Secondary Prevention of Coronary Artery Disease: Lipid Management as a Priority for Improvement

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• **Objective:** To determine the extent to which outpatients with coronary artery disease (CAD) receive adequate secondary prevention and to identify predictors of these services.

• **Design:** Cross-sectional study linking administrative and laboratory data with medical record review.

• **Setting:** Outpatient practices affiliated with a large, urban, academic health center.

• **Participants:** 3920 patients with CAD seen in outpatient practices during fiscal year 1997.

• **Measurements:** Over a 2-year study period, demographic and laboratory information were collected on all patients, and a medical record review was performed on 302 patients with confirmed CAD to determine blood pressures, comorbidities, and medications.

• **Results:** 83% of patients received a low-density lipoprotein (LDL) cholesterol test during the study period. The last LDL level was ≤ 100 mg/dL in only 34% of patients. 65% of patients had an average blood pressure less than 140/90 mm Hg. 75% of patients were prescribed a β-blocker, and 86% were prescribed aspirin. In multivariable models, an LDL level less than 130 mg/dL was less likely among patients 71 to 80 years of age (odds ratio [OR], 0.76 [95% confidence interval {CI}, 0.65–0.89]), female patients (OR, 0.58 [CI, 0.51–0.68]), and those whose type of insurance indicated lower socioeconomic status (OR, 0.78 [CI, 0.66–0.93]). Women were less likely to have a blood pressure below 140/90 mm Hg (OR, 0.44 [CI, 0.24–0.81]).

• **Conclusions:** Even at a major academic medical center, there is substantial room for improvement in outpatient secondary prevention of CAD. Deficiencies were greatest in lipid management, where nonclinical factors were prominent predictors. Older patients and women also were less likely to receive adequate secondary prevention. These findings suggest specific risk factors and subpopulations that should be targeted for quality improvement.

**Recommendations for long-term treatment of patients with coronary artery disease (CAD) have emerged from drug development research, population studies, and clinical trials. However, the full benefits of this research cannot be realized unless these recommendations are followed. Efforts to make clinical practice more consistent with current guidelines will have a great impact on public health. To make these efforts more effective, it is vital to understand where practice currently falls short of the ideal and to determine the factors that predict these shortcomings.**

CAD is the leading cause of death in the United States, accounting for 1.1 million myocardial infarctions and almost 500,000 deaths in 2000. The cost of medical care and lost economic productivity due to CAD is estimated to be over $100 billion annually [1]. A substantial portion of morbidity and mortality occurs in patients already known to have CAD. This makes the prevention of recurrent cardiac events, or secondary prevention, a key clinical strategy in CAD management [2,3].

While there are many facets to secondary prevention, the following strategies are among the most formalized, evidence-based, measurable, and widely recommended:

1. **Lipid management:** Fasting lipid panels and control of low-density lipoprotein (LDL) cholesterol levels to a goal of less than 2.6 mmol/L (100 mg/dL) in all patients with CAD [4,5].

2. **Blood pressure management:** To a goal of less than 140/90 mm Hg in all patients with CAD, and less than 130/85 mm Hg in patients with heart failure, renal insufficiency, or diabetes mellitus [4,6].

3. **β-adrenergic antagonists (β blockers):** In all patients status post myocardial infarction or acute ischemia [7,8], and in other patients with CAD as needed for angina, rhythm, or blood pressure control [4].

4. **Aspirin:** In all patients with coronary disease [4,9,10]; warfarin or clopidogrel may be substituted in patients who cannot take aspirin [4].

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Secondary Prevention of CAD

Despite the wealth of data confirming the benefits of these interventions, these measures have not been universally adopted in clinical practice, particularly in the outpatient setting [11–13]. In different populations of patients with CAD, only 25% to 67% had received recent lipid testing [14–21]. Among tested patients, 37% to 61% had an LDL level less than 3.4 mmol/L (130 mg/dL) [18,21–23], and only 10% to 25% had an LDL level below 2.6 mmol/L (100 mg/dL) [18,19,21–23]. Drug treatment, principally with hydroxymethylglutaryl-CoA-reductase inhibitors (“statins”), was prescribed in 8% to 39% of CAD patients [11,12,14,15,17–19,21,23–26].

Studies of blood pressure control found that 59% to 75% of patients with CAD had a blood pressure less than 160/90 mm Hg [11,16,27], and 30% to 46% of patients had a blood pressure less than 140/90 mm Hg [12,20]. Reports of outpatient utilization of β blockers have shown rates of use between 31% and 58% [11,12,16,24,28–33]. Aspirin use has been recorded in 56% to 81% of eligible patients [11,12,16,24,27,29,33].

Many past studies have focused on patients with recent hospitalizations for acute coronary syndromes. Because of increased attention focused on hospitalized patients, these studies may overestimate adherence to recommended secondary prevention activities among all patients with CAD. To better define patterns of outpatient secondary prevention activities, we have performed a comparative analysis of the levels and predictors of CAD management among a primary care population with long-standing CAD.

Methods

Patients

The study population consisted of 3920 patients with a diagnosis of CAD, based on electronic billing information (ICD-9 codes 410.0–414.99), who were seen at least once in 1 of 9 Massachusetts General Hospital (MGH) outpatient practices between 1 October 1996 and 30 September 1997. The 9 primary care practices included practices associated with the Massachusetts General Physician Organization, hospital-based practices, and practices at MGH-affiliated health centers. These practices account for approximately 70% of all MGH outpatient visits. All providers in these practices are primary care physicians trained in internal medicine. Exclusion criteria included patient age greater than 85 years before 1 October 1996, a diagnosis of metastatic cancer, discharge to a nursing home, or death before 30 September 1998.

For a randomly selected 10% of the cohort (n = 379), we performed a detailed medical record review to confirm the diagnosis of coronary disease and obtain information regarding medication use, comorbidities, and blood pressure measurements. CAD was defined as a medical problem of coronary disease, angina, or history of myocardial infarction; a documented positive exercise tolerance test, pharmacologic stress test, or coronary angiography; or history of percutaneous transluminal coronary angioplasty or coronary artery bypass graft surgery. Of the 379 patients, 302 (80%) were deemed eligible for the study. Reasons for exclusion among the other 77 patients included lack of evidence of coronary disease in the medical record (n = 37), chart unavailable (16), no patient data during the study period (5), no primary care physician at MGH (5), and other exclusion criteria (14). Included and excluded patients were comparable in terms of sex (63% versus 65% male, P = 0.70) and median age (71 versus 73 years, P = 0.36).

Outcome Measures

Five indicators of adequate secondary prevention of CAD were measured during the study period between 1 October 1996 and 30 September 1998: cholesterol testing, cholesterol level, blood pressure level, β-blocker use, and aspirin use. Because patients were identified by 30 September 1997 and were evaluated through 30 September 1998, physicians had at least 1 year from the diagnosis of CAD, and often substantially longer, to institute these prevention strategies.

For data on lipid testing and levels, we used the MGH Patient Care Information System (PCIS), a computerized laboratory database, to determine whether a LDL cholesterol level was measured during the 2-year study period and, if available, the last reported value. Blood pressure measurements were calculated as the mean of the values during the last 2 patient visits during the study period. Aspirin and β-blocker use were defined as the presence of these medications on a medication list at least once during the study period (for aspirin use, once daily or every other day, non-as-needed orders were required, and clear mention of aspirin for analgesic or anti-inflammatory purposes was excluded). Use of other antiplatelet agents or anticoagulants was considered to meet the performance measure for aspirin use. The use of anti-arrhythmic agents with β-blocker activity (eg, amiodarone or sotalol) were included as β blockers.

Predictors of Adherence to Prevention Strategies

To gain insight into the predictors of practice variation in secondary prevention, we collected information on several variables at the patient, physician, and practice level. These included demographics such as patient age, sex, race, primary and secondary insurance coverage, and zip code, as determined from electronic billing records. As proxies for socioeconomic status (SES), we considered certain types of insurance status (including Medicaid or Medicaid-affiliated insurance, Medicare without secondary insurance, free care, self-pay, or general relief) as markers of lower SES, and also calculated the median income of each zip code (using the Sourcebook of Zip Code Demographics [34]). An overlapping set
of patients whose insurance status indicated Medicare without secondary insurance, self-pay, partial free care, or general relief were considered not to have insurance coverage of medications. We also noted if a patient was hospitalized for CAD during the study period.

Physician-level data were collected using hospital credentialing records and billing data and included physician sex, postgraduate year, and total number of patient visits per year. We also examined practice site as an explanatory variable to investigate the potential role of health system factors separate from patient or physician factors.

In the subset of 302 patients, we examined possible medication contraindications or other “acceptable reasons” for lack of achievement of each prevention strategy, based on each patient’s comorbidities, other medications, allergies, number of visits, and other possible explanations offered in the medical record. Information on medication use, medical conditions, and allergies was abstracted from the medical record for all patients, except those in one practice that used a simplified electronic medical record to track this information. The reliability of this system was verified using standard chart review of 20 patients (average kappa for medication contraindications and statin data was 0.78). Starting and maximum statin doses were based on the American Hospital Formulary Service [35].

### Statistical Analyses

The primary outcome was the proportion of patients who met each secondary prevention performance indicator. For the analyses of lipid and blood pressure management, we chose modest goals of LDL less than 3.4 mmol/L (130 mg/dL) and blood pressure less than 140/90 mm Hg. Values above these thresholds could clearly be considered suboptimal management. For blood pressure, we also noted the number of patients who met JNC-VI criteria (blood pressure < 130/85 mm Hg in patients with heart failure, renal insufficiency, or diabetes mellitus, and blood pressure < 140/90 mm Hg in all other patients with CAD) [6]. Analyses of lipid control were performed on both the entire cohort and the subset of 302 patients subjected to medical record review, while the analyses of blood pressure levels, β-blocker use, and aspirin use were based only on the subset. Univariable predictors of each outcome were tested using chi-square or Fisher’s exact tests, with age divided into 4 groups (≤ 60, 61–70, 71–80, > 80 years). Multivariable analyses also were conducted using logistic regression models and including a common set of predictors based on the results of univariable testing, as well as variables unique to each prevention strategy (eg, asthma and heart failure in the model of β-blocker use).

To account for the effects of clustering of patients with the same physician, we also repeated the logistic regression analyses employing general estimating equations (GEE). Because of the small number of patients relative to the number of physicians in the study (an average of only 17 patients per physician) and the lack of intra-class correlation among visits to the same physician, results were essentially unchanged using GEE compared with standard logistic regression; therefore, the unclustered analyses are presented here.

For all statistical tests, 2-sided P values ≤ 0.05 were considered significant. All analyses were conducted using SAS 7.0 (Cary, NC). This study was approved by the institutional review board of MGH.

### Results

Table 1 presents the characteristics of the entire study cohort of 3920 patients and the subset of 302 patients subjected to medical record review. Except for a 2-year difference in age (P = 0.004), there were no statistically significant differences between the subset and the entire cohort. Compared with most studies of patients with newly diagnosed coronary

### Table 1. Characteristics of Outpatients with Coronary Artery Disease

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Entire Cohort (n = 3920)</th>
<th>Subset (n = 302)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median age, yr (interquartile range)*</td>
<td>69 (61–76)</td>
<td>71 (63–77)</td>
</tr>
<tr>
<td>Male, n (%)</td>
<td>2422 (62)</td>
<td>187 (62)</td>
</tr>
<tr>
<td>Race, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>3469 (88)</td>
<td>275 (91)</td>
</tr>
<tr>
<td>Nonwhite</td>
<td>342 (9)</td>
<td>19 (6)</td>
</tr>
<tr>
<td>Unknown</td>
<td>109 (3)</td>
<td>8 (3)</td>
</tr>
<tr>
<td>Median household income ($ (interquartile range)</td>
<td>38,254 (34,008–44,725)</td>
<td>38,947 (34,797–45,470)</td>
</tr>
<tr>
<td>No insurance coverage of medications, n (%)</td>
<td>103 (4)</td>
<td>11 (4)</td>
</tr>
<tr>
<td>Lower socioeconomic status by type of insurance, n (%)</td>
<td>930 (24)</td>
<td>60 (20)</td>
</tr>
<tr>
<td>Hospitalization for CAD, n (%)</td>
<td>1096 (28)</td>
<td>72 (24)</td>
</tr>
<tr>
<td>Comorbidities, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>60 (20)</td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>88 (29)</td>
<td></td>
</tr>
<tr>
<td>Asthma/COPD</td>
<td>64 (21)</td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>43 (14)</td>
<td></td>
</tr>
<tr>
<td>Impotence</td>
<td>21 (7)</td>
<td></td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>36 (12)</td>
<td></td>
</tr>
<tr>
<td>History of gastrointestinal bleed</td>
<td>25 (8)</td>
<td></td>
</tr>
<tr>
<td>Peptic ulcer disease</td>
<td>24 (8)</td>
<td></td>
</tr>
</tbody>
</table>

CAD = coronary artery disease; COPD = chronic obstructive pulmonary disease.

*P < 0.01 for comparison; all other comparisons nonsignificant.
Adherence to Secondary Prevention Guidelines
A comparison of the different prevention strategies shows that practices were most deficient in the area of lipid management (Figure). The last LDL level during the study period was less than 2.6 mmol/L (100 mg/dL) in only 34% of patients, while 19% had an LDL ≥ 3.4 mmol/L (130 mg/dL), and 17% never received an LDL test during the 2-year time period. Results using the entire cohort of 3920 patients were virtually identical to those shown for the patient subset (33% LDL < 2.6 mmol/L, 20% ≥ 3.4 mmol/L, 17% not tested).

Among the 302 patients in the subset, 190 (63%) were on lipid-lowering medication, including 177 (59%) on a statin. Among patients with an LDL greater than 130 mg/dL, 41% were on no medication, 16% were on a starting dose of a statin, and only 5% were on a maximum dose. Among untested patients, 69% were not on any type of lipid-lowering medication. In contrast, among 102 patients with optimal lipid management (LDL < 100 mg/dL), only 23% were able to achieve this goal without any medication.

Blood pressure levels also were higher than expected (Figure). Forty-two percent of patients had an optimal or normal blood pressure (systolic < 130 mm Hg, diastolic < 85 mm Hg), while an additional 23% had high-normal blood pressure (130–139/85–89 mm Hg), 27% had stage 1 hypertension (140–159/90–99 mm Hg), 4% had stage 2 or 3 hypertension, and 4% did not have a documented blood pressure measurement during the time period. Using JNC-VI criteria, 53% of patients could be considered adequately controlled. Among the 108 patients with elevated blood pressure, 101 (94%) were on at least one antihypertensive medication.

In contrast to lipid and blood pressure management, use of cardioprotective medications was considerably better; 75% of patients were prescribed a β blocker, and 86% were prescribed aspirin during the study period.

Predictors of CAD Management
An analysis of the entire cohort of 3920 CAD patients shows several patient factors to be associated with lower lipid levels (Table 2). Male patients were 24% more likely than females to have adequate lipid management (67% versus 54%). Patients recently hospitalized for CAD also were more likely to have lower lipid levels (65% versus 61%, P = 0.01). The effect of patient age was curvilinear, with patients 61 to 70 years of age the most likely to have lower lipid levels compared with older or younger patients. Both lack of insurance coverage of medications and lower SES by insurance type were significant predictors of high lipid levels, as was nonwhite race (46% versus 37% compared with whites, P = 0.002). Median income by zip code was a small but significant predictor, with higher incomes associated with more frequent lipid control. Of note, elevated transaminases (greater than 2 times normal) had no effect on lipid control (68% versus 66%, P = 0.51). In the subset of 302 patients whose CAD was confirmed through medical record review, similar trends were seen, although not all the findings were statistically significant due to the smaller sample size (Table 2).

In a multivariable model of the entire cohort (Table 3), male sex, middle age, higher SES by insurance type, and insurance coverage of medications remained significant predictors of adequate lipid management, as was hospitalization for CAD (odds ratio [OR], 1.28 [95% confidence interval [CI]], 1.10–1.48). Race and income by zip code were not independent predictors in this model. In the subset analysis, the magnitude
of the effects was comparable despite additional adjustment for reasons for lack of testing (such as lab results from outside hospitals) or reasons for elevated LDL levels (including only 1 or 2 outpatient visits during the study period, nonadherence with medications, inability to afford medications, or statin allergy). Among the 199 patients without any listed reason for lack of testing or high LDL levels, 138 (69%) had an LDL level less than 130 mg/dL.

In a univariable analysis of blood pressures less than 140/90 mm Hg (Table 2), patients 71 to 80 years of age were less likely to have lower blood pressures than younger patients, as were women, patients nonadherent with their medication regimens (as defined by their physicians; 34% versus 67%, \(P = 0.001\)), or patients on at least 3 antihypertensive medications (45% versus 68%, \(P = 0.003\)). Insurance coverage of medications was of borderline significance in predicting adequate blood pressure control. In a multivariable model, male sex remained a significant predictor of lower blood pressure levels (OR, 2.28 [95% CI, 1.23–4.23]; Table 3). Among patients without any recorded reason for an elevated blood pressure, 74% had a blood pressure less than 140/90 mm Hg.

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There was a trend for older patients to be treated less consistently with \(\beta\)-blockers (Table 2). Intolerance to \(\beta\)-blockade, as noted in the chart for 29 patients (10%), was significantly but not absolutely associated with lack of \(\beta\)-blocker use (49% versus 78%, \(P = 0.0005\)). In a multivariable model, only \(\beta\)-blocker intolerance was a significant predictor of diminished use. Among patients lacking contraindications, 84 of 106 (79%) were prescribed a \(\beta\)-blocker.

There were few predictors of the use of aspirin or other antithrombotics. In univariable analyses, male sex was of borderline significance (Table 2). In a multivariable model, only aspirin allergy/intolerance and other reason for lack of use were significant predictors. Among patients without any contraindications, 88% were prescribed aspirin or another antithrombotic agent.

Variations by Physician Factors and Practice Site

Female physician sex was of borderline statistical significance in predicting adequate blood pressure control in multivariable analyses (OR, 2.04 [95% CI, 0.99–4.17]). Physicians in the oldest quartile (> 25 years since medical school graduation) were less likely to have patients with adequate lipid control (OR, 0.71 [95% CI, 0.58–0.86]). Otherwise, there were no significant differences in secondary prevention practices by physician age, sex, or number of patient visits.

In contrast, we noted several differences in the provision of secondary prevention strategies by practice site (Table 4). Coefficients of variation (a measure of variability among practice sites) was in the 9.3% to 11.4% range, and the differences

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**Table 2. Univariate Analysis of Secondary Prevention**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>LDL &lt; 130 mg/dL Entire Cohort ((n = 3920))</th>
<th>LDL &lt; 130 mg/dL Subset ((n = 302))</th>
<th>BP &lt; 140/90 mm Hg Subset ((n = 302))</th>
<th>(\beta)-Blocker Use Subset ((n = 302))</th>
<th>Aspirin Use Subset ((n = 302))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>(&lt; 0.0001)</td>
<td>0.09</td>
<td>0.004</td>
<td>0.17</td>
<td>0.08</td>
</tr>
<tr>
<td>Male</td>
<td>1626/2422 (67)</td>
<td>126/187 (67)</td>
<td>132/187 (71)</td>
<td>145/187 (78)</td>
<td>167/187 (89)</td>
</tr>
<tr>
<td>Female</td>
<td>803/1498 (54)</td>
<td>66/115 (57)</td>
<td>62/115 (54)</td>
<td>81/115 (70)</td>
<td>94/115 (82)</td>
</tr>
<tr>
<td>Age</td>
<td>(&lt; 0.001)</td>
<td>0.08</td>
<td>0.001</td>
<td>0.21*</td>
<td>0.47</td>
</tr>
<tr>
<td>(\leq 60) yr</td>
<td>546/901 (61)</td>
<td>35/58 (60)</td>
<td>47/58 (81)</td>
<td>47/58 (81)</td>
<td>52/58 (90)</td>
</tr>
<tr>
<td>61–70 yr</td>
<td>833/1240 (67)</td>
<td>58/82 (71)</td>
<td>56/82 (68)</td>
<td>65/82 (79)</td>
<td>73/82 (89)</td>
</tr>
<tr>
<td>71–80 yr</td>
<td>856/1419 (60)</td>
<td>80/122 (66)</td>
<td>63/122 (52)</td>
<td>88/122 (72)</td>
<td>104/122 (85)</td>
</tr>
<tr>
<td>&gt; 80 yr</td>
<td>194/360 (54)</td>
<td>19/40 (48)</td>
<td>28/40 (70)</td>
<td>26/40 (65)</td>
<td>32/40 (80)</td>
</tr>
<tr>
<td>Insurance coverage of medications</td>
<td>(&lt; 0.0001)</td>
<td>0.21</td>
<td>0.06</td>
<td>0.74</td>
<td>0.65</td>
</tr>
<tr>
<td>Yes</td>
<td>2353/3755 (63)</td>
<td>187/291 (64)</td>
<td>190/291 (65)</td>
<td>217/291 (75)</td>
<td>252/291 (87)</td>
</tr>
<tr>
<td>No</td>
<td>76/163 (47)</td>
<td>5/11 (45)</td>
<td>4/11 (36)</td>
<td>9/11 (82)</td>
<td>9/11 (82)</td>
</tr>
<tr>
<td>Lower SES by insurance</td>
<td>(&lt; 0.0001)</td>
<td>0.004</td>
<td>0.18</td>
<td>0.62</td>
<td>0.68</td>
</tr>
<tr>
<td>Yes</td>
<td>509/930 (55)</td>
<td>28/60 (47)</td>
<td>34/60 (57)</td>
<td>47/60 (78)</td>
<td>51/60 (85)</td>
</tr>
<tr>
<td>No</td>
<td>1920/2988 (64)</td>
<td>164/242 (68)</td>
<td>160/242 (66)</td>
<td>179/242 (74)</td>
<td>210/242 (87)</td>
</tr>
</tbody>
</table>

\*\(P < 0.01\) for trend.

BP = blood pressure; LDL = low-density lipoprotein; SES = socioeconomic status.
were statistically significant for the analysis of LDL levels among the entire cohort (P < 0.0001). Certain practices consistently performed above average (Site 2) or below average (Site 4) across prevention strategies. When practice site was added to each of the multivariable analyses, we found several significant differences among sites in each of the performance measures, even when adjusting for several patient and physician variables.

**Discussion**

The findings from this study show that at outpatient practices affiliated with a major academic medical center, there is substantial room for improvement in the secondary prevention of CAD. Deficiencies were greatest in the area of lipid management. Deficiencies also were noted in blood pressure control and less so in the provision of \( \beta \) blockers or aspirin. Compared with other national and international studies, provision of secondary prevention strategies was better at MGH than at most sites, but still far from optimal. Other studies also have noted difficulties with lipid management compared with provision of other components of secondary prevention, although not always as pronounced as those we observed [11,16,27,36]. It is significant that this gap exists at practices affiliated with an academic medical center and despite the results of statin trials having been available to all physicians for several years.

Analysis of predictors of lipid management showed variations by patient sex, age, SES, and insurance coverage of medications. Other studies also have shown variations in lipid management on the basis of age (fewer services in both younger and older patients), sex, and insurance status [14,21,25,27,37]. Physicians may be reluctant to treat older patients with lipid-lowering agents given the lack of randomized trial data in patients over 75 years of age. Nevertheless, a meta-analysis of these studies [38] has shown no difference in relative benefit (and an increase in absolute benefit) as patient age increases, and there is no reason to believe that this trend stops after age 75 years. Variations on the basis of sex and SES are more difficult to rationalize. Other studies have shown less aggressive care of women with CAD in other areas of treatment [39], and this may be another manifestation of this phenomenon. Patients recently hospitalized for CAD were more likely to have better lipid control, highlighting the importance of studying patients with prevalent CAD and not just patients with recent acute coronary events.

It is noteworthy that SES was most significantly associated with lipid management compared with the other secondary prevention strategies, given that lipid management,
particularly with the use of statins, is probably the most expensive of the 4 interventions.

Differences by practice site, even when adjusted for several patient and physician factors, suggest that some variations in care are due to factors at the health system level, although we cannot rule out the possibility of unmeasured patient factors (such as primary language). Such health system factors might include methods of record keeping, nursing practices, or the prevention-mindedness of the practice. Differences on the basis of physician sex and age are intriguing and should be investigated further in a study designed and powered to detect such findings.

Consistent with the lipid management results, we also found deficiencies in blood pressure management among female patients and older patients. As almost every patient with hypertension was receiving some kind of antihypertensive medication, the effect of age may reflect the natural history of hypertension in the elderly, rather than an unwillingness to treat. Nevertheless, if older individuals require more aggressive treatment as they age, then they should receive it. This is particularly true given the increased potential benefits of prevention in the elderly.

Concerning β-blocker use, we saw a trend for older patients not to be treated, a trend noted in other studies [30–32,40–42]. Interestingly, we did not see a relationship between β-blocker use and most commonly cited relative contraindications, including asthma, chronic obstructive pulmonary disease, and depression. This finding suggests that the mere presence of a relative contraindication on a medical problem list should not preclude a physician from attempting to start a patient on a β blocker.

As the vast majority of patients were taking aspirin or another suitable substitute, it was difficult for us to determine predictors of its use. While 86% aspirin use may sound close to ideal, other institutions have achieved rates close to 97% [36], so it is possible that there is still room for improvement even in this area.

The results of this study should be viewed in light of certain limitations. First, this study may not be generalizable to the practice patterns of all outpatient practices in the United States. Our study is instructive as a comparative analysis of the shortcomings of outpatient internal medicine practices associated with a large teaching hospital. Of note, our results were consistent with those shown in other practice settings.

Second, the sample size of the subset subjected to medical record review may have been too small to detect all the clinically relevant predictors of secondary prevention. Fortunately, for the lipid analyses, we had the advantage of also relying on the entire study population. We found the results of the lipid analyses for the entire population and the subset to be of very similar direction and magnitude. This finding justified the use of the entire population in the lipid analyses and allowed us to take advantage of the increased sample size. As with all quality improvement research that relies on medical records, this study could only detect provision of secondary prevention strategies (or contraindications) that were mentioned in the chart or from electronic sources. The cross-sectional nature of the study also made it difficult to detect prior intolerance to medications, or to capture detailed information about responses to treatment or the frequency of dose adjustments.

Finally, it may not be fair to compare outcomes dependent only on physician intent (ie, prescribing aspirin and β blockers) with outcomes additionally dependent on patient adherence with medications and responsiveness to treatment (blood

| Table 4. Variation in the Provision of Secondary Prevention Strategies by Practice Site |
|---|---|---|---|---|---|
| Site | LDL < 130 mg/dL | LDL < 130 mg/dL | BP < 140/90 mm Hg | β-Blocker Use | Aspirin |
| Use | Entire Cohort (n = 3920) | Subset (n = 302) | Subset (n = 302) | Subset (n = 302) | Subset (n = 302) |
| 1 | 49/94 (52) | 5/7 (71) | 4/7 (57) | 5/7 (71) | 5/7 (71) |
| 2 | 505/716 (71) | 48/66 (73) | 46/66 (70) | 45/66 (68) | 61/66 (92) |
| 3 | 191/315 (66) | 23/26 (65) | 21/23 (65) | 20/23 (65) | 20/23 (65) |
| 4 | 263/493 (53) | 19/37 (51) | 22/37 (59) | 23/37 (62) | 28/37 (76) |
| 5 | 453/671 (68) | 32/53 (60) | 22/37 (57) | 39/53 (74) | 46/53 (87) |
| 6 | 33/564 (59) | 25/38 (66) | 30/53 (63) | 30/53 (79) | 29/38 (67) |
| 7 | 355/567 (63) | 26/39 (67) | 24/38 (72) | 33/39 (85) | 37/39 (95) |
| 8 | 228/405 (56) | 16/30 (53) | 28/39 (60) | 23/30 (77) | 26/30 (87) |
| 9 | 54/95 (57) | 6/9 (67) | 7/9 (78) | 7/9 (78) | 8/9 (89) |
| P value | < 0.0001 | 0.55 | 0.79 | 0.23 | 0.11 |
| Coefficient of variation, % | 9.7 | 11.4 | 9.3 | 10.8 | 8.3 |
pressure and LDL levels). On the other hand, all 4 of these outcomes are considered the standard of care in patients with CAD and will likely be the focus of future health care scrutiny (eg, “Get With The Guidelines,” sponsored by the American Heart Association, which uses similar methodologies [43]).

The results of this study have several implications for future efforts to improve the quality of care of patients with CAD. First, they suggest that any CAD quality improvement intervention should focus first on lipid management. Given the current state of medical practice and the benefits of achieving National Cholesterol Education Program goals in patients with existing CAD, improving adherence with lipid guidelines alone would have a tremendous impact on morbidity and mortality. For example, using the results of secondary prevention statin trials [44–46] and assuming that the 12 million Americans with prevalent CAD currently achieved lipid management similar to that achieved at MGH, then reducing the LDL to 100 mg/dL among patients with untested LDL levels or LDL greater than 130 mg/dL would prevent approximately 220,000 coronary events, including 100,000 coronary deaths, over 5 years.

Second, this study suggests that certain types of quality improvement interventions may be more effective than others. Deficiencies on the basis of patient age and sex may be amenable to interventions such as physician education (eg, regarding the magnitude and timing of benefit of lipid lowering in the elderly) and feedback (eg, regarding undertreatment of women). In contrast, deficiencies on the basis of SES may be less amenable to physician-level interventions and may require system-level changes. Differences in quality of care on the basis of practice site offer further indirect evidence that system changes may be an effective means of improving quality. Such changes could include the use of nurses or pharmacists as case managers, who could keep track of patients with CAD, provide counseling, and maintain close follow-up [47–49]. Physician reminder systems, particularly those providing individualized patient recommendations, offer another potential means to improve care [50]. Such interventions have the potential to decrease disparities while improving care for all patients. Given the prevalence of CAD and the potential impact of secondary prevention measures, attempts to improve and implement such interventions may have a profound impact on public health.

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