PCI COHORT—METHODS OVERVIEW

Cohort Definition for Patients Undergoing PCI

We studied two cohorts of patients undergoing percutaneous coronary interventions (PCI)—a VA cohort and a Medicare cohort. Each cohort was further subdivided according to fiscal year (FY 1997-1999, with a baseline year of FY 1994 for VA patients).

The VA PCI cohort included individuals undergoing PCI in a given fiscal year (See Table H1 for CPT codes) subject to the following exclusion criteria: (1) those who were enrolled in a Medicare health maintenance organization; (2) those with an AMI (ICD-9-CM codes 410, excluding 410.x2) during the index admission or in the 90 days prior to undergoing PCI; and (3) those undergoing another revascularization procedure (CABG or PCI, see Table H1 for CPT codes) in the 90 days prior to undergoing the index PCI. For patients in the Medicare cohort we excluded (1) individuals under the age of 65; (2) those who were enrolled in a Medicare health maintenance organization; (3) those with an AMI (ICD-9-CM codes 410, excluding 410.x2) in the index admission or in the 90 days prior to undergoing PCI; and (4) those undergoing another revascularization procedure (CABG or PCI, see Table H1 for CPT codes) in the 90 days prior to undergoing the index PCI. We included patients identified through both inpatient and outpatient records.

Table H1: Procedure Codes

Procedure Category	Identifying Codes	
	ICD-9	CPT-4
Percutaneous Coronary Interventions (PCI)	36.01 36.02 36.05 36.06	92980 92981 92982 92984
Coronary Artery Bypass Graft (CABG)	36.10 36.11 36.12 36.13 36.14 36.15 36.16 36.19	33510 33511 33512 33513 33514 33516 33517 33518 33519 33521 33522 33523 33533 33534 33535 33536
Catheterization	37.22 37.23 88.53 88.54 88.55 88.56 88.57	93508 93510 93511 93524 93526 93539 93540 93545

Once a patient was identified as meeting the inclusion criteria for a cohort, contiguous records were linked together to create an index episode. We assumed VA patients identified through outpatient records (OPC) were one-day admissions (because we have been told that outpatient PCI procedures are not performed in VA facilities). Medicare patients identified through outpatient records were assumed to be patients undergoing PCI as an outpatient and

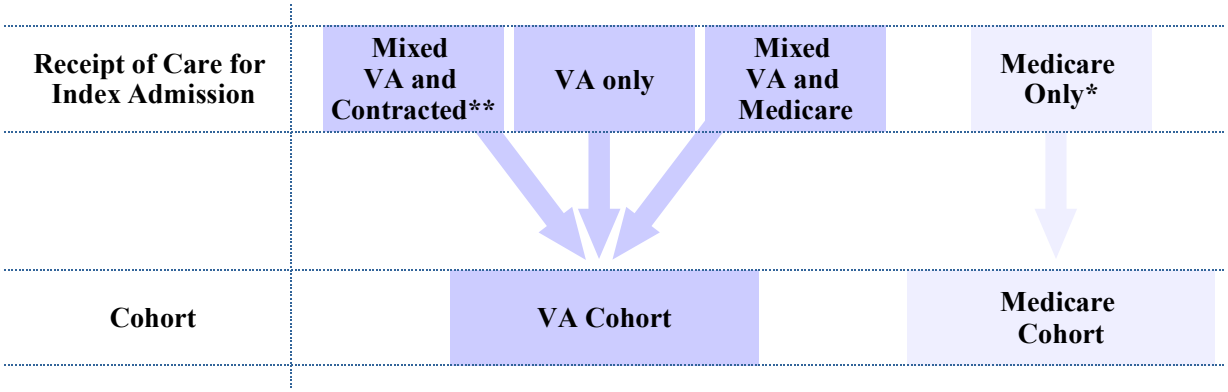
were excluded from length of stay analyses. For patients in the VA cohort, all contracted care (care provided to veterans in private sector hospitals on a contract basis and paid for by the VHA) captured in the non-VA PTF and OPC files were included[1].

Because previous studies have demonstrated that users of VA services age 65 and older who are also eligible for Medicare receive a substantial portion of their care in the private sector (Fleming, Fisher et al. 1992), (Wright, Daley et al. 1997), we obtained Medicare claims for elderly (age ≥ 65) patients in the VA cohort. For patients identified in a VA cohort who also received care covered by Medicare in a non-VHA hospital during their index episode, we included their stays in private sector hospitals as part of their index episode. Thus, the VA cohorts consisted of three sub cohorts of patients (i) those receiving *all* of the care for the index event in VA facilities, (ii) those receiving a mixture of care for the index event in VA facilities and in non-VA facilities (contracted care) paid for under VHA, and (iii) those receiving a mixture of care for the index event in VA facilities and in private sector facilities under Medicare (Figure 1). The Medicare cohort consisted of patients who received inpatient care for their index admission only in the private sector although some of these patients may have received follow up care (either inpatient or outpatient) in the VA (Figure 1)[2].

[1] It was beyond the scope of this project to collect data on care received in the private sector that was covered under private insurance.

[2] It was beyond the scope of this project to identify and study patients who received care for their index PCI in the private sector but who may have received care in the VA either prior to or following the index event.

Figure 1: Inclusion of Patients into VA and Medicare Cohorts According to Receipt of Care in the VHA and Private Sector Patients 65 and over



*Patients who received treatment during the index admission only under Medicare in private sector hospitals; some of these patients may have received care (inpatient or outpatient) in the VA prior to or following discharge.
**Patients receiving a mixture of care for the index event in VA facilities and in non-VA facilities (contracted care) paid for under VHA, for which data were captured in the non-VA PTF.

Outcome Measures

For each cohort several measures were obtained from administrative sources. Information on the receipt of revascularization procedures following PCI, length of stay, and readmission for AMI was obtained from the PTF and OPC files for the VA cohorts and from Part A, Part B, and hospital outpatient files for the Medicare cohorts. Receipt of a subsequent revascularization procedure—repeat PCI or CABG—was measured during the index admission, and within 6 months of undergoing PCI. Readmission for AMI (ICD-9-CM 410) was measured within 6 months of discharge.

Our primary source of vital status data for patients treated in the VA was the Veterans Affairs Beneficiary Identification and Records Location Subsystem (BIRLS) and the PTF[3]. Previous research has demonstrated that these two data sources in combination have high sensitivity[4]. However, we were unable to match approximately 15% (19,692) of the 127,252 VA patients in all VA cohort years to the BIRLS file. We thus supplemented vital status information by matching to Medicare enrollment data and to the National Death Index (NDI), for veterans with uncertain vital status data (those we could not match to the BIRLS). Vital status for the Medicare cohorts was determined from the Medicare enrollment[5] and inpatient files. Mortality rates were measured at 30 days and 1 year.

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[3] Date of death is recorded in the BIRLS if a survivor requests the veteran's death benefit while the PTF captures deaths occurring during a VA hospitalization.

[4] Sensitivity of the BIRLS ranged between 80% and 95% [Cowper, D. C., J. D. Kubal, et al. (2002). "A primer and comparative review of major U.S. mortality databases." Archives of Epidemiology.

[5] Vital status in the Medicare enrollment files is based on payment of Social Security benefits and has been demonstrated to be a highly accurate source of mortality data. The Research Data Assistance Center (ResDAC), a center funded by the Centers for Medicaid and Medicare Services to assist researchers using Medicare data, has calculated the likelihood of someone deceased not having a date of death in the denominator file at 0.4% (in other words death information is 99.6% accurate; personal communication with Barbara Frank, ResDAC).

Statistical Methods

We first describe the VA cohorts from all years under study according to their demographic and clinical characteristics and present unadjusted measures for VA patients by year and by demographic subgroups (age, gender, and race). Because one goal of our analysis was to compare outcomes across VISNs and across patient subgroups (gender and race), we also report these comparisons adjusted for differences in disease severity using hierarchical regression models. Finally, we compared outcomes between VA patients over the age 65 to a matched sample of Medicare patients with similar observed characteristics for the FY 1997, 1998, and 1999 cohorts. As requested, we report 90% confidence intervals for all comparisons. Moreover, we studied a large number of utilization and outcome variables, comparing measures between the VHA and Medicare and across 22 service networks and demographic subgroups within the VA. Approximately 10% of these comparisons are expected to be statistically significantly due to chance alone. These results are thus best seen as highlighting areas for further study of quality of care received within the VHA. Details of these approaches follow:

Risk Adjustment Variables

We adjusted utilization and outcomes measures for the demographic characteristics of the patients (age, gender, and race), a set of clinical comorbidities (see Table H2), and a set of socioeconomic variables derived from the U.S. Census (see Table H3). Clinical comorbidities were coded based on primary and secondary diagnoses codes from inpatient encounters. Information on comorbidities was obtained from the index admission as well as from inpatient

claims in the year prior to admission[6]. We linked the zip code of each patient's residence to data from the 1990 U.S. Census to obtain information on their socioeconomic characteristics (median household income, proportion of population with a high school education, proportion of population with professional occupations, proportion of population receiving public assistance, proportion of population over 65 receiving public assistance, proportion of population that are African Americans, and proportion of population that are Hispanic) (Table H3). All adjusted analyses (both within VA and comparisons between the VA and Medicare) control for the full set of risk adjustment variables described above.

[6] Initially we planned on using information on comorbidities obtained from *both* inpatient data as well as outpatient data for the year prior to the index admission. However, outpatient data from the VA were not available for the FY 1994 and 1997 cohorts. For consistency, we wanted to use the same risk adjustment approach for all years within the VA and Medicare cohorts.

Table H2
Clinical Characteristic of VA PCI Cohorts

	Cohort			
	FY 1994 (n=3321)	FY 1997 (n=4453)	FY 1998 (n=4839)	FY 1999 (n=4976)
Hypertension (%)	62.8	62.4	64.1	63.3
Diabetes (%)	26.4	28.1	28.1	28.7
COPD (%)	15.9	16.1	15.5	15.9
Arthritis (%)	12.5	9.6	8.3	7.4
Diabetes (end organ damage) (%)	6.2	4.6	3.8	3.7
Psychosis (%)	3.0	2.8	3.0	3.0
Alcohol/drug abuse (%)	5.8	5.8	5.5	5.3
PVD (%)	10.3	9.5	8.8	9.5
Prior MI (%)	18.6	16.2	16.4	15.4
Cancer (%)	4.2	3.4	3.2	2.9
Renal Failure (%)	1.9	2.0	1.8	1.7
Thyroid disease (%)	3.2	3.4	3.7	3.8
Hypertension w/ complications (%)	1.4	1.1	1.0	1.4
Dementia (%)	0.4	0.3	0.6	0.6
Neurological disorders (%)	0.9	0.8	0.7	0.6
Paralysis (%)	2.1	0.2	0.2	0.3
Connective Tissue Disorder (%)	0.3	0.3	0.3	0.2
Liver Disease (%)	0.6	0.3	0.4	0.3
Lung Disease (%)	0.2	0.4	0.3	0.3
Chronic angina (%)	49.2	12.1	9.0	8.1
CHF (%)	7.9	7.8	7.4	7.6
Unstable angina (%)	23.2	18.5	16.5	14.9
Arrhythmias (%)	8.9	6.3	7.2	7.2
Neurotic disorders (%)	3.6	2.9	2.9	2.3
CVA (%)	4.1	2.5	1.9	1.2
Hypotension (%)	1.9	1.5	1.7	2.0
Ulcer (%)	3.2	2.0	1.8	1.5
Pneumonia (%)	1.7	1.6	1.9	1.9
Fluid disorder (%)	2.4	2.0	1.9	1.9
Urinary tract infection (%)	2.5	1.6	1.8	1.5
Endocarditis (%)	2.8	2.7	2.4	1.7
GI bleeding (%)	1.4	0.8	1.1	1.0
Syncope (%)	1.5	1.2	1.3	1.5
Cardiac arrest (%)	1.1	1.0	1.0	1.1
Coagulation disorders (%)	2.1	1.2	1.0	1.2
Conduction abnormalities (%)	2.9	2.0	2.0	1.7
Conductive disorders (%)	0.4	0.3	0.4	0.2

Table H3
Demographic and Socioeconomic Characteristics of VA PCI cohorts

	Cohort			
	FY 1994 (n=3321)	FY 1997 (n=4453)	FY 1998 (n=4839)	FY 1999 (n=4976)
Age: Under 45 (%)	4.7	3.7	4.4	3.1
45-54 (%)	20.3	24.2	24.5	24.7
55-64 (%)	37.2	32.3	29.3	28.6
65-74 (%)	31.9	28.6	29.9	29.9
75-84 (%)	5.8	11.0	11.6	13.1
Over 85 (%)	0.1	0.3	0.3	0.6
Gender: Males (%)	98.6	98.4	98.7	98.4
Females (%)	1.4	1.6	1.3	1.7
Race: White (%)	83.2	81.7	79.8	78.0
African American (%)	9.1	8.6	8.2	8.9
Hispanic (%)	3.7	4.2	4.0	4.3
Other/missing (%)	4.0	5.5	8.0	8.8
Socioeconomic:				
% with college degree in zip code of residence[a]	21.5	21.5	21.3	21.3
% professionals in zip code of residence[a]	22.2	22.2	22.0	22.1
% with public assistance in zip code of residence[a]	9.8	9.7	9.6	9.6
% over 64 with public assistance in zip code of residence[a]	11.4	11.4	11.3	11.3
% African American in zip code of residence[a]	13.3	12.7	12.5	12.2
% Hispanic in zip code of residence[a]	7.4	6.4	7.1	7.1
Median Household Income in zip code of residence[a]	36556	36525	36551	36985
Missing Census Data (%)	6.1	6.1	6.6	6.2

[a] Obtained from 1990 U.S. Census by linking to the zip code of the patient's residence.

Comparison of Outcomes for Patients within the VA

In order to increase the precision and reliability of the network-level estimates, we fitted hierarchical regression models to data from four cohort years (FY 1994, 1997, 1998, and 1999) to estimate adjusted (for clinical and socioeconomic characteristics) utilization and outcomes within each service network and within demographic subgroups (gender and race)[7] [Gatsonis, 1993; Daniels, 1999]. Prior research has demonstrated significant geographic variation in practice patterns and in the adoption of new technologies. We thus assumed that networks differed both in terms of the average level of utilization and outcomes and in terms of trends in utilization or outcome across the cohort years (Bronskill, Normand et al. 2002). Hierarchical modeling techniques fit a regression model to each network. In this case we estimated a linear time trend across the cohort years (FY 1994, 1997-1999). Each network-level regression model was then combined to estimate national trends in utilization and outcomes. Hierarchical regression models allowed for the estimation of the network-specific and national models simultaneously and for adjustment with patient-level covariates. For each model we adjusted for gender, race, and severity score; a severity score was defined as the predicted utilization or outcome based on the set of risk adjustment variables described above. Because of the small number of females and minorities in each cohort (see Table H3), we assumed that the effect of race and gender on utilization and outcomes was constant across all cohort years.[8] We modeled each utilization and outcome measure independent of the others. As is standard, logistic and normal linear regression models were employed for binary and continuous variables respectively.

[7] See Appendix F1 for a more complete description of the models.
[8] We also assumed the effect of the severity score was constant across years. We refit models to the use of catheterization within 30 days that relaxed the assumption of constant effects for gender, race, and severity score to test the sensitivity of our results to these assumptions and found similar results.

We first compared networks in terms of the level of utilization or outcome and report estimated values in FY 1999 and associated 90% confidence intervals within each network. Estimated rather than actual values are reported to adjust for differences across networks in patient's demographic and clinical characteristics. These estimates are predictions from the network-specific regression lines of the utilization or outcome for a VA patient of average severity treated in a facility located in the VISN in FY 1999. We also compared networks in terms of trends in utilization and outcomes across the cohort years and report the estimated rate of change in utilization or outcome (i.e., the slope from the regression line) within each network and associated 90% confidence interval.

Finally, due to the small number of females and minorities in each cohort (see Table H3) we report gender and race effects pooled across the study years (FY 1994, 1997-1999) as adjusted odds-ratios comparing male to female veterans and comparing African American and Hispanic veterans to white veterans (effects on length of stay are reported as absolute differences between demographic subgroups). Race data were not available for approximately 4 to 9% of the veterans in each cohort and there were a small number of veterans representing other racial groups. We included these patients in the regression models, but because of difficulty in the interpretation of results for patients with missing race data and small numbers of patients in other racial categories, we present only comparisons of white, African American, and Hispanic patients.

Comparison of Outcomes for Elderly VA and Medicare Patients (the "Matched Cohorts")

Because patients undergoing PCI in the VA differed in many important socio-demographic and clinical characteristics (Tables H4, H5, H6) compared to Medicare patients treated in private sector facilities, we created a matched sample of the two cohorts for fiscal

years 1997, 1998, and 1999. For example, prior to matching, VA patients were more likely to be African American, more likely to live in areas with lower levels of educated and income, were more likely to have a variety of chronic conditions (e.g., arthritis, CHF, COPD and diabetes), but were less likely to have experienced a prior MI. We used a propensity score approach to take into account these differences and matched patients according to their propensity to receive care in each system (Rosenbaum and Rubin, 1983; Rubin, 1997; D'Agostino, 1998).

Creation of the matched cohorts required several steps. For each male VA patient aged 65 or older in a given year, we first selected a group of male Medicare patients treated in the same quarter of the fiscal year who were cared for in a private sector facility located within the geographic boundary of the VISN in which the VA patient was treated. We then developed a score for each patient that represented their propensity to be treated in the VA system (the so-called "propensity score"); for this purpose we used a logistic regression model that included the entire set of risk adjustment variables described above as well as the socioeconomic status variables. We then matched each male elderly VA patient to the Medicare patient with the closest estimated propensity to be treated in a VA facility.

We then compared outcomes between the VA and Medicare using the matched samples. For each cohort year, we used chi-square and t-tests to test for differences in utilization and outcomes at the national level and noted significant differences at the 5% and 10% level. We also plotted outcomes and corresponding 90% confidence intervals in the matched cohorts within each service network.

Table H4
Demographic and Clinical Characteristics of the VA and Medicare
FY 1997 PCI Cohorts (Male patients, age 65 and older)

	Prior to Matching		Matched Sample	
	VA	Medicare	VA	Medicare
	(n=1748)	(n=68865)	(n=1711)	(n=1711)
Age 65-69 (%)	37.9	32.8	38.0	40.2
70-74 (%)	34.2	32.3	34.3	33.1
75-79 (%)	22.8	22.1	22.6	21.7
80-84 (%)	4.5	10.0	4.6	4.2
85 and older (%)	0.6	2.8	0.6	0.8
Race: White (%)	82.9	94.0	83.6	85.0
African American (%)	8.4	3.3	8.5	8.3
Hispanic (%)	4.0	0.5	3.1	2.9
Missing/other (%)	4.8	2.2	4.7	3.8
Socioeconomic Variables[a]:				
% with college degree in zip code of residence	18.7	21.7	18.7	18.5
Median household income in zip code of residence	31511.4	36439.0	31526.2	30837.9
% professionals in zip code of residence	19.5	21.8	19.5	19.1
% African American in zip code of residence	12.2	7.6	12.3	11.8
% Hispanic in zip code of residence	5.6	5.0	5.5	5.4
% with public assistance in zip code of residence	8.9	6.9	8.9	8.6
% > 64 with public assistance in zip code of residence	10.2	8.2	10.2	10.2
Missing census data (%)	11.3	12.2	11.2	11.9
Clinical Variables[b]:				
Prior MI (%)	14.3	18.6	14.2	13.7
Chronic angina (%)	25.7	23.2	25.7	24.8
Unstable angina (%)	55.7	61.5	56.0	54.9
Arrhythmia (%)	21.9	23.2	21.9	21.7
Cardiac arrest (%)	4.5	5.5	4.6	4.8
Arthritis (%)	12.1	7.9	11.8	11.8
Cancer (%)	6.4	3.4	6.0	5.5
CHF (%)	13.2	13.4	13.1	13.6
Coagulation disorder (%)	2.5	1.7	2.4	2.1
Conduction abnormality (%)	8.0	8.9	8.0	7.1
Conduction disorder (%)	1.1	1.1	1.1	1.4
COPD (%)	24.3	17.2	24.1	24.0
Connective tissue disease (%)	0.3	0.4	0.4	0.2
CVA (%)	6.5	3.6	6.4	5.6
Dementia (%)	0.5	0.9	0.5	0.6
Diabetes (%)	30.7	20.5	30.3	29.9
Diabetes w/ end organ damage (%)	5.6	2.5	5.3	5.1
Alcohol/drug abuse (%)	2.6	1.3	2.6	3.3
Thyroid disease (%)	4.4	3.8	4.4	4.5

	Prior to Matching		Matched Sample	
	VA (n=1748)	Medicare (n=68865)	VA (n=1711)	Medicare (n=1711)
Fluid disorder (%)	5.2	6.2	5.1	5.7
GI bleeding (%)	2.8	1.4	2.6	3.0
Hypertension (%)	66.5	51.2	66.0	65.5
Hypertension w/ complications (%)	1.5	3.9	1.4	0.9
Liver disease (%)	0.3	0.2	0.3	0.4
Neurological disorder (%)	1.2	1.3	1.2	1.1
Paralysis (%)	0.3	0.1	0.2	0.1
Pneumonia (%)	4.1	3.0	3.8	4.0
Psychosis (%)	1.7	0.7	1.6	1.5
Neurotic disorder (%)	3.4	1.6	3.4	3.5
Lung disease (%)	0.3	0.4	0.4	0.5
Renal failure (%)	2.8	1.3	2.6	2.6
Hypotension (%)	4.4	3.3	4.4	4.9
Syncope (%)	4.0	2.6	3.8	4.2
Ulcers (%)	4.9	2.2	4.7	3.7
UTI (%)	5.0	2.8	4.9	5.1
Endocarditis (%)	8.4	10.8	8.4	8.5
PVD (%)	13.4	9.7	13.4	12.4

[a] Obtained from 1990 census by linking to the zip code of the patient's residence.
[b] Obtained from primary and secondary diagnoses from inpatient claims.

Table H5
Demographic and Clinical Characteristics of the VA and Medicare
FY 1998 PCI Cohorts (Male patients, age 65 and older)

	Prior to Matching		Matched Sample	
	VA	Medicare	VA	Medicare
	(n=2000)	(n=76733)	(n=1964)	(n=1964)
Age 65-69 (%)	38.0	31.1	38.3	37.6
70-74 (%)	33.9	31.9	33.9	33.7
75-79 (%)	22.3	23.1	22.1	21.9
80-84 (%)	5.3	10.7	5.2	6.2
85 and older (%)	0.7	3.3	0.6	0.7
Race: White (%)	82.2	94.0	82.5	83.6
African American (%)	7.8	3.4	7.8	7.6
Hispanic (%)	4.0	1.1	3.8	3.3
Missing/other (%)	6.1	1.6	5.9	5.5
Socioeconomic Variables[a]:				
% with college degree in zip code of residence	18.1	21.7	18.0	18.2
Median household income in zip code of residence	31098.2	36399.2	31083.9	30971.7
% professionals in zip code of residence	18.8	21.8	18.8	18.6
% African American in zip code of residence	10.9	7.4	10.9	10.9
% Hispanic in zip code of residence	6.0	5.0	6.1	5.5
% with public assistance in zip code of residence	8.5	6.8	8.5	8.2
% > 64 with public assistance in zip code of residence	10.1	8.2	10.0	9.9
Missing census data (%)	12.4	12.6	12.4	12.6
Clinical Variables[b]:				
Prior MI (%)	16.1	18.1	16.0	16.2
Chronic angina (%)	21.0	24.1	21.1	20.3
Unstable angina (%)	54.0	57.4	54.1	55.9
Arrhythmia (%)	20.6	22.6	20.4	23.1
Cardiac arrest (%)	4.3	5.4	4.3	4.1
Arthritis (%)	10.4	7.9	10.3	10.8
Cancer (%)	6.0	3.5	5.9	6.2
CHF (%)	12.7	13.6	12.6	14.2
Coagulation disorder (%)	2.3	1.9	2.3	2.1
Conduction abnormality (%)	6.9	8.1	6.8	6.4
Conduction disorder (%)	1.2	1.1	1.1	1.4
COPD (%)	22.1	17.1	22.0	21.5
Connective tissue disease (%)	0.3	0.5	0.3	0.3
CVA (%)	3.2	2.6	3.1	3.1
Dementia (%)	1.0	0.9	0.9	1.0
Diabetes (%)	29.5	21.3	29.2	30.6
Diabetes w/ end organ damage (%)	4.1	2.8	3.9	3.5
Alcohol/drug abuse (%)	2.2	1.3	2.2	2.0
Thyroid disease (%)	4.8	4.1	4.8	5.2

	Prior to Matching		Matched Sample	
	VA (n=2000)	Medicare (n=76733)	VA (n=1964)	Medicare (n=1964)
Fluid disorder (%)	4.8	5.6	4.7	4.5
GI bleeding (%)	3.5	1.4	3.2	3.2
Hypertension (%)	69.1	53.5	68.9	70.1
Hypertension w/ complications (%)	1.2	3.8	1.2	1.3
Liver disease (%)	0.2	0.2	0.2	0.1
Neurological disorder (%)	1.2	1.3	1.2	1.4
Paralysis (%)	0.3	0.1	0.3	0.3
Pneumonia (%)	4.6	3.3	4.5	4.7
Psychosis (%)	2.0	0.7	1.9	2.0
Neurotic disorder (%)	4.2	1.6	4.1	4.1
Lung disease (%)	0.4	0.5	0.4	0.6
Renal failure (%)	2.1	1.3	2.1	1.9
Hypotension (%)	3.9	3.3	3.9	4.1
Syncope (%)	2.9	2.7	2.9	3.4
Ulcers (%)	3.6	2.0	3.5	3.6
UTI (%)	6.3	2.6	6.0	5.8
Endocarditis (%)	7.9	10.7	7.9	6.8
PVD (%)	12.7	10.1	12.5	10.9

[a] Obtained from 1990 census by linking to the zip code of the patient's residence.
[b] Obtained from primary and secondary diagnoses from inpatient claims.

Table H6
Demographic and Clinical Characteristics of the VA and Medicare
FY 1999 PCI Cohorts (Male patients, age 65 and older)

	Prior to Matching		Matched Sample	
	VA (n=2141)	Medicare (n=83026)	VA (n=2110)	Medicare (n=2110)
Age 65-69 (%)	37.4	29.8	37.2	37.1
70-74 (%)	31.7	31.4	31.7	31.8
75-79 (%)	23.1	23.9	23.2	23.3
80-84 (%)	6.6	11.3	6.6	6.5
85 and older (%)	1.3	3.6	1.3	1.3
Race: White (%)	79.2	93.6	79.7	80.4
African American (%)	8.4	3.6	8.2	8.5
Hispanic (%)	4.4	1.1	4.3	4.4
Missing/other (%)	8.0	1.7	7.8	6.6
Socioeconomic Variables[a]:				
% with college degree in zip code of residence	18.3	21.6	18.3	18.2
Median household income in zip code of residence	31464.4	36331.4	31479.4	30962.7
% professionals in zip code of residence	19.1	21.7	19.2	19.0
% African American in zip code of residence	11.4	7.6	11.3	11.0
% Hispanic in zip code of residence	6.3	4.9	6.3	6.2
% with public assistance in zip code of residence	8.7	6.8	8.7	8.5
% > 64 with public assistance in zip code of residence	10.0	8.2	10.0	10.0
Missing census data (%)	12.5	12.5	12.4	13.3
Clinical Variables[b]:				
Prior MI (%)	15.4	18.2	15.6	15.3
Chronic angina (%)	21.4	25.2	21.5	21.7
Unstable angina (%)	47.1	54.0	47.3	47.9
Arrhythmia (%)	20.8	22.4	20.7	19.9
Cardiac arrest (%)	3.9	5.1	3.9	3.7
Arthritis (%)	9.4	8.4	9.4	9.7
Cancer (%)	5.1	3.6	5.0	5.0
CHF (%)	12.9	13.8	12.8	13.2
Coagulation disorder (%)	2.3	2.0	2.3	2.4
Conduction abnormality (%)	5.2	7.0	5.2	5.1
Conduction disorder (%)	0.8	1.0	0.9	1.0
COPD (%)	22.2	17.2	22.0	21.9
Connective tissue disease (%)	0.2	0.4	0.2	0.1
CVA (%)	2.1	2.2	2.0	2.7
Dementia (%)	1.3	0.9	1.2	1.4
Diabetes (%)	29.6	22.4	29.6	29.1
Diabetes w/ end organ damage (%)	4.1	3.0	4.1	3.7
Alcohol/drug abuse (%)	2.6	1.3	2.5	2.6
Thyroid disease (%)	4.8	4.4	4.8	5.1

	Prior to Matching		Matched Sample	
	VA (n=2141)	Medicare (n=83026)	VA (n=2110)	Medicare (n=2110)
Fluid disorder (%)	4.6	5.0	4.6	4.7
GI bleeding (%)	2.9	1.5	2.6	3.4
Hypertension (%)	67.1	55.2	67.0	67.1
Hypertension w/ complications (%)	1.1	3.8	1.1	1.4
Liver disease (%)	0.2	0.2	0.2	0.4
Neurological disorder (%)	0.9	1.5	0.9	1.0
Paralysis (%)	0.2	0.1	0.1	0.2
Pneumonia (%)	3.9	3.5	3.9	4.0
Psychosis (%)	2.4	0.7	2.1	2.4
Neurotic disorder (%)	2.7	1.6	2.7	2.8
Lung disease (%)	0.3	0.5	0.3	0.3
Renal failure (%)	2.5	1.4	2.4	2.5
Hypotension (%)	4.7	3.3	4.7	4.4
Syncope (%)	4.0	2.7	3.9	3.8
Ulcers (%)	3.6	1.8	3.5	4.1
UTI (%)	4.9	2.4	4.6	5.3
Endocarditis (%)	5.8	10.2	5.8	5.6
PVD (%)	12.7	10.5	12.7	12.0

[a] Obtained from 1990 census by linking to the zip code of the patient's residence.
[b] Obtained from primary and secondary diagnoses from inpatient claims.

Results—Descriptive Characteristics of Patients

The general clinical and demographic characteristics of VA patients in the cohorts studied are shown in Tables H2 and H3. Severity scores by VISN, cohort year, by race and by gender for the predicted 30-day mortality rate are plotted in Figures H1-H4. These scores summarize the clinical characteristics of the patients as the predicted risk of death. Severity scores differed across the cohort years, by race and by VISNs suggesting variability in the clinical characteristics of patients and highlighting the need for risk-adjustment. Note that for comparisons of utilization and outcomes across cohort years, by demographic subgroups, and by VISN we used outcome-specific severity scores for risk adjustment. For illustrative purposes we only report the severity scores for predicted 30-day mortality.

Socio-demographic and clinical characteristics of the FY 1997, 1998, and 1999 VA (male patients age 65 and older) and Medicare cohorts are reported in Tables H4, H5, H6. Characteristics of the patients prior to matching are reported in the second and third columns. Characteristics of the matched cohorts are reported in the last two columns.

Matched Cohort (VA and Medicare) Findings

- Patients undergoing PCI in the VA were younger, but were more likely to have comorbid disease compared to Medicare patients.
- The VA cohorts also had larger numbers of racial and ethnic minorities and VA patients were more likely to live in areas with lower levels of education and income.
- Medicare patients selected into the matched sample were younger, were more likely to have comorbid disease, more likely to be a racial minority, and were more likely to live in areas with lower levels of education and income compared to the general population of Medicare beneficiaries undergoing PCI.

After matching the cohorts were remarkably similar, allowing us to make more valid comparisons of the use of procedures and outcomes in the two systems.

Figure H1

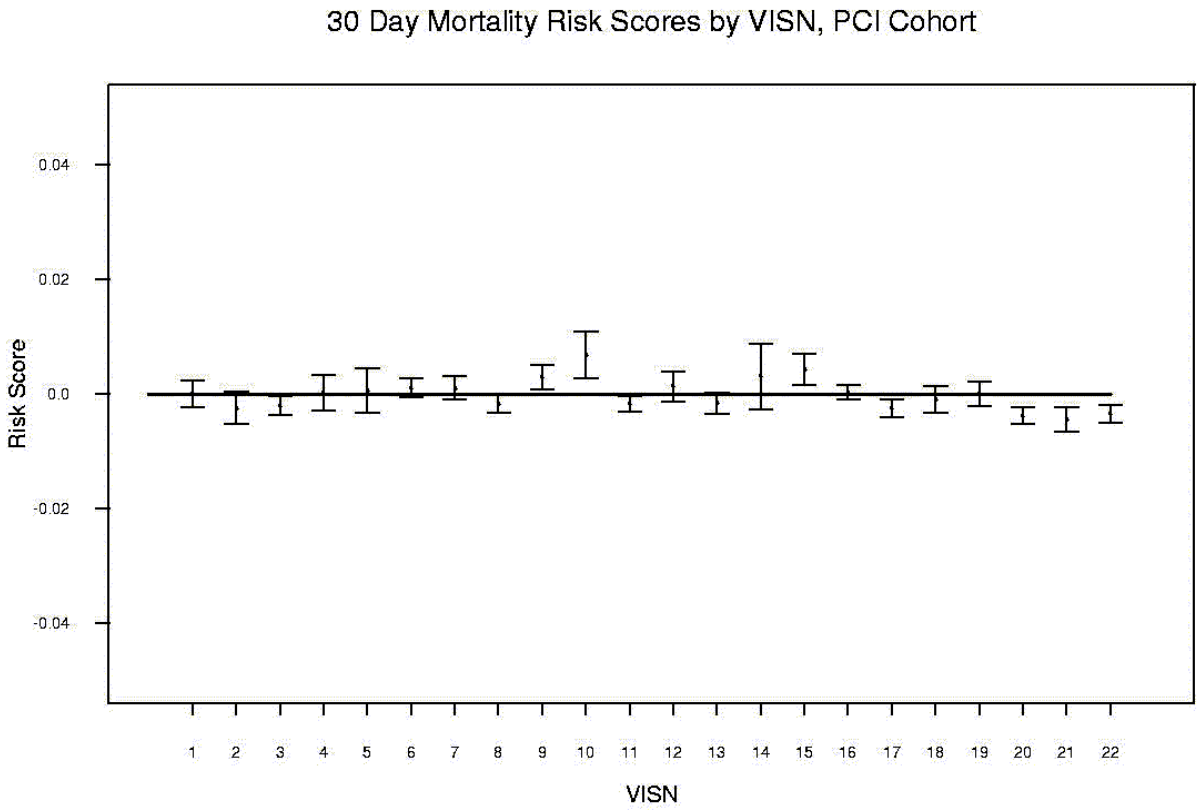


Figure H2

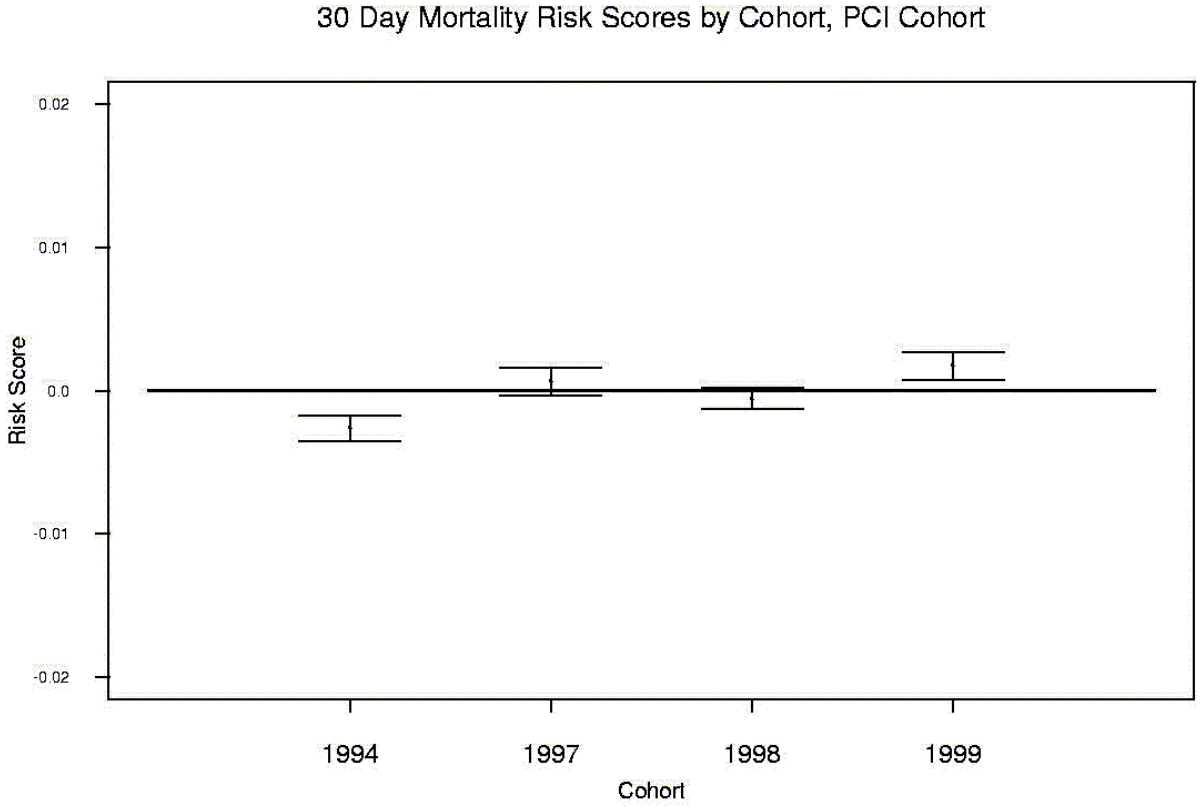


Figure H3

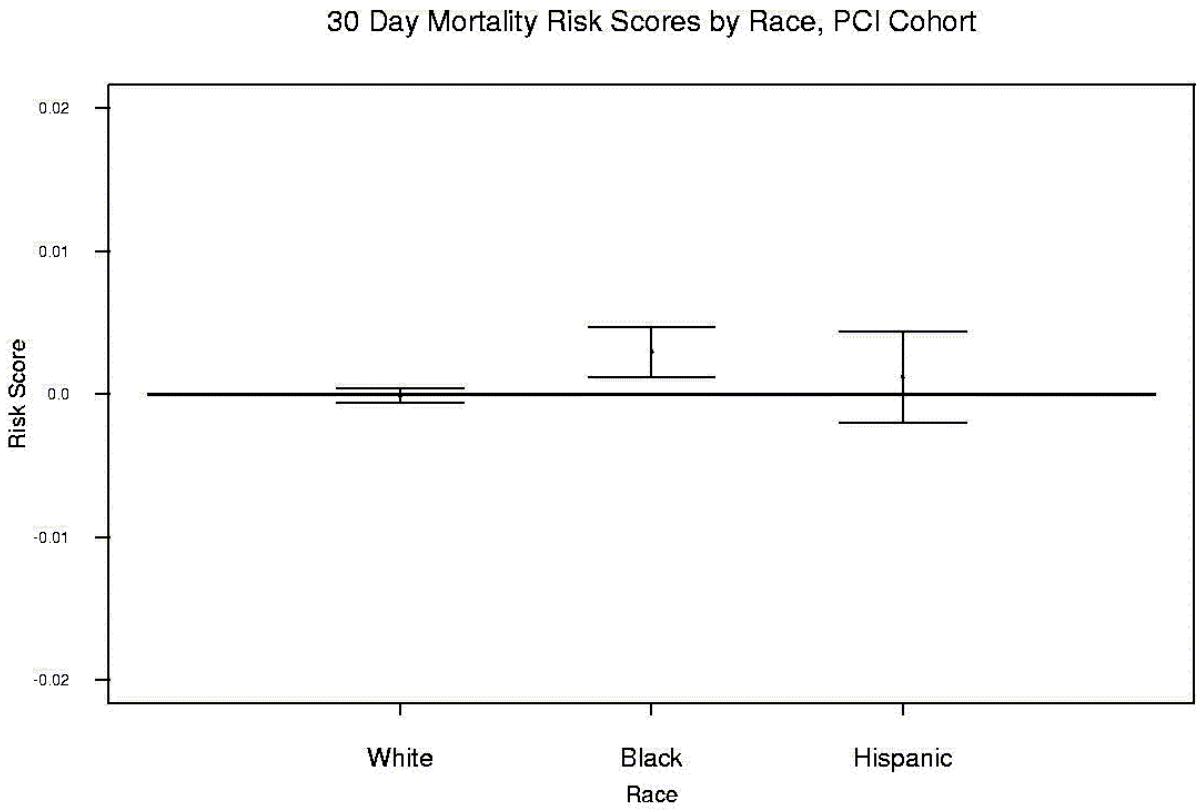
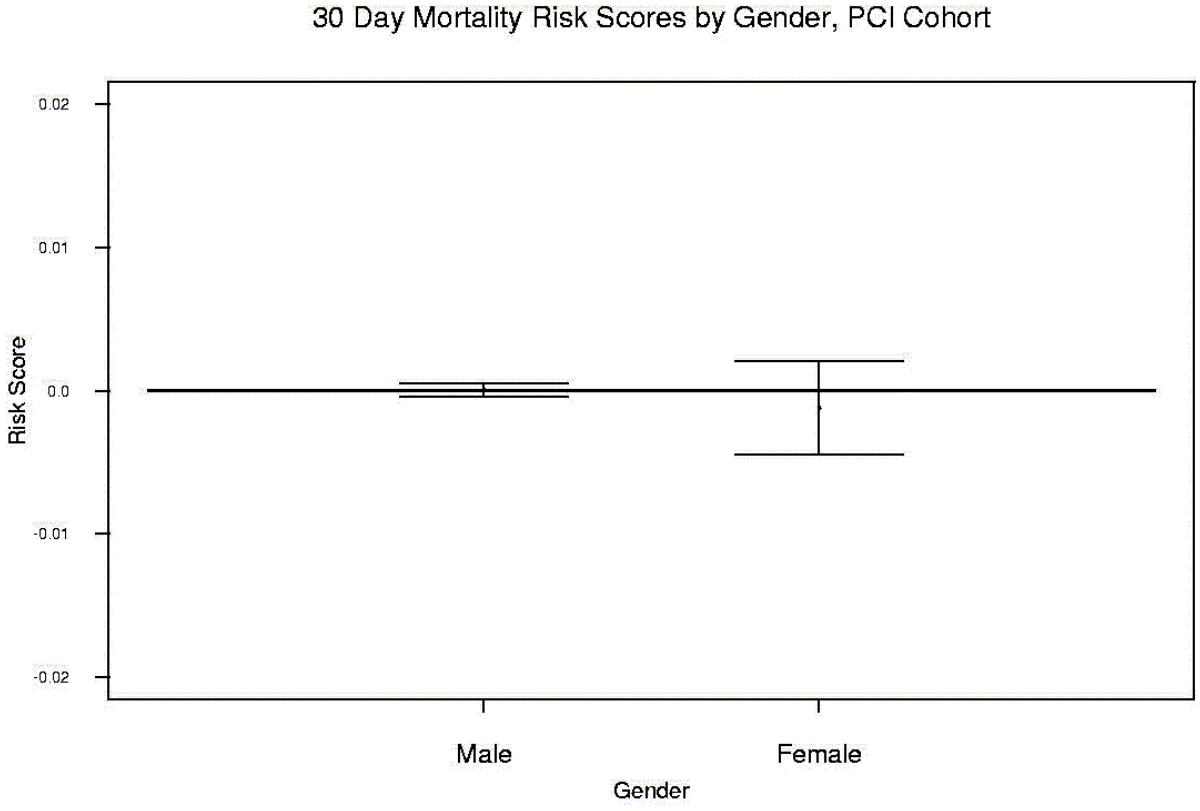


Figure H4



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Appendix H

APPENDIX H1

Statistical Analyses

Hierarchical Models

We fitted hierarchical regression models to data from four cohort years (FY 1994, 1997, 1998, and 1999) to estimate adjusted utilization and outcomes within each service network and within demographic subgroups (gender and race). In this section we illustrate our approach by describing a model for the likelihood of a VA patient undergoing a repeat PCI within 30 days of their index PCI. Similar hierarchical models were fit to the other utilization and outcome measures.

Let *i* index VISN; *j* index patients within a VISN; and *t* denote year. We let s_{ijt} be the centered severity score for patient *j* treated in VISN *i* in year *t*, m_{ijt} be a binary variable equal to one if the patient was male, b_{ijt} be a binary variable equal to 1 if the patient was African American, h_{ijt} be a binary variable equal to 1 if the patient was Hispanic, o_{ijt} be a binary variable equal to 1 if the patient's race was missing or if the patient represented another racial minority and y_{ijt} be a binary variable equal to 1 if patient received a repeat PCI in the 30 days following their index PCI. We estimated the following model:

1. Patient-Level (Within-VISN and Time): $\text{log-odds}[P(y_{ijt} = 1)] = \eta_{0it} + \eta_1 s_{ijt} + \eta_2 m_{ijt} + \eta_3 b_{ijt} + \eta_3 h_{ijt} + \eta_4 o_{ijt}$;

   where η_{0it} represents the adjusted log-odds of receiving a repeat PCI for an average patient treated in VISN *i* in year *t*, and η_1, η_2, η_3, and η_4 describe the impact of the severity, gender

and race on the log-odds of receiving a repeat PCI. This model hypothesized that the log-odds of receiving a repeat PCI varied across VISNs and cohort years.

2. Within-VISN: $\eta_{0it} = \beta_{0i} + \beta_{1i}T + \varepsilon_{it}$;

   where T is a variable equal to –5 for t=1994, -2 for t=1997, -1 for t=1998, and 0 for t=1999, and ε_{it} represents random error, which we assumed was approximately normally distributed. This model hypothesized that the likelihood of receiving a repeat PCI within a VISN followed a linear trend (on the log-odds scale) across the cohort years. β_{0i} represents the log-odds of a repeat PCI in VISN *i* in 1999, and β_{1i} estimates the linear trend in VISN *i*.

3. Between VISN: $(\beta_{0i}, \beta_{0i})^T = \boldsymbol{\gamma}_0 + \boldsymbol{\omega}_i$;

   where $\boldsymbol{\omega}_i$ is a vector of VISN random effects, which we assumed were approximately bivariate-normally distributed. The components of $\boldsymbol{\gamma}_0$ represent the national trend in the receipt of a repeat PCI across the cohort years.

Models were estimated using the BUGS software (Gilks, Thomas A et al. 1994)

Propensity Score Analyses

We created matched samples of VA and Medicare patients for fiscal years 1997, 1998, and 1999, using a propensity score approach. Creation of the matched cohorts required several steps. For each male VA patient aged 65 or over undergoing PCI in a given year, we first selected a group of male Medicare patients treated in the same quarter of the fiscal year who were cared for in a private sector facility located within the geographic boundary of the VISN in which the VA patient was treated.

We then developed a score for each patient that represented their propensity to be treated in the VA system (the so-called "propensity score"). The propensity score was estimated by fitting a logistic regression model to estimate the probability that a patient was treated in a VHA hospital:

$$\text{logit}(P(VA_{it}=1)) = \beta_{0t} + \beta_{1t} X_{it}$$

where VA_{it} is a dichotomous variable equal to 1 if the i^{th} patient undergoing PCI in year t was treated in a VHA hospital and equal to zero if the patient was a Medicare beneficiary, X_{it} is a vector of clinical and socioeconomic risk adjustment variables previously described. Models were fit to each cohort year independently. The area under the ROC curve was equal to 0.73, 0.72, and 0.72 for the FY 1997, 1998, and 1999 models respectively.

After fitting the propensity score models we estimated a predicted propensity score, p_{it}, for each patient where

$$p_{it} = \frac{\exp(\hat{\beta}_{0t} + \hat{\beta}_{t1} X_{it})}{1 + \exp(\hat{\beta}_{0t} + \hat{\beta}_{t1} X_{it})}.$$

Within cells defined by quarter of discharge and VISN, we then matched each male elderly VA patient to the Medicare patient with the closest estimated propensity (on the logit scale) to be treated in a VA facility within a specified range ($\leq$0.6 of the pooled standard deviation of estimated logits) to reduce differences between groups by at least 90% (Rosenbaum and Rubin 1985). VA patients for whom suitable matches could not be found were removed from the analysis (fewer than 10% in each cohort year). The adequacy of the propensity score model to adjust for differences between VA and Medicare patients was assessed by calculating standardized difference statistics in the observed characteristics between the groups pre and post matching on the estimated propensity score. Standardized differences between VA and Medical

patients in their clinical and socioeconomic characteristics were substantially reduced after matching on the estimated propensity score (all standardized differences were less than 10% and most were less than 5% in each cohort year).