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Dual-system Utilization Affects Regional Variation in Prevention Quality Indicators: The Case of Amputations Among Veterans With Diabetes

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Objective: To determine the impact of dual-system utilization by veterans on regional variation in lower-extremity amputation rates.

Study Design: Retrospective longitudinal cohort analysis.

Patients and Methods: Subjects were veterans with diabetes who used Veterans Health Administration (VHA) care and were dually enrolled in Medicare fee for service in fiscal years (FY) 1997-1999. We evaluated the impact of Centers for Medicare and Medicaid Services (CMS) data on prevalence of baseline foot risk factors, medical comorbidities, and amputations in FY 1997-1998, and ranking of 22 regions using risk-adjusted major and minor amputation rates in FY 1999.

Results: The addition of CMS data significantly increased the prevalence of amputations and risk factors for the 218 528 dually eligible veterans (all *P* values <.001). In FY 1999, we identified 3.1 minor and 4.5 major amputations per 1000 patients (VHA data) versus 5.5 minor and 8.6 major amputations per 1000 patients (VHA/CMS data); the prevalence of any peripheral vascular condition in FY 1997-1998 was 5.7% (VHA) versus 13.0% (VHA/CMS). The impact of including CMS data varied across regions for amputation outcomes, ranging from an additional 34.3% to 150.7%. Using observed-to-expected amputation ratios and 99% confidence intervals, the addition of CMS data changed the outlier status for 8 of 22 regions for both major and minor amputations.

Conclusion: Risk covariates and amputation outcomes were substantially underestimated using VHA data only. Our findings demonstrate the importance of evaluating dual-system utilization when conducting program evaluations for healthcare systems with a substantial number of dual enrollees.

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There is an increasing emphasis by the private sector,[1] accrediting organizations,[2] and government agencies[3] on measuring adherence to recommended process and interim outcomes to decrease hospitalizations and patient morbidity and mortality at the provider, plan, and population level. In the current healthcare environment, variation in health outcomes within payer and provider healthcare systems is likely to be used for internal benchmarking and accreditation, and may be subject to public reporting.[4] Thus, it is critical to address issues such as data availability and risk adjustment to ensure the accuracy of the results and fairness in comparisons.

Recently, the Agency for Healthcare Research and Quality (AHRQ) included prevention quality indicators in its National Healthcare Quality Report Card.[5] These indicators were chosen based on expert consensus that the provision of timely and effective outpatient care before hospitalization could prevent the hospitalization. Because the indicators were developed using hospitalization rates rather than individual patient-level data, they primarily are intended to assess community-level variation; however, they could be adapted by healthcare systems as well.

However, healthcare system accountability for preventable hospitalizations would be contingent on the ability of these systems both to control and evaluate the quality of ambulatory preventive care provided to their enrollees. Consequently, a significant methodological challenge for both federal and private healthcare systems is how to evaluate variation in health outcomes—that is, identification of best- and worst-performing regions or units—when beneficiary care may be fragmented among more than 1 healthcare system.

This fragmentation of care is especially true within the Department of Veterans Affairs (VA), the nation's largest integrated healthcare system. Based on a large, comprehensive survey of veteran clinical users in 1999, approximately 62% of veterans self-reported utilization of non-VA care during the prior year.[6] The largest dual-coverage category was Medicare, which was

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a source of care for 53% of all veteran enrollees reporting dual coverage.

To evaluate the impact of dual Medicare enrollment patterns on evaluation of regional variation in a prevention quality indicator among veterans, we chose lower-extremity amputations. In addition to being 1 of the 3 diabetes-specific AHRQ prevention quality indicators,[5] amputations result in substantial morbidity, disability, and costs for persons with diabetes.[7] Consequently, a reduction in amputation rates is the focus of multiple governmental programs.[3,5,8]

Within the Veterans Health Administration (VHA), the Preservation Amputation Care and Treatment Program[8] mandates VA medical centers to develop multidisciplinary programs to identify veterans at risk for lower-extremity complications and to refer them to foot-care specialists for ongoing evaluation and care. However, prior epidemiologic studies and operational reports of amputation rates and trends have exclusively utilized VHA administrative datasets, thus not capturing relevant amputation data outside the VHA.[9-11]

Consequently, our specific objectives in this study were to determine and evaluate the impact of the inclusion of Medicare utilization data (ie, Centers for Medicare and Medicaid Services [CMS] data) on the prevalence of foot risk factors, medical comorbidities, and prior amputations during a 2-year baseline period; and to determine the impact of these data on the regional variation in minor and major amputation outcomes in the subsequent year. We defined the regions using the service areas of the Veterans Integrated Service Networks (VISNs).

METHODS

Data Sources and Cohort Assembly

We utilized a cohort of veteran clinical users with diabetes who also were enrolled in Medicare in fiscal year (FY) 1997 or FY 1998 as previously described.[12] Potential subjects were identified from several inpatient and outpatient claims-data sources by the presence of at least 1 diabetes-specific (250.xx, 357.2, 362.0, 366.41) *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* code or prescription of a diabetes-specific medicine.

Sample Selection

A total of 446 896 veterans with diabetes were identified and were alive as of September 30, 1998. Of these, 338 028 patients were enrolled in both the VHA and Medicare programs, and had 1999 Medicare Part A and VHA claims data. Because outpatient utilization data for Medicare beneficiaries enrolled in HMOs were not captured for this period, we excluded cohort members with any HMO membership. Consequently, we had 218 689 unique patients with inpatient and outpatient data from both VHA and CMS. Of these patients, 62 had missing race information, and 99 had no face-to-face clinical encounter in the claims data, resulting in a final sample of 218 528 subjects for analysis.

Variables in the Study

Amputation Outcomes in FY 1999. We defined FY 1999 minor amputations (toe [*ICD-9-CM* 84.11] and transmetatarsal [84.12]) and major amputations (transtibial [84.15] and transfemoral [84.17]) as those with an *ICD-9-CM* procedure code in any field in either VHA patient treatment files or Medicare Part A files.[9-11] Multiple procedures with the same *ICD-9-CM* code on the same day were considered to be a single amputation, because there are no modifiers to enable identification of bilateral amputations. Similarly, different amputation codes from the same hospitalization were assigned as a single procedure at the highest level.

Risk Factors Associated With Amputation Outcome. We used administrative claims data to identify potential risk factors for lower-extremity ulcers and amputations based on prior epidemiologic studies,[7,13] classifying them into demographic variables, foot risk factors, and medical comorbidities. Demographic variables consisting of age, sex, and race were obtained from both VHA and Medicare files. Age and sex information from the 2 data sources were comparable. However, because race was self-reported in the CMS data, in contrast to the VHA data, we used CMS data as the primary source of race.[14] As previously described,[15] we created 5 categorical baseline (FY 1997 and FY 1998) foot risk factors: peripheral neuropathy, chronic infections, peripheral vascular diseases, foot deformity, and prior amputation (FY 1997 or FY 1998). We also included relevant major medical comorbidities such as ischemic heart disease, congestive heart failure, stroke, and renal disease. All variables were binary (0/1) except for peripheral vascular disease, which had 4 categories of severity (0 indicating not present).

Statistical Analysis

First, we described the population prevalence foot risk factors, medical comorbidities, and amputation outcomes using VHA-only data versus VHA/CMS combined data. We also used multiple logistic regression to examine the association between demographic variables, foot risk factors and medical comorbidities, and the healthcare system (VHA or Medicare) in which the amputation occurred. Second, we obtained the prevalence using VHA/CMS combined data at the VISN regional area level (VISN level) for these variables. At the VISN level, we also calculated the effect of CMS data on the study variables as 100% multiplied by the ratio of the number of additional subjects diagnosed with a condition using CMS data alone to the number of subjects diagnosed with a condition using VHA data alone. We summarized the distribution of these VISN-level percentages (the prevalence and CMS impact) using median, minimum, and maximum values.

Third, we separately fit a risk-adjustment model for VHA-only data versus combined VHA/CMS data for major and minor amputations using a multinomial logistic regression model previously validated for total amputations with combined VHA/CMS data.[15] Because our response outcome is dichotomized, we simultaneously modeled 2 sets of logits (eg, major amputation versus no amputation, minor amputation versus no amputation); this approach is more sophisticated and efficient than if the same 2 sets of logits were modeled separately (ie, binomial logistic regression) We then compared and noted the magnitudes, signs, and significance levels of each variable for VHA versus combined VHA/CMS data. The C-statistic was used to evaluate the predictive ability of models, and the Hosmer-Lemeshow statistic was reported as a global index for evaluation of goodness-of-fit.[16,17]

We used the risk-adjustment model to calculate observed-to-expected (O/E) ratios and to rank VISNs based on these standardized ratios. The observed number of total amputations was determined in each VISN. The expected number of amputations in each VISN was calculated by summing the predicted probability of amputations derived from the multinomial logistic model for all patients from each VISN. VISNs were ranked in order of their O/E ratios and identified as outliers if the 99% confidence interval (CI) for the O/E ratios did not include 1.0.[18] VISNs with O/E ratios greater than 1 and 99% CIs that did not cross 1 were classified as "high" outliers, implying a higher number of amputations than predicted by the model using baseline characteristics. Similarly, VISNs with O/E ratios less than 1 and 99% CIs that did not cross 1 were classified as "low" outliers, implying a lower number of amputations than predicted by the model using baseline characteristics. We note that the outlier identification methodology is solely based on statistical significance tests, and does not necessarily imply clinically important differences. Finally, we evaluated the changes in ranking of the 22 VISNs when VHA-only data were compared with combined VHA/CMS data.

RESULTS

The study cohort of 218 528 veterans with diabetes was predominantly male (98.5%) and white (79.9%); 33.1% of the study subjects were aged 75 years or older. In **Table 1** we present the prevalence of our outcome variable (amputations) and independent risk-adjustment variables for VHA-only data and combined VHA/CMS data. For independent variables, as shown in Table 1, the addition of CMS data to VHA data resulted in various degrees of increase in their prevalence rates. The prevalence of key major disease conditions increased from 0.6% to 1.2% for stroke, 15.5% to 26.1% for congestive heart failure, 42.0% to 54.4% for ischemic heart disease, and 6.9% to 11.0% for chronic renal disease. Similarly, we found an increased prevalence of foot-specific conditions. The prevalence of any peripheral vascular condition (regardless of severity levels) based on VHA data more than doubled when CMS data were added (5.7% vs. 13.0%). The prevalence rate of any chronic deep skin infection also rose from 5.3% to 8.9%.

Using only VHA datasets, we identified 3.1 minor amputations and 4.5 major amputations per 1000 patients in the cohort. The addition of CMS data increased the crude amputation rate to 5.5 per 1000 patients for minor amputations (75% increase) and 8.6 per 1000 patients for major amputations (90% increase), respectively.

The percentage of veterans with diabetes incurring an amputation in the CMS data ranged from 26.4% to 61.8% among the VISNs. Ten VISNs were in the range of 40% to 50%, while the remaining 12 VISNs were equally split in the ranges of less than 40% and more than 50%. We examined whether the healthcare system in which the amputation occurred (Medicare vs VHA) was associated with the independent variables under study, as well as the VISN region. Because the results from the multiple logistic regression models were similar for major and minor amputations, we combined the 2 amputation categories. We found that VISN variation in the healthcare system site of amputations was significant ($P < .001$). We found that the site of the amputations (VHA or the private sector) was significantly associated with VISN region. In addition, we found that veterans who incurred an amputation in the private sector compared with the VHA were more likely to be older ($P < .01$), Caucasian, and to have more severe peripheral vascular conditions and medical comorbidities such as congestive heart failure. On the other hand, they were less likely to have preexisting chronic skin infections ($P < .01$) and prior amputations.

We also evaluated VISN-level variation in the prevalence of baseline (FY 1997-1998) covariates and the outcome variable, amputations in FY 1999, using VA-only or combined datasets (**Table 2**). The variation in CMS contribution across VISNs ranged from 34.3% to 150.7% for FY 1999 amputation outcomes. For the independent variables, the variation in CMS contribution across VISNs ranged from 32.9% to 106.0% for prior (FY 1997-1998) amputation and from 24.9% to 257.6% for any peripheral vascular condition.

We contrasted the parameter estimates and model performance using VHA-only data versus VHA/CMS combined data separately for major (versus no) amputation and minor (versus no) amputation (data not shown). Although small differences in the parameter estimates were noted for the VHA and VHA/CMS minor-amputation risk-adjustment models (with the exception of patient sex), the results were similar; no parameter estimates changed direction of association (positive to negative or vice versa) and all variables remained significant. The addition of CMS data had no impact on the C-statistic for the major-amputation model (C = 0.82 for both VHA-only and VHA/CMS data). Similarly, the addition of CMS data for the minor-amputation model minimally decreased the C-statistic from 0.79 to 0.78. All models demonstrated adequate goodness-of-fit, based on the Hosmer-Lemeshow test ($P > .05$).

Table 1. Prevalence of Foot Risk Variables, Medical Comorbidities, and Amputation Outcomes: VHA-only Data Versus VHA/CMS Combined Data*

	No. (%)	
Patient Characteristic	**VHA-only Data (n = 218 528)**	**VHA/CMS Combined Data (n = 218 528)**
Independent variable (FY 1997-1998)		
Prior amputation		
Minor	1171 (0.54)	1867 (0.85)
Major	1166 (0.53)	2039 (0.93)
Peripheral neuropathy	3232 (1.48)	5012 (2.29)
Chronic skin condition		
Corn callus	13 877 (6.35)	12 634 (5.78)
Superficial infection	4046 (1.85)	10 425 (4.77)
Deep infection	11 484 (5.26)	19 354 (8.86)
Any foot deformity (Charcot foot, bunions, hammertoes)	5439 (2.49)	8464 (3.87)
Peripheral vascular severity level		
Generalized ASVD, embolism, and PVD	9018 (4.13)	19 242 (8.81)
Peripheral angioplasty and bypass procedure	1537 (0.70)	4772 (2.18)
Gangrene	1855 (0.85)	4304 (1.97)
Medical comorbidities		
Stroke	1244 (0.57)	2543 (1.16)
Congestive heart failure	33 896 (15.51)	57 099 (26.13)
Ischemic heart disease	91 742 (41.98)	118 803 (54.37)
Renal disease	15 035 (6.88)	24 014 (10.99)
Dependent variable		
Amputation outcome (FY 1999)		
Minor	683 (0.31)	1198 (0.55)
Major	987 (0.45)	1879 (0.86)

*ASVD indicates arteriosclerotic vessel disease; CMS, Centers for Medicare and Medicaid Services; FY, fiscal year; PVD, peripheral vascular disease; VHA, Veterans Health Administration.

Table 3 shows our evaluation of individual VISN performance as determined by O/E ratios of major-amputation rates versus minor-amputation rates and outlier status. The range of O/E ratios across VISNs for major amputations was greater for VHA-only data (0.58 to 1.45) than for VHA/CMS data (0.72 to 1.31). Similarly, the range of O/E ratios for minor amputations was greater for VHA-only data (0.56 to 1.42) than for VHA/CMS data (0.75 to 1.46).

For major amputations, the addition of CMS data changed the ranking of 17 of 22 VISNs and the outlier status of 8 VISNs. Specifically, the CMS data changed 3 VISNs (H, M, T) that were rated as high outliers by VHA-only data to nonoutlier status with VHA/CMS data. Furthermore, 2 VISNs (A, S) that were initially rated as nonoutliers were reclassified as low outliers after addition of the CMS data. Two nonoutlying VISNs (G, O) changed to high outliers, and one VISN (R) changed from a low outlier to a nonoutlier. For minor amputations, the addition of CMS data changed the ranking of 19 of 22 VISNs and the outlier status of 8 VISNs. These 8 VISNs were not the same 8 VISNs whose outlier status changed for major amputations. The VISNs that changed from high outliers to nonoutliers for either major or minor amputations were those that had the lowest percentages (<40%) of veterans who had amputations in the private sector. On the other hand, those whose status changed from nonoutlier/low outlier to high outlier in either amputation category were among

Table 2. Summary of Variation in Prevalence of Foot Risk Factors, Medical Comorbidities, and Amputations Outcomes Among the 22 VISNs*

	VHA/CMS Combined Data (%)			CMS Contribution (%)		
Patient Characteristic	**Minimum**	**Maximum**	**Median**	**Minimum**	**Maximum**	**Median**
Prior amputation (FY 1997-1998)	1.33	2.33	1.76	32.89	106.03	67.78
Chronic skin condition	7.33	10.95	8.82	23.43	110.93	64.63
Any foot deformity (Charcot foot, bunions, hammertoes)	2.22	8.38	3.31	23.55	112.31	62.65
Peripheral vascular severity	10.04	18.21	13.01	24.92	257.60	136.26
Medical comorbidities						
Stroke	0.78	1.46	1.17	48.94	246.34	92.20
Congestive heart failure	23.42	30.79	25.78	40.11	109.37	65.93
Ischemic heart disease	47.78	59.52	53.64	18.70	49.11	27.04
Renal disease	8.25	16.30	10.77	19.57	92.13	59.85
Amputation outcome (FY 1999)	1.06	1.80	1.39	34.33	150.68	76.39

*CMS indicates Centers for Medicare and Medicaid Services; FY, fiscal year; VHA, Veterans Health Administration; VISN, Veterans Integrated Service Network.

those that had the highest percentage (>50%) of veterans who had amputations in the private sector (data not shown).

DISCUSSION

Our results demonstrate that the inclusion of Medicare administrative data yielded a more comprehensive dataset for foot risk factors, comorbidities, and amputations. In some instances (eg, peripheral vascular conditions), the addition of CMS data doubled the prevalence. Most importantly, the addition of Medicare data to VHA data changed the outlier designation for 8 of 22 VISN regions for major amputations and a different subset of 8 of 22 VISN regions for minor amputations. There were marked demographic differences among dually enrolled veterans incurring amputations in the VHA compared with the private sector, and the VISN high-outlier designation based on VHA data alone was associated with higher proportions of amputations performed within the VHA. These 2 findings suggest that selection biases in patient choice of healthcare site are significant factors in the evaluation of health outcomes.

Our findings are consistent with prior research demonstrating the difficulties in evaluating care provided to individuals with chronic diseases across multiple health systems. In addition to underestimating hospitalizations,[19,20] it is increasingly appreciated that use of administrative data underestimates performance measurement adherence in both VHA and Medicare facilities.[21,22] Rather than being unique to the VHA, the challenges of dual-system enrollment for health outcome assessment are pertinent to other governmental agencies, including the Medicare and Medicaid programs[23,24] and the Department of Defense Tricare program.[25] Our findings raise legitimate policy questions regarding how decision makers can assess the effectiveness of disease management programs if payment and eligibility issues present both patients and providers with conflicting rules and incentives that may lead to discoordination of care.[26] CMS recently initiated a number of demonstration projects on care coordination and disease management in beneficiaries with chronic disease; in some, a single disease management program will pay for all medications, even if enrollees are dually eligible.[27] However, because fair and accurate comparison of specific hospitalization rates requires a totality of data to ascertain and risk-adjust outcomes, comparisons among national systems may not be possible until there is a single electronic medical record.[28]

Consequently, as an interim proposal for implementation of prevention quality indicators within large national healthcare systems, we suggest that single-payer administrative data could be used to identify regional variation for the purpose of programmatic evaluation rather than benchmarking. This proposal is consistent with recent disease-specific certification standards established by the Joint Commission on Accreditation of Healthcare Organizations.[29]

We previously demonstrated that although system-level care coordination for patients with feet at high risk

Table 3. Ranking of VISNs Using Fiscal Year 1999 (FY 99) Standardized Amputation Ratios (O/E) : VHA-only Data Versus VHA/CMS Combined Data*

VISN (No. of Diabetes Patients)	Major Amputation						Minor Amputation					
	VHA-only Data			VHA/CMS Combined Data			VHA-only Data			VHA/CMS Combined Data		
	Rank	O/E	99% CI†	Rank	O/E	99% CI†	Rank	O/E	99% CI†	Rank	O/E	99% CI†
A (11 563)	8	0.91	0.79, 1.04	8	0.9	0.81, 0.99L	20	1.2	1.19, 1.56H	22	1.46	1.33, 1.60H
B (7671)	5	0.76	0.61, 0.93L	5	0.78	0.68, 0.90L	19	1.2	1.10, 1.59H	13	1.01	0.87, 1.18
C (11 980)	3	0.66	0.57, 0.77L	1	0.72	0.65, 0.79L	5	0.64	0.64, 0.92L	16	1.11	1.01, 1.23H
D (13 055)	2	0.6	0.51, 0.71L	6	0.83	0.75, 0.91L	13	0.87	0.87, 1.17	18	1.14	1.03, 1.26H
E (5485)	11	0.96	0.80, 1.14	12	0.98	0.87, 1.11	14	0.82	0.82, 1.28	12	0.95	0.80, 1.13
F (11 796)	15	1.09	0.98, 1.21	14	1.01	0.93, 1.10	6	0.71	0.71, 0.98L	3	0.81	0.72, 0.91L
G (13 543)	16	1.1	0.99, 1.23	19	1.2	1.12, 1.30H	1	0.56	0.56, 0.80L	10	0.91	0.82, 1.02
H (18 423)	18	1.21	1.10, 1.33H	10	0.96	0.89, 1.03	7	0.74	0.74, 0.98L	2	0.8	0.72, 0.89L
I (11 952)	22	1.45	1.30, 1.60H	22	1.31	1.21, 1.42H	8	0.73	0.73, 1.01	8	0.89	0.78, 1.01
J (7878)	14	1.06	0.91, 1.23	16	1.07	0.97, 1.19	15	1.03	1.03, 1.44H	19	1.3	1.15, 1.46H
K (11 619)	7	0.83	0.72, 0.97L	9	0.9	0.82, 0.99L	4	0.63	0.63, 0.92L	4	0.82	0.72, 0.93L
L (10 951)	1	0.58	0.49, 0.68L	2	0.73	0.66, 0.81L	22	1.42	1.42, 1.81H	20	1.37	1.24, 1.51H
M (6112)	17	1.17	1.01, 1.35H	17	1.12	0.99, 1.27	9	0.74	0.74, 1.11	14	1.03	0.88, 1.20
N (4861)	4	0.71	0.54, 0.92L	4	0.78	0.65, 0.93L	16	0.97	0.97, 1.55	17	1.12	0.93, 1.34
O (10 556)	13	1.04	0.91, 1.20	18	1.14	1.04, 1.25H	2	0.58	0.58, 0.87L	6	0.86	0.75, 0.99L
P (18 684)	20	1.26	1.15, 1.38H	21	1.27	1.19, 1.36H	10	0.81	0.81, 1.06	7	0.86	0.78, 0.95L
Q (8887)	21	1.28	1.12, 1.46H	20	1.25	1.14, 1.37H	12	0.82	0.82, 1.18	11	0.95	0.83, 1.09
R (8840)	6	0.8	0.66, 0.96L	15	1.06	0.94, 1.18	17	1.04	1.04, 1.46H	9	0.9	0.77, 1.04
S (4975)	12	0.97	0.77, 1.21	3	0.76	0.63, 0.92L	21	1.31	1.31, 1.95H	21	1.4	1.19, 1.64H
T (6818)	19	1.25	1.08, 1.45H	13	0.99	0.87, 1.13	18	1.03	1.03, 1.48H	15	1.05	0.90, 1.22
U (6771)	10	0.95	0.80, 1.14	7	0.89	0.78, 1.02	3	0.56	0.56, 0.92L	5	0.83	0.70, 0.99L
V (6108)	9	0.94	0.78, 1.12	11	0.97	0.85, 1.09	11	0.78	0.78, 1.21	1	0.75	0.62, 0.90L

*CMS indicates Centers for Medicare and Medicaid Services; CI, confidence interval; O/E, observed number of amputations/expected number of amputations after risk adjustment; VHA, Veterans Health Administration; VISN, Veterans Integrated Service Network.
†H indicates high outlier; L, low outlier.

of amputation may be an important process in reducing amputation,[30] opportunities remain for improvement in the organizational coordination of foot-care programs.[31] Consistent with the chronic-care model,[32] we propose that healthcare systems could utilize electronic medical records to create disease-specific registries to identify individuals who receive care in more than 1 healthcare system. Healthcare systems would then be able to proactively coordinate care between, as well as within, systems of care. Such efforts would respect patient choice, inform local quality improvement efforts to address unmet needs and improve access, and may improve cost and health outcomes.

This study has a number of strengths. First, our national cohort of dually eligible veterans with diabetes was analyzed on an individual patient level. We were able to reliably ascertain the diagnosis of diabetes for our cohort, as well as identify both major-amputation and minor-amputation outcomes and comorbidities using both VHA and Medicare datasets. Second, our study of VHA and Medicare fee-for-service users explicitly excluded users of Medicare HMOs. Thus, there was more certainty about the totality of medical information. We were able to identify the relative contribution of Medicare data to comorbidities and amputation outcomes, as well as the impact of these data on network rank and outlier status.

However, we also acknowledge several limitations. We were unable to ascertain Medicaid or private-sector utilization. Although the accuracy of amputation coding has been validated in the VHA,[33] the accuracy of the outpatient coding for covariates in both the VHA and Medicare datasets has not been systematically analyzed.

CONCLUSION

Our study demonstrates that addition of CMS administration data to VHA databases not only adds important comorbidity data and amputation outcomes, but also alters statistical comparisons of regional variations defined by VHA network service areas. Our results demonstrate the potential limitations of the use of amputation rates in particular, and perhaps all prevention quality indicators, within systems of care where fragmentation of healthcare occurs. Further research is necessary to understand the various factors, including plan benefits, access, and system-level quality-of-care issues, that impact patient care preferences and their choice of care.

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