Outcomes in Patients With Coronary Heart Disease Who Do Not Undergo Lipid Testing*

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A large proportion of patients with coronary heart disease (CHD) do not have a current measurement of their low-density lipoprotein (LDL) levels.[1–7] The patient level determinants of not getting a LDL measurement and the outcomes of patients who do not have a current LDL level are unknown, as most studies have not focused on this group of patients. Our objectives were to identify patients at risk for not undergoing a lipid measurement and to determine whether patients without a LDL measurement had higher risk-adjusted morbidity and mortality compared with patients with a lipid measurement.

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The Veterans Affairs (VA) Ischemic Heart Disease Quality Enhancement Research Initiative (IHD-QUERI) is a national initiative to improve outcomes in veterans with CHD by improving concordance with national treatment guidelines. As part of IHD-QUERI, we extracted data on all active primary care and cardiology patients with CHD from 8 VA hospitals in the Pacific Northwest from an existing relational database. This database contains data from the clinical information systems at each of the 8 facilities, including patient demographics, outpatient and inpatient diagnoses, pharmacy records, and laboratory data.

Any lipid level measured within 15 months before the October 1, 1998 index date was included in the analyses as a "current" lipid measurement. Although the National Cholesterol Education Program, Adult Treatment Panel III guidelines recommend yearly LDL cholesterol measurements, the 15-month cutoff was chosen to account for the practicalities of clinical care.[8] The 15 months before October 1, 1998 were defined as the baseline period.

Prescription of any lipid-lowering medication was determined using VA pharmacy prescription data. Patients with a current lipid-lowering medication prescription were defined as those who were dispensed a 3-hydroxy-3-methylglutaryl coenzyme-A reductase inhibitor (statins), fibric acid derivatives, or bile acid sequestrants within the 12 months before October 1, 1998. A current prescription for β-adrenergic blocking agents was defined in a similar fashion.

Patients were included in the analyses if they were active patients in primary care or cardiology clinics in the Northwest VA hospital facilities and if they had known CHD. The VA facilities were located in Alaska (Anchorage), Idaho (Boise), Oregon (Portland, Roseburg, and White City), and Washington (Puget Sound, Spokane, and Walla Walla). Active patients were defined as being alive on October 1, 1998 and having ≥ 1 primary care or cardiology clinic visit per year in each of the 2 previous years. Patients were defined as having CHD if they met ≥ 1 of the following criteria: (1) percutaneous transluminal coronary angioplasty or coronary artery bypass graft surgery performed at any VA facility; (2) a hospital discharge diagnosis of myocardial infarction or unstable angina (*International Classification of Diseases*, 9th Revision (ICD-9) codes 410 to 411); (3) a hospital discharge diagnosis of previous myocardial infarction, stable angina, or other chronic CHD (ICD-9 codes 412 to 414); (4) >1 outpatient visit at a Northwest Network VA facility with a CHD diagnosis (ICD-9 code(s) 410 to 414) in the 12 months before October 1, 1998 and ≥ 3 prescriptions filled with a nitrate antianginal medication(s); or (5) a recorded history of percutaneous transluminal coronary angioplasty or coronary artery bypass grafting (ICD-9 codes V45.81, V45.82).

We reviewed inpatient discharge diagnoses and procedures from Septemer 3, 1986 to October 1, 1998 and outpatient diagnoses for the 12 months before October 1, 1998. This algorithm was then validated with chart review of 306 patients. Overall, a large proportion of patients met criteria for CHD on >1 level of the identification algorithm. The degree of corroboration for the diagnosis of CHD from chart review ranged from 98% for criteria 4 to 68% for criteria 5, which is not surprising because the purpose of the V-codes is to document procedures occurring outside the treating facility. Using these criteria, 12,135 patients were determined to have CHD and comprised the study population. Patient follow-up occurred through December 31, 2000.

Co-morbidities were defined by the following ICD-9 codes from the current year outpatient diagnoses: diabetes (250), hypertension (401), chronic obstructive pulmonary disease (490 to 496, 500 to 505), peripheral vascular disease (440.2, 441 to 443, V434), cerebrovascular disease (433 to 437), congestive heart failure (428), and depression (311).

Distance to medical center was calculated using the

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TABLE 1 Baseline Characteristics of Patients With Ischemic Heart Disease (n = 12,135)

Characteristic	LDL Measured: Yes (n = 7,188)	LDL Measured: No (n = 4,947)	p Value
Age (yrs)	67 ± 10	71 ± 10	<0.0001
Men	98.2%	97.5%	0.008
Race			0.004
African-American	2.7%	3.0%	
Caucasian	89.4%	90.4%	
Hispanic	0.9%	0.8%	
Other	1.1%	1.2%	
Unknown	5.8%	4.3%	
History of			
Myocardial infarction	21.1%	16.5%	<0.0001
Diabetes mellitus	33.7%	27.1%	<0.0001
Hypertension	66.9%	54.6%	<0.0001
Percutaneous coronary intervention	13.2%	7.5%	<0.0001
Coronary artery bypass surgery	33.4%	23.7%	<0.0001
Chronic obstructive pulmonary disease	44.8%	52.1%	<0.0001
Cerebrovascular disease	23.7%	24.4%	0.39
Peripheral vascular disease	9.1%	9.7%	0.20
Congestive heart failure	18.7%	23.1%	<0.0001
Depression	22.3%	22.3%	0.95
Lipid-lowering medication prescription	64.0%	18.4%	<0.0001
Statin prescription	58.2%	15.6%	<0.0001
β-blocker prescription	53.2%	35.4%	<0.0001
No. of visits during the previous year	5.3 ± 3.7	4.8 ± 3.5	<0.0001
Residence >25 miles from medical center	51.3%	52.7%	0.12

TABLE 2 Multivariate Predictors of Having a LDL Measurement (n = 12,135)*†

Variable	Odds Ratio	95% Confidence Interval
History of hypertension	1.55	1.43–1.68
β-blocker prescription	1.52	1.40–1.64
History of diabetes	1.25	1.14–1.36
Hispanic race	1.14	0.75–1.72
Residence >25 miles from medical center	0.90	0.84–0.98
History of depression	0.82	0.74–0.90
History of chronic obstructive pulmonary disease	0.78	0.72–0.85
African-American race	0.74	0.59–0.94
Age (per 10-yr increase)	0.66	0.63–0.68

*An odds ratio <1.0 indicates a decrease in likelihood of LDL measurement.
†Adjusted for qualifying criteria for CHD, co-morbidities, medication prescription, and patient demographics.

longitude and latitude coordinates of a patient's home address, based on their zip code and the longitude and latitude coordinates of the medical center based on the medical center zip code.[9]

The study design was approved by the Human Subjects Division at the University of Washington and by the appropriate committees at each VA facility involved in the study.

Multivariate logistic regression was used to determine patient characteristics associated with not having a LDL measurement, which was the dependent or outcome variable. The candidate predictors, demographics, and cardiac and noncardiac variables, as listed in Table 1, were entered into the logistic regression models using a backward selection method. Next, Cox proportional hazards regression was used to determine predictors of survival during the follow-up period. All variables, as listed in Table 1, except the LDL measurement status, were entered using backward selection to create a baseline survival model, with a $p < 0.05$ to allow the variable to stay in the model. Then, the LDL measurement variable was forced into the model to determine its independent association with survival. Statistical analyses were performed using SPSS (version 11.0; SPSS Inc., Chicago, Illinois) and Stata (release 6; Stata Corp., College Station, Texas).

Characteristics of the study population, stratified by the presence or absence of a LDL measurement, are listed in Table 1. Overall, 40.7% of the patients did not have a LDL measurement during the 15-month baseline period. Patients without a LDL measurement were older and more likely to have a history of congestive heart failure or chronic obstructive pulmonary disease compared with patients with a LDL measurement. In addition, patients without a LDL measurement were less likely to have a history of myocardial infarction, diabetes, hypertension, or revascularization procedures; they were also less likely to be prescribed lipid-lowering medications or β blockers.

In multivariate logistic regression analyses, patients of African-American race and those with a history of chronic obstructive pulmonary disease or depression were less likely to have a baseline LDL measurement (Table 2). Patients who lived >25 miles from the medical center and older patients were also less likely to have a LDL measurement.

During an average follow-up period of 1.8 ± 0.6 years, patients without a baseline LDL measurement had higher hospitalization rates and worse survival compared with patients with a baseline LDL measurement (Table 3).

In Cox proportional hazards regression, patients with a history of congestive heart failure had the highest risk for death during the follow-up period (Table 4). Older patients and those with a history of myocardial infarction, chronic obstructive pulmonary disease, diabetes, cerebrovascular disease, and peripheral vascular disease also had worse survival. In contrast, male patients, those prescribed a lipid-lowering medication, and those prescribed β blockers had better survival. After adjustment for all of these factors, the absence of a baseline LDL measurement was associated with a 36% worse survival during the follow-up period (hazard ratio 0.64, 95% confidence interval

TABLE 3 Follow-up Unadjusted Survival and Hospitalization Rates

Characteristic	LDL Measured: Yes (n = 7,188)	LDL Measured: No (n = 4,947)	p Value
Survival	95%	89%	<0.0001
Any hospitalization	29%	34%	<0.0001
Hospitalization for acute myocardial infarction	3%	3%	0.25
Hospitalization for congestive heart failure	14%	16%	0.017
Percutaneous coronary intervention	1%	1%	0.09
Coronary artery bypass surgery	1%	1%	0.24

TABLE 4 Predictors of Survival from Cox Regression Analysis*†

Variable	Hazard Ratio	95% Confidence Interval
History of congestive heart failure	2.23	2.01–2.47
Age (per 10-yr increase)	1.51	1.42–1.60
History of		
Myocardial infarction	1.46	1.26–1.69
Chronic obstructive pulmonary disease	1.42	1.28–1.57
Diabetes mellitus	1.33	1.20–1.47
Cerebrovascular disease	1.27	1.15–1.41
Peripheral vascular disease	1.22	1.06–1.41
African-American race	1.20	0.92–1.58
History of depression	1.11	1.00–1.24
β-blocker prescription	0.84	0.76–0.93
Lipid-lowering medication prescription	0.80	0.72–0.90
Male sex	0.75	0.62–0.91
LDL measurement	0.64	0.58–0.70

*A hazard ratio <1.0 indicates improved survival.
†Adjusted for qualifying diagnosis for CHD, co-morbidities, medication prescription, and patient demographics.

0.58 to 0.70) compared with patients with a baseline LDL measurement.

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We found that >40% of patients with CHD did not have a LDL measurement over the 15-month baseline period. Older patients, those with a history of chronic obstructive pulmonary disease or depression, patients of African-American race, and those who lived farther from the medical center were less likely to have a lipid measurement. During the follow-up period, patients without a baseline LDL measurement had increased morbidity and mortality, including a 5% higher hospitalization rate and a 36% worse survival, even after adjustment for baseline patient characteristics.

We identified patients at risk for not undergoing a LDL measurement and evaluated their outcomes because they are often overlooked in the literature. The finding of increased morbidity and mortality in this group of patients is hypothesis-generating and should be explored further. Future interventions to improve the quality of care for patients with CHD should focus on increasing LDL measurements and lipid-lowering medication use.

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