

The Burden of Diabetes-Associated Cardiovascular Hospitalizations in Veterans Administration (VA) and Non-VA Medical Facilities

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OBJECTIVE — This study examines the relative burden of cardiovascular disease in diabetic and nondiabetic admissions to Veterans Administration (VA) and non-VA hospitals.

RESEARCH DESIGN AND METHODS — Calendar year 1997 hospitalization data were collected from the VA Patient Treatment File and the National Hospital Discharge Survey, National Center for Health Statistics. Discharge diagnoses based on ICD-9 codes were used to classify cardiovascular events and procedures and diabetes. Proportionate hospitalization ratios (PHRs) were calculated based on the number of cardiovascular hospitalizations from among all hospitalizations.

RESULTS — We identified 119,653 VA hospitalizations (19.1%) and 3,765,696 non-VA hospitalizations (16.8%) that coded diabetes among the discharge diagnoses. Cardiovascular hospitalizations, primarily coronary in origin, accounted for nearly 50% of all hospitalizations of persons with diabetes within VA and non-VA medical care systems. Coronary events and procedures (PHR = 1.85 and 1.68) and, to a lesser extent, cerebrovascular events and procedures (PHR = 1.55 and 1.33) were more common in VA hospitalizations where diabetes was listed as a comorbidity than in VA hospitalizations where diabetes was not listed. The burden of coronary hospitalizations was larger in VA than non-VA facilities for men (PHR = 1.82 vs. 1.66) and smaller in VA than non-VA facilities for women (PHR = 3.11 vs. 3.44) in age and race-standardized analyses. The burden of coronary hospitalization was higher for whites and blacks in VA facilities (PHR = 1.83 and 2.01) when compared with non-VA facilities (PHR = 1.68 and 1.84).

CONCLUSIONS — The burden of cardiovascular hospitalizations is not equally borne across hospitalizations with and without diabetes and across VA and non-VA facilities.

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The sequelae of diabetes include both microvascular and macrovascular complications. As empirical evidence continues to demonstrate that glycemic control reduces microvascular

morbidity (1–3), research attention has shifted focus to macrovascular diseases (that is, cardiovascular disease [CVD]) in adults with diabetes. Among these, coronary and cerebral arterial diseases are the

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Abbreviations: CVD, cardiovascular disease; NHDS, National Hospital Discharge Survey; PHR, proportionate hospitalization ratio; PTF, Patient Treatment File; VA, Veterans Administration; VISN, Veteran Integrated Service Network.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

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health outcomes of greatest concern since combined, CVD deaths account for 41% of all deaths in persons 45 years of age or older in the U.S. (4).

The Veterans Administration (VA) health care system is the largest single provider of health care services in the U.S. and provides some level of care to ~3 million Americans, ~1.1% of the total U.S. population in 1997. This study examined the relative burden of CVD in diabetic and nondiabetic admissions to VA and non-VA short-term medical facilities. We were interested in knowing if there was a proportionately larger number of cardiovascular hospitalizations in diabetic hospitalizations compared with nondiabetic hospitalizations and if the cardiovascular burden associated with diabetes in VA facilities was similar to the burden in non-VA facilities.

RESEARCH DESIGN AND METHODS

Data were collected from the VA Patient Treatment File (PTF) and the National Hospital Discharge Survey (NHDS) from the National Center for Health Statistics.

Cross-sectional data analysis of hospitalization episodes for calendar year 1997 was used to compare diabetic and nondiabetic cardiovascular hospitalizations in VA and non-VA inpatient facilities.

Hospitalizations

The PTF is a national VA administrative database containing selected demographic and utilization information abstracted from medical records of all episodes of inpatient care. For this study, data were collected from all of the 172 VA medical facilities that were in operation in 1997. Data were organized according to hospital discharge date, and multiple within-person hospitalizations can be internally linked using scrambled social security numbers.

The NHDS contains abstracted med-

ical record information on a national probability sample of hospital discharges from short-stay, non-federal hospitals. Detailed sampling strategies are published elsewhere (5). In 1997, the NHDS sample consisted of 300,464 hospitalizations from 474 medical facilities in 50 states and the District of Columbia. The NHDS data did not include hospitalizations from VA and military facilities. As such, virtually all hospitalizations in the U.S., with the exception of military hospitals, were potentially eligible to be included in our study.

We excluded hospitalizations for which patients were <30 years of age because these admissions were rare in VA hospitalizations and accounted for nearly a third of the NHCS hospitalizations. We also excluded VA hospitalizations that extended over 100 days to increase the comparability of the VA and NHDS data. Hospitalizations for pregnancy and its complications (ICD-9 codes V22, V23, V24, and 630–676) were removed from both the VA and non-VA datasets because VA facilities are not generally equipped for obstetric services.

The NHDS contains seven diagnostic code fields for each hospitalization. The PTF differs and contains 11 diagnostic fields for each hospitalization. For the PTF, the first field is the Diagnostic Related Group diagnosis and represents the diagnosis that was responsible for the hospitalization. The second field is the First Diagnosis and represents the diagnosis that was responsible for the longest length of stay in any bedsection of the hospital. Since we found that these fields contain redundant information for 95% of the hospitalizations, we selected the first eight diagnostic fields for the PTF to compare with the seven diagnostic fields of the NHDS. We also found that the cardiovascular diagnosis of interest was listed in the first half of all ICD-9 codes recorded for 71% of the VA and 77% of the non-VA hospitalizations eligible for this analysis.

The NHDS contains four procedure code fields for each hospitalization. The PTF differs and contains multiple procedure and surgery records that correspond to each delivery of a procedure service during a hospitalization. Each VA record can contain up to five procedure codes per day and five surgery codes. As such, VA hospitalizations contain many times more procedure and surgery codes than

NHDS hospitalizations. To compensate for the nonequivalence of the two systems for recording procedures, we chose to search for the procedure codes of interest to this study from among any of the procedure and surgery codes listed in any of the records for a hospitalization. This decision was based on our observation that clinically important and expensive procedures are virtually always coded among the first itemized procedures in the discharge record in large health care administrative databases similar to NHDS.

Diabetes

Diabetes status for each hospitalization was determined by the inclusion of any ICD-9 code for diabetes (ICD-9 code 250). Because unique identifiers were available to us in the PTF, we were able to partially gauge the extent to which diabetes may have been misclassified by relying exclusively on discharge codes to classify diabetes status. We found that among veterans who had more than one VA admission in 1997, a discharge diagnosis of diabetes (ICD-9 code 250) was given in 42% of the other hospitalizations for that year for that veteran.

Cardiovascular diagnoses

We divided cardiovascular events into those that were coronary and those that were cerebral in nature according to ICD-9 diagnostic and procedure discharge codes. Coronary events included acute myocardial infarction (code 410), acute coronary syndrome (411), chronic coronary syndromes (413 and 414), congestive heart failure (428), and cardiac arrest (427.4 and 427.5). Coronary procedures included coronary artery bypass grafting (36.10–36.19) and percutaneous transluminal angioplasty with (36.01, 36.02, and 36.05) and without (36.06) stent placement. Cerebrovascular events were restricted to strokes, both hemorrhagic (430–432) and ischemic (433–434), and cerebrovascular procedures were restricted to carotid endarterectomy (38.12). Events and procedures were not arranged hierarchically; thus, multiple diagnoses per hospitalization were possible.

Covariates

Information was available from both the PTF and NHDS for sex, age, race (white, black, and other), marital status (married versus other), discharge status (alive to community, alive to another care facility,

dead, and other), length of stay in hospital, and geographic location of hospital (northeast, midwest, south, and west). For the PTF, we included Veteran Integrated Service Networks (VISNs) 1–5 in the northeast region; VISNs 10–15 in the midwest region; VISNs 6–9, 16, and 17 in the south region; and VISNs 18–22 in the west region.

Statistical analysis

Proportions of total hospitalizations were calculated for each type of cardiovascular event and procedure among nondiabetic VA, diabetic VA, nondiabetic non-VA, and diabetic non-VA hospitalizations. These proportions were used to calculate proportionate hospitalization ratios (PHRs). The PHR statistic is a ratio of two proportions and was calculated by dividing the proportion of event-specific hospitalizations in the diabetic VA (or non-VA) group by the proportion in the nondiabetic VA (or non-VA) group. Age-, sex-, and race-standardized PHRs for NHDS data were calculated by direct standardization, whereby age-sex-race-specific weights from the VA hospitalizations were applied to the non-VA hospitalizations. Age adjustment was by decade, and the third and fourth, as well as the eighth and ninth-plus, decades were collapsed due to small cell sizes for several outcomes.

The NHDS data are based on a national sampling frame and therefore need weighted adjustments when calculating statistics and their confidence intervals. Weights, constants, and formulae for estimating relative standard errors were supplied by the National Center for Health Statistics (5). Confidence intervals were not calculated on VA data since these data represent a complete enumeration of VA hospitalizations in 1997 and inferential statistics are not necessary.

RESULTS — There were 644,335 hospitalizations at VA facilities in 1997. We excluded 8,676 hospitalizations (1.3%) for patients who were <30 years of age, 7,557 hospitalizations (1.2%) for stays that extended beyond 100 days, and 43 (<0.1%) hospitalizations that were pregnancy related. There were estimated to be 34,704,006 hospitalizations in non-federal medical facilities in 1997 after appropriately weighting the 300,464 observations in the sample. We excluded 10,821,513 hospitalizations (31.2%) for

Table 1—Patient characteristics of diabetic and nondiabetic hospitalizations in VA and non-VA medical facilities, 1997

	VA		Non-VA	
	Diabetes (n = 119,653)	No diabetes (n = 508,406)	Diabetes (n = 3,765,696)	No diabetes (n = 18,590,914)
Age (years)	64.4	59.6*	66.3	62.9
Male (%)	97.8	96.6*	44.4	45.0
Race (%)				
White	68.9	71.9*	61.5	68.4*
Black	28.1	24.8*	15.1	9.9*
Other/unknown	3.0	3.3*	23.4	22.7*
Married (%)	52.3	41.2*	31.1	31.7
Length of stay (days)	9.7	10.0*	6.1	5.8
Discharge status (%)				
Home	83.2	82.2*	69.7	73.7*
Transferred	11.6	10.2*	18.7	15.5*
Dead	3.4	3.9*	3.6	3.3
Geographic region (%)				
Northeast	20.6	20.3	22.6	22.1
Midwest	23.3	22.8*	24.1	23.7
South	38.4	37.4*	37.9	37.3
West	17.8	19.5*	15.5	16.9

* $P \leq 0.05$ that diabetic values differ from nondiabetic values.

patients <30 years of age, 16,624 (<0.1%) for hospitalizations that extended beyond 100 days, and 1,509,259 hospitalizations (4.3%) that were pregnancy related. These exclusions resulted in a study population of 628,059 VA hospitalizations and 22,356,610 non-VA hospitalizations.

We identified 119,653 VA hospitalizations (19.1%) and 3,765,696 non-VA hospitalizations (16.8%) that coded diabetes among the discharge diagnoses. Table 1 characterizes hospitalizations among those with and without diabetes diagnoses in VA and non-VA medical facilities. Hospitalized patients with diabetes discharge diagnoses in either VA or non-VA facilities were more likely to be older and black. VA facility users tended to be younger, male, white, and married. The length of stay was nearly twice as long in VA facilities compared with non-VA facilities.

The cardiovascular hospitalization proportions and PHR statistics that compare diabetic and nondiabetic VA hospitalizations for each coronary and cerebrovascular event and procedure are listed in Table 2. Overall, there were ~10 times more coronary events than cerebrovascular events in both diabetic (42 vs. 4%) and nondiabetic hospitalizations (23 vs. 2%). Hospitalizations for acute myocardial infarction were 65% more com-

mon (PHR = 1.65) and hospitalizations for congestive heart failure were nearly 120% more common (PHR = 2.19) among diabetic than among nondiabetic hospitalizations. Neither ventricular fibrillation nor hemorrhagic stroke was strongly associated with diabetes status.

Table 3 lists the cardiovascular hospitalization proportions and PHR statistics that compare diabetic and nondiabetic non-VA hospitalizations for each coronary and cerebrovascular event and procedure. Similar to what was seen in VA hospitalizations, there were ~10 times more coronary events than cerebrovascular events in both diabetic (44 vs. 5%) and nondiabetic hospitalizations (27 vs. 3%). Hospitalizations for acute myocardial infarction were 47% more common (PHR = 1.47) and hospitalizations for congestive heart failure were nearly 83% more common (PHR = 1.83) among diabetic than among nondiabetic hospitalizations. Again, neither ventricular fibrillation nor hemorrhagic stroke was strongly associated with diabetes status.

Standardized comparisons of PHRs are listed in Table 4. The age- and race-standardized PHR for any coronary event in men at VA hospitals was larger than the PHR for any coronary event in men at non-VA hospitals. The PHR was smaller for any cerebrovascular event and equivocal for procedures in VA compared with

non-VA facilities. The PHRs for any coronary event and procedure in women hospitalized at VA facilities were lower than in non-VA facilities, and the PHRs for any cerebrovascular event and procedure were markedly higher.

For whites, blacks, and other races, the age- and sex-standardized PHRs were uniformly higher in VA facilities compared with non-VA facilities for any coronary hospitalization. Cerebrovascular PHRs were nearly equal in VA and non-VA hospitalizations when the data were stratified by race. Proportional hospitalization ratios for either coronary or cardiovascular procedures at VA hospitals were larger for whites and smaller for blacks when compared with non-VA hospitals.

CONCLUSIONS— Cardiovascular hospitalizations accounted for nearly 50% of all diabetic hospitalizations within the VA and the non-VA medical care systems. Our findings show that coronary events and procedures and, to a lesser extent, cerebrovascular events and procedures were more common in hospitalizations where diabetes was listed as a comorbidity than in hospitalizations where diabetes was not listed. These findings were not surprising since diabetes is estimated to be associated with a 150–250% increase in risk of CVD (6,7). When

Table 2—Proportions of cardiovascular hospitalizations and PHRs in VA medical facilities, 1997

	Diabetes (n = 119,653)		No diabetes (n = 508,406)		PHR
	n	P*	n	P†	
Coronary event					
Acute myocardial infarction	4,286	0.036	11,005	0.022	1.65
Acute coronary syndrome	7,080	0.059	17,044	0.034	1.77
Chronic coronary syndrome	36,876	0.308	84,185	0.166	1.86
Ventricular fibrillation	545	0.005	2,552	0.005	0.91
Congestive heart failure	20,601	0.172	40,008	0.079	2.19
Any event above	50,543	0.422	116,227	0.229	1.85
Coronary procedure					
Percutaneous transluminal coronary angioplasty	1,743	0.015	4,771	0.009	1.55
Coronary artery bypass grafting	2,016	0.017	4,769	0.009	1.80
Any procedure above	3,734	0.031	9,438	0.019	1.68
Cerebrovascular event					
Ischemic stroke	4,029	0.034	10,603	0.021	1.61
Hemorrhagic stroke	351	0.003	1,451	0.003	1.03
Any event above	4,358	0.036	11,939	0.023	1.55
Cerebrovascular procedure					
Carotid endarterectomy	851	0.007	2,715	0.005	1.33

*Proportion of diabetic hospitalizations; †proportion of nondiabetic hospitalizations.

the burden of cardiovascular hospitalizations associated with diabetes was compared in VA and non-VA medical care systems, we found the burden to be generally but not exceptionally larger for coronary events and smaller for cerebrovascular events among men, who accounted for nearly 98% of the VA hos-

pitalizations. Exceptions included lower PHRs for coronary and cerebrovascular procedures among blacks in VA hospitals compared with blacks in non-VA facilities.

Recent epidemiologic data suggest a rise in the age-adjusted incidence and prevalence of type 2 diabetes in the U.S.,

most notably among blacks and Hispanic whites (8–10). The effect of this increase on hospitalization burden is unknown, although we might expect a disproportionately increased burden in VA medical care facilities compared with non-VA facilities for two reasons. First, coronary hospitalizations, which account for the

Table 3—Proportions of cardiovascular hospitalizations and PHRs in non-VA medical facilities, 1997

	Diabetes (n = 3,765,696)		No diabetes (n = 18,590,914)		PHR
	n	P*	n	P†	
Coronary event					
Acute myocardial infarction	194,949	0.052	652,638	0.035	1.47
Acute coronary syndrome	237,305	0.063	699,482	0.038	1.67
Chronic coronary syndrome	1,038,098	0.276	3,065,581	0.165	1.67
Ventricular fibrillation	22,549	0.006	113,639	0.006	0.98
Congestive heart failure	821,995	0.218	2,212,166	0.119	1.83
Any event above	1,639,083	0.435	4,926,933	0.265	1.64
Coronary procedure					
Percutaneous transluminal coronary angioplasty	95,744	0.025	349,938	0.019	1.35
Coronary artery bypass grafting	85,900	0.023	276,465	0.015	1.53
Any procedure above	179,300	0.047	619,532	0.033	1.43
Cerebrovascular event					
Ischemic stroke	165,109	0.044	522,279	0.028	1.56
Hemorrhagic stroke	19,439	0.005	118,499	0.006	0.81
Any event above	183,258	0.049	634,121	0.034	1.43
Cerebrovascular procedure					
Carotid endarterectomy	28,409	0.008	114,598	0.006	1.22

*Proportion of diabetic hospitalizations; †proportion of nondiabetic hospitalizations.

Table 4—Standardized sex- and race-stratified PHRs for diabetic and nondiabetic hospitalizations in VA medical facilities, 1997

	Sex				Race					
	Male		Female		White		Black		Other	
	VA	non-VA*	VA	non-VA*	VA	non-VA†	VA	non-VA†	VA	non-VA†
Coronary event										
Acute myocardial infarction	1.64	1.30	2.20	2.54	1.68	1.35	1.74	1.35	1.56	1.14
Acute coronary syndrome	1.74	1.64	2.79	3.01	1.74	1.68	2.00	1.72	1.82	1.55
Chronic coronary syndrome	1.84	1.56	3.20	3.94	1.84	1.68	2.14	1.50	2.16	1.67
Ventricular fibrillation	0.89	1.64	1.87	2.47	0.90	1.15	0.94	3.26	0.97	0.68
Congestive heart failure	2.15	2.10	4.00	4.52	2.22	2.13	2.11	2.33	2.42	2.00
Any event above	1.82	1.66	3.11	3.44	1.83	1.68	2.01	1.84	2.04	1.62
Coronary procedure										
PTCA	1.53	2.21	2.65	3.18	1.56	1.35	1.89	4.88	1.30	1.18
Coronary artery bypass grafting	1.76	1.45	14.26	19.17	1.80	1.39	2.16	3.88	1.95	1.32
Any procedure above	1.65	1.64	3.35	4.12	1.69	1.37	2.00	2.74	1.65	1.23
Cerebrovascular event										
Ischemic stroke	1.60	1.88	2.16	1.95	1.60	1.71	1.76	2.22	1.93	2.88
Hemorrhagic stroke	1.03	1.46	0.61	0.66	0.97	1.65	1.10	0.93	1.16	0.48
Any event above	1.54	1.60	1.90	1.30	1.55	1.54	1.63	1.69	1.83	1.76
Cerebrovascular procedure										
Carotid endarterectomy	1.32	1.32	1.71	0.90	1.35	1.23	1.55	612.23	1.45	0.61

*Age- and race-standardized using the distribution of hospitalization characteristics in VA facilities; †age- and sex-standardized using the distribution of hospitalization characteristics in VA facilities. PTCA, percutaneous transluminal coronary angioplasty.

vast majority of all cardiovascular hospitalizations, are more common in diabetic VA admissions than in diabetic non-VA admissions. Second, a larger proportion of hospitalizations is for blacks in VA compared with non-VA medical facilities, and we know the diabetes-associated coronary hospitalization burden in blacks is larger in the VA setting. Attenuating this increasing burden may be possible by increasing cardiovascular risk factor control, which has been demonstrated in clinical trial settings to reduce cardiovascular morbidity and mortality (11–15). The extent to which this effect can be generalized to veterans—black or white—is unknown.

Limitations

The PHR statistic has several limitations. First, rates of hospitalization are not reflected in the PHR statistic. These data reflect hospital counts only and do not consider the number at risk for hospitalization. For example, if group A and group B each had 10,000 people, a PHR statistic would equal 1.0 in the situation where 50 of the 100 hospitalizations for group A were for disease X and 500 of the 1,000 hospitalization for group B were for disease X, even though the event rate for X was 10 times higher in group B (1 per 20) compared with group A (1 per 200). As

such, we were not able to conclude that cardiovascular disease hospitalization rates were higher in diabetic versus nondiabetic patients (although this is probably true), nor were we able to conclude that rates were higher in VA medical facilities (primarily veterans) versus non-VA medical facilities (primarily non-veterans). Second, the PHR statistic can be a biased estimate of relative risk of hospitalization since the number of hospitalizations for conditions not of interest can be different in the two comparison groups. In these data, the extent to which people with diabetes have more hospitalizations for other, non-CVD conditions (microvascular complications) increases the probability that the PHR for CVD is an underestimate of the true relative risk of CVD in diabetic and nondiabetic patients.

Other limitations need to be considered when evaluating this article. First, a diabetic hospitalization was defined only by the listing of ICD-9 code 250 in the discharge diagnosis. This approach misclassified many hospitalizations. We were able to estimate the magnitude of misclassification in VA hospitalizations by looking at multiple within-year hospitalizations for veterans but were not able to do so in non-VA hospitalizations since no patient identifiers were available for analysis. If misclassification was not compara-

ble across the type of medical facility, the PHR presented in this article will be biased estimates, in an unknown direction and magnitude, of the true PHRs. Second, there was a limit to the number of diagnostic and procedure code fields available for analysis, which may have also led to underreporting of cardiovascular diagnoses. The extent of this type of misclassification is likely small since the majority of cardiovascular diagnoses of interest to the study were coded in the top half of the diagnostic positions and thus were less likely to be placed in a diagnostic field that would have been missed by this analysis. Last, all analyses were done at the hospitalization level, which means that a person with multiple hospitalizations appears as more than one observation. Although this does not distort the magnitude of the hospitalization burden of cardiovascular disease in those with and without diabetes, it would distort person-level conclusions, which have been avoided in this study. Similarly, veterans receive care from VA and non-VA sources (16), so the PHR for VA facilities cannot be a proxy for global veteran health and health care.

Summary

These data suggest that the burden of cardiovascular disease morbidity and

mortality associated with diabetes is substantial in the VA. Successful primary and secondary prevention efforts to reduce the macrovascular complications of diabetes may help to reduce the substantial burden of cardiovascular hospitalizations in VA and non-VA medical facilities.

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