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State-Level Variability in Veteran Reliance on Veterans Health Administration and Potentially Preventable Hospitalizations: A Geospatial Analysis

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Abstract

Most Veterans who use the Veterans Health Administration (VHA) also utilize private-sector health care providers. To better inform local and regional health care planning, we assessed the association between reliance on VHA ambulatory care and total and system-specific preventable hospitalization rates (PHRs) at the state level. We conducted a retrospective dynamic cohort study using Veterans with diabetes mellitus, aged 66 years or older, and dually enrolled in VHA and Medicare parts A and B from 2004 to 2010. While controlling for median age and proportion of males, we measured the association between reliance on VHA ambulatory care and PHRs at the state level using multivariable ordinary least square regression, geographically weighted regression, and generalized additive models. We measured geospatial patterns in PHRs using global Moran's *I* and univariate local indicator spatial analysis. Approximately 30% of hospitalized Veterans experienced a preventable hospitalization. Reliance on VHA ambulatory care at the state level ranged from 13.92% to 67.78% and was generally not associated with PHRs. Geospatial analysis consistently identified a cluster of western states with low PHRs from 2006 to 2010. Given the generally low reliance on VHA ambulatory care and lack of association between this reliance and PHRs, policy changes to improve Veterans' health care outcomes should address private-sector care in addition to VHA care.

Keywords

care quality, preventable hospitalizations, care access, geographic variation, VHA reliance

Introduction

Diabetes is a common chronic condition. The prevalence of diabetes is over 9% in the general US population and approximately 25% among Veterans actively utilizing the Veterans Health Administration (VHA).[1,2] Regular health care visits to primary care providers and specialists are prominent features of diabetes management. Of 22 million living Veterans, 9 million have enrolled in Veterans Affairs (VA) services and 5.9 million are regular users of the VHA.[3] VHA offers a spectrum of integrated health care services including preventive, ambulatory, and inpatient care. VHA functions as a safety net provider for some Veterans, potentially mitigating the effects of barriers to accessing private-sector health care services. VHA also utilizes an integrated electronic medical record system, which makes all care received within the system available to all VHA providers and facilitates better care coordination within the system. Studies have reported better uptake of preventive services in the VHA as compared with the private sector.[4-7] Numerous studies have also indicated that VHA performs better than the private sector in the ambulatory care and management of diabetes, including diabetes care processes,

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preventive services, patient satisfaction, patient education, and management of blood sugar and cholesterol levels.[7,8] Despite the promise of comprehensive and coordinated care, few veterans receive all of their care from VHA.[9-11] For example, among Medicare eligible veterans, a plurality (46%) utilize VHA and private-sector services.[12] Although having coverage for services in 2 systems may result in increased choice and improved access to care, some studies indicate that Veterans who receive care outside of the VHA are more likely to experience poor outcomes.[13,14]

Preventable hospitalizations (PHs) reflect access to high-quality ambulatory care. They represent potentially avoidable hospitalizations for conditions that can be controlled with timely access to high-quality ambulatory care.[15,16] The ambulatory care may not prevent disease progression, but if proper care is received in a timely manner, hospitalization for complications may be less likely.

Although VHA and Medicare are federally funded and operated programs, regional variations in utilization patterns and distribution of resources have been observed in both programs.[17-19] For instance, the administrative region of VHA made up of northeastern states was found to have the greatest rate of hospitalizations as compared with regions in the rest of the country.[17] Availability of VHA resources also varies at the state level with the number of operational VA medical centers ranging from 1 in the state of Alaska to 14 in the state of New York.[19] Multiple studies have also found differences (at state or hospital referral level) in the amount of Medicare spending per beneficiary and the quality of care received.[18,20-22] The ratio of providers to persons, which may impact access to Medicare providers, also varies drastically from state to state. For example, in 2012, there were 94 primary care physicians (PCPs) per 100,000 population in the state of Hawaii but only 27 PCPs per 100,000 population in Mississippi.[23] Such variation in health care resources may impact patients' access to care, regardless of health care coverage. State laws and policies directly regulate many aspects of health care delivery (eg, medical professional licensure, certification for large capital investments, insurance coverage), making state-level analyses important and relevant for health services research.

We explore variability in state-level VHA and private-sector preventable hospitalization rates (PHRs) among veterans with diabetes dually enrolled in VHA and Medicare. This population offers a unique opportunity to examine the potential impact of dual-system ambulatory care use on PHs. Given the VHA's integrated system, we hypothesize that states in which Veterans demonstrate greater reliance on VHA ambulatory care will demonstrate lower PHRs. The findings have implications for state and federal policies regarding Veteran utilization of and access to high-quality ambulatory care, more generally.

Materials and Methods

IRB Approval

Our study was approved via an expedited review by the Veterans Affairs New Jersey Healthcare System's Institutional Review Board (IRB) (study IRB No. 01191). Given that our study is a retrospective assessment of data from de-identified medical records, we were approved for waiver of Health Insurance Portability and Accountability Act (HIPAA) authorization and waiver of patient consent.

Study Design

We conducted a retrospective dynamic cohort study with calendar years 2006-2010 serving as the outcome years and the 24 months preceding each outcome year serving as a baseline period. We identified the state of residence during the outcome year for each VHA user with diabetes.

Data Sources

The data we used for this study included 2004-2010 demographic summary, inpatient, outpatient, and long-term care file extracts from VHA Corporate Data Warehouse (CDW) production tables and VA Information Resource Center (VIReC) Medicare and Medicaid data files.[24,25]

We used SAS Enterprise Guide 7.1 software for data cleaning and manipulation on Veterans Affairs Informatics and Computing Infrastructure (VINCI), the VA's cloud platform for data analytics.[26,27]

Sample Inclusion/Exclusion Criteria

The study population consisted of Veterans with diabetes mellitus type 1 or 2, who were 66 years of age or older as of January 1 of each baseline period and dually enrolled in VHA and Medicare during baseline and outcome years. To identify patients with diabetes, we modified the method published by Miller et al.[28] We defined diabetes based on at least 1 inpatient stay or 2 outpatient face-to-face visits associated with an International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis code for diabetes mellitus (250.xx) during the baseline period. We defined face-to-face visits as in-person encounters involving a clinician with independent decision-making capacity; we identified face-to-face visits based on Current Procedural Terminology (CPT) codes associated with each visit.

We excluded patients from the study for the following reasons in the order listed: died before start of outcome year, lacked continuous (full 36 months) Medicare part A and B coverage during study period, participated in a Health Maintenance Organization (HMO) for 1 month or longer during study period, used hospice services or experienced at

least 1 long-term stay at a skilled nursing facility during study period, experienced a hospital stay of longer than 180 days during the study period, and/or did not have an outpatient face-to-face visit or an inpatient stay in either system during baseline years.

Dependent Variable

Our outcome of interest was any PH experienced by the patient during the outcome years 2006-2010. We adopted the Agency for Healthcare Research and Quality's (AHRQ) definition of the Prevention Quality Indicators (PQIs) as our definition of PHs.[29] We identified PQIs based on the associated ICD-9-CM diagnostic codes. PQIs we measured included (1) diabetes short-term complications, (2) diabetes long-term complications, (3) chronic obstructive pulmonary disease, (4) asthma,(5) hypertension, (6) congestive heart failure, (7) dehydration, (8) bacterial pneumonia infections, (9) urinary tract infections, (10) angina without a procedure, (11) uncontrolled diabetes, and (12) lower extremity amputations.

We calculated PHRs by dividing the total number of unique patients in each state who experienced at least 1 episode of a PH during the outcome year by the number who were hospitalized during the outcome year. We distinguished between total PHR (Medicare [MC] and VHA PHRs combined) and system-level PHR (ie, MC PHR and VHA PHR).

Independent Variables

The key independent variable in our analysis was percent reliance on VHA ambulatory care. We adjusted for median age of patients and proportion of males. We measured all variables at the patient level and aggregated to the state level.

We defined reliance on VHA as the proportion of all outpatient face-to-face visits that were made to VHA facilities [VHA visits / (VHA visits + Medicare visits)]. We measured utilization of ambulatory care services as the number of outpatient face-to-face visits made by patients residing in a particular state to providers in the VHA and in the Medicare system during the baseline period. We excluded visits associated with urgent care (VHA-associated primary clinic stop code: emergency medicine, admitting/screening, emergency department, observation emergency room, observation psychiatry, observation rehabilitation, observation spinal cord, observation medicine, observation neurology, observation surgery, and urgent care unit; Medicare-treating provider was listed as emergency medicine, or the revenue center code listed on the claim was associated with emergency medicine).

Spatial and Statistical Analyses

Geomapping. We mapped the state-level total PHR, VHA PHR, and MC PHR using ArcGIS 10.3.[30] Given the distribution of data, we used 20%, 25%, 30%, 35%, and 40% as the cutoff points to group state-level PHRs in each year.

Global Moran's I and LISA. We used global Moran's *I* to determine whether there are clustering of PHRs among states. The global Moran's *I* is an indicator of spatial association and ranges between −1 (clustering of dissimilar values) and +1 (clustering of similar values). A value of 0 for Moran's *I* indicates absence of clusters.

We used the univariate local indicator spatial analysis (LISA) to identify the location and type of clusters present.[31] Spatial patterns which can be visualized with this technique include low-low cluster, high-high cluster, high-low outlier, and low-high outlier. For example, high-high cluster indicates that a state with higher than average value of PHs is surrounded by neighboring states with higher than average value of PHs. High-low and low-high outliers indicate random dispersion of PHR rates.

OLS regression. We used multivariable ordinary least squares (OLS) regression to evaluate the association between reliance on VHA ambulatory care and PHRs at the state level. In these models, a negative coefficient indicates that higher reliance on VHA ambulatory care is associated with lower PHRs and a positive coefficient indicates that higher reliance on VHA ambulatory care is associated with higher PHRs.

GWR. We also used geographically weighted regression (GWR) to summarize spatially varying relationships between VHA reliance and PHRs. GWR is a local spatial statistical technique that can be applied to produce locally specific parameters and to, therefore, examine the regression parameter varying across states.[32] GWR operates under the assumption that information from nearby states is more important than distant states. We calculated separate *t* statistics for each centered state and used the cutoff points ±1.96 to identify correlations between the VHA ambulatory care reliance and PHRs.

GAM. We used a generalized additive model (GAM) to reassess the association between VHA ambulatory care reliance and PHRs while controlling for any variance that may result from physical geographic differences among states. GAM is a nonparametric generalization of multiple linear regression which can identify a more realistic effect of the geographic location by use of smooth functions instead of least squares fit.[33]

We used the "mgcv" package in R for the GAMs, GWR 4.0 for the GWRs, and GeoDa 1.6.7 for the LISAs.[33-37] We used a *P* value of .05 to assess significance for all analyses. We used 50 observations (one for each state) for the OLS, GWR, and the GAM analyses.

Results

Cohort characteristics for all outcome years have been summarized at the state level in Table 1. The cohort (sample size range: 524,530-572,461) primarily consisted of males aged 73 to 77 years. In any given outcome year, of those patients who utilized inpatient services (sample size range: 148,060-150,808), at the state level, on average, 17% or less had at

Table 1. Sample Characteristics of Elderly Veterans With Diabetes Mellitus, Dually Enrolled in VHA/Medicare.

Variable	2006	2007	2008	2009	2010
N	524 530	556 439	563 932	570 390	572 461
Total number of patients hospitalized	148 060 (28.23%)	153 805 (27.64%)	154 605 (27.42%)	151 806 (26.61%)	150 808 (26.34%)
Number of patients hospitalized under Medicare[a]	131 913 (89.09%)	137 276 (89.25%)	138 063 (89.30%)	135 654 (89.36%)	133 808 (88.73%)
Number of patients hospitalized at VHA[a]	21 019 (14.20%)	21 504 (13.98%)	21 578 (13.96%)	22 052 (14.53%)	22 058 (14.63%)
Percentage of patients hospitalized at VHA[b]					
Mean	16.65	16.61	16.56	16.78	17.08
Median	15.57	15.10	15.63	16.13	16.15
SD	7.12	7.96	7.95	6.97	7.80
Range	4.90-49.42	3.46-58.38	3.85-59.44	4.27-48.55	3.87-55.43
Median age (years)					
Mean	74	75	75	75	75
Median	74	75	75	75	75
SD	0.90	0.90	0.94	0.97	0.90
Range	73-76	73-77	73-77	74-77	74-77
Percent male					
Mean	98.36	98.36	98.32	98.30	98.28
Median	98.41	98.45	98.42	98.36	98.37
SD	0.45	0.42	0.43	0.43	0.46
Range	97.14-99.04	97.48-98.99	97.09-98.91	97.01-98.96	96.73-98.95
VHA ambulatory care reliance (%)[c]					
Mean	31.39	29.80	28.68	27.91	27.66
Median	31.04	29.40	28.28	28.02	27.85
SD	7.92	7.85	7.23	7.08	7.02
Range	15.65-67.78	14.98-66.10	14.28-58.09	14.11-57.43	13.92-56.43
Total number of unique patients with a PQI[a]	43 538 (29.41%)	46 758 (30.40%)	46 585 (30.13%)	45 316 (29.85%)	45 297 (30.04%)
Number of unique patients with a PQI under Medicare[d]	38 384 (29.10%)	41 368 (30.13%)	40 960 (29.67%)	39 786 (29.33%)	39 561 (29.57%)
Number of unique patients with a PQI at VHA[e]	5942 (28.27%)	6229 (28.97%)	6493 (30.09%)	6616 (30.00%)	6582 (29.84%)
Total preventable hospitalization rate (%)[f]					
Mean	29.54	30.45	30.06	29.91	29.97
Median	29.73	30.46	30.09	29.96	30.14
SD	2.56	2.51	2.32	2.14	2.35
Range	21.44-3.49	23.59-36.55	22.82-34.48	23.92-33.84	23.51-35.96
VHA preventable hospitalization rate (%)[g]					
Mean	28.66	29.12	29.71	30.46	29.42
Median	28.19	28.54	29.93	29.96	29.03
SD	4.73	3.93	3.70	4.79	3.98
Range	17.61-44.05	20.83-42.42	22.70-41.76	20.33-49.44	21.21-42.39
Medicare preventable hospitalization rate (%)[h]					
Mean	29.00	30.00	29.55	29.11	29.31
Median	29.36	30.32	29.56	29.06	29.74
SD	2.70	2.82	2.32	2.35	2.51
Range	19.38-34.52	22.76-35.46	22.47-34.06	22.68-33.21	22.58-33.94

Source. Authors' analysis of data for 2004-2010 from Veteran's Health Administration's Corporate Data Warehouse and Veteran Affairs Information Resource Center Medicare inpatient, outpatient, and denominator files.

Note. Data from all 50 states summarized, 2006-2010. VHA = Veterans Health Administration; PQI = Prevention Quality Indicator.

[a]The total number of hospitalized patients was used as the denominator for calculating percentages.

[b]Values for individual states were measured as percentage of the total number of patients hospitalized at the state level. Values presented in this table are a summary of measures from all 50 states.

[c]Based on outpatient face-to-face visits which occurred during the baseline years. Only outpatient visits made by patients who were hospitalized during the outcome year were considered for this calculation. Total number of outpatient face-to-face visits made at VHA was used as the numerator, whereas the total number of visits made at both VHA and Medicare was used as the denominator.

[d]The total number of patients hospitalized under Medicare was used as the denominator for calculating percentages.

[e]The total number of patients hospitalized at VHA was used as the denominator for calculating percentages.

[f]Calculated as percentage of total number of hospitalized patients who experienced a PQI during the outcome year.

[g]Calculated as percentage of patients hospitalized at VHA who experienced a PQI during the outcome year.

[h]Calculated as percentage of patients hospitalized under Medicare who experienced a PQI during the outcome year.

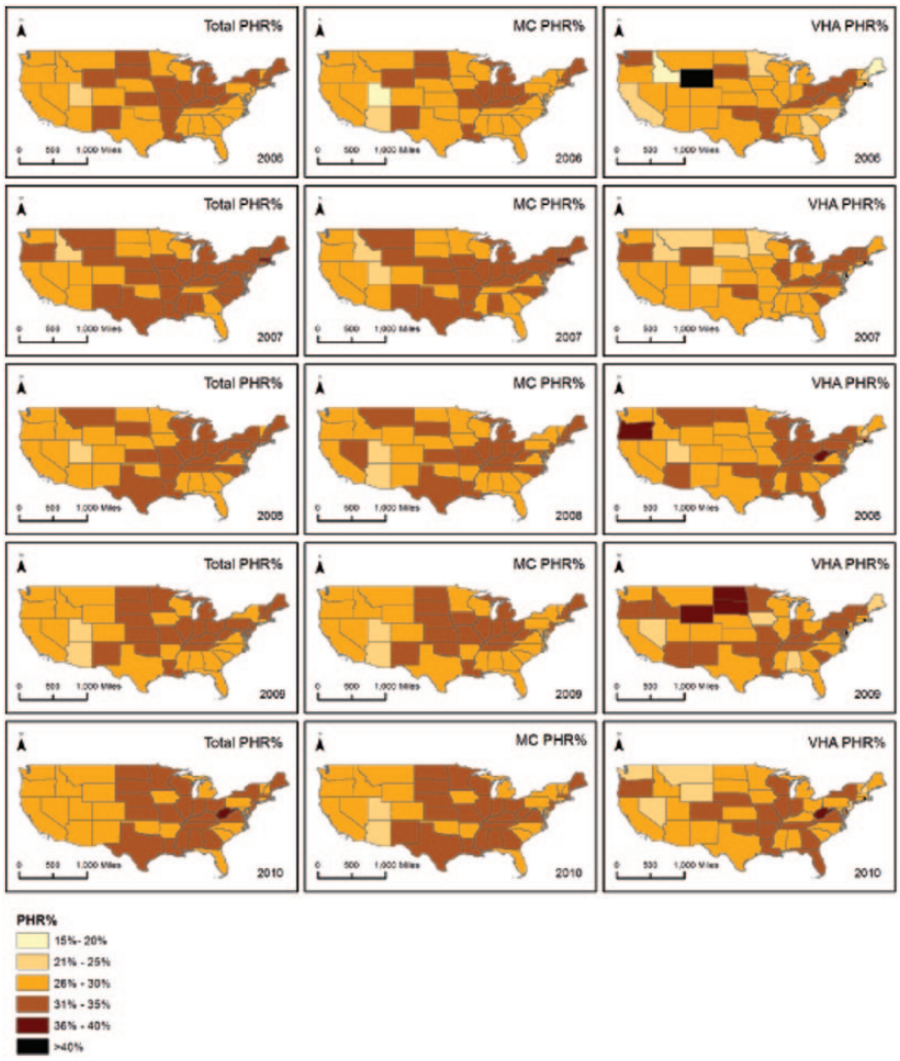

Figure 1. Choropleth Maps for the State-Level System Specific and Total Preventable Hospitalization Rates among Veterans with Diabetes Mellitus, Dually Enrolled in VHA and Medicare, 2006-2010.

Source: Authors' analysis of inpatient stay data for 2006-2010 from Veteran's Health Administration's Corporate Data Warehouse and Veteran's Affairs Information Resource Center Medicare files.

Notes: VHA=Veteran's Health Administration; MC=Medicare; PHR=preventable hospitalization rate. We used cut-off points of 20%, 25%, 30%, 35%, and 40% to group state-level PHRs in each year

least 1 hospital stay at a VHA facility. Throughout the study period, the cohort's state-level reliance on VHA ambulatory care ranged from 13.92% to 67.78%. On average, approximately 30% of those hospitalized experienced at least 1 PH during any given outcome year.

Figure 1 is the choropleth maps for the state-level PHRs. The state-level total PHR varied from 21% to 37% from 2006 to 2010. The VHA PHR ranged from as low as 18% to as high as 60%. The Medicare PHR ranged from 19% to 38%.

We found significant clustering of state-level total PHR and MC PHR (global Moran's Is > 0.20; $P < .05$ in all years). However, we did not find any significant clustering of VHA PHR (data not shown). Using the univariate LISAs, we identified low-low clusters of total PHR and MC PHR among many states in the western region of the United States from 2006 to 2010 (Figure 2). The low-low cluster indicated states with lower than average PHRs were surrounded by states with lower than average PHRs. A high-high cluster was inconsistently present around the states of Illinois, Indiana, and Ohio for all years in total PHRs and MC PHRs.

Table 2 presents the results from our regression models of the state-level association between VHA ambulatory reliance and total and system-level PHRs, controlling for sex and median age. Based on the OLS model, we observed a significant positive association between VHA ambulatory care reliance and VHA PHR only in 2006 and between VHA ambulatory care reliance and MC PHR in 2006 and 2008; no significant associations were observed between VHA ambulatory care reliance and total PHR. Based on the GWR model, we found a significant geographic pattern in the association between VHA

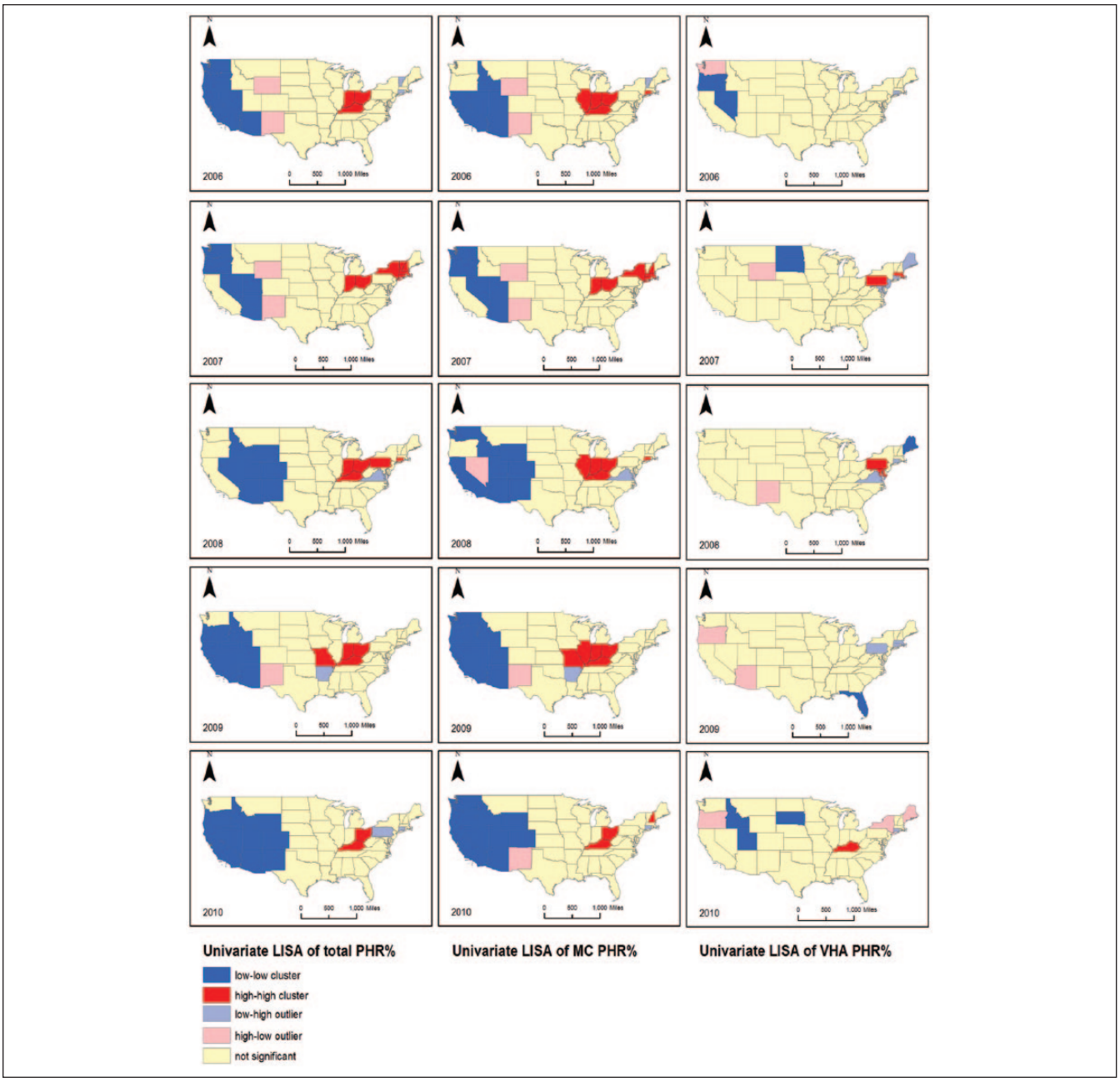

Figure 2. Univariate LISA of State-Level System Specific and Total Preventable Hospitalization Rates among Veterans with Diabetes Mellitus, Dually Enrolled in VHA and Medicare, 2006-2010.

Source: Authors' analysis of inpatient stay data for 2006-2010 from Veteran's Health Administration's Corporate Data Warehouse and Veteran's Affairs Information Resource Center Medicare files.

Notes: VHA=Veteran's Health Administration; MC=Medicare; PHR=preventable hospitalization rate. A low-low cluster (dark blue) indicates that a state with lower than average value in preventable hospitalizations is surrounded by neighboring states with lower than average value of preventable hospitalizations. A high-high cluster (dark red) indicates that a state with higher than average value in preventable hospitalizations is surrounded by neighboring states with higher than average value of preventable hospitalizations. High-low (light red) and low-high (light-blue) outliers indicate random dispersion of PHR rates.

ambulatory care reliance and total PHR in 2008 and between VHA reliance and VHA PHR in 2006 only. We found no significant geographic patterns in the association between VHA ambulatory care reliance and MC PHR. Using a generalized additive model controlling for physical geographic variations among states, we found a significant association between VHA ambulatory care reliance and VHA PHR in 2006 only (Table 2). Overall, there were few statistically significant relationships between VHA ambulatory care reliance and PHRs at the state level between 2006 and 2010 (Table 2).

Discussion

Contrary to our hypothesis, across study years, state-level VHA reliance on ambulatory care was only rarely associated with PHs and the strength of association was weak. Given

Table 2. Parameter Estimates and Relationship Between VHA Ambulatory Care Reliance and Preventable Hospitalization Rates From Multivariable Ordinary Least Squares Regression, Geographically Weighted Regression, and Generalized Additive Models of Preventable Hospitalizations Among Elderly Veterans With Diabetes Mellitus, Dually Enrolled in VHA/Medicare, 2006-2010.

	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010
Multivariable ordinary least squares regression[a]					
State-level preventable hospitalization—VHA and Medicare combined					
Parameter estimates	0.03	0	0.03	0.01	0
P value	.13	.91	.17	.5	.88
State-level preventable hospitalization—VHA only					
Parameter estimates	0.4	−0.08	−0.04	−0.09	−0.03
P value	< .001	.17	.53	.07	.68
State-level preventable hospitalization—Medicare only					
Parameter estimates	0.12	−0.03	0.08	0.03	−0.04
P value	< .001	.51	.04	.7	.38
Geographically weighted regression[b]					
State-level preventable hospitalization—VHA and Medicare combined					
t statistics					
<–1.96	0%	0%	0%	0%	0%
–1.96 to 1.96	100%	100%	32.70%	100%	100%
>1.96	0%	0%	67.30%	0%	0%
State-level preventable hospitalization—VHA only					
t statistics					
<–1.96	0%	0%	0%	0%	0%
–1.96 to 1.96	0%	100%	100%	100%	100%
>1.96	100%	0%	0%	0%	0%
State-level preventable hospitalization—Medicare only					
t statistics					
<–1.96	0%	0%	0%	0%	0%
–1.96 to 1.96	100%	100%	100%	100%	100%
>1.96	0%	0%	0%	0%	0%
Generalized additive model[c]					
State-level preventable hospitalization—VHA and Medicare combined					
Parameter estimates	0.07	0.04	0.04	0.04	0.01
P value	.19	.23	.32	.26	.82
State-level preventable hospitalization—VHA only					
Parameter estimates	0.27	0.03	0.08	0.1	0.03
P value	.003	.69	.37	.32	.72
State-level preventable hospitalization—Medicare only					
Parameter estimates	0.02	−0.01	0.02	−0.04	−0.05
P value	.67	.88	.48	.21	.24

Source. Authors' analyses of data for 2004-2010 from VHA's Corporate Data Warehouse and Veteran Affairs Information Resource Center Medicare inpatient, outpatient, and denominator files.

Note. VHA = Veterans Health Administration; PHR=preventable hospitalization rate. For all models, a *P* value of .05 was used for test of significance. We measured associations between VHA ambulatory care reliance and PHRs only for the subpopulation of hospitalized patients. We controlled for median age and sex proportions at the state level in all analysis models.

[a]A negative parameter estimate indicates that higher reliance on VHA ambulatory care is associated with lower PHRs, and a positive coefficient indicates that higher reliance on VHA ambulatory care is associated with higher PHRs.

[b]The percentage of the 50 state-level associations between reliance on VHA ambulatory care and PHRs (VHA, Medicare, total) falling below the 95% confidence interval ($t < -1.96$), within the 95% confidence interval (–1.96 to 1.96), or above the 95% confidence interval ($t > 1.96$), is indicated for each outcome year.

[c]A negative parameter estimate indicates that higher reliance on VHA ambulatory care is associated with lower PHRs and a positive coefficient indicates that higher reliance on VHA ambulatory care is associated with higher PHRs, while controlling for variance resulting from physical geographic variations among states.

the integrated nature of the VHA system and numerous publications touting VHA success in ambulatory care through various metrics, we expected higher state-level reliance on VHA ambulatory care to be associated with lower PHRs. Failure to demonstrate this association using several analytic approaches raises the possibility that despite greater reliance on VHA ambulatory care services, other factors negate the expected benefits in VHA quality of and access to

ambulatory care for veterans at the state level. In support of our findings, some published analyses have found that dual VHA and Medicare health care utilization may actually compromise quality of care or result in provision of redundant services.[13,14,38] Perhaps the fragmentation of care resulting from the use of ambulatory care services across systems cancels out the benefits of utilizing superior VHA services.

It is also possible that differences in the quality of ambulatory care between VHA and private-sector providers are not sufficient to impact the PHR at the state level. However, this would contradict numerous reports of the superiority of VHA preventive and diabetes ambulatory care.[4-8] Equivalency between VHA and private-sector ambulatory care is not the most plausible explanation for our finding of no association between PHs and the reliance on VHA ambulatory care. The most likely explanation for the observed lack of association is based on the fact that reliance on VHA outpatient services in this sample was generally less than 30% and decreased slightly over the study period. This relatively low reliance on VHA services is consistent with other published reports of dual-system use.[12,14,39-41] This may explain why reliance on VHA ambulatory care, despite being widely acknowledged as equivalent or even superior to private sector, was not associated with PHRs at the state level. Perhaps the overall utilization of VHA ambulatory services by elderly veterans with diabetes does not achieve the minimal threshold of engagement with VHA ambulatory services necessary to reap the benefits. Further research is necessary to explore these possible explanations.

Our analysis is the most comprehensive examination of PHRs among VHA users reported in the literature. As expected, most dually enrolled Veterans who were hospitalized experienced their inpatient stay in the private sector (>80% across study years), not VHA. This reliance on the private sector for inpatient services varied little across states and study years, indicating a pervasive and enduring pattern and underscoring the importance of including data from VHA and non-VHA sources. Because we examined the totality of hospitalizations considered preventable, our findings are more robust and meaningful than if we had considered VHA or private-sector hospitalizations in isolation. For veterans who use both VHA and private-sector ambulatory care, apportioning responsibility for PHs to one or the other system is impossible. In absolute terms, PHs are an uncommon outcome; fewer than 10% of veterans in our sample experienced a PH per year, and only 1% to 2% experienced a PH in VHA. Limiting our sample to those with a hospitalization enriches the prevalence of the outcome and also partially controls for unmeasured severity of illness and disease severity. By aggregating patient experience to the state level, including both VHA and private-sector hospitalizations, limiting the statistical modeling to only those with a hospitalization, and using multiple modeling approaches, we designed our analyses with the power to detect even a small association between reliance on VHA ambulatory care and PHR at the state level and yet did not find this association.

Our state-level findings of PHRs are consistent with other studies of health care quality, supporting our use of PHRs as a focus for these analyses. There is a range of PHRs across states, although the PHRs of each state are largely consistent across study years. The presence of a cluster of states in the Western United States with lower PHRs throughout the study years suggests that broader market forces, patient preferences, or standards of practice may be a stronger influence on state PHR than VHA reliance. The high-high cluster inconsistently present in the central Midwest region over the study years similarly speaks to a regional effect. The states with the highest PHRs according to our calculations (see Supplemental Table 1) are Louisiana (LA), Kentucky (KY), West Virginia (WV), Indiana (IN), Ohio (OH), Massachusetts (MA), and Rhode Island (RI). At the other end of the rankings, Utah (UT), Idaho (ID), Arizona (AZ), Florida (FL), Hawaii (HI), Washington (WA), and California (CA) are consistently among the states with the lowest PHRs. According to America's Health Rankings, an annual compilation of state-level health and health care statistics, LA, WV, KY, OH, and IN also consistently rank among the 10 states with the highest PHRs for Medicare enrollees.[42] MA and RI rank in the bottom 40% for PHRs among Medicare enrollees. Consistent with our findings of low PHRs for veterans with diabetes, UT, ID, HI, WA, AZ, and CA are among the states with the lowest PHRs for Medicare enrollees. Florida, on the contrary, ranks in the bottom half for PHR.[43] The discrepancy between PHRs for veterans of Florida indicates the possibility that Veterans' health care experience may differ from that of non-Veterans, at least in some states. Overall, however, our PHRs are consistent with the experience in most of the states with PHRs at either end of the spectrum, supporting the external validity of our findings.

Our findings may be applicable to other cohorts of VHA users, as most veterans use a combination of VHA and private-sector care. Dual-system use is likely to increase further through the Veterans Access, Choice and Accountability Act of 2014 (PL 113-146; "Veterans Choice Act"). The Veterans Choice Act allows eligible Veterans who have difficulty receiving care at a VHA facility (for reasons such as long travel time and/or unavailability of appointments) to receive care from private-sector providers in their community at the expense of the VHA. Since the implementation of the Veterans Choice Act, 500 000 private-sector providers have joined the VHA network to provide care to Veterans in the community.[44] Strengthening and adapting the relationship with these providers may be an opportunity to experiment with care coordination and other interventions to improve quality and access to ambulatory care. Exploring the relationship between reliance on VHA ambulatory care and PHRs in younger groups of VHA users, in particular, will require analysis of data from VHA and commercial insurance plans.

Our findings indicate that federal and state policy makers may wish to more closely examine the role of VHA ambulatory services for elderly Veterans with diabetes who are enrolled in both VHA and the Medicare program within a state. The lack of association between reliance on VHA ambulatory care and PHs may signal a limited role for VHA in the totality of care for this population and suggest new interventions to optimize the use of health care resources at a state level. To date, VHA's efforts to monitor and improve quality of care focused primarily on VHA facilities. Our findings suggest that additional care coordination resources, a major focus of preventing hospitalizations and rehospitalizations,[42,45] may have a greater impact on veterans' health if directed toward care in the private sector. However, given the low rates of hospitalization of these veterans in VHA, perhaps VHA should focus on ambulatory care and improved coordination of care, rather than on inpatient services. Although the state-level variability in VHA ambulatory care reliance and hospitalization rates was not large, it is possible that different approaches may be more effective in different states.

Strengths and Weaknesses

These analyses of PHRs represent an overview of state-level ambulatory care for older Veterans with diabetes and test the hypothesis that VHA reliance on ambulatory care is associated with PHRs at the state level. We captured the entire population of VHA users with diabetes over 65 years old during the study years, a strength of this analysis. We also used the PQI methodology, an accepted industry standard, for determining PHRs. The utility of this methodology, although not universally accepted, has been recognized through continued promulgation by health care policy and research entities. The data used in the analyses include VHA clinical and both VHA and Medicare claims data and represent a near totality of inpatient and ambulatory care services for this population. By utilizing several different models to analyze the geographic variation at the state level, we are confident that the findings are robust. There is the possibility of misattribution of individual veterans' care to a state if their residence was different from the state in which they received health care; we suspect that outpatient VHA care mostly occurred in the state of residence. In addition, we arbitrarily chose the state of residence at the beginning of the outcome year, resulting in possible misclassification due to receipt of ambulatory care during the baseline period being in a different state from the outcome year. However, state of residence changed for less than 2% of any outcome year cohort between first and second baseline years (data not shown). Therefore, we do not anticipate misattributed state of residence to affect our results in a meaningful way.

We did not include Medicaid and other non-Medicare private-sector care in our analysis. Only 6% of the cohort was enrolled in Medicaid in any given year (data not shown). Because Medicare is the primary payer for individuals dually enrolled in Medicare and Medicaid, our analysis captures any services covered by both plans. Common Medicaid services, such as nursing home care and personal care services, are of less relevance to our study because we focus on community-dwelling Veterans. Considering the median age in our cohort was 74 to 75 years, we anticipate that a negligible proportion may also have had coverage through a private health insurance plan.

Conclusions

Given the unanticipated lack of association between reliance on VHA ambulatory care services and PHRs across states, federal and state officials may want to reconsider how best to allocate resources to ensure access to and quality of ambulatory care services for Veterans. Examining the totality of health care utilization utilized by veterans may suggest new approaches.

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