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ORIGINAL RESEARCH

Transitions of Care Among Patients Undergoing Percutaneous Coronary Intervention for Stable Angina: Insights From the Veterans Affairs Clinical Assessment Reporting and Tracking Program

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BACKGROUND: Effective transitions from the procedural to outpatient setting are essential to ensure high-quality cardiovascular care across health care systems, particularly among patients undergoing invasive cardiac procedures. We evaluated the association of postprocedural follow-up visits and antiplatelet prescriptions with clinical outcomes among patients undergoing percutaneous coronary intervention for stable angina at community or Veterans Affairs (VA) hospitals.

METHODS AND RESULTS: Patients who actively received care within the VA Healthcare System and underwent percutaneous coronary intervention for stable angina at a community or VA hospital between October 1, 2015, and September 30, 2019, were identified. We compared mortality for patients receiving community or VA care, and among subgroups of community-treated patients by the presence of a postprocedural follow-up visit within 30 days or prescription for antiplatelet (P2Y12) medication within 120 days of the procedure. Among 12 837 patients who survived the first 30 days, 5133 were treated at community hospitals, and 7704 were treated in the VA. Prescriptions for antiplatelet therapy were less common for those treated in the community (85%) compared with the VA at 1 year (95%; hazard ratio [HR], 0.46; 95% CI, 0.44–47). Compared with VA-treated patients, the hazards for death were similar for patients treated in the community with a follow-up visit (HR, 1.17; 95% CI, 0.97–1.40) or with a fill for an antiplatelet therapy (HR, 1.08; 95% CI, 0.90–1.30). However, patients treated in the community without a follow-up visit had an 86% (HR, 1.86; 95% CI, 1.40–2.48) increased hazard of death, and those without antiplatelet prescription fill had a 144% increased hazard of death (HR, 2.44; 95% CI, 1.85–3.21) compared with all VA-treated patients.

CONCLUSIONS: Patients treated at community facilities have a decreased chance of receiving antiplatelet prescriptions after percutaneous coronary intervention with a concordant increased hazard of mortality, emphasizing the importance of transitions of care across health care systems when assessing cardiovascular quality.

Key Words: clinical outcomes ■ coronary artery disease ■ percutaneous coronary intervention

The ongoing proliferation of coronary interventional programs in the United States, including new availability in outpatient surgical centers, has the potential to provide more convenient and cost-effective care to patients. However, there is also potential for harm for patients who transition across health care systems for their care, especially if they are less likely to receive recommended medical therapies and clinical

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CLINICAL PERSPECTIVE

What Is New?

- Patients treated outside an integrated health care system have a decreased chance of receiving appropriate antiplatelet prescriptions after percutaneous coronary intervention, with a concordant increased hazard of mortality.

What Are the Clinical Implications?

- Contemporary evaluation of interventional cardiology quality should incorporate measures of appropriate care transitions from the inpatient and outpatient settings, particularly when patients are treated across different health care systems.

Nonstandard Abbreviations and Acronyms

KM	Kaplan-Meier
VA	Veterans Affairs

follow-up. The Department of Veterans Affairs (VA) has established and maintained the largest integrated health care system in the United States. Over the past decade, the system has developed mechanisms to improve access to care through its internal health care system as well as expansion of care delivered through partnerships with community care practitioners.[1] These efforts have increased the use of health care in the community for veterans suffering from cardiovascular disease,[2] though community providers have struggled to meet the need for increased capacity.[3] Because of this, patients often receive care in multiple venues emphasizing the importance of ensuring adequate transitions of care from the procedural to outpatient setting across health care systems.[4]

The expansion of the community care program has resulted in an increase in percutaneous coronary intervention (PCI) for patients with stable angina at community care facilities. The increase in community care use, however, has been accompanied by an increased hazard for mortality among those patients.[2] An early difference in outcomes may be related to the procedure itself, but the observed persistent divergence over time suggests potential deficiencies in the coordination of postprocedural care. With this in mind, the present analysis compared postprocedural follow-up visits and antiplatelet prescriptions among veterans undergoing elective percutaneous revascularization at community and VA hospitals, with associated mortality outcomes. This analysis provides a contemporary view into difficulties in ensuring optimal transitions of care from the procedural to outpatient setting in the VA, and the potential detrimental outcomes for our patients.

METHODS

The data that support the findings of this study are available from the corresponding author upon reasonable request, though they will be subject to the stringent data privacy rules of the VA Healthcare System and the US government.

Population

The VA Clinical Assessment Reporting and Tracking program is a national quality and safety program for medical specialty care including invasive cardiac procedures within the VA Healthcare System. With the expansion of care to the community over the past 4 years, this program has also been interested in ensuring that the quality of invasive cardiac care for veterans remains unchanged regardless of treatment venue. The present project identified patients actively enrolled in the VA Healthcare System that underwent elective percutaneous revascularization for stable angina between October 1, 2015, and September 30, 2019. A patient was considered actively enrolled in the integrated health care system if they had ≥2 visits to a primary care physician or cardiologist within the VA Healthcare System within 2 years before their procedure and filled at least 1 medication in the VA in the prior year, to have the opportunity to accurately document demographic information and comorbid conditions. Stable angina was defined using clinician reported data for patients treated within the VA Healthcare System and billing codes for those treated at community care hospitals. Patients who underwent revascularization for acute or emergent indications, such as ST-segment–elevation myocardial infarction (*International Classification of Diseases, Tenth Revision* [*ICD-10*]: I21.01, I21.02, I21.09, I21.11, I21.19, I21.21, I21.29, I21.3, I22.0, I22.1, I22.2, I22.8, I22.9), non–ST-segment–elevation myocardial infarction (*ICD-10*: I21.4), or unstable angina (*ICD-10*: I20.0), were excluded from the analysis to create a comparable cohort for those treated inside and outside the VA. Similarly, patients who underwent a diagnostic procedure in the VA only to undergo revascularization in the community within 1 month (30 days) were also excluded to reduce the chances of higher-risk staged procedures and their associated outcomes to be associated with the given location. Finally, only the index revascularization procedure for each patient was included, and analyses were restricted to those who survived the first 30 days after PCI so postprocedural

care could be tracked. Among the population meeting the inclusion criteria for the study, we limited analyses to patients living in US congressional districts where no more than 4 of 5 patients received PCI in 1 location (VA or community) to ensure that each veteran had a reasonable option for care in either setting. To minimize the potential of residual confounding through study design, we also limited the analytic cohort to those who received the dominant care in a given district, as those receiving nondominant care could have unique characteristics that we could not measure or control for, thus leading to residual confounding. This is particularly true as more patients who received the nondominant care in a given district were treated in community care hospitals, potentially suggesting unique characteristics that may increase their risk for an adverse event and thus bias the results. The analysis was performed in an operational capacity for the Department of Veterans Affairs, and thus institutional review board approval and informed consent was deemed unnecessary by the local authorities.

Measurements

Patient and procedural characteristics were derived from the linked electronic medical record and cardiac catheterization report documentation for those treated within the VA Healthcare System. Data for patients treated in the community was derived from the Program Integrity Tool database, which includes administrative claims data with diagnosis and procedure codes for each patient treated to facilitate reimbursement for the community care hospitals. This information was augmented with data from the internal electronic medical record to provide additional demographic information and medical comorbidities for patients treated at these facilities. Mortality was ascertained from the VA electronic medical record.

Outcomes

All-cause mortality was ascertained for patients treated at VA and community facilities, and further stratified in the community by a postprocedural visit at any site within 30 days, as this is deemed the standard of care. Additional analyses stratified patients in the community by a fill for P2Y12 inhibitors within 120 days, a longer follow-up time to conservatively capture prescription refills after the initial procedure, which could include a 90-day supply at discharge. All follow-up was capped at 1 year after the procedure and censored as of December 31, 2019. When assessing the death outcome, the 30-day mark after the procedure was used as baseline (time 0), and follow-up began at that time. Follow-up was then limited to 11 months since death was only ascertained in the year following the procedure.

Statistical Analysis

Machine learning methods were used to estimate the probability of receiving PCI in the community versus VA. Separate multinomial propensity models estimated location of care as a 3-level predictor, stratifying community procedures among those with and without 30-day post-PCI visits or 120-day P2Y12 fills after the procedure. The "twang" package in R 4.0.3 was used for all propensity models and adjusted for demographic information (age/sex/race/ethnicity/urban versus rural/distance to nearest VA primary care/US Census Division) as well as medical comorbidities (atrial fibrillation/alcohol abuse/heart failure/chronic kidney disease/chronic obstructive lung disease/cerebrovascular disease/depression/diabetes mellitus/family history of coronary artery disease/hypertension/hyperlipidemia/peripheral artery disease/posttraumatic stress disorder/sleep apnea).[5,6] Additional covariates representing prior PCI, myocardial infarction, or surgical coronary revascularization (coronary artery bypass graft) were included, as was prior hospitalization within 90 days of the index procedure in attempts to capture overall medical acuity. Inverse probability of treatment weights were calculated and stabilized, providing an average weight of ≈1 for veterans treated in the VA and community to prevent the inflation of power.[7] The clinical characteristics of patients treated within the VA Healthcare System were then compared with the same characteristics for those treated at community care hospitals with standardized differences <0.10 indicating good balance across groups. Using the weighted cohort, Kaplan-Meier (KM) curves illustrated the trajectory of mortality rates over time and estimated 1-year rates, while Cox proportional hazards models compared the hazards for mortality, both on the basis of a binary treatment location predictor and separately for 3-level predictors stratifying community patients on the basis of postprocedural care using all patients treated in the VA as the reference group. Sensitivity analyses assessed changes in our primary findings assuming the presence of a hypothetical confounder with specified prevalence and association with the outcome similar to congestive heart failure.[8]

RESULTS

Population

Over the study time frame, 12 962 patients met the inclusion criteria and underwent elective PCI in regions with similar access to care across different venues, of which 5200 received this procedure in the community and 7762 received care in the VA. Among the eligible population, 0.7% of VA patients died within the first 30 days of PCI and 1.3% of community care patients (P=0.003). Subsequent analyses were performed on patients who survived 30 days after the procedure,

resulting in 5133 community patients and 7704 patients treated in the VA (Figure 1).

Patient Characteristics

The patient characteristics stratified by treatment location are summarized in Table. As shown, the measured patient characteristics are similar across the groups with equivalent ages (69 versus 69) and proportions of patients suffering from heart failure (23% versus 22%), chronic kidney disease (18% versus 16%) and diabetes (51% versus 51%). The proportions of patients who were hospitalized in the 90 days before the index intervention were also comparable (21% versus 20%).

Transitions of Care

Transitions of care among patients undergoing elective percutaneous revascularization for stable angina were compared on the basis of treatment location. Diagnostics from the propensity models were assessed, including those that showed adequate balance of covariates across predictor groups. Postprocedure follow-up visits with primary care or cardiovascular providers occurred within 30 days for the majority of patients treated in the VA (KM 30-day rate,: 81.7%), with similar rates among those treated in the community (KM 30-day rate, 82.7%; hazard ratio [HR], 0.97; 95% CI, 0.93–1.02). However, prescriptions of antiplatelet therapy (P2Y12) were common among patients treated within the VA (KM 120-day rate, 95.0%) and significantly lower for those treated in the community (KM 120-day rate, 85.3%; HR, 0.46; 95% CI, 0.44–0.47), Lower community P2Y12 fill rates were observed across the full 120-day period, including at 30 days (VA, 82.4%; community, 61.5%; difference, 20.9%; 95% CI, 19.2%–22.6%) and 60 days (VA, 88.7%; community,

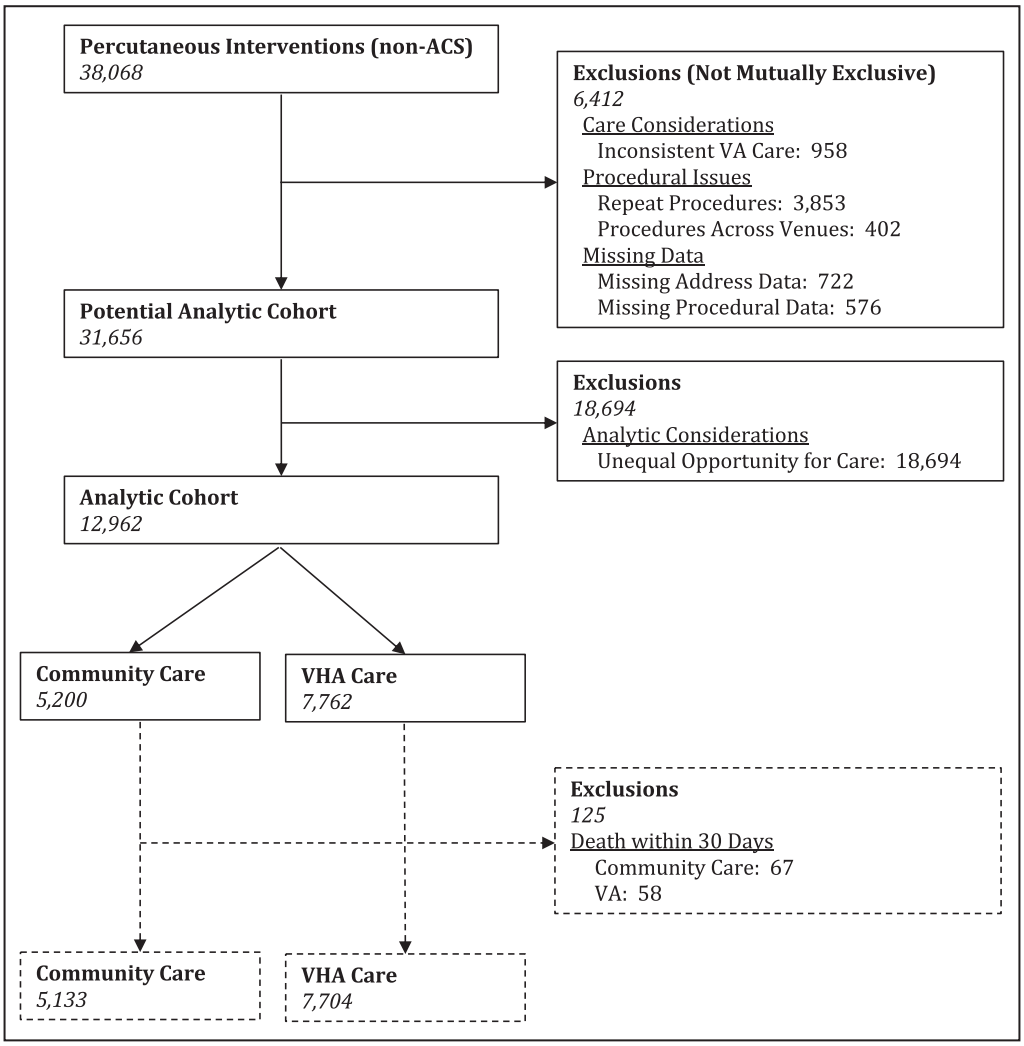

Figure 1. Patients included in the analytic cohort.
ACS indicates acute coronary syndrome; VA, Veterans Affairs; and VHA, Veterans Health Administration.

Table. Demographic and Clinical Characteristics of Patients Before Weighting Undergoing Percutaneous Coronary Intervention for Stable Angina, Stratified by Treatment Location

	VA	Community	
	n=7704	n=5133	|Std Diff|
Demographics			
Age, y	68.5 (8.1)	68.5 (8.5)	0.006
Male	0.982	0.978	0.031
Race			
White	0.845	0.869	0.071
Black	0.103	0.066	0.136
Other*	0.022	0.028	0.039
Unknown	0.035	0.043	0.040
Hispanic	0.028	0.036	0.046
Urban	0.538	0.478	0.119
Distance to VA primary care, miles	17.9 (16.0)	20.8 (19.2)	0.162
Census division			
East North Central	0.226	0.106	0.328
East South Central	0.093	0.107	0.045
Middle Atlantic	0.035	0.080	0.196
Mountain	0.058	0.123	0.229
New England	0.039	0.036	0.015
Pacific	0.066	0.068	0.005
South Atlantic	0.245	0.205	0.096
West North Central	0.085	0.122	0.119
West South Central	0.153	0.154	0.003
Medical history			
Atrial fibrillation	0.157	0.171	0.039
Alcohol abuse	0.048	0.040	0.038
Congestive heart failure	0.227	0.223	0.009
Chronic kidney disease	0.176	0.163	0.035
Chronic obstructive pulmonary disease	0.220	0.276	0.130
Cerebrovascular disease	0.127	0.172	0.127
Depression	0.125	0.151	0.076
Diabetes	0.513	0.511	0.004
Hypertension	0.859	0.810	0.133
Hyperlipidemia	0.806	0.800	0.015
Peripheral artery disease	0.156	0.187	0.081
Prior myocardial infarction	0.156	0.213	0.149
Posttraumatic stress disorder	0.099	0.134	0.111
Obstructive sleep apnea	0.281	0.265	0.035
Prior procedures			
Prior coronary artery bypass surgery	0.155	0.177	0.061
Prior percutaneous coronary intervention	0.150	0.158	0.020
Recent hospitalizations			
Prior hospitalization within 90 days	0.214	0.200	0.034

(Continued)

Table. Continued

Data presented as mean (SD) for continuous variables or proportions for categorical variables. Std Diff indicates absolute standardized difference. VA indicates Veterans Affairs.

*Other: American Indian, Alaskan Native, Asian, Native Hawaiian, Pacific Islander

75.2%; difference, 13.5%; 95% CI, 12.0%–15.0%). Compared with patients treated in the VA, community patients had lower rates of P2Y12 prescriptions whether they received (KM 120-day rate, 87.4%) or did not receive (KM 120-day rate, 75.1%) follow-up visits within 30 days (risk difference *P* values <0.01, accounting for censoring).

Clinical Outcomes

Overall, a Cox proportional hazards model for death demonstrated a 30% (HR, 1.30; 95% CI, 1.10–1.55) increase in the hazard for mortality among patients treated in the community who survived the first 30 days after a procedure (KM 1-year rate, 5.9%), compared with those treated in the VA (KM 1-year rate, 4.7%; difference, 1.2%; 95% CI, 0.3%–2.2%) (Figure 2). There were significant differences in mortality among

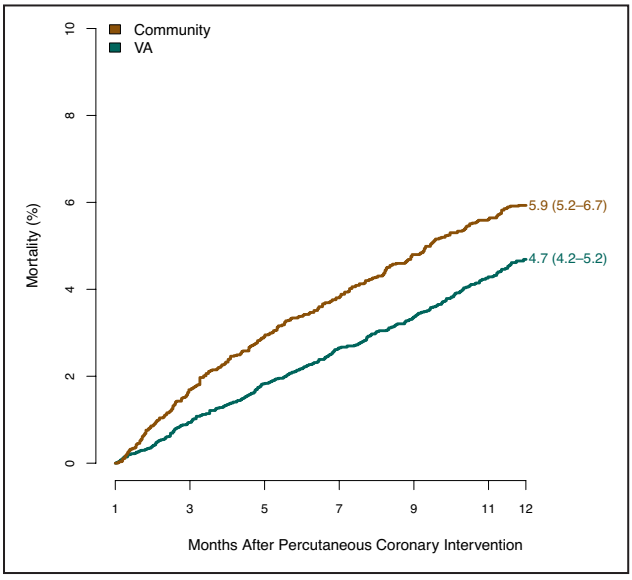

Figure 2. All-cause mortality among the propensity-weighted study population undergoing elective percutaneous coronary intervention for stable angina, stratified by treatment venue.
VA indicates Veterans Affairs.

subgroups of community-treated patients defined by follow-up status and P2Y12 prescription. Patients treated in the community with a follow-up visit had a similar hazard for death (HR, 1.17; 95% CI, 0.97–1.40) compared with those treated in the VA. However, patients treated in the community who did not undergo a postprocedural follow-up visit within 30 days had an 86% (HR, 1.86; 95% CI, 1.40–2.48) increased hazard of death compared with those treated in the VA. Similarly, patients treated in the community who filled an antiplatelet prescription had a similar hazard for death (HR, 1.08; 95% CI, 0.90–1.30). However, those without a fill for antiplatelet therapy within 120 days of the index procedure had a 144% (HR, 2.44; 95% CI, 1.85–0.321) increased hazard of death compared with VA-treated patients (Figure 3). To allow for our inability to capture P2Y12 fills at private pharmacies, we removed community patients without any VA medication fills within 120 days after the procedure and again observed higher mortality for community patients without fills for antiplatelet agents (HR, 2.01; 95% CI, 1.46–2.76). A more granular comparison of antiplatelet prescriptions and follow-up visits across treatment venues is reproduced in Figure S1, reinforcing the worsened outcomes among patients treated in the community without a follow-up visit or prescription for antiplatelet therapy.

Sensitivity Analysis for Unmeasured Confounding

Using a hypothetical confounder with a prevalence similar to heart failure (≈20%) in the VA, a prevalence 10% higher for community patients, and a similar association with death as heart failure (HR, 2.0), the HRs for death in the community among those without a follow-up visit (HR, 1.72; 95% CI, 1.29–2.229) or antiplatelet prescription (HR, 2.25; 95% CI, 1.71–2.97) were attenuated but remain significant. This would suggest that the differences in prevalence and association with mortality for an unmeasured confounder would need to exceed these reference values to negate the observed discrepancies.

DISCUSSION

The present analysis confirms that veterans undergoing elective percutaneous coronary revascularization in

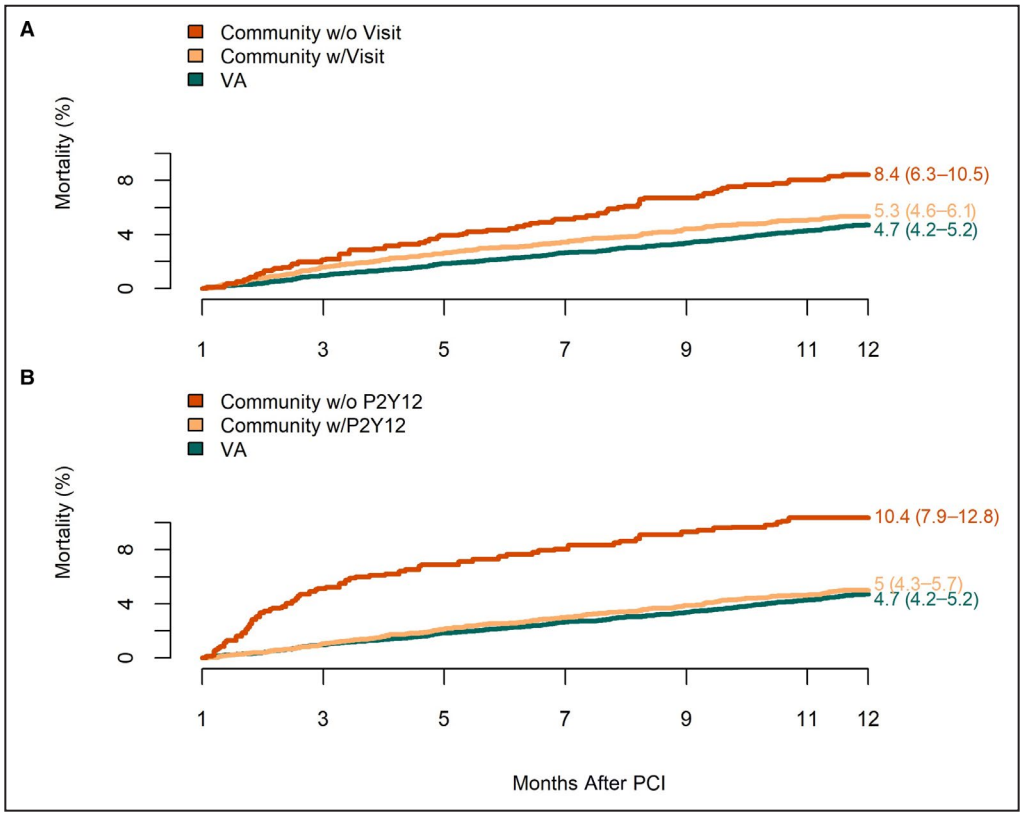

Figure 3. All cause mortality among propensity weighted study population undergoing elective PCI for stable angina stratified by treatment venue (Community or VA).
(**A**), depicts outcomes according to completion of a post-proceudral follow-up visit and (**B**) depicts outcomes according to a prescription for anti-platelet medication. PCI indicates percutaneous coronary intervention; and VA, Veterans Affairs.

the community have an increased hazard of mortality compared with those treated in the integrated VA Healthcare System. Further, the data demonstrate that the immediate increase in mortality is accompanied by a continued worsening in outcomes over time suggesting possible deficiencies in postprocedural care. Stratified analyses demonstrate that patients treated at community care facilities with appropriate postprocedural follow-up have equivalent outcomes to those treated in the integrated health care system. In contrast, patients treated in the community without 1-month follow-up visits or prescriptions for appropriate antiplatelet therapy have significantly worse outcomes. Given the increasing fracturing of cardiovascular care in the United States, these data have implications as patients transition from the procedural to outpatient setting across health care systems.

Coordinating care during the transition from the inpatient to outpatient setting is complex, particularly when this transition spans multiple health care systems with different electronic health records and quality control apparatuses. Accordingly, previous research has demonstrated that veterans obtaining care both inside and outside the VA Healthcare System can lead to waste and inefficiencies, with associated reduction in the quality of care received and attendant worse outcomes.[9,10] Some have suggested that improved outcomes among patients treated solely within the integrated health care system are primarily attributable to improvements in care coordination.[11] This is supported by data from veterans surveyed during prior implementations of the community care program, demonstrating dissatisfaction with the care coordination available in the community.[12] The present study builds on these findings among patients undergoing elective coronary intervention, demonstrating a similar proportion of patients undergoing appropriate follow-up within the community and the VA. However, a small proportion of patients treated in the community do not undergo appropriate follow-up, thus hindering an appropriate transition of care that facilitates a positive outcome.

Professional society guidelines have emphasized the importance of a postprocedural clinic visit to assess compliance with secondary prevention therapies after PCI.[13] Consistent with this, we demonstrated that the majority (>80%) of all revascularized patients had a clinic visit within 30 days of the procedure regardless of treatment venue. However, postprocedural prescriptions for antiplatelet therapies were markedly different across locales, with a 54% decreased hazard of receiving these therapies if a patient was treated at a community facility. Deficiencies in coordinating the transition of care across health care systems could have accounted for a reduction in the fill of critical medications. This is supported by the significantly lower prescription fills for patients who did not receive a postprocedural visit, highlighting those who could be lost to follow-up when moving between health care systems. This could also serve as a surrogate for other evidence-based and guideline-indicated therapies for stable ischemic heart disease for those without visits. Concordant with this, patients treated in the community without a fill for antiplatelet therapies had a 144% increased hazard of death compared with all patients treated within the VA. As access to community care expands under the most recent legislation,[14] there must also be an expansion of mechanisms to coordinate care and assure its quality.

Clinical outcomes following elective procedures do not occur in a vacuum and require the coordination of care between the procedural and outpatient setting, which can be significantly more complex when it occurs across health care systems. The quality of invasive procedures thus depends upon a well-defined system to ensure that patients receive adequate follow-up and guideline-concordant prescriptions regardless of treatment venue. This remains relevant for all nonveteran and veteran patients alike, given the significant movement of patients across different health care systems nationwide. Mechanisms to follow patients and ensure that they are receiving guideline-concordant care after a procedure are inconsistently available in the community. Professional society registries concentrating on procedural quality often focus on the procedure itself, with incomplete mechanisms to follow all patients longitudinally thereafter.[15] The Clinical Assessment Reporting and Tracking Program serves to monitor and enhance the quality of medical specialty care within the VA Healthcare System, with a focus on patients who have undergone invasive cardiac procedures. This program now captures information about appropriate follow-up visits and VA medication prescriptions after a veteran undergoes percutaneous revascularization regardless of treatment venue, increasing the overall quality of care.

Limitations

The present analysis should be interpreted in the context of several limitations. Data were derived from clinical documentation for care provided within the VA Healthcare System and administrative billing data from community care hospitals. Administrative billing data provide diagnoses and procedural codes but have limited additional clinical information. Medications filled at private pharmacies may not be captured and is more likely for community care patients, though a sensitivity analysis using only community patients with post-PCI VA fills of other medications reinforced worse outcomes for patients without P2Y12 fills. A propensity-weighted cohort was developed to balance measured demographic and clinical characteristics between

groups, though it is possible that other unmeasured differences between patients in the community and those treated internally exist and are not accounted for. The cause of death is not uniformly available, and thus differences in cardiovascular and noncardiovascular death cannot be accurately ascertained. Finally, the patient population treated by the VA is unique, and thus the findings are relevant only to veterans receiving care paid for by the federal government at community care or VA hospitals.

CONCLUSIONS

Veterans treated in the community have a decreased chance of receiving antiplatelet prescriptions after PCI, with a concordant increased hazard of mortality emphasizing the importance of transitions of care across health care systems when assessing cardiovascular quality.

ARTICLE INFORMATION

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Supplemental Material

Figure S1

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SUPPLEMENTAL MATERIAL

Figure S1. All-cause mortality among propensity weighted study population undergoing elective percutaneous coronary intervention for stable angina, stratified by treatment venue (community care or VA) and transitions of care, either post procedural follow-up visit (**A**) or antiplatelet prescription (**B**).