The Intersection of Patient Complexity, Prescriber Continuity and Acute Care Utilization

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BACKGROUND: Care continuity is considered a critical characteristic of high-performing health systems. Few studies have examined the continuity of medication management of complex patients, who often have multiple providers and complex medication regimens.

PURPOSE: The purpose of this study was to characterize patient factors associated with having more prescribers and the association between number of prescribers and acute care utilization.

DESIGN AND SUBJECTS: A retrospective cohort study was conducted of 7,933 Veterans with one to four cardiometabolic conditions (diabetes, hypertension, hyperlipidemia or congestive heart failure) and prescribed medications for these conditions in 2008.

MAIN MEASURES: The association between number of cardiometabolic conditions and prescribers was modeled using Poisson regression. The number of cardiometabolic conditions and number of prescribers were modeled to predict probability of inpatient admission, probability of emergency room (ER) visits, and number of ER visits among ER users. Demographic characteristics, number of cardiometabolic medications and comorbidities were included as covariates in all models.

KEY RESULTS: Patients had more prescribers if they had more cardiometabolic conditions ($p < 0.001$). The adjusted odds of an ER visit increased with the number of prescribers (two prescribers, Odds Ratio (OR)=1.16; three prescribers, OR=1.21; 4+ prescribers, OR=1.39), but not with the number of conditions. Among ER users, the number of ER visits was neither associated with the number of prescribers nor the number of conditions. The adjusted odds of an inpatient admission increased with the number of prescribers (two prescribers, OR=1.27; three prescribers, OR=1.30; 4+ prescribers, OR=1.34), but not with the number of conditions.

CONCLUSIONS: Having more prescribers was associated with greater healthcare utilization for complex patients, despite adjustment for the number of condi-

tions and medications. The number of prescribers may be an appropriate target for reducing acute care utilization by complex patients.

KEY WORDS: comorbidity; multi-morbidity; complex patient; prescriber; provider; emergency room; hospitalization; Veterans.

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INTRODUCTION

Patients with multiple chronic conditions (MCC) are increasingly prevalent, have worse disease control^{1,2} and functional status³ than patients with fewer conditions, and incur a disproportionate share of health care utilization⁴ and expenditures.^{5,6} Prior studies have not identified provider or organizational factors that contribute to adverse outcomes of patient complexity. Nevertheless, health system reforms are currently being undertaken in hopes of improving the health and health care of MCC patients, including patient-centered medical homes (PCMHs) and accountable care organizations (ACOs).⁷ Continuity of care is a central tenet of PCMHs and ACOs, which could reduce the fragmented care experienced by MCC patients who often receive care and medications from multiple providers.⁸

Seeing multiple providers without proper coordination risks suboptimal health care and outcomes, particularly for chronic disease medication management, where ongoing monitoring, adjustment, and re-evaluation of care goals may benefit from a continuous, longitudinal patient-provider relationship. There is limited evidence about the adverse events associated with having multiple providers. A study of 315 elderly inpatients found that risk of admission due to medication noncompliance increased with the number of physicians regularly seen, even after adjusting for the number of prescription medications and other factors.⁹ Another study found that the number of prescribers was the strongest predictor of potentially inappropriate drug combinations for 51,587 elderly patients taking cardiovas-

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cular, psychotropic or nonsteroidal anti-inflammatory drugs.¹⁰ Two other studies found that having multiple prescribers was a significant predictor of having unnecessary drug use at hospital discharge,¹¹ or an adverse drug event.¹²

These studies suggest that medication-related outcomes are associated with increasing numbers of prescribers, but no prior studies have examined the association between number of prescribers and other types of health care utilization. This study's purpose was to examine patient factors associated with having more prescribers, and to examine the association of patient complexity (i.e., number of conditions) and prescriber continuity (i.e., number of prescribers) with emergency room (ER) visits and hospital admissions. We examine these utilization outcomes because they have been associated with visit-based care continuity for complex patients in prior studies.^{13,14} Examining patient complexity together with prescriber continuity can identify their relative contributions to variation in healthcare utilization, which may suggest the potential benefits of improved continuity of medication management in PCMHs and ACOs.

METHODS

Sample and Data

We conducted a retrospective cohort study of Veterans from a single Veterans Affairs Medical Center (VAMC) in the Southeastern US in 2008 with one to four cardiometabolic conditions (diabetes, hypertension, dyslipidemia and heart failure, see Online Appendix A). We focused on these four cardiometabolic conditions, because they are the most prevalent and costly chronic conditions in the United States,^{5,15} and adherence to medications for these conditions protects against morbidity and mortality.

From an initial cohort of 29,368 Veterans identified from medical records (Fig. 1), we excluded Veterans if they had no outpatient utilization in 2008 ($n=3,001$), were receiving outpatient care at other VAMCs ($n=11,594$), died before the end of the study period ($n=518$), were younger than 40 in 2008 ($n=173$), had a diagnosis for these conditions that could not be confirmed in VA claims data ($n=5,363$), were seen in outpatient primary care clinics staffed by resident physicians ($n=339$), had a medication for at least one of these four conditions that could not be confirmed in claims data ($n=401$), or were missing data for marital status or copayment status ($n=46$). We restricted the sample to Veterans age 40 or older, because the risk of cardiovascular disease increases markedly with each 20 mmHg increment in systolic blood pressure for adults 40 and over¹⁶ and the onset for the majority of Type 2 diabetes occurs after the age of 40. The study sample included 7,933 Veterans for the analysis of factors associated with the number of pre-

scribers. The sample was reduced to 7,771 Veterans for the analysis of ER visits and hospital admissions using lagged predictors, because 162 Veterans were censored for no VA utilization in 2009 or 2010. In all analyses, person-year was the unit of analysis.

We obtained 2008–2010 VA data on emergency room visits, race, and marital status from Outpatient Care Files (OPC), age and gender from the Vital Status mini file, hospital admissions from Patient Treatment Files, and the numbers of medications and prescribers from the Decision Support System pharmacy files. Veteran copayment status was obtained from the Enrollment file. Comorbidity burden was measured by the Gagne measure that integrates conditions from the Charlson and Elixhauser measures into a comprehensive set of comorbidities,¹⁷ and was obtained from diagnosis fields in OPC and inpatient records.

Outcomes, Explanatory Variables and Analysis

The prescriber continuity outcome was defined as the number of unique providers who prescribed one or more medications for one or more of the four cardiometabolic conditions at least once each year (2008–2010). We counted any prescriber who wrote a prescription for a filled (or refilled) medication, which reflects the complete set of providers who had a direct role in each patient's treatment. This implies that every new prescriber could complicate a patient's regimen or introduce discontinuity in medication management, even if a prescriber simply refilled the same medication and same dose from a prior prescriber. We excluded prescriptions of fewer than 30 days, as these were less likely to reflect longitudinal management. The prescriber continuity outcome was estimated using a generalized estimating equation (GEE) model with a Poisson distribution to account for three observations per person, with the number of cardiometabolic conditions in each year (2008–2010) as the explanatory variable of interest.

The VA utilization outcomes, estimated using GEE models, were the probability of one or more ER visits in each year, the number of ER visits in each year among ER users, and the probability of inpatient admission in each year. Utilization of non-VA services was not considered, because we focused on all-cause and cardiometabolic disease-specific VA utilization. A Poisson distribution was used when estimating the number of ER visits, and a binomial distribution was used when estimating probabilities. For the utilization outcomes, there were two explanatory variables of interest: number of cardiometabolic conditions and number of prescribers. The variables were lagged one year (2008 and 2009) to reduce the reverse causality that could arise by modeling these variables and outcomes in the same year.

Figure 1. Sample flow diagram for Durham VA patients.

We also examined ER visits and inpatient admissions related to these four cardiometabolic conditions using a similar set of regressions and covariates (age, gender, race (white vs. non-white/unknown), marital status, VA copayment status for outpatient visits and medications, and indicators from the Gagne score¹⁷) that were predictive of VA utilization in prior studies.^{18–21} We adjusted for the lagged number of cardiometabolic medications taken to adjust for the possibility of confounding by indication. In a sensitivity analysis, we instead adjusted for the total count of medications and results were similar, so we present results adjusting for cardiometabolic medications. Patients with ER visits or admissions in 2008 may be at increased risk of these events in 2009 or 2010, so we included indicators of whether Veterans had an ER visit or admission in 2008 in the models. Among patients with at least one visit, we modeled the number of ER visits, adjusting for the number of ER visits in 2008. Regression results are presented as coefficients because we are primarily interested in the significance and direction of covariates. Given the number of analyses conducted, discussion of results below focuses primarily on the covariates of interest. Human subjects approval was obtained from the Institutional

Review Boards at the Durham VAMC, Duke University, University of North Carolina, and Auburn University.

RESULTS

Descriptive Statistics

In the baseline year, 53 % of the 7,933 patients had a single prescriber, 30 % had two prescribers, 11 % had three prescribers, and 6 % had four or more prescribers (Fig. 1). Compared to patients with two or more prescribers (Table 1), patients with one prescriber in 2008 were more likely to be white (62 % vs. 59 %, $p<0.0001$), married (66 % vs. 63 %, $p=0.047$), required to pay copayments for health care visits (28 % vs. 22 %, $p<0.0001$) or medications (72 % vs. 65 %, $p<0.0001$), and had a higher comorbidity burden ($p<0.0001$). The sample had a mean of 1.5 (standard deviation=1.0) of the four cardiometabolic conditions, with hypertension being most prevalent and congestive heart failure (CHF) being least prevalent.

Patient Complexity and Prescriber Continuity

Compared to patients with one condition, patients with two cardiometabolic conditions (coefficient=0.17, 95 % confidence interval [CI]: 0.15–0.19) or three or more conditions (coefficient=0.34, 95 % CI: 0.31–0.37) had more prescribers in 2008–2010 (Table 2). The average number of prescribers declined from 2008 to 2010 ($p<0.0001$). See Table 2 for other significant results.

Patient Complexity and Prescriber Continuity Associated with Emergency Room Visits

In 2008, 26.8 % of patients had one or more ER visits. The unadjusted proportion of patients with ER visits did not vary significantly by number of cardiometabolic conditions, but patients with four or more prescribers were twice as likely to have ER visits (48.4 % vs. 21.0 %) as patients with one prescriber (Fig. 2). In adjusted analyses of all-cause ER visits that controlled for the lagged number of cardiometabolic medications (see Online Appendix B, Table 3), the odds of an ER visit increased with the number of prescribers (two prescribers, OR=1.16; 95 % CI: 1.05–1.28; three prescribers, OR=1.21; 95 % CI: 1.05–1.39; 4+ prescribers, OR=1.39; 95 % CI: 1.16–1.66), but not with the number of conditions. Among patients who had one or more ER visits in 2009–2010, the number of ER visits was not associated with the number of cardiometabolic conditions or number of prescribers. However, the number of ER visits in 2008 (indicated by 2008 Utilization in Table 3) was associated with ER visits in 2009 or 2010 ($p<0.0001$).

Table 1. Descriptive Statistics of Study Sample

Patient characteristics	Patients with...				P value†
	One prescriber	Two prescribers	Three prescribers	Four+ prescribers	
Age, mean (sd)	64.8 (11.0)	64.6 (10.8)	65.1 (10.9)	64.9 (10.3)	0.676
Male, n (%)	4,030 (94.6)	2,249 (95.6)	836 (95.8)	428 (95.1)	0.255
Race, n (%)					<0.0001
Caucasian	2,638 (62.0)	1,391 (59.1)	528 (60.5)	257 (57.1)	
Non-caucasian	1,474 (34.6)	909 (38.6)	334 (38.3)	191 (42.4)	
Unknown	146 (3.4)	52 (2.2)	11 (1.3)	2 (0.4)	
Marital status, n (%)					0.259
Married	2,797 (65.7)	1,482 (63.0)	554 (63.5)	282 (62.7)	
Divorced/widowed	1,000 (23.5)	593 (25.2)	226 (25.9)	121 (26.9)	
Never married	461 (10.8)	277 (11.8)	93 (10.7)	47 (10.4)	
Must pay health care copays, n (%)	1,192 (28.0)	534 (22.7)	184 (21.1)	80 (17.8)	<0.0001
Must pay medication copays, n (%)	3,072 (72.1)	1,581 (67.2)	550 (63.0)	272 (60.4)	<0.0001
Gagne comorbidity score, median (IQR)	0.0 (1.0)	0.0 (2.0)	0.0 (2.0)	1.0 (2.0)	<0.0001
Number of conditions in 2008, mean (sd)	1.4 (0.6)	1.5 (0.7)	1.7 (0.7)	2.0 (0.7)	<0.0001
Patients diagnosed in 2008 with..., n (%)					<0.0001
One condition	2,689 (63.2)	1,306 (55.5)	390 (44.7)	131 (29.1)	
Two conditions	1,260 (29.6)	808 (34.4)	345 (39.5)	202 (44.9)	
Three+ conditions	309 (7.3)	238 (10.1)	138 (15.8)	117 (26.0)	
Patients diagnosed in 2008 with...					
Hypertension, n (%)	3,338 (78.4)	1,987 (84.5)	748 (85.7)	411 (91.3)	<0.0001
Hyperlipidemia, n (%)	1,958 (46.0)	1,103 (46.9)	460 (52.7)	285 (63.3)	<0.0001
Diabetes, n (%)	792 (18.6)	467 (19.9)	235 (26.9)	148 (32.9)	<0.0001
Congestive heart failure, n (%)	50 (1.2)	88 (3.7)	59 (6.8)	51 (11.3)	<0.0001
Number of cardiometabolic medication classes in 2008, mean (sd)	3.1 (1.7)	3.6 (1.7)	4.3 (1.8)	5.4 (1.8)	<0.0001
Sample size	4,258	2,352	873	450	

†P values based on ANOVA (age, number of conditions), Kruskal-Wallis test (Gagne score) and Chi Square tests (all others)

As in the adjusted all-cause ER analyses that controlled for the lagged number of cardiometabolic medications (see Online Appendix C, Table 4), the probability of a cardiometabolic disease-specific ER visit was strongly associated with the number of prescribers (zero prescribers, OR=2.75; 95 % CI: 1.40–5.39; three prescribers, OR=1.58; 95 % CI: 1.17–2.13; 4+ prescribers, OR=1.96; 95 % CI: 1.39–2.75). Among those with one or more disease-specific ER visits, having zero prescribers (OR=1.89; 95 % CI: 1.02–3.49) or having four or more prescribers was associated with more ER visits (OR=1.38; 95 % CI: 1.13–1.70).

Patient Complexity and Prescriber Continuity Associated with Inpatient Admissions

In 2008, 8.5 % of patients were hospitalized. Patients with three or more cardiometabolic conditions were twice as likely to be hospitalized as patients with one condition (13 % vs. 7 %). Patients with four or more prescribers were almost five times more likely to be hospitalized as patients with one prescriber (24 % vs. 5 %) (Fig. 2).

In adjusted regression analysis of all-cause admissions (see Online Appendix B, Table 3), the odds of an inpatient admission increased with the number of prescribers (two prescribers, OR=1.31; 95 % CI: 1.13–1.52; three prescribers, OR=1.38; 95 % CI: 1.12–1.70; 4+ prescribers, OR=1.49; 95 % CI: 1.14–1.94) or if a patient was admitted in 2008 (OR=3.70, 95 % CI: 3.08–4.44), but not with the number of conditions.

The odds of a cardiometabolic disease-specific inpatient admission increased with the number of prescribers (two

Table 2. Regression Predictors of Number of Prescribers, 2008–2010

	Number of prescribers coefficient (95 % CIs)
1 Condition	Reference
2 Conditions	0.17 (0.15, 0.19) ***
3+ Conditions	0.34 (0.31, 0.37) ***
Age	-0.001 (-0.002, 0.00)
Male	0.01 (-0.04, 0.05)
Non-white race	0.05 (0.03, 0.07) ***
Unmarried	0.01 (-0.01, 0.04)
Must pay prescription copays	-0.05 (-0.07, -0.02) ***
Must pay health care copays	-0.06 (-0.09, -0.04) ***
Alcohol Use	0.02 (-0.02, 0.06)
Anemia	0.10 (0.05, 0.15) ***
Arrhythmia	0.14 (0.10, 0.19) ***
Coagulopathy	0.13 (0.04, 0.23) *
Dementia	0.05 (-0.08, 0.19) ***
Electrolyte disorder	0.16 (0.10, 0.22) ***
Hemiplegia	0.01 (-0.14, 0.16)
HIV/aids	0.26 (0.12, 0.40) **
Liver problems	0.10 (0.03, 0.17) *
Metastatic cancer	0.03 (-0.14, 0.19) *
Psychosis	0.05 (0.02, 0.09) *
Pulmonary/circulatory	0.17 (0.01, 0.32) ***
Pulmonary	0.06 (0.03, 0.09) ***
Peripheral vascular disease	0.12 (0.08, 0.17) ***
Renal	0.32 (0.28, 0.36) ***
Tumor	0.03 (-0.01, 0.06)
Weight loss	0.10 (-0.13, 0.34)
Year 2009	-0.16 (-0.17, -0.14) ***
Year 2010	-0.22 (-0.24, -0.20) ***
Intercept	0.43 (0.35, 0.51) ***
Sample size	7,933

*** $p < 0.0001$, ** $p < 0.001$, * $p < 0.01$

Figure 2. Unadjusted proportion of patients with emergency room visits and inpatient admissions in 2008, stratified by number of conditions and number of unique prescribers.

prescribers, OR=1.37; 95 % CI: 1.14-1.64; three prescribers, OR=1.44; 95 % CI: 1.11-1.86; 4+ prescribers, OR=1.74; 95 % CI: 1.29-2.35) or if a patient was admitted in 2008 (OR=3.77, 95 % CI: 2.95-4.83). Disease-specific admission rates were similar for patients with one condition, two conditions or three or more conditions (see Online Appendix C, Table 4).

DISCUSSION

This study examined whether VA hospital admissions and ER visits were associated with patient complexity and prescriber continuity among Veterans with cardiometabolic conditions. Consistent with the hypothesis that more complex patients receive care from more providers, the number of prescribers increased with the number of cardiometabolic conditions and other comorbid conditions.

Prior studies found that inpatient admission rates^{5,6}, number of prescriptions⁵, number of specialist visits⁴ and health expenditures^{5,6} increased with the number of chronic conditions, so we expected to observe similar trends.

However, we found that the number of prescribers was a stronger predictor of ER and inpatient utilization than the number of cardiometabolic conditions, which is somewhat consistent with prior studies examining adverse medication-related outcomes.^{9-12,22} There are several possible hypotheses to explain these findings. ER and inpatient utilization may have been higher for patients with multiple prescribers because continuity of care remains problematic, even in the VA health system with a longstanding electronic health record (EHR) that should improve informational continuity. It is also possible that these results are confounded by patient-level factors (disease severity) or prescriber-level factors (extent of coordination between prescribers, prescribing and practice patterns of prescribers) for which we were unable to adjust. It is also possible that higher acute care utilization is driven by worse medication adherence by patients with multiple prescribers.²³

We also found that patients with zero prescribers had an increased probability of ER visits and increased number of ER visits. All patients had one or more prescribers in 2008 (the study's baseline year), so zero prescribers could only occur in 2009 through two scenarios. Either Veterans

Table 3. Regression Results of Emergency Room and Hospital Utilization, 2009-2010

	Emergency room visits		Probability of hospital admission
	Probability of 1+ visits	Number of visits	
	Odds ratio (95 % CI)	IRR (95 % CI)	Odds ratio (95 % CI)
1 Condition (lagged)	Reference	Reference	Reference
2 Conditions (lagged)	0.95 (0.86, 1.05)	0.99 (0.91, 1.07)	1.04 (0.89, 1.22)
3+ Conditions (lagged)	0.94 (0.80, 1.11)	0.98 (0.87, 1.11)	1.01 (0.79, 1.28)
0 Prescriber (lagged)	0.88 (0.63, 1.24)	0.88 (0.66, 1.16)	1.32 (0.78, 2.23)
1 Prescriber (lagged)	Reference	Reference	Reference
2 Prescribers (lagged)	1.16 (1.05, 1.28)*	1.06 (0.99, 1.14)	1.27 (1.10, 1.48)*
3 Prescribers (lagged)	1.21 (1.05, 1.39)*	0.99 (0.89, 1.10)	1.30 (1.05, 1.61)*
4+ Prescribers (lagged)	1.39 (1.16, 1.66)**	1.05 (0.92, 1.19)	1.34 (1.02, 1.75)*
Number of cardiometabolic medication classes (lagged)	1.04 (1.01, 1.08)*	1.02 (0.99, 1.04)	1.09 (1.04, 1.14)**
2008 Utilization ^a	4.75 (4.31, 5.23)***	1.16 (1.13, 1.19)***	3.72 (3.10, 4.46)***
Sample size	7,771	2,636	7,771

Adjusted for age, gender, race, marital status, copay status, alcohol use, anemia, arrhythmia, electrolyte disorder, psychosis, pulmonary, PVD, renal, tumor; and year fixed effect (2010). See Online Appendix B for full set of results

Rx medication; PVD peripheral vascular disease

*** $p < 0.0001$, ** $p < 0.001$, * $p < 0.01$

^a2008 utilization covariate differed by regression: In the probability of ER visits, an indicator of whether each Veteran had an ER visit in 2008 was used. In the number of ER visits among those with one or more visits, the number of ER visits in 2008 was used. In the probability of hospital admission, an indicator of whether each Veteran had an admission in 2008 was used

Table 4. Regression Results of Cardiometabolic Disease-Specific Emergency Room and Hospital Utilization, 2009–2010

	Emergency room visits		Probability of hospital admission
	Probability of 1+ visits	Number of visits	
	Odds ratio (95 % CI)	IRR (95 % CI)	Odds ratio (95 % CI)
1 Condition (lagged)	Reference	Reference	Reference
2 Conditions (lagged)	1.02 (0.80, 1.29)	0.98 (0.83, 1.15)	1.07 (0.88, 1.29)
3+ Conditions (lagged)	1.38 (0.99, 1.91)	0.86 (0.71, 1.04)	1.11 (0.84, 1.46)
0 Prescriber (lagged)	2.75 (1.40, 5.39) *	1.89 (1.02, 3.49) *	1.31 (0.69, 2.52)
1 Prescriber (lagged)	Reference	Reference	Reference
2 Prescribers (lagged)	1.24 (0.99, 1.56)	1.15 (0.98, 1.35)	1.31 (1.09, 1.57) *
3 Prescribers (lagged)	1.58 (1.17, 2.13) *	1.18 (0.99, 1.41)	1.31 (1.01, 1.69) *
4+ Prescribers (lagged)	1.96 (1.39, 2.75) ***	1.38 (1.13, 1.70) *	1.47 (1.08, 2.01) ***
Number of cardiometabolic Medication classes (lagged)	1.18 (1.11, 1.26) ***	1.04 (1.00, 1.07)	1.13 (1.07, 1.20) ***
2008 utilization ^a	2.85 (2.20, 3.69) ***	1.07 (1.01, 1.14) *	3.82 (2.98, 4.89) ***
Sample size	7,771	2,636	7,771

Adjusted for age, gender, race, marital status, copay status, alcohol use, anemia, arrhythmia, electrolyte disorder, psychosis, pulmonary, PVD, renal, tumor, and year fixed effect (2010). See Online Appendix C for full set of results

Rx medication; PVD peripheral vascular disease

*** $p < 0.0001$, ** $p < 0.001$, * $p < 0.01$

^a2008 utilization covariate differed by regression: In the probability of ER visits, an indicator of whether each Veteran had an ER visit in 2008 was used. In the number of ER visits among those with one or more visits, the number of ER visits in 2008 was used. In the probability of hospital admission, an indicator of whether each Veteran had an admission in 2008 was used

stopped all cardiometabolic medications in 2009 (and thus had no prescriber of these medications), or they received cardiometabolic medication elsewhere (e.g., providers outside of the VA, such as those reimbursed by Medicare). We lacked the data in the current study to differentiate these two, but the increased ER utilization associated with zero prescribers was likely driven by the first group. Health care systems, such as the VA, may want to identify such patients to ensure that their cardiometabolic medication needs are being met outside of the VA. If Veterans are not getting these medications elsewhere, they may need to be seen by a VA provider who can restart their regimens, since prior work has demonstrated that patients were more likely to re-start statins after an extended discontinuation if they visited the physician who initiated the statin regimen (odds=6.1).²⁴

To best answer our study question, we would ideally conduct a multi-arm trial of thousands of patients who are randomized into alternative combinations of prescribers and stratified by number of conditions. A pragmatic trial could allow less restrictive inclusion criteria to inform the evidence base about appropriate interventions for complex patients. However, such trials are unlikely to be feasible or cost-effective, so observational comparative effectiveness research must fill this gap.²⁵ The observational study design used in our study introduces the possibility of unobserved confounding, which precludes causal inference regarding the number of conditions, number of prescribers, and acute care utilization. For example, the number of prescribers for a particular patient may reflect that person's preferences as a health care consumer or their severity of illness in ways that are not captured in our other covariates. We attempted to adjust for confounding by indication related to unobserved

disease severity by controlling for the number of cardiometabolic medications.

Other limitations concern the validity of the prescriber construct, which was constructed as a crude count in each year and lacked detail needed to determine prescriber specialty or which prescribers were providing routine outpatient care (due to an inability to link VA prescription and utilization files).⁸ A patient could have two prescribers via at least three scenarios that have different implications. First, a patient could have seen both providers all year and received prescriptions from each prescriber the entire year. Second, a patient could have seen one provider/prescriber the first half of the year and then switched to a second provider/prescriber in the second half of the year. Third, a patient could have a regular prescriber the entire year, but had a second prescriber refill a prescription without any change in medication or dose, or the patient was referred to a specialist once who then prescribed a new medication and returned the patient back to the PCP for regular follow-up. Future research should validate this prescriber construct to ensure that multiple prescribers are aggregated into a measure that reflects discontinuity in medication management. Future research should also replicate these results in a larger sample of Veterans and non-Veterans in health systems with and without EHRs, since these results may not generalize outside this single VAMC with a longstanding EHR.

Finally, these results may not be generalizable to other patient populations. Our sample was from a single VAMC with significant training programs, and these analyses were based entirely on VA claims. Inclusion of Medicare and Medicaid claims may change the number of observed prescribers. If we had access to these data, these additional

prescribers might change the number of observed prescribers and the associations between number of prescribers and our acute care utilization outcomes.

This study has several strengths, including the identification of predictors of more prescribers and understanding the relative importance of multiple prescribers and multiple conditions on acute care utilization. These analyses are also conducted using high-quality VA data obtained from an EHR, illustrating the types of analyses that non-VA investigators may be able to conduct once EHR data are more widely available to understand the care of complex patients. This study also informs the more general issue of the value of longitudinal continuity when informational continuity between providers and patients is improved by EHR availability. The EHR at the VA has been available since 1994, and gives VA providers access to a patient's health history, diagnostic tests, visits, and treatments across the spectrum of care settings throughout the entire VA health system. One might expect care and medication continuity to be optimal for patients with a regular primary care provider within a health system using a highly integrated EHR, but this idealized version of care continuity is rarely possible. More typically, MCC patients see various providers for a range of acute and chronic conditions. The potential value of comprehensive patient information may not always be realized, particularly in primary care clinics where providers have limited time between appointments to review the notes and medication history. Given the VA's longstanding EHR and unusually complex patient profile, these results may be informative as EHRs proliferate.

EHRs are being widely implemented in the larger U.S. health care system through financial incentives made available in the 2009 Health Information Technology for Economic and Clinical Health (HITECH) Act²⁶ under the assumption that improved informational continuity should improve quality of care and patient outcomes. The results of this VA study suggest that improved informational continuity may be a necessary but insufficient condition to reduce ER visits and hospital admissions of complex patients. If longitudinal continuity declines, patients' health and the associated economic outcomes may suffer, even as informational continuity improves. EHRs may facilitate a transition to more team care, which may be reasonable for less complex patients. If these results are validated in more current, nationally representative samples of Veterans and non-Veterans, then they would suggest that avoidable health care utilization might be reduced by minimizing the number of prescribers involved in a patient's care.

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