-month follow-up. Use of the service was established if a patient was hospitalized with a primary diagnosis (admission or discharge) that matched 1 of the identified ACSCs (by ICD-9-codes).

Covariates or risk factors consisted of 2 broad categories of variables. First, the sociodemographic factors included patient age, race/ethnicity (white, African American, all other),

marital status, gender, priority for VHA medical care (high, low), and living within a 30-minute drive to the closest VHA hospital. Patient priority for VHA care was created based on the Means Test Indicator in VHA inpatient databases; VHA investigators often use this indicator to determine a patient's eligibility to receive care within the VHA system.[19]

Second, clinical factors collected during patients' index hospitalization included stroke type (hemorrhagic stroke; ischemic stroke; and all other for multiple stroke diagnoses and/or the other stroke diagnosis), medical comorbid conditions, length of stay at index, and discharge location at index hospitalization (home/community, nursing home, inpatient care facility, other). We also calculated the number of inpatient episodes during the 12 months before the index hospitalization admission date. A modified Charlson comorbidity index was

used to assess the medical comorbid conditions at index; the higher the weighted summary score was the more severe we considered the burden of comorbidity.[20] We excluded the stroke diagnoses as a comorbid condition since all study patients were stroke patients.

To analyze the data, we used SAS version 9.1 (SAS Institute in Cary, North Carolina). First, we obtained descriptive statistics on all risk factors and used statistical inference to compare the demographic and clinical factors between the groups of patients with and without preventable hospitalization. Second, we fitted a logistic regression model to estimate the impact of potential risk factors on preventable hospitalization. Considering the observational nature of the study, we also examined potential bias and confounding concerns of the study using propensity analysis. The procedure can be specified in the fol-

Table 3. Risk factors for preventable hospitalization use			
Factor	Sample, % (n = 7,224)	User, % (11.5%)	Nonuser, % (88.5%)
Sociodemographic factors			
Age in y[a,b]	67.6 (11.1)	68.6 (11.3)	67.4 (11.1)
Race[b]			
White	64.4	60.9	64.8
African American	20.8	24.5	20.3
Married	48.9	48.8	48.9
Male	98.0	98.0	98.0
High VHA medical care priority[b]	89.7	92.8	89.4
Travel to VA hospital ≤ 30 min[b]	48.8	54.5	48.1
Clinical factors			
Ischemic stroke diagnosis at index	91.5	92.8	91.3
Comorbid summary score at index[a,c]			
Length of stay at index[a,b]	11.3 (15.2)	12.9 (17.3)	11.1 (14.9)
Discharge destination at index[b]			
Community nursing home	14.7	17.9	14.3
Home/community	81.7	77.9	82.2
Hospital	2.5	2.8	2.5
Prestroke inpatient use[a,c]	0.4 (0.9)	0.7 (1.3)	0.4 (0.9)

[a]Factors presented as mean (SD). [b]$P < .05$. [c]$P < .001$ (all P values from t test for continuous variables and χ^2 test or Fisher's exact test for categorical variables).

lowing 4 steps: for each risk factor such as race, (1) we calculated the propensity score of all other covariates using the linear predictor from a logistic model excluding that factor; (2) we stratified the patients into 4 strata based on the propensity score obtained from step 1; (3) for each stratum, we fit a logistic regression model to obtain the coefficient(s) estimating the log-odds ratio(s) of that factor; (4) we averaged the resulting log-odds ratios from the 4 models, then derived the odds ratio estimate.

RESULTS

Of the 7,224 stroke patients, 11.5% had experienced at least 1 preventable hospitalization during the 12 months follow up. The ACSCs most often resulting in hospitalization (cumulative total admissions, 1,030) were ischemic stroke (30%), congestive heart failure (16%), urinary tract infection (16%), pneumonia (14%), and chronic obstructive pulmonary disease (7%) (Table 2).

Our bivariate analyses showed that, compared with patients who did not undergo preventable hospitalizations, those patients who did were significantly ($P < .05$) more likely to be older, African American, have a high priority ranking for VHA care, live closer to VHA hospitals, have a heavier burden of comorbid conditions, have had a longer stay during their index hospitalization, were more likely to be discharged to a community nursing home but less likely to be discharged to home/community, and have had more frequent inpatient care before the index hospitalization for stroke (Table 3).

Finally, our logistic regression analysis suggested that the following risk factors were significantly ($P < .05$) associated with the likelihood of preventable hospitalization use among the study cohort: older age (vs younger age, adjusted odds ratio [AOR] 1.01), being African American (vs white, AOR 1.2), having a high priority ranking for VHA care (AOR 1.4), frequently using prestroke inpatient care (AOR 1.3), having a higher burden of comorbid conditions (AOR 1.1), being discharged to a nursing home (vs to home) at index (AOR 1.2), and living

Table 4. Logistic regression coefficients for 12-month poststroke preventable hospitalization

Characteristics	Estimates	Multiple LR results OR (95% CI)	Multiple LR adjusting for PS estimates	OR
Age, y	0.01[a]	1.01(1.00–1.02)	0.01	1.01
Race (Reference = white)				
African American	0.21[a]	1.23 (1.02–1.48)	0.21	1.23
All other	0.03	1.03 (0.83–1.28)	-0.06	0.94
Married	0.03	1.03 (0.89–1.20)	-0.02	0.98
Male	-0.06	0.94 (0.56–1.57)	0.02	1.02
Ischemic stroke at index	0.25	1.29 (0.97–1.71)	0.27	1.31
High VHA care priority	0.34[a]	1.41 (1.07–1.86)	0.38	1.46
Prestroke inpatient use	0.28[b]	1.33 (1.25–1.41)	0.27	1.31
Comorbidity score	0.11[a]	1.11 (1.05–1.18)	0.12	1.13
Length of stay at index	0.01[a]	1.005 (1.00–1.009)	0.01	1.00
Discharge destination (Reference = home)				
Community nursing home	0.20[a]	1.22 (1.00–1.49)	0.24	1.28
Hospital	0.28	1.32 (0.84–2.09)	0.21	1.24
All other	0.33	1.39 (0.74–2.64)	0.41	1.51
Travel to VHA hospital > 30 min	-0.19[a]	0.83 (0.71–0.96)	-0.18	0.84

CI = confidence interval; LR = logistic regression; OR = odds ratio; PS = propensity score. [a]$P < .05$. [b]$P < .001$.

close to a VHA medical center (AOR 0.8) (Table 4). These results were similar to our findings from the multivariate logistic regression with propensity score adjustment, suggesting that bias and confounding should not be a concern for this observational study. In both bivariate and multivariate analyses, we consistently found that patients' preventable hospitalization use was significantly associated with their age, race, VHA care priority, comorbidity, length of stay and discharge disposition at index, prestroke inpatient use, and travel distance to the closest VHA medical center.

DISCUSSION

This is the first study to systematically examine preventable hospital-ization utilization among stroke patients and assess the impact of patients' demographic and clinical characteristics on the medical service use. We found that 11.5% of the VHA stroke patients in 2001 and 2002 were admitted to VHA hospitals at least once, primarily for medical conditions that may have been preventable, during the 12 months after the index stroke. That about one-third of the potentially preventable hospitalizations among the study cohort were for recurrent ischemic stroke underlines the importance of risk management and prevention of secondary stroke among VHA stroke survivors. The AHA/ASA have published numerous risk factors for primary or secondary stroke.[14] Many of these factors are modifiable, such as atrial fibrillation, obesity, tobacco and alcohol use, hypertension, and physical inactivity.[21–23] Previous reports also demonstrated that prevention of secondary stroke is possible through timely identification of the stroke risk factors and effective medication intervention, rehabilitation therapy, or an appropriate health promotion program aimed at the known modifiable risk factors.[24–27]

Our logistic regression revealed the clinical and sociodemographic factors that increase the odds of a preventable hospitalization. These findings suggest that continuing effort is needed to enhance patients' secondary stroke prevention, monitor comorbidities, and increase accessibility to timely and effective ambulatory care poststroke. These efforts will re-

duce preventable hospitalization and health care costs and improve functional recovery and quality of life for VHA patients diagnosed with acute stroke.

STUDY LIMITATIONS

This study included all VHA patients who were diagnosed with acute stroke in 2001 and 2002 and survived 12 months after the index stroke. Our findings therefore may not be representative of stroke patients in general because, compared with this population, our cohort was older (average age, 68 years), included a larger proportion of males (98%), and was sicker.

CONCLUSION

Our research team has been continuously engaged in improving the post-stroke care and functional recovery in VHA stroke survivors. Findings from this study represent the beginning of our effort to address the risk factors for potentially preventable hospitalization identified in this research, particularly the factors that are modifiable. Our research also complements the VHA's transition in recent years from a hospital-based system to one that emphasizes ambulatory and patient-centered care.[28] The national VHA Care Coordination Home Telehealth program, for example, was developed in keeping with these transforming strategies to improve the accessibility of care and to provide timely and appropriate care for community-dwelling veterans with chronic diseases, including stroke. This approach is achieved through care coordination by nurse practitioners or registered nurses and by monitoring disease using supportive home telemonitoring technology. Further study is necessary to evaluate the influence of VHA's transition from acute care to patient-centered

ambulatory care on preventable hospitalization of VHA stroke patients. In addition, because stroke patients are older, with a heavier burden of comorbid conditions than the VHA population overall; are frequent users of prestroke inpatient service; and often need long-term care poststroke, VHA policymakers should continue addressing the complex and special health delivery needs of its patients with stroke to reduce preventable hospitalization as well as VHA health care costs. ●

Author disclosures

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