An Evaluation of Statin Use Among Patients with Type 2 Diabetes at High Risk of Cardiovascular Events Across Multiple Health Care Systems

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ABSTRACT

BACKGROUND: Patients with more than one chronic condition often receive care from several providers and facilities, which may lead to fragmentation of care. Poor care coordination in dual health care system use has been associated with increased emergency department visits, hospitalizations, and costs.

OBJECTIVE: Dual health care system use is increasing among veterans, and we sought to evaluate the effect of dual health care system use on statin treatment in veterans with type 2 diabetes at high risk of cardiovascular events, using varying degrees of Centers for Medicare & Medicaid Services (CMS) services.

METHODS: This was a 10-year retrospective longitudinal cohort study of national clinical and administrative data that included 689,138 veterans with type 2 diabetes who were aged 65 years or older on January 1, 2006. Patients were followed from January 1, 2007, until December 31, 2016. Administrative and clinical data from the Veterans Health Administration's (VHA) Corporate Data Warehouse were merged with CMS inpatient, outpatient, and pharmacy data. Statin use was defined as any therapy and subcategorized as high versus low or moderate intensity per the American College of Cardiology/American Heart Association guidelines. Marginal generalized estimating equation-type models for longitudinal data were used to model the association between dual health care utilization status (<50%, 50%-80%, and >80% VHA utilization, with the first group serving as the reference group) and statin use after adjusting for measured covariates.

RESULTS: The mean ages at baseline for each group were similar and ranged between 75.4 and 76.9 years. For the outcome of any statin use, the group with <50% VHA utilization was significantly less likely to receive statin therapy compared with the group with >80% VHA utilization (OR=0.26, 95% CI=0.26-0.26), while the group with 50%-80% VHA utilization was slightly more likely (OR=1.05, 95% CI=1.04-1.07). Similarly, for the high-intensity versus low-/moderate-intensity or no statins outcome, the group with <50% VHA utilization was significantly less likely to receive a high-intensity statin compared with the group with >80% VHA utilization (OR=0.56, 95% CI=0.55-0.57), while the group with 50%-80% VHA utilization was only slightly less likely (OR=0.95, 95% CI=0.94-0.96).

CONCLUSIONS: Among veterans with diabetes at high risk of cardiovascular events, dual health care system utilization status appeared to affect statin use. We observed lower odds for any statin use and high-intensity statin therapy among the cohort with the lowest degree of VHA utilization (i.e., <50%). Interventions to increase statin use among veterans at high risk of cardiovascular events with lower degrees of VHA utilization should be explored.

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What is already known about this subject

- Patients often receive care from several providers and facilities, which may lead to fragmentation of care.
- Poor care coordination in dual health care system use has been associated with increased resource utilization.
- Dual health care system use is increasing among veterans.

What this study adds

- Dual health care system utilization status appeared to affect statin use.
- We observed lower odds for any statin use and high-intensity statin therapy among veterans with low Veterans Health Administration (VHA) utilization.
- Interventions to increase statin use among veterans at high risk of cardiovascular events with lower degrees of VHA utilization should be explored.

Patients with chronic conditions often receive care from more than one health care provider or system.^{1,2} Although visiting multiple providers may be clinically necessary and offer enhanced access, it can also result in fragmentation of care.¹⁻⁴ Lack of care coordination has been associated with increased emergency department visits, hospitalizations, and costs.^{2,5-9} Veterans Health Administration (VHA) patients using health care services from VHA and non-VHA organizations may be at risk of receiving fragmented care. This usage, also known as dual health care system use, is increasing among veterans and has been associated with suboptimal outcomes.^{3,4,10,11} For instance, dual health care system use has been associated with increased resource utilization and mortality among veterans with cardiovascular disease (CVD).^{3,8,12}

Over 130 million adults in the United States are projected to have some form of CVD by 2035.¹³ Among patients with diabetes, atherosclerotic cardiovascular disease (ASCVD) is the leading cause of mortality and the largest contributor to costs, resulting in \$37.3 billion in cardiovascular-related costs each year.^{14,15} Studies demonstrate substantial reductions in cardiovascular events and mortality with the use of HMG-CoA reductase inhibitors (statins).¹⁶⁻²⁰ Statins were historically

dosed to lower low-density lipoprotein cholesterol (LDL) below targets determined by cardiovascular risk.²¹ The American College of Cardiology/American Heart Association guidelines released in 2013 and subsequently updated in 2018 recommend fixed-dose statins (i.e., statins dosed at either high or moderate intensity) for the following benefit groups: (a) clinical ASCVD, (b) LDL $\geq$ 190 mg/dL, (c) diabetes, and (d) 10-year ASCVD risk $\geq$ 7.5%.^{16,17} However, previous studies demonstrate that not all patients receive statin therapy, leading to guideline discordant care.^{22,23}

Dual health care system users may use VHA and non-VHA prescription plans.⁴ This has the potential advantage of providing increased access to medications, including statins. For instance, if a medication is not on the VHA formulary, it could be obtained through the non-VHA prescription plan. However, using multiple prescription plans also increases complexity. Patient cost sharing (e.g., copayments) differs between VHA and non-VHA plans. Moreover, duplications in therapy or drug interactions would be more difficult to identify when a patient filling prescriptions through separate plans presents to a pharmacy that can only view medications filled through one of these plans. Omissions in therapy may also arise, since providers can assume that different systems are providing the necessary therapies for a given indication. Because of these complexities and the association between dual health care system use and suboptimal outcomes among patients with CVD,^{3,8,12} we sought to evaluate the effect of dual health care system use on the use of statins in veterans with type 2 diabetes at high risk of cardiovascular events. We hypothesized that a lower degree of VHA utilization would be associated with less statin use.

Methods

Study Design and Data Sources

We performed a 10-year retrospective longitudinal cohort study using detailed administrative and clinical data from multiple sources. We gathered national clinical and administrative data from the VHA Corporate Data Warehouse (CDW) and Centers for Medicare & Medicaid Services (CMS) from 2007 to 2016 and created a large national cohort of veterans with type 2 diabetes. VHA CDW data, including prescription data, diagnostic codes, laboratory values, and demographic information from outpatient visits, outpatient pharmacy claims, and inpatient admissions, were obtained from the Veterans Health Information Systems and Technology Architecture (VistA). CMS data for Medicare Part A, B, and D and managed care claims were linked to this VHA dataset using patient scrambled social security numbers. This study was a hypothesis evaluating treatment effectiveness study and was not registered on a public registration site.²⁴ The study was

approved by our Institutional Review Board and the local VHA Research and Development committee.

Study Population

Veterans with type 2 diabetes were identified from a cohort formed for an earlier study.²⁵ Type 2 diabetes was defined as *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes for diabetes (250, 357.2, 362.0, and 366.41) on 2 or more occasions during the 24 months before 2002 and again during 2002 with prescriptions for insulin or oral hypoglycemic agents based on a previously validated algorithm.^{25,26} Only those patients aged 65 years or older, and thus eligible for Medicare, on January 1, 2006 (the inception of Medicare Part D) were included. Patients were followed from January 1, 2007, through December 31, 2016. We did not include the year 2006 in the analysis dataset in order to allow the disruption in prescription trends to settle after the Part D system launch.

Exposure and Covariates

The primary exposure variable was CMS-VHA dual health care system use. Cohorts were defined by >80% VHA, 50%-80% VHA, and <50% VHA utilization.^{27,28} The first group served as the reference group, since we hypothesized that statin use would be highest in this group. Dual-use status was time varying over the study period and thus could change for a given patient each year. This status was based on the proportion of a given patient's annual primary care provider visits that were provided by the VHA versus CMS visits, since chronic statin therapy is typically managed in a primary care setting.²⁹

We adjusted for several demographic, clinical, and socioeconomic variables, which were selected after reviewing the literature and variables that we had validated in our previous work.^{3,4,15,16,18,26-28,30} Age was treated as continuous and gender as nominal, with males as the reference group. Race/ethnicity was identified from VHA and CMS sources and was classified as non-Hispanic White (NHW), non-Hispanic Black (NHB), Hispanic, and other, with NHW serving as the reference group. Marital status was classified as nonmarried or married (reference group). Percentage service connectedness, representing the degree of disability related to military service, was dichotomized at 50%, with the <50% group serving as the reference. Patients with service-connected diabetes and those with greater than 50% service-connected disability do not pay for medications in the VHA system, while others are usually subject to a copay. Smoking status was classified as smoker and nonsmoker (reference group).

Medical comorbidities were based on the ICD-9/10-CM codes obtained from VHA and CMS. Comorbidities were summarized by the Elixhauser Comorbidity Index definition and were accounted for in our model.³¹ We also accounted

for the following clinical variables: number of annual primary care visits (time varying); ASCVD (acute coronary syndrome, atherosclerotic cerebrovascular disease, coronary heart disease, and acute coronary syndrome); and mean annual hemoglobin A1c control ($\leq 8\%$, $> 8\%$; time varying). Finally, we identified patients with any of the following characteristics: ASCVD, LDL ≥ 190 mg/dL, risk-enhancing factors (including diabetes for ≥ 10 years or microvascular complications) or between the ages of 50-75 years, and those with a 10-year ASCVD risk $\geq 20\%$. This was done to estimate the proportion of patients who could benefit from high-intensity statins.¹⁶

Outcome Measures

Outcomes for this study were any statin use (with no statin use defined as the reference) and high-intensity statin use (with the reference group consisting of patients with no statin use and patients on low-/moderate-intensity statins). High-intensity statins were defined as atorvastatin 40 to 80 mg and rosuvastatin 20 to 40 mg.¹⁶ Statin use was a binary measure and was defined as at least 1 prescription filled in the measurement year. Prescription data were captured from the VHA and CMS (i.e., Medicare Part D). Data on statin use were considered missing if patients had no prescription data. The terminology “receiving statins” and the “use of statins” are used interchangeably in this study to describe prescription filling for these agents.

Statistical Analysis

Statin use over time is reported descriptively and is stratified by dual utilization group. Characteristics to be included in the multivariable models were first examined through bivariate analysis via chi square tests for categorical variables and t-tests for continuous variables. Next, missing data methods were applied, since the longitudinal dataset had a substantial level of non-monotone missingness: 43% of rows had 1 or more missing values, including 17% of the exposure variable (no VHA or CMS health care utilization data for a patient in a given year) and 31% of the outcome (no VHA or CMS pharmacy data for any agent for an enrolled patient in a given year). We conducted multiple imputations using fully conditional specification (MI-FCS) to generate 10 imputed datasets, whereas multinomial logistic or logistic regression was used for categorical variables, and predictive mean matching was used to impute continuous variables within MI-FCS.³² Following the bivariate analysis, we used marginal generalized estimating equation (GEE)-type generalized linear models for longitudinal data to model the association between the primary exposure (dual health care utilization status) and statin use outcomes.

We developed explanatory models in incremental steps, starting from only the exposure variable and adding a domain of explanatory variables (demographic, clinical). We next ran the full models on each imputed dataset, and results were

combined using Rubin’s method.³³ We report odds ratios (ORs) and associated 95% confidence intervals (CIs) for each predictor in each model. Our missing data methods assumed missing at random, which we found to be reasonable given the many covariates involved and the extent of missing data we had in the outcome variables.

We also conducted propensity score analysis on each imputed dataset as a sensitivity analysis to check for possible confounding from measured differences in risk between dual-use groups. Because the dual-use variable had 3 levels, we used propensity score methods developed for multilevel exposures developed by Imbens et al. (2000) and Zanutto et al. (2005).³⁴⁻³⁶ To determine propensity scores, we used a multinomial logistic regression model with dual-use status as the outcome and adjusted for demographic variables, comorbidities, mean A1c, and mean LDL. The maximum likelihood estimates for each patient were used as covariate balancing scores; these scores were stratified by quintiles per methods developed by Cochran (1968) and Rosenbaum and Rubin (1984).^{37,38}

Covariate balance and score overlap were verified within each stratum and within each exposure level. Marginal GEE-type generalized linear models for clustered data were run for each stratum, and the results were pooled using Rubin’s method.³³ Finally, the propensity score results from the 10 imputed datasets were pooled. Analyses were performed using Stata MP version 15.1 (StataCorp, College Station, TX) and SAS version 9.4 (SAS Institute, Cary, NC).

Results

There were 689,138 veterans who met criteria and were included in this analysis. Table 1 provides a summary of demographic and clinical characteristics for this cohort. The mean ages at baseline for each dual-use group were similar and ranged between 75.4 and 76.9 years. The $< 50\%$ VHA group had the lowest proportions of minority groups (6.5% NHB, 2.5% Hispanic), while the $> 80\%$ VHA group had the highest (12.1% NHB, 7.1% Hispanic). Females comprised approximately 1% of each dual-use group. The $> 80\%$ VHA group was more likely to smoke (16.9% vs. 10.2% for $< 50\%$ VHA); more likely to be unmarried (44.5% vs. 33.8% for $< 50\%$ VHA); and slightly less likely to live in rural areas (33.6% vs. 37.6% for $< 50\%$ VHA). The dual-use groups also differed by the occurrence of ASCVD; 21.7% of the $> 80\%$ VHA group had acute coronary syndrome versus 27.2% for the $< 50\%$ VHA group; for coronary heart disease these values were 58.9% and 75.7%, respectively; for peripheral artery disease, these values were 41.7% and 52.1%, respectively. Overall, 97% were identified as patients for whom high-intensity statins would be recommended.

Figure 1 compares the proportions of patients with any statin or with a high-intensity statin by dual-use group. The $< 50\%$ VHA group was substantially less likely to have any

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TABLE 1 Baseline Patient Characteristics by Dual-Use Status^a

	>80% VHA	50%-80% VHA	<50% VHA
N	379,038	55,829	254,271
Mean age (SD)	75.4 (6.1)	76.1 (6.2)	76.9 (6.2)
Primary care visits, mean (SD)	3.1 (2.8)	5.0 (3.4)	6.5 (4.8)
Race/ethnicity			
Non-Hispanic White	78.6	84.3	89.2
Non-Hispanic Black	12.1	9.1	6.5
Hispanic	7.1	4.4	2.5
Other	2.2	2.1	1.9
Sex			
% female	1.3	1.1	1.3
High-intensity statin treatment preferred ^b	96.5	98.3	97.1
Smoking status			
Smokers	16.9	14.4	10.2
Service-connected disability			
> 50% disabled	17.1	18.6	16.3
Marital status			
Unmarried	44.5	40.2	33.8
Residence location			
Rural or highly rural	33.6	37.2	37.6
ASCVD			
Acute coronary syndrome	21.7	29.2	27.2
Coronary heart disease	58.9	72.9	75.7
Atherosclerosis cerebrovascular disease	18.5	23.6	23.4
Peripheral artery disease	41.7	51.7	52.1
Congestive heart failure	38.9	51.9	53.2
Valvular disease	21.7	30.9	32.5
Pulmonary circulation disease	11.6	16.0	16.3
Hypertension	77.2	79.0	81.8
Hypertension with complications	35.3	48.8	50.2
Paralysis	8.7	11.4	10.4
Other neurological disorders	26.9	34.7	35.1
Chronic pulmonary disease	47.8	56.7	54.2
Diabetes with chronic complications	62.1	67.6	65.5
Hypothyroidism	18.7	23.7	26.8
Renal failure	40.0	49.4	50.2
Liver disease	6.0	7.7	7.1
Peptic ulcer disease	0.7	0.8	0.6
Acquired immune deficiency syndrome	0.2	0.2	0.1
Lymphoma	2.8	3.3	3.6
Metastatic cancer	8.2	9.9	9.4
Solid tumor without metastasis	29.8	33.0	32.5
Rheumatoid arthritis	6.2	7.8	8.1
Coagulopathy	15.2	21.2	21.2
Obesity	43.7	44.8	40.5
Weight loss	19.7	24.4	23.8
Fluid and electrolyte disorders	49.3	63.3	63.1
Chronic blood loss anemia	4.4	7.2	7.7
Deficiency anemias	51.6	62.4	62.7
Alcohol abuse	8.0	8.1	5.5
Drug abuse	2.5	2.7	1.9
Psychoses	18.6	21.2	18.1
Depression	29.9	34.5	31.5

Note: All statistics are shown as percentages unless indicated otherwise.

^aBaseline statistics are based on each patient's earliest observed year in which dual utilization could be determined.

^bDefined as patients meeting any of the following criteria: (a) ASCVD, (b) LDL ≥ 190 mg/dL, (c) risk-enhancing factors (including diabetes for ≥ 10 years or microvascular complications) or between the ages of 50-75 years, and (d) those with a 10-year ASCVD risk $\geq 20\%$.

ASCVD = atherosclerotic cardiovascular disease; SD = standard deviation; VHA = Veterans Health Administration.

statin or a high-intensity statin use, while statin use was similar in the >80% VHA and 50%-80% VHA groups.

Table 2 provides the results for the marginal generalized linear models from the pooled multiple imputation results. Appendices A and B (available in online article) provide the complete case and propensity score analysis results as well. For the outcome of any statin use, the <50% VHA group was significantly less likely to receive statin therapy compared with the >80% VHA group (OR=0.26, 95% CI=0.26-0.26), while the 50%-80% VHA group was slightly more likely (OR=1.05, 95% CI=1.04-1.07). Similarly, for the high-intensity versus low-/moderate-intensity or no statin use outcome, the <50% VHA group was significantly less likely to receive a high-intensity therapy compared with the >80% VHA group (OR=0.56, 95% CI=0.55-0.57), while the 50%-80% VHA group was only slightly less likely (OR=0.95, 95% CI=0.94-0.96).

Temporal trends are also displayed in Table 2, demonstrating that the use of any statin therapy became less likely each year following baseline (OR=0.94, 95% CI=0.94-0.94), while the use of high-intensity statins became significantly more common (OR=1.26, 95% CI=1.26-1.27). The NHB group was more likely to receive a high-intensity statin compared with the NHW group (OR=1.15, 95% CI=1.13-1.17), but was somewhat less likely to receive any statin (OR=0.94, 95% CI=0.93-0.96). Females were 10% more likely to receive high-intensity statins and 16% more likely to receive any statin (OR=1.10, 95% CI=1.04-1.17 and OR=1.16, 95% CI=1.12-1.20). Veterans with more than 50% service-related disability were 9% more likely to receive a high-intensity statin and 53% more likely to receive any statin (OR=1.09, 95% CI=1.08-1.11 and OR=1.53, 95% CI=1.51-1.54). Rural veterans were 10% less likely to receive a high-intensity statin (OR=0.90, 95% CI=0.88-0.91).

FIGURE 1 Proportions of Patients with Any Statin or with a High-Intensity Statin by Dual-Use Group

VHA = Veterans Health Administration.

but were 13% more likely to receive any statin (OR=1.13, 95% CI=1.13-1.14).

Receipt of high-intensity and any statins increased with each additional primary care visit per year (OR=1.02, 95% CI=1.02-1.02 and OR=1.06, 95% CI=1.06-1.06, respectively). Receipt of high-intensity statins was 14% more likely for each 1% increase in mean A1c (OR=1.14, 95% CI=1.14-1.15). Similarly, receipt of high-intensity and any statins was significantly associated with ASCVD for acute coronary syndrome (OR=1.30, 95% CI=1.28-1.32 and OR=1.08, 95% CI=1.07-1.09, respectively); for atherosclerotic cerebrovascular disease (OR=1.77, 95% CI=1.74-1.80 and OR=1.06, 95% CI=1.05-1.07); for coronary heart disease (OR=1.14, 95% CI=1.12-1.16 and OR=1.07, 95% CI=1.06-1.08); and for peripheral artery disease (OR=1.19, 95% CI=1.18-1.21 and OR=1.19, 95% CI=1.18-1.21).

The results from the propensity score analysis (Appendix B, available in online article) were consistent with the GEE model results and suggest that our results are not confounded by risk differences between dual-use groups.

Discussion

In this longitudinal analysis of 689,138 older veterans with diabetes, we evaluated the effect of dual health care system utilization on statin treatment using national data from the VHA

and CMS over a 10-year period. Compared with veterans with greater than 80% VHA utilization, veterans with less than 50% VHA utilization were substantially less likely to receive either high-intensity statins or any statin at all. Patients with an intermediate degree of dual utilization (50%-80% VHA) received statins at similar rates as the >80% VHA group. Although 97% of patients had important cardiovascular risk factors (e.g., known ASCVD and risk-enhancing features such as long-standing diabetes and microvascular complications) and could benefit from high-intensity statin therapy, disappointingly, less than one-third of patients received these agents.

Use of VHA and non-VHA prescription plans may increase medication access by allowing patients to use more than 1 drug formulary; however, our findings of decreased statin use in the <50% VHA utilization group is consistent with several studies, highlighting the challenges in medication management when patients use both VHA and non-VHA services.^{4,39,40} In an analysis of 254,267 veterans with diabetes, dual pharmacy system users had a lower odds of medication adherence when compared with VHA-only pharmacy users (OR=0.61, 95% CI=0.60-0.61).⁴ Further, in a study of 760 veterans receiving buprenorphine from the VHA and dually enrolled in Medicare Part D, 26% of patients had overlapping opioid prescriptions, and 16% had overlapping benzodiazepine prescriptions.³⁹ VHA pharmacists have also reported challenges in dispensing

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TABLE 2 GEE-Type Generalized Linear Models: Pooled Results from 10 Multiple Imputation Datasets

	OR (95% CI)	
	Any Statins vs. None	High-Intensity vs. Low-/Moderate-Intensity Statin or None
Dual VHA-CMS utilization		
>80% VHA	reference	reference
50%-80% VHA	1.05 (1.04-1.07)	0.95 (0.94-0.96)
<50% VHA	0.26 (0.26-0.26)	0.56 (0.55-0.57)
Index year		
Per additional year	0.94 (0.94-0.94)	1.26 (1.26-1.27)
Age at baseline		
Per additional year	0.96 (0.96-0.96)	0.94 (0.94-0.94)
Race/ethnicity		
Non-Hispanic White	reference	reference
Non-Hispanic Black	0.94 (0.93-0.96)	1.15 (1.13-1.17)
Hispanic	1.01 (0.99-1.03)	0.82 (0.80-0.84)
Other	0.89 (0.87-0.91)	0.92 (0.88-0.97)
Sex		
Female	1.16 (1.12-1.20)	1.10 (1.04-1.17)
Disability category		
>50% service related	1.53 (1.51-1.54)	1.09 (1.08-1.11)
Location of residence		
Rural vs. urban (reference)	1.13 (1.13-1.14)	0.90 (0.88-0.91)
Smoking status		
Smoke vs. nonsmoking	1.00 (0.99-1.02)	0.97 (0.95-0.98)
Marital status		
Unmarried vs. married	0.98 (0.97-0.99)	0.94 (0.92-0.95)
Number primary care visits		
Per year	1.06 (1.06-1.06)	1.02 (1.02-1.02)
Mean HbA1c		
Per percent change	0.98 (0.97-0.98)	1.14 (1.14-1.15)
ASCVD		
Acute coronary syndrome	1.08 (1.07-1.09)	1.30 (1.28-1.32)
Atherosclerosis, cerebrovascular disease	1.06 (1.05-1.07)	1.77 (1.74-1.80)
Coronary heart disease	1.07 (1.06-1.08)	1.14 (1.12-1.16)
Peripheral artery disease	1.19 (1.18-1.21)	1.19 (1.18-1.21)

ASCVD = atherosclerotic cardiovascular disease; CI = confidence interval; CMS = Centers for Medicare & Medicaid Services; GEE = generalized estimating equation; HbA1c = hemoglobin A1c; OR = odds ratio; VHA = Veterans Health Administration.

prescriptions from non-VHA providers, including lack of laboratory data required to safely monitor medications, having to obtain hand-delivered prescriptions for controlled substances, and the time needed to contact non-VHA providers, which further highlights complexities in medication management introduced with dual health care system use.⁴⁰

Patient cost sharing (e.g., copayments) differs across VHA and non-VHA prescription plans, which also adds to the complexity of using both services. Copayments have been

hypothesized as a factor that affects the prescription plan that veterans elect to use.⁴¹ In an analysis by Schleiden et al. (2019), factors known to affect copayments (i.e., Medicaid eligibility and veteran disability status) strongly influenced whether a veteran filled prescriptions through VHA pharmacies or Medicare Part D.⁴¹ While most statins likely had low out-of-pocket copayments due to generic availability during our study, atorvastatin and rosuvastatin were only available as brand-name medications for approximately 5 and 10 years of our study, respectively, and thus likely had higher copayments.⁴²

Since veterans with service-connected diabetes and those with greater than 50% service-connected disability have no out-of-pocket costs for medications in the VHA system, copayments were likely higher for these medications for some dual users who filled prescriptions through Medicare Part D. Lower rates of statin use in those with more Medicare services (i.e., those with <50% VHA utilization) in our study could be partially explained by higher copayments for this cohort. This hypothesis is consistent with several studies that demonstrate that increased copayments are associated with decreased adherence and increased medication discontinuation in patients with type 2 diabetes.⁴³⁻⁴⁵ For instance, in an analysis of 15,000 U.S. patients with type 2 diabetes, out-of-pocket costs of \$51-\$75 resulted in patients missing an average of 77 days of therapy over a 1-year period, when compared with those with out-of-pocket costs of \$0 to \$10.⁴³

Challenges in medication management introduced by dual use would be expected to negatively affect clinical outcomes. Several studies have demonstrated that dual use is associated with increased emergency department visits, hospitalization, and mortality among veterans with CVD.^{3,8,12,46} An analysis comparing dual use with VHA-only episodes for heart failure (HF) exacerbation among 3,439 veterans found that dual-use episodes were significantly associated with a 54%-89% increased odds of all-cause and HF-specific rehospitalizations and emergency department visits.³ Dual-use episodes were also associated with higher mortality (hazard ratio=1.52; 95% CI=1.07-2.16). Similarly, among 1,818 veterans hospitalized for treatment of an acute stroke, dual-use episodes were significantly associated with 3.0 to 5.2 times the odds of recurrent stroke hospitalization or mortality when compared with VHA-only episodes.¹²

Certain challenges that providers face when caring for patients across 2 health care systems also likely contributed to these results and our finding of suboptimal statin use among patients using both VHA and CMS services. For instance, barriers to communication and information sharing between VHA and non-VHA health care systems have been described.^{47,48} In interviews with 31 VHA and non-VHA providers, non-VHA providers frequently expressed frustration with and difficulty

in making referrals into the VHA system, accessing records, and contacting VHA providers when treating HF in patients using both VHA and non-VHA services.⁴⁷ Similarly, in focus groups consisting of VHA and Indian Health Service (IHS) providers who cared for veterans using both VHA and IHS systems, providers described little coordination between systems leading to delays in care, duplications in therapy, and longer patient visits resulting from the need to identify conflicts in treatment.⁴⁸

Our findings are important given several key changes in VHA policy and workflow.¹¹ First, the 2018 Maintaining Internal Systems and Strengthening Integrated Outside Networks (MISSION) Act drastically increased the number of veterans who are eligible to receive non-VHA care and is expected to increase dual use.¹¹ Moreover, the VHA is implementing a new electronic health record (EHR), which affects health information exchange (HIE) programs. VHA HIE programs enable VHA and non-VHA clinicians to view VHA and non-VHA medication information⁴⁹⁻⁵¹; however, the current VHA HIE program is built around an EHR that is being phased out. With the MISSION Act and a new EHR being implemented simultaneously, interventions aimed at ensuring that clinicians have accurate and up-to-date medication information when veterans receive care in more than 1 health care system are needed to prevent fragmented care and to ensure optimal outcomes for dual-use veterans.

The increase in high-intensity statin use during our study period likely reflected changes in the U.S. guidelines for the management of cholesterol in 2013, which recommended high-intensity statins in patients at high risk of cardiovascular events.⁵² Nearly all of the patients in our cohort were at high risk of cardiovascular events and could benefit from high-intensity statin therapy; yet, less than 30% of patients were treated with these agents at the end of our study's follow-up period in 2016.¹⁶ This is consistent with previous observations.^{22,23,30,53,54} In a study of U.S. administrative data by Tran et al. (2016), only about 18% of patients with ASCVD and 15% of patients with diabetes were receiving high-intensity statin treatment in 2014.⁵⁴ Although the decision to use a high- versus moderate-intensity statin requires a patient-specific assessment of many factors (e.g., tolerability, drug-drug interactions, and ASCVD risk), these data suggest efforts aimed at increasing the use of high-intensity statin therapy are still needed.^{16,52}

Limitations

Our findings should be interpreted with attention to several limitations. First, as our study was retrospective and dependent on administrative data to define the VHA utilization cohorts, misclassification bias is possible. We attempted to address this by assessing utilization using primary care visits and analyzed these visits annually in a time-dependent manner. Second, we

did not have data to evaluate the effect of out-of-pocket copayments on our findings.

Third, changes in clinical practice and policy that occurred over the 10-year follow-up period likely influenced our results. For example, U.S. guidelines on the management of cholesterol changed in 2013.⁵² That same year, the Medicare Part D coverage gap, known as the donut hole, began to narrow because of changes introduced by the Affordable Care Act, which likely resulted in lower out-of-pocket costs for some patients obtaining prescriptions through Medicare Part D.⁵⁵ Using a longitudinal analysis and assessing for differences over time, instead of cross-sectionally, likely mitigated this issue to some degree.

Fourth, our analysis was unable to capture non-VHA care covered by TRICARE, which provides benefits to qualifying uniformed service members, retirees, and their families. Therefore, our findings may have decreased applicability to veterans receiving these benefits. Additionally, some veterans may use VHA pharmacy benefits and obtained prescriptions through VHA services such as the Consolidated Mail Outpatient Pharmacy, even though the majority of their primary care is provided outside of the VHA, so they do not have an established relationship with a VHA primary care provider. This is an important source of potential care fragmentation.

Fifth, we were not able to define dual-use status based on if a veteran had an established relationship with a VHA primary care provider. However, defining dual-use status based on the proportion of VHA primary care provider visits likely captured this to some degree, and our results would likely remain the same even if our definition required veterans to have an established relationship with a VHA primary care provider.

Sixth, lack of medication adherence assessment to statin therapy is a shortcoming of this study. However, this study also has several important strengths, including a large national sample of veterans with type 2 diabetes at high risk of cardiovascular events, a comprehensive dataset that included VHA and CMS information, and detailed assessments of administrative, medication, and clinical variables to conduct a thorough assessment of factors associated with statin therapy.

Finally, it should be noted that having detailed prescription data allowed us to determine differences in statin use longitudinally by the level of intensity, another strength of this study.

Conclusions

Among older veterans with diabetes, dual health care system utilization status appeared to affect statin use. Compared with veterans with greater than 80% VHA utilization, veterans with less than 50% VHA utilization were substantially less likely to receive either a high-intensity statin or to receive any statin therapy. Interventions to increase statin use among veterans at high risk of cardiovascular events with lower degrees of VHA utilization should be explored.

An Evaluation of Statin Use Among Patients with Type 2 Diabetes at High Risk of Cardiovascular Events Across Multiple Health Care Systems

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APPENDIX A GEE-Type Generalized Linear Models: Complete Case Results

	OR (95% CI)	
	Any Statins vs. None	High-Intensity vs. Low-/Moderate-Intensity Statin or None
Dual VHA-CMS utilization		
>80% VHA (reference)	reference	reference
50%-80% VHA	1.54 (1.38-1.71)	0.95 (0.94-0.97)
<50% VHA	0.42 (0.40-0.44)	0.82 (0.80-0.83)
Index year		
Per additional year	0.83 (0.83-0.84)	1.31 (1.31-1.31)
Age at baseline		
Per additional year	0.95 (0.95-0.96)	0.95 (0.95-0.95)
Race/ethnicity		
Non-Hispanic White	reference	reference
Non-Hispanic Black	1.58 (1.44-1.74)	1.18 (1.16-1.21)
Hispanic	1.21 (1.09-1.35)	0.80 (0.78-0.83)
Other	0.90 (0.77-1.05)	0.95 (0.90-0.99)
Sex		
Female	1.41 (1.10-1.80)	1.07 (1.00-1.14)
Disability category		
>50% service related	2.11 (1.96-2.28)	0.98 (0.96-1.00)
Location of residence		
Rural vs. urban (reference)	1.06 (1.01-1.12)	0.86 (0.84-0.87)
Smoking status		
Smoke vs. nonsmoking	1.15 (1.07-1.24)	0.97 (0.95-0.98)
Marital status		
Unmarried vs. married	1.16 (1.1-1.22)	0.96 (0.95-0.97)
Number primary care visits		
Per year	1.10 (1.08-1.11)	1.01 (1.01-1.01)
Mean HbA1c		
Per percent change	1.19 (1.17-1.22)	1.15 (1.14-1.15)
ASCVD		
Acute coronary syndrome	1.30 (1.21-1.40)	1.28 (1.26-1.31)
Atherosclerosis cerebrovascular disease	1.16 (1.08-1.24)	1.13 (1.11-1.15)
Coronary heart disease	1.39 (1.32-1.47)	1.79 (1.76-1.82)
Peripheral artery disease	1.19 (1.13-1.25)	1.17 (1.16-1.19)

ASCVD = atherosclerotic cardiovascular disease; CI = confidence interval; CMS = Centers for Medicare & Medicaid Services; GEE = generalized estimating equation; HbA1c = hemoglobin A1c; OR = odds ratio; VHA = Veterans Health Administration.

APPENDIX B Propensity Score Results from Pooled Results (10 Multiple Imputation Datasets)

	OR (95% CI)	
	Any Statins vs. None	High-Intensity vs. Low-/Moderate-Intensity Statin or None
Dual VHA-CMS utilization		
>80% VHA (reference)	reference	reference
50%-80% VHA	0.99 (0.65-1.50)	0.93 (0.79-1.09)
<50% VHA	0.25 (0.16-0.39)	0.54 (0.44-0.66)
Index year		
Per additional year	0.94 (0.91-0.96)	1.27 (1.25-1.28)
Age at baseline		
Per additional year	0.96 (0.95-0.98)	0.94 (0.93-0.95)
Race/ethnicity		
Non-Hispanic White	reference	reference
Non-Hispanic Black	0.93 (0.68-1.27)	1.15 (1.02-1.30)
Hispanic	1.07 (0.63-1.82)	0.82 (0.66-1.01)
Other	0.89 (0.56-1.43)	0.93 (0.76-1.13)
Sex		
Female	1.16 (0.66-2.07)	1.10 (0.85-1.42)
Disability category		
>50% service related	1.51 (1.23-1.86)	1.09 (1.01-1.18)
Location of residence		
Rural vs. urban (reference)	1.14 (0.99-1.32)	0.90 (0.85-0.96)
Smoking status		
Smoke vs. nonsmoking	1.00 (0.79-1.28)	0.97 (0.88-1.07)
Marital status		
Unmarried vs. married	0.98 (0.80-1.20)	0.94 (0.86-1.03)
Number primary care visits		
Per year	1.11 (1.02-1.20)	1.04 (1.01-1.08)
Mean HbA1c		
Per percent change	0.98 (0.92-1.05)	1.14 (1.11-1.17)
ASCVD		
Acute coronary syndrome	1.08 (0.90-1.30)	1.30 (1.21-1.40)
Atherosclerosis cerebrovascular disease	1.04 (0.85-1.28)	1.76 (1.61-1.93)
Coronary heart disease	1.07 (0.89-1.29)	1.14 (1.06-1.23)
Peripheral artery disease	1.10 (0.94-1.28)	1.19 (1.11-1.27)

ASCVD = atherosclerotic cardiovascular disease; CI = confidence interval; CMS = Centers for Medicare & Medicaid Services; HbA1c = hemoglobin A1c; OR = odds ratio; VHA = Veterans Health Administration.