Quality and Outcomes

Mortality of Department of Veterans Affairs Patients Undergoing Coronary Revascularization in Private Sector Hospitals

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Objective. A limitation of studies comparing outcomes of Veterans Affairs (VA) and private sector hospitals is uncertainty about the methods of accounting for risk factors in VA populations. This study estimates whether use of VA services is a marker for increased risk by comparing outcomes of VA users and other patients undergoing coronary revascularization in private sector hospitals.

Data Sources. Males 67 years and older undergoing coronary artery bypass graft (CABG; $n = 687,936$) surgery or percutaneous coronary intervention (PCI; $n = 664,124$) during 1996–2002 were identified from Medicare administrative data. Patients using VA services during the 2 years preceding the Medicare admission were identified using VA administrative files.

Study Design. Thirty-, 90-, and 365-day mortality were compared in patients who did and did not use VA services, adjusting for demographic and clinical risk factors using generalized estimating equations and propensity score analysis.

Results. Adjusted mortality after CABG was higher ($p < .001$) in VA users compared with nonusers at 30, 90, and 365 days: odds ratio (OR) = 1.07 (95 percent confidence interval [CI], 1.03–1.11), 1.07 (95 percent CI, 1.04–1.10), and 1.09 (95 percent CI, 1.06–1.12), respectively. For PCI, mortality at 30 and 90 days was similar ($p > .05$) for VA users and nonusers, but was higher at 365 days (OR = 1.09; 95 percent CI, 1.06–1.12). The increased risk of death in VA users was limited to patients with service-connected disabilities or low incomes. Odds of death for VA users were slightly lower using samples matched by propensity scores.

Conclusions. A small difference in risk-adjusted outcomes for VA users and nonusers undergoing revascularization in private sector hospitals was found. This difference reflects unmeasured severity in VA users undergoing revascularization in private sector hospitals.

Key Words. Hospital mortality, severity of illness, hospitals, veterans, risk adjustment, coronary artery bypass graft surgery

A number of studies over the past two decades have compared outcomes in Department of Veterans Affairs (VA) and private sector hospitals (Department of Veterans Affairs 1987, 1989, 1991, 2003; Rosenthal, Larimer, and Owens 1994; Gordon et al. 2000; Petersen et al. 2000, 2001, 2003; Kaboli et al. 2001; Stineman et al. 2001; Rosenthal, Vaughan-Sarrazin, and Hannan 2003; Rosenthal et al. 2003). While these studies have yielded conflicting results, studies that found worse outcomes in VA hospitals have often led to intense scrutiny of the VA health care system, and efforts to restructure the delivery of care. For example, following a study indicating that VA hospitals had worse outcomes for acute myocardial infarction (AMI) (Department of Veterans Affairs 2003), the VA outlined a number of costly organizational changes in its 162 hospitals (Brown 2003).

A limitation of research comparing VA and private sector hospitals is uncertainty about the adequacy of methods used to adjust for severity of illness. Outcomes of hospital care depend on three factors: (1) patients' underlying risk before treatment, (2) random variation, and (3) quality of care (Iezzoni 1997a). By controlling for patients' underlying risk and by using appropriate statistical methods to account for random variation, inferences about hospital quality can be made. However, if the measurement of patient risk is inadequate, differences in outcomes across hospitals may be inappropriately attributed to quality. It is generally recognized that VA patients are subject to unique socioeconomic, clinical, and psychosocial factors that may affect outcomes. For example, VA users may have poorer functional status, which is an important prognostic variable (McCarthy et al. 1995). If methods do not appropriately adjust for such factors, it is difficult to discern whether differences in outcomes between VA and private sector hospitals are due to differences in the effectiveness of care (i.e., quality) or unmeasured patient risk.

The goal of this study is to estimate whether the use of VA services is a marker for increased risk among patients in private sector hospitals undergoing revascularization by coronary artery bypass graft (CABG) surgery or percutaneous coronary intervention (PCI). The study used VA and Medicare administrative data to identify patients treated in private sector hospitals who

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also use VA services (i.e., “VA users”), and then compare outcomes with other private sector patients (“nonusers”), after adjusting for measurable risk factors. Because the availability of coronary revascularization in VA hospitals is limited (e.g., CABG is currently performed in only 42 VA hospitals), it is likely that many VA users undergo revascularization in private sector hospitals. This natural experiment allows us to compare outcomes in VA users and nonusers in *similar* hospitals. Thus, differences in outcomes between VA users and nonusers represent unmeasured risk for VA users undergoing revascularization in private sector hospitals. We also evaluated whether VA users in private sector hospitals are atypical VA users, in order to assess whether this estimate of unmeasured risk corresponds to the magnitude of unmeasured risk that may confound prior studies comparing VA and private sector hospitals.

METHODS

Study Design and Data Sources

This retrospective cohort study primarily involved analysis of Medicare beneficiaries undergoing CABG or PCI during calendar years 1996–2002, as identified in Centers for Medicare and Medicaid (CMS) Medicare Provider Analysis and Review (MedPAR) data files. MedPAR files contain data from UB-92 hospital discharge abstracts for 100 percent of patients enrolled in Medicare Part A. Data elements include: demographics; patient zip code; primary and secondary diagnoses and procedures (captured by ICD-9-CM codes); admission source (e.g., transfer from another hospital); admission and discharge dates; disposition at discharge; a six-digit unique hospital identifier; and dates of death up to 2 years after hospital discharge. CMS Denominator files for the same years were also used to identify patient enrollment periods for Medicare Parts A and B.

Information on prior VA use was identified in the VA patient treatment file (PTF) and outpatient care file (OPC) for years 1994–2002. These files provide patient-level information on all encounters with VA facilities. In addition to diagnosis and procedure codes for the encounters, the PTF and OPC include information on income and patients’ eligibility classification for VA care (e.g., service-connected disability level) (VIREC Research User Guide 2003a, b). Finally, to compare VA users in VA and private sector hospitals, male VA users age 67 and older undergoing CABG ($N = 21,839$) or PCI ($N = 18,403$) in VA hospitals during 1996–2002 were identified in the PTF.

Patients

Eligible patients aged 67 years or older were identified on the basis of ICD-9-CM procedure codes 36.10–36.19 for CABG ($n = 1,129,246$) and 36.01, 36.02, 36.05, and 36.06 for PCI ($n = 1,595,184$). Patients who underwent PCI and CABG during the same admission were considered CABG patients. For patients with more than one CABG admission or more than one PCI admission, a single admission within each procedure was randomly selected for inclusion, resulting in 1,118,159 and 1,244,775 unique patients undergoing CABG and PCI, respectively. Patients who were also VA users were identified by merging each procedure cohort by social security number with the VA PTF and OPC files for the 2 years before the Medicare admission.

Medicare patients who were not the primary beneficiary were excluded ($n = 154,513$ for CABG and 206,405 for PCI) because social security numbers are only available in the MedPAR files for persons who are primary beneficiaries. The sample was further limited to men due to the small number (< 1 percent) of VA users who were women, leaving 711,879 CABG and 685,971 PCI patients.

Patient records were matched by zip code to U.S. Census Summary Files containing zip code-level socioeconomic data based on the U.S. 1990 and 2000 census. For patients discharged in 1996–1999, zip code characteristics were interpolated by calculating the annual change between 1990 and 2000 values. Values for 2001–2002 were similarly extrapolated by adding the estimated annual change to the 2000 census values. Patients who could not be matched to the zip code-level data were excluded ($n = 23,943$ [3.4 percent] for CABG; $n = 25,443$ [3.7 percent] for PCI). The final sample included 687,936 CABG patients (68,727 VA users [10.0 percent]), and 664,124 PCI patients (70,604 VA users [10.6 percent]).

Analyses

Analyses examined mortality occurring 30, 90, and 365 days following CABG or PCI. For each procedure and each endpoint, risk-adjustment models were developed using demographic and clinical factors that were independently related to mortality. Patient risk factors included demographics (age, sex, and race), surgical priority (i.e., emergent, urgent), admission source (e.g., transfer from another acute-care facility), zip code-level socioeconomic characteristics (e.g., median income, percent of population with income $> \$75k$), indicators of cardiac disease severity, and comorbid conditions. Cardiac disease indicators were defined as in prior studies of cardiac disease (Hannan et al. 1997,

2003; Vaughan-Sarrazin et al. 2002; Landrum et al. 2004; Popescu, Vaughan-Sarrazin, and Rosenthal 2006). Conditions included previous CABG, cardiac catheterization on same day as CABG or PCI, concurrent valve surgery, primary diagnosis of AMI and location of MI, PCI on the same day as CABG (CABG only), use of an intracoronary stent (PCI only), use of a mechanical ventilator on the day of admission, and use of intraaortic balloon pump on the day of admission. Because the latter two variables may also reflect processes of care, models were estimated with and without these factors. For the primary analyses, comorbid conditions were defined using the approach by Elixhauser et al. (1998), which considers 30 specific conditions defined by ICD-9-CM diagnosis codes. Additional analysis was conducted using an alternative morbidity classification system, the Clinical Classifications Software (CCS) (Elixhauser, Steiner, and Palmer 2006), which has good discrimination for cardiac conditions (Ash et al. 2003). In both sets of analyses, ICD-9-CM codes present on the index admission as well as any admission during the prior 2 years were used.

Bivariate relationships between mortality and patient risk factors were determined using the χ^2 -test for categorical variables and *t*-test for continuous variables. Factors significantly related to mortality ($p < .01$) were included in stepwise logistic regression models to identify factors independently related to mortality. In the risk-adjustment models, age was expressed as five indicator variables (70–74, 75–79, 80–84, 85–89, 90 years and older), with a referent category of 65–69 years. Race was expressed using four indicator variables for patients who were “non-Hispanic black,” “Hispanic,” “Asian,” or “Other non-Hispanic nonwhite race.” Surgical priority was expressed using two indicator variables for emergent and urgent admissions, relative to elective admissions. Admission source was expressed as indicator variables for patients transferred from another acute-care facility and patients admitted through the emergency department, with a referent category that primarily included patients referred by a physician. Primary diagnosis of AMI was expressed as anterior or lateral, inferior or posterior, subendocardial, and other unspecified locations, with a referent category that included patients without a primary diagnosis of AMI. Model discrimination was evaluated using the *c*-statistic.

Differences in risk-adjusted mortality for VA users and nonusers undergoing procedures in private sector hospitals were determined separately for each endpoint by adding an indicator variable for VA users to models that included patient-level risk factors. Additional analyses used separate indicator variables for specific categories of VA users, including: VA users who had a service-connected disability and were 0–40 percent disabled; VA users

50 percent or more disabled or living in a domiciliary; VA users who were not service-connected but who were classified by the VA as “low income”; and all other VA users. Finally, analyses were conducted that examined the consistency of findings in separate strata defined by year of discharge (1996–1997, 1998–2000, and 2001–2002), age (67–70, 70–75, and 76 years and older), and distance to the nearest VA hospital (0–25, 26–100, and >100 miles). These analyses evaluated potential biases introduced by the increasing proportions of patients accessing VA services during the study period, the lack of information on younger veterans, and the relative availability of VA revascularization services.

Finally, demographic and clinical risk factors were compared for VA users undergoing revascularization in private sector hospitals and VA hospitals. Additionally, the predicted risk of 30-day mortality, which represents an overall measure of severity and was calculated based on risk-adjustment models using variables common to the MedPAR and VA administrative datasets, was compared for VA users in private sector and VA hospitals.

All models were estimated using generalized estimating equations with an exchangeable working correlation matrix to account for clustering within hospitals (Liang and Zeger 1986). All analyses were performed using *SAS* (Version 9.1; SAS Institute, Cary, NC).

Propensity Score Adjustment

To further account for differences in patient risk, matched samples of VA users and nonusers were created using propensity scores. The propensity of being a VA user was calculated for each patient based on logistic regression models using the previously listed demographic, socioeconomic, disease severity, and comorbidity characteristics. Each VA user was matched to the nonuser treated in the same hospital and discharge year, and residing in the same geographic region (defined by Veterans Integrated Service Network [VISN] areas) with the nearest propensity score. VA users for whom no other Medicare patient in the same hospital, discharge year, and VISN had a “near” propensity score were excluded from the matched samples, where a near propensity score was defined as within 1 SD of the estimated logit. Based on these criteria, 3,056 (4.4 percent) and 2,822 (4.0 percent) of VA users undergoing CABG or PCI, respectively, were excluded, resulting in matched samples of 131,950 for CABG and 135,564 for PCI.

Baseline characteristics of VA users and other patients were compared before and after matching, and the relative odds of death for VA users and

other patients in private sector hospitals were estimated again using risk-adjustment models based on the matched samples.

RESULTS

Differences in the prevalence for most demographic and clinical risk factors between VA users and nonusers were statistically significant ($p < .01$), but small in magnitude (Table 1). VA users had slightly higher rates of cerebrovascular disease, chronic obstructive pulmonary disease, heart failure, diabetes, hypertension, peripheral vascular disease, and renal disease and resided in zip codes with somewhat lower socioeconomic characteristics. Markers of cardiac disease severity (e.g., primary diagnosis of MI) were generally similar. After matching VA users and nonusers by discharge year, provider, region, and propensity score, differences in risk factors were further diminished and were generally not statistically significant (results not shown).

More notable was the increase over time in the number of VA users undergoing CABG and PCI in private sector hospitals. The number of VA users undergoing CABG in private sector hospitals increased more than 85 percent from 1996–1997 to 2001–2002, while the number of nonusers undergoing CABG decreased by 21 percent. For PCI, the number of VA users increased by 300 percent, during 1996–1997 to 2001–2002, while the number of nonusers increased only 28 percent.

Risk-adjustment models developed using demographics, zip code-level socioeconomic markers, disease severity indicators, and comorbid conditions defined by Elixhauser et al. (1998) exhibited good discrimination. For CABG, c -statistics ranged were 0.75 and 0.74 for each endpoint in matched and unmatched samples, respectively. For PCI, c -statistics ranged from 0.79 to 0.85 for matched and unmatched samples. Risk factors that met criteria for inclusion in the risk-adjustment models for 30-day mortality after CABG or PCI based on samples before propensity matching are shown in the Appendix A.

Unadjusted mortality rates 30, 90, and 365 days after CABG were higher ($p < .001$) in VA users, compared with nonusers (4.8 versus 4.3 percent, $p < .001$; 7.3 versus 6.5 percent, $p < .001$; 11.3 versus 10.0 percent, $p < .001$ for 30-, 90-, and 365-day mortality, respectively). For PCI, mortality rates were similar after 30 days (3.2 versus 3.1 percent, $p = .55$), but were higher ($p < .001$) for VA users after 90 and 365 days (5.1 versus 4.8 percent and 10.6 versus 9.4 percent, respectively).

Table 2 shows the odds of death for VA users, relative to other patients, unadjusted and adjusted for patient risk factors, and based on unmatched and

Table 1: Characteristics of VA Users and Other (Nonusers) Patients Undergoing CABG and PCI in Private Sector Hospitals during 1996–2002

	CABG		PCI	
	VA Users	Non-VA Users	VA Users	Non-VA Users
Total patients	68,727	619,209	70,604	593,520
Discharge year				
1996–1997 (%)	21	32	16	25
1998–2000 (%)	40	43	36	43
2001–2002 (%)	39	25	48	32
Mean age in years (SD)	74.4 (4.7)	74.4 (5.1) $p < .001$	74.8 (5.0)	74.7 (5.6) $p < .001$
White race (%)	93%	91% ($p < .001$)	93%	91% ($p < .001$)
Admission priority				
Emergent	25%	25% ($p = .10$)	32%	33% ($p = .01$)
Urgent	29%	29% ($p = .90$)	32%	31% ($p < .001$)
Elective	46%	46% ($p = .70$)	36%	36% ($p = .01$)
Admission source				
Transfer	18%	17% ($p < .001$)	17%	17% ($p < .001$)
Emergency room	18%	17% ($p = .006$)	26%	26% ($p = .18$)
Common comorbid conditions				
Cerebrovascular disease	14%	12% ($p < .001$)	4%	4% ($p = .02$)
Chronic obstructive pulmonary disease	27%	22% ($p < .001$)	22%	17% ($p < .001$)
Congestive heart failure	27%	24% ($p < .001$)	19%	17% ($p < .001$)
Diabetes	30%	25% ($p < .001$)	29%	23% ($p < .001$)
Hypertension	58%	54% ($p < .001$)	60%	54% ($p < .001$)
Peripheral vascular disease	14%	12% ($p < .001$)	13%	10% ($p < .001$)
Renal disease	4%	3% ($p < .001$)	4%	3% ($p < .001$)
Valve disease	22%	22% ($p < .001$)	12%	11% ($p < .001$)
Number of comorbid conditions	2.5 (1.3)	2.3 (1.3) $p < .001$	1.9 (1.3)	1.7 (1.3) ($p < .001$)
Disease severity				
Primary diagnosis of acute myocardial infarction	18%	19% ($p = .001$)	27%	29% ($p < .001$)
Location anterior/lateral	3%	4% ($p < .001$)	6%	7% ($p < .001$)
Location inferior/posterior	4%	5% ($p < .001$)	8%	9% ($p < .001$)
Location subendocardial	10%	9% ($p < .001$)	11%	12% ($p < .001$)
Unspecified location	1%	1% ($p = .46$)	1%	1% ($p < .001$)
Use of mechanical ventilation on day of admission	2%	2% ($p = .005$)	1%	1% ($p < .001$)
Use of intraaortic balloon pump on day of admission	3%	3% ($p = .84$)	2%	2% ($p < .001$)
Cardiac catheterization on same day as CABG or PCI	8%	9% ($p < .001$)	60%	60% ($p = .005$)
Previous CABG surgery	6%	5% ($p < .001$)	19%	16% ($p < .001$)
Concurrent valve replacement (CABG sample only)	11%	11% ($p = .65$)		

Continued

Table 1. *Continued*

	<i>CABG</i>		<i>PCI</i>	
	<i>VA Users</i>	<i>Non-VA Users</i>	<i>VA Users</i>	<i>Non-VA Users</i>
Stent placement (PCI sample only)			81%	78% ($p < .001$)
Zip code characteristics				
Mean percent of elderly population disabled	23%	22% ($p < .001$)	22%	23% ($p = .11$)
Mean percent of households with annual income > \$75,000	19%	20% ($p < .001$)	21%	21% ($p = .04$)

VA, Veterans Affairs; CABG, coronary artery bypass graft; PCI, percutaneous coronary intervention.

propensity matched CABG and PCI samples. For CABG, differences in mortality persisted after adjusting for patient risk factors (odds ratio, OR = 1.07, 95 percent confidence interval [CI]: 1.03–1.11, $p < .001$; OR = 1.07, 95 percent CI: 1.04–1.10, $p < .001$; and OR = 1.09, 95 percent CI: 1.06–1.12, $p < .001$ for

Table 2: Odds of Death of VA Users, Relative to Other (Nonuser) Patients, as Determined by Generalized Estimating Equations Models with and without Controlling for Additional Patient Risk Factors, in Unmatched and Matched Patient Samples

	<i>Unmatched Sample</i>	<i>Matched Sample</i>
CABG	<i>N</i> = 687,936	<i>N</i> = 131,950
Models without patient risk factors		
30-day mortality	1.10 (1.07–1.14; $p < .001$)	1.03 (0.98–1.08; $p = .30$)
90-day mortality	1.12 (1.09–1.16; $p < .001$)	1.04 (1.00–1.09; $p = .05$)
365-day mortality	1.15 (1.12–1.18; $p < .001$)	1.06 (1.03–1.10; $p < .001$)
Models with patient risk factors		
30-day mortality	1.07 (1.03–1.11; $p < .001$)	1.03 (0.98–1.08; $p = .23$)
90-day mortality	1.07 (1.04–1.10; $p < .001$)	1.05 (1.00–1.09; $p = .03$)
365-day mortality	1.09 (1.06–1.12; $p < .001$)	1.07 (1.03–1.10; $p < .001$)
PCI	<i>N</i> = 664,124	<i>N</i> = 135,564
Models without patient risk factors		
30-day mortality	1.01 (0.97–1.06; $p = .54$)	1.00 (0.94–1.07; $p = .91$)
90-day mortality	1.06 (1.03–1.10; $p < .001$)	1.03 (0.98–1.09; $p = .19$)
365-day mortality	1.14 (1.11–1.17; $p < .001$)	1.09 (1.05–1.13; $p < .001$)
Models with patient risk factors		
30-day mortality	1.02 (0.97–1.06; $p = .45$)	0.99 (0.93–1.06; $p = .80$)
90-day mortality	1.04 (1.00–1.07; $p = .06$)	1.02 (0.96–1.07; $p = .56$)
365-day mortality	1.09 (1.06–1.12; $p < .001$)	1.08 (1.03–1.12; $p < .001$)

VA, Veterans Affairs; CABG, coronary artery bypass graft; PCI, percutaneous coronary intervention.

Table 3: Adjusted Odds of 30-Day Mortality for Subgroups of VA Users, Relative to Other Patients, as Determined by Generalized Estimating Equations

Eligibility Category	CABG (N= 68,727)	PCI (N= 70,604)
Low income without disability	N= 27,143 (39%)	N= 28,028 (40%)
30-day mortality	1.08 (1.02–1.14; $p = .005$)	1.09 (1.01–1.16; $p = .02$)
90-day mortality	1.09 (1.04–1.13; $p < .001$)	1.10 (1.04–1.17; $p < .001$)
365-day mortality	1.16 (1.11–1.20; $p < .001$)	1.19 (1.14–1.24; $p < .001$)
50% or more service-connected disability	N= 6,721 (10%)	N= 7,151 (10%)
30-day mortality	1.19 (1.07–1.32; $p < .001$)	1.08 (0.95–1.23; $p = .22$)
90-day mortality	1.20 (1.10–1.30; $p < .001$)	1.06 (0.96–1.18; $p = .25$)
365-day mortality	1.22 (1.13–1.31; $p < .001$)	1.13 (1.05–1.12; $p < .001$)
0–40% service connected disability	N= 14,259 (21%)	N= 14,197 (20%)
30-day mortality	1.07 (0.99–1.15; $p = .07$)	0.92 (0.84–1.01; $p = .08$)
90-day mortality	1.04 (0.99–1.10; $p = .15$)	0.96 (0.89–1.04; $p = .32$)
365-day mortality	1.05 (1.00–1.11; $p = .07$)	1.01 (0.96–1.07; $p = .69$)
All other VA users	N= 20,362 (30%)	N= 21,228 (30%)
30-day mortality	1.01 (0.95–1.08; $p = .71$)	0.96 (0.88–1.04; $p = .27$)
90-day mortality	1.02 (0.96–1.08; $p = .54$)	0.96 (0.90–1.03; $p = .30$)
365-day mortality	0.99 (0.94–1.04; $p = .64$)	0.98 (0.93–1.03; $p = .39$)

VA, Veterans Affairs; CABG, coronary artery bypass graft; PCI, percutaneous coronary intervention.

30-, 90-, and 365-day mortality). In analyses based on samples of CABG patients matched by propensity score, the risk of death was similar at 30 days, but slightly higher for VA users at 90 and 365 days. Results were virtually identical in models that did not include mechanical ventilation and use of an intraaortic balloon pump, or that were developed using the alternative CCS comorbidity system (not shown).

For PCI, the unadjusted odds of death for VA users relative to nonusers were similar at 30 days, but 6 and 14 percent higher at 90 and 365 days, respectively ($p < .001$). After adjusting for patient risk factors, the relative odds of death were similar at 30 and 90 days, but 9 percent higher after 365 days ($p < .001$). Results were similar in analyses based on propensity-matched samples and in models developed without the mechanical ventilation and IABP variables. The relative odds of death were similar in models developed using the CCS comorbidity system.

In analyses that examined groups of VA users defined by eligibility category (Table 3), risk-adjusted odds of death 30-, 90-, and 365-day after CABG or PCI were 8–19 percent higher across all the endpoints for VA users with low incomes compared with nonusers, using unmatched samples. For

Table 4: Adjusted Odds of 30-Day Mortality of VA Users, Relative to Other Patients, as Determined by Generalized Estimating Equations, Stratified by Age, Year of Discharge, and Distance to Closest VA Facility Performing Cardiac Surgery

	CABG		PCI	
	<i>N</i>	<i>Odds Ratio (95% CI)</i>	<i>N</i>	<i>Odds Ratio (95% CI)</i>
Year of discharge				
1996–1997	213,332	1.10 (1.02–1.19; <i>p</i> = .01)	158,966	1.12 (1.00–1.25; <i>p</i> = .04)
1998–2000	291,370	1.06 (1.00–1.11; <i>p</i> = .06)	276,946	1.05 (0.97–1.13; <i>p</i> = .20)
2001–2002	183,234	1.06 (1.00–1.13; <i>p</i> = .06)	225,302	0.95 (0.89–1.02; <i>p</i> = .18)
Age				
67–70 years	184,232	1.17 (1.07–1.27; <i>p</i> < .001)	180,623	1.03 (0.91–1.17; <i>p</i> = .61)
71–75 years	236,388	1.07 (1.01–1.14; <i>p</i> = .03)	212,513	0.99 (0.90–1.09; <i>p</i> = .81)
76 years or older	267,316	1.04 (0.99–1.09; <i>p</i> = .13)	268,078	1.02 (0.96–1.09; <i>p</i> = .47)
Distance to the nearest VA cardiac facility				
25 miles or less	160,397	1.10 (1.02–1.19; <i>p</i> = .02)	161,112	1.03 (0.92–1.15; <i>p</i> = .58)
26–100 miles	314,237	1.06 (1.00–1.12; <i>p</i> = .03)	295,079	0.98 (0.91–1.05; <i>p</i> = .50)
> 100 miles	212,302	1.06 (1.00–1.12; <i>p</i> = .04)	205,023	1.06 (0.99–1.14; <i>p</i> = .12)

VA, Veterans Affairs; CABG, coronary artery bypass graft; PCI, percutaneous coronary intervention.

CABG, the odds of death were 19–22 percent higher across all the endpoints for VA users with 50 percent or greater service-connected disabilities or who were otherwise severely disabled, compared with nonusers. For PCI, the odds of death for this category of VA users was higher only after 365 days. VA users with <50 percent service-connected disability and all other VA users had risk-adjusted outcomes similar to nonusers. Results based on matched samples (not shown) were similar.

For CABG, differences in 30-day mortality were generally similar in stratum defined by discharge year and by distance to nearest VA cardiac facility (Table 4). In analyses stratified by age, the relative difference in mortality between VA users and nonusers 30 days after CABG decreased with increasing age, from 1.17 for patients age 67–70 to 1.04 for patients age 76 and older. For PCI, no differences were detected across any strata defined by year, age, or distance to nearest VA facility performing cardiac surgery. In analyses based on propensity-matched samples, mortality was generally similar for VA users and nonusers across all strata for PCI and CABG.

In the comparison of VA users in VA and private sector hospitals, VA hospital patients had significantly higher prevalence of some comorbid

conditions, including diabetes (33 versus 27 percent) and hypertension (61 versus 52 percent). However, they had fewer markers of severe cardiac disease. For example, only 6 percent patients undergoing CABG in VA hospitals had a primary diagnosis of AMI compared with 18 percent in private sector hospitals, and only 37 percent of patients in VA hospitals were 75 years or older compared with 51 percent in private sector hospitals. In addition, the predicted risk of death after 30-days was lower for CABG patients in VA hospitals compared with VA users in private hospitals (e.g., 3.7 versus 4.4 percent). Results were similar for PCI, with 20 percent of patients in VA hospitals having a primary diagnosis of AMI and 39 percent being 75 years and older, compared with 27 and 50 percent for VA users in private sector hospitals, respectively.

DISCUSSION

This study estimates the degree to which being a user of VA services is a marker for increased severity. Using Medicare administrative data for older patients undergoing revascularization in private sector hospitals, we found that VA users had somewhat higher mortality after adjusting for differences in observed patient risk factors, compared with nonusers. Differences in mortality were larger for patients undergoing CABG, and tended to be greatest for VA users with low income and with service-connected disabilities. Because outcomes are compared for VA users and other patients treated in the same hospitals, the quality of care received by VA users and other patients should be similar—thereby making it likely that differences in risk-adjusted outcomes reflect unmeasured severity. Moreover, because the majority of veterans undergo revascularization in private sector hospitals, these results provide insight into the magnitude of unmeasured risk that may be present among all users of VA health care—at least to the degree that VA users in private sector and VA hospitals are similar. Thus, a finding of unmeasured risk for VA users suggests that unmeasured risk may be a confounder in prior studies comparing outcomes of patients receiving cardiac care in VA private sector hospitals (Rosenthal, Vaughan-Sarrazin, and Hannan 2003; Landrum et al. 2004).

Prior studies using both administrative and clinical data have yielded conflicting results regarding the quality of cardiac care in VA hospitals relative to private sector hospitals (Rosenthal, Larimer, and Owens 1994; Petersen et al. 2000, 2001; Landrum et al. 2004). Two studies found no significant

difference in risk-adjusted mortality for patients admitted to VA and private sector facilities for AMI (Rosenthal, Larimer, and Owens 1994; Petersen et al. 2000), although a more recent study found roughly 20 percent higher mortality in AMI patients treated at VA hospitals (Landrum et al. 2004).

A previous study by the current authors found roughly 70 percent higher risk-adjusted mortality after CABG in VA hospitals compared with private sector hospitals. That study used clinical data abstracted from the medical records of patients in VA hospitals and private sector hospitals in New York State and Northeast Ohio (Rosenthal, Vaughan-Sarrazin, and Hannan 2003), although subsequent analyses of Medicare and VA administrative data for patients undergoing CABG in the entire United States found nearly identical results (Rosenthal 2002). While the current study found that VA users undergoing CABG in private sector hospitals have a higher risk of death than nonusers, the difference (7 percent) does not account for the higher mortality in VA hospitals in our prior analyses.

Like the current study, two prior studies comparing VA and private sector hospitals used propensity score analysis to match VA patients with similar cohorts of private sector patients (Petersen et al. 2000; Landrum et al. 2004). The propensity score approach attempts to balance observed characteristics in the VA user and nonuser groups as would occur if patients were randomized (Landrum and Ayanian 2001). In this study, the observed characteristics of VA users and nonusers were generally similar in propensity matched samples. Nevertheless, we still found some evidence of increased risk in VA users, although the difference was smaller than in analyses based on full samples.

Our results differ slightly from a study that compared outcomes of CABG for VA users and nonusers in 32 private sector hospitals in New York (Weeks et al. 2005). In that study, VA users were older and had higher comorbidity and more severe cardiac disease. Our national sample of patients also found that VA users were older and had higher rates of several comorbid diseases, but found little evidence that VA users had more severe cardiac disease. Differences between our study and the prior study may be due to limitations of administrative data, use of a national sample in our study, or to the inclusion of younger patients in the prior study. The fact that our study found higher risk-adjusted odds of death for VA users as age decreased suggests that part of the difference may be attributable to the younger patients in the prior study. Moreover, our prior study using clinical data also found higher odds of death for VA hospital patients as age decreased (Rosenthal, Vaughan-Sarrazin, and Hannan 2003). Thus, comparisons of VA users and nonusers

among younger patients would likely find stronger results than were found in the current study.

This study may be subject to several other limitations. First, the sensitivity and specificity of ICD-9-CM codes in administrative databases and the accuracy of ICD-9-CM codes relative to information in patients' medical records may vary across individual diagnoses (Hsia et al. 1988; Waterstraat, Barlow, and Newman 1990). In addition, comorbidity recorded for outpatient care may not be reflected in inpatient administrative data. Moreover, administrative data may also not capture important prognostic factors (e.g., laboratory values, functional status). Nevertheless, the discriminatory power of our models approached that of prior models developed using clinical data for CABG or PCI (Shroyer et al. 1999; Glance et al. 2003; Shaw et al. 2003; Geraci et al. 2005; Moscucci et al. 2005). Moreover, many prior studies have used administrative data to examine quality of hospital care (Iezzoni 1997b; Birkmeyer et al. 2002; Vaughan-Sarrazin et al. 2002; Hannan et al. 2003), including several studies comparing VA and private sector hospitals (Department of Veterans Affairs 1987, 1989, 1991, 2003). Finally, administrative data may yield similar results to clinical data in characterizing variations in hospital mortality and in identifying factors related to hospital mortality (Krakauer et al. 1992).

Second, MedPAR data generally do not include patients who were enrolled in a Medicare managed care plan at the time of their admission (roughly 15 percent of Medicare beneficiaries in 2001). Nevertheless, at least one prior study showed no evidence that veterans' enrollment in Medicare HMOs affected either the type or amount of care sought (DeVito, Morgan, and Virnig 1997). Third, the study also only examined associations between VA use and mortality for patients age 67 years and older. Our finding that differences in risk-adjusted mortality between VA users and nonusers increased as age decreased suggests that the current study may not generalize to younger veteran populations.

Fourth, the use of private sector services by veterans may differ for different illnesses. If, for example, veterans with relatively high risk of death seek private sector services for cardiac disease, but not for diseases requiring less specialized care, then our results may not generalize to other illnesses. Moreover, the proportion of veterans who use VA services is increasing, likely due to an increase in the number of veterans accessing outpatient care at VA clinics (Department of Veterans Affairs 2002). The proportion of VA users in our analysis who did not have service-connected disabilities and were not considered low income increased more than three-fold between 1996 and 2002 (13–42 percent). Although we expected these patients would have risk

levels similar to other private sector patients, we found only small decreases in the odds of death for VA users over time.

Finally, it is possible that VA users undergoing revascularization in private sector hospitals are atypical of VA users undergoing revascularization in VA hospitals, leading to potential bias in our estimate of unmeasured risk. In addition, differences in the necessity of procedures may exist between patients undergoing CABG or PCI in VA and private sector hospitals. Our comparison of VA users undergoing revascularization in VA and private sector hospitals showed that, while patients in VA hospitals had higher prevalence of some comorbid conditions, they had fewer markers of severe cardiac disease and were somewhat younger. Similarly, our prior study using clinical data also found fewer markers of cardiac disease severity and lower risk of death, for patients undergoing CABG in VA hospitals (Rosenthal, Vaughan-Sarrazin, and Hannan 2003). Thus, these data do not suggest higher unmeasured risk for VA users in VA hospitals.

Despite these limitations, this study has important implications for the measurement of hospital performance within the VA. In 1995, the VA initiated an effort to systemize quality management and ensure the provision of high-quality care across the entire system through the development and implementation of clinical guidelines and other benchmark initiatives in such areas as cancer treatment, patient safety, end-of-life care, HIV/AIDS treatment, and pain management (Kizer, Demakis, and Feussner 2000). A component of this effort was continued reliance on programs to collect and disseminate facility-specific outcomes, such as the National Surgical Quality Improvement Program (NSQIP) (Khuri et al. 1998), Continuous Improvement in Cardiac Surgery Program (CICSP) (Hammermeister et al. 1994), and External Peer Review Program (EPRP). While these programs were designed to compare facilities within the VA, the continued importance of quality improvement efforts will inevitably lead to additional comparisons of VA and private sector care as health care administrators and policy makers strive to develop appropriate benchmarks for performance and define the value of VA care. The current findings provide new insight into the magnitude of unmeasured severity that may confound such analyses.

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SUPPLEMENTARY MATERIAL

The following supplementary material for this article is available:

Appendix A. Patient Characteristics in Risk-Adjustment Models for 30-day Mortality Based on Unmatched Samples for CABG and PCI.

This material is available as part of the online article from: <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1475-6773.2007.00720.x>
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