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# Lipid Management in Contemporary Community Practice: Results from the Provider Assessment of Lipid Management (PALM) Registry

**Ann Marie Navar, MD, PhD**[a], **Tracy Y. Wang, MD, MHS, MSc**[a], **Shuang Li, MS**[a], **Jennifer G. Robinson, MD, MPH**[b], **Anne C. Goldberg, MD**[c], **Salim Virani, MD**[d], **Veronique L. Roger, MD**[e], **Peter W.F. Wilson, MD**[f], **Joseph Elassal, MD**[g], **L. Veronica Lee, MD**[h], and **Eric D. Peterson, MD, MPH**[a]

[a]Duke Clinical Research Institute, Durham, NC

[b]University of Iowa, Iowa City, IA

[c]Washington University, St. Louis, MO

[d]VA Medical Center and Baylor College of Medicine, Houston, TX

[e]Mayo Clinic, Rochester, MN

[f]Emory University, Atlanta, GA

[g]Regeneron Pharmaceuticals, Tarrytown, NY

[h]Sanofi Pharmaceuticals, Bridgewater, NJ

## Abstract

**Address for correspondence:** Ann Marie Navar, MD, PhD; Duke Clinical Research Institute, 2400 Pratt St. #7521, Durham, NC, USA 27705; Tel: 919-668-8666; Fax: 919-668-7089; navar006@dm.duke.edu.



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**Background—**The latest cholesterol guidelines have shifted focus from achieving low-density lipoprotein cholesterol (LDL-C) targets towards statin use and intensity guided by atherosclerotic cardiovascular disease (ASCVD) risk.

**Methods—**Statin use and intensity were evaluated in 5,905 statin-eligible primary or secondary prevention patients from 138 PALM Registry practices.

**Results—**Overall, 74.7% of eligible adults were on statins; only 42.4% were on guideline-recommended intensity. Relative to primary prevention patients, ASCVD patients were more likely to be on a statin (83.6% vs. 63.4%, p<0.0001) and guideline-recommended intensity (47.3% vs. 36.0%, p<0.0001). Men were more likely than women to be prescribed recommended intensity for primary (OR 1.87, 95% CI 1.49–2.34) and secondary (OR 1.47, 95% CI 1.26–1.70) prevention. In primary prevention, increasing age, diabetes, obesity, hypertension, and lower 10-year ASCVD risk were associated with increased odds of receiving recommended intensity. Among ASCVD patients, those with coronary artery disease were more likely to be on recommended intensity than cerebrovascular or peripheral vascular disease patients (OR 1.71, 95% CI 1.41–2.09), as were those seen by cardiologists (OR 1.43, 95% CI 1.12–1.83). Median LDL-C levels were highest among patients not on statins (124.0 mg/dL), and slightly higher among those on lower-than-recommended intensity compared with recommended therapy recipients (88.0 mg/dL and 84.0 mg/dL, respectively, p≤0.0001).

**Conclusion—**In routine contemporary practice, one in four guideline-eligible patients were not on a statin; less than half were on the recommended statin intensity. Untreated and under-treated patients had significantly higher LDL-C levels than those receiving guideline-directed statin treatment.

## Keywords

low-density lipoprotein cholesterol; untreated patients; under-treated patients; guideline-recommended treatment

In 2013, the American College of Cardiology (ACC) and American Heart Association (AHA) released new guidelines on the treatment of blood cholesterol to reduce atherosclerotic cardiovascular disease (ASCVD).[1] These guideline recommendations moved away from treatment targeting low-density lipoprotein cholesterol (LDL-C) levels towards utilization of appropriate intensity statins for high-risk adults.[2] The rationale for the focus on statin intensity was based on the results of multiple trials that demonstrated improved cardiovascular risk reduction with high-intensity statins compared to low- or moderate-intensity statins in adults with prior ASCVD, as well as in adults at high risk of developing ASCVD.[3–6]

Prior studies predating the newest guideline release demonstrated that statin therapy was underutilized in the United States.[7,8] What remains unclear is how statin utilization for primary and secondary prevention has changed since the 2013 ACC/AHA Guideline on the Treatment of Blood Cholesterol was published in 2014. Additionally, the degree to which statin intensity recommendations have been implemented in clinical practice remains unknown.

In this study, we examined the early impact of the new cholesterol guideline on statin utilization in primary and secondary prevention patients, including the proportion of patients on guideline-recommended statin intensity in the Patient and Provider Assessment of Lipid Management (PALM) Registry. Specifically, we evaluated the proportion of adults on any statin and on guideline-recommended statin intensity, as well as core lab lipid levels by treatment status. We also examined the clinical and demographic characteristics associated with receipt of guideline-recommended statin intensity.

## Methods

The PALM Registry is comprised of 7,938 total patients enrolled from 140 cardiology, primary care, and endocrinology practices in the United States. The PALM patient population included adults on statins, adults at high risk of ASCVD, and adults with prior ASCVD. Patient surveys, core lab lipid panels, and chart abstractions were completed to assess current lipid-lowering therapy in high-risk groups.[9] Enrollment was conducted between May 27, 2015 and November 12, 2015. All participants provided signed informed consent to participate, and each site obtained institutional review board approval for participation.

For this analysis, subjects were excluded if they had incomplete laboratory or chart abstraction data to evaluate statin candidacy such as smoking status, blood pressure, lipid values, or comorbidities (n=224), or were missing dose information on statin utilization to evaluate statin intensity (n=60). After exclusions, the study population was comprised of 7,614 patients.

Per the 2013 ACC/AHA Guideline, the following criteria were used to identify adults recommended for a high-intensity statin: 1) prior ASCVD (prior coronary artery disease [CAD] or coronary revascularization, abdominal aortic aneurysm, carotid artery stenosis, peripheral arterial disease or peripheral revascularization, and prior stroke or transient ischemic attack) and age ≤75 years; 2) LDL-C ≥190 mg/dL; or 3) type 2 diabetes, age 40–75 years, and LDL-C ≥70 mg/dL, and with estimated 10-year ASCVD risk ≥7.5% by the Pooled Cohort Equation.[10] Adults were considered recommended for a moderate-intensity statin if they did not meet an indication for a high-intensity statin and met at least one of the following criteria: 1) 10-year ASCVD risk ≥7.5%, LDL-C ≥70 mg/dL, and age 40–75 years; 2) prior ASCVD and age >75 years; or 3) type 2 diabetes, age 40–75, LDL-C ≥70 mg/dL, and 10-year risk <7.5%. Since the guideline recommends either moderate- or high-intensity statins for adults with 10-year ASCVD risk ≥7.5%, we analyzed these adults as if they were recommended for moderate-intensity statins. The ACC/AHA recommends statins for primary prevention patients who meet the above criteria and have a pre-treatment LDL-C ≥70 mg/dL. As pre-treatment LDL-C values were unavailable, adults already on a statin who otherwise met indications for statins except had an on-treatment LDL-C ≤ 70 mg/dL were considered recommended. Statin dose and utilization were determined by chart review of the statin dose and type at the time of the enrolling clinic visit. Statin intensity classification is summarized in Supplemental Table I, based on criteria from the 2013 ACC/AHA Guideline, with atorvastatin ≥40 mg and rosuvastatin ≥20 mg daily considered to be high-intensity statins.[1]

Statin treatment was evaluated using chart-reviewed statin dose and type at enrollment. Undertreatment was defined as either not on a statin or on a less-than-recommended statin intensity. Adults on guideline-recommended or higher-than-recommended statin intensity were considered "appropriately treated" given pre-treatment LDL-C levels were unavailable. Treatment patterns and statin intensity were evaluated for the overall population and by indication (either primary or secondary prevention). The proportions of adults on appropriate treatment, on lower-than-recommended statin intensity, and not on treatment were assessed. Characteristics of adults who were treated per guideline recommendations versus undertreated were compared including age, sex, race, ethnicity, insurance, education, income, clinical diagnoses, 10-year risks (for those without prior ASCVD), recommended statin intensity, and provider type (cardiology vs. non-cardiology). Using these characteristics, a multivariable logistic regression model was used to determine factors associated with statin undertreatment separately for primary and secondary prevention, including adjustment for statin intensity recommendation (e.g., moderate- vs. high-intensity). For multivariable modeling of statin utilization for primary prevention, 115 (4.4%) adults with LDL-C ≥190 mg/dL were excluded to allow for evaluation of the impact of 10-year risk on treatment patterns.

Core lab lipid panels were performed by Labcorp (Burlington, NC), including direct LDL-C measurements. LDL-C levels and LDL-C <100 mg/dL achievement rates were compared between those not on treatment, those on a statin but on a lower-than-recommended intensity, and those who were on guideline-recommended treatment.

Categorical variables were summarized using frequencies and percentages and compared using Mantel-Haenszel chi-square tests. Continuous variables were presented as median (first quartile, third quartile) and compared using Wilcoxon rank sum tests. Multivariable modeling was performed using generalized estimating equations (GEE) logistic regression with backward model selection using a p-value for retention of <0.05. The GEE method was implemented with a compound symmetric working correlation matrix and empirical (sandwich) standard error estimates were used to account for within-site clustering. Linearity testing was performed for continuous variables. Missing data were rare (<1%) for all variables except for education and household income, which was missing for 6.4%, and 7.9%of patients, respectively. In multivariable modeling, missing values of the categorical variables were imputed to their most common value by primary prevention- or secondary prevention-status, except for insurance status and income. When insurance status was missing (n=14), a patient was considered uninsured. When income was missing, patient zip code was used and income imputed to the median household income in the Census SAIPE 2014 data. All statistical analyses were performed using SAS version 9.4 (Cary, NC).

## Results

Of the 7,614 adults evaluated in the study population, 5,905 (77.6%) met guideline recommendations for a moderate- or high-intensity statin and were included for this analysis. The median age of the study population was 68.0 years, 56.5% were male, and 15.8% self-identified as non-white race. Table I shows characteristics of statin-eligible adults overall and by indication.

Overall, 74.7% of all adults recommended for a statin were taking a statin, but only 42.4% of all eligible adults were on a dose and statin type consistent with guideline recommendations for statin intensity. Figure 1 shows statin utilization by indication. Statin utilization was higher in adults with prior ASCVD (83.6%) than in primary prevention (63.4%, p<0.001). Similarly, secondary prevention patients were more likely than primary prevention patients to be on the correct statin intensity based on guideline recommendations (47.3% vs. 36.0%, respectively, p<0.0001).

Table II shows the types of statin used by indication and recommended statin intensity. Low-intensity statins were infrequently used: only 6.9% of adults were on a low-intensity statin (7.5% in primary prevention and 6.6% in secondary prevention, p<0.0001). As a result, statin under-dosing was largely due to utilization of moderate-intensity statins in adults who were recommended for high-intensity statins. For both primary and secondary prevention, undertreatment was more common in adults recommended for high-intensity statins than among adults recommended for moderate-intensity statins: in primary prevention, 15.9% of those recommended for high-intensity statins were on guideline-recommended treatment versus 51.8% of those recommended for moderate-intensity statin (p<0.001); in secondary prevention, 36.0% of those recommended for high-intensity statins were on guideline-recommended treatment versus 73.6% of those recommended for moderate-intensity statins (p<0.001).

The 2013 ACC/AHA Guideline recommends moderate- or high-intensity statins for adults who meet recommendations for statins based on an elevated 10-year risk (e.g., no diabetes, no prior ASCVD, LDL-C <190 mg/dL, and 10-year risk ≥7.5%). Among adults in PALM who met a guideline recommendation for statins based on 10-year risk, 42.1% were on a moderate-intensity statin and 7.9% were on a high-intensity statin.

Table III compares characteristics of adults treated with guideline-recommended statin intensity versus under-treated adults who were either not on a statin or on a lower-than-recommended intensity statin. In univariable analysis, adults with diabetes were less likely to be on guideline-recommended treatment than adults without diabetes (p<0.001). However, 76.3% of adults with diabetes were recommended for a high-intensity statin (between 40–75 years of age with a 10-year ASCVD risk ≥7.5%). Consequently, after adjusting for recommended statin intensity in multivariable modeling, diabetes was associated with an increased odds of receiving guideline-recommended statin intensity (odds ratio [OR] 2.26, 95% confidence interval [CI] 1.49–3.44, p<0.001). In the multivariable model, other factors that remained associated with receiving guideline-recommended statin intensity were male sex, increasing age, body mass index ≥30 kg/$m^2$, hypertension, and lower 10-year predicted ASCVD risk (Table III).

Among adults who were recommended statin therapy for secondary prevention, patients with CAD were more likely to receive guideline-recommended statin intensity than those with other types of ASCVD (51.1% of adults with CAD were on guideline-recommended treatment vs. 34.9% of those without CAD, p<0.001). This association persisted in multivariable modeling (Table IV); adults with CAD were more likely to receive guideline-recommended therapy than adults with other types of ASCVD (OR 1.71, 95% CI 1.41–2.09,

p<0.001). Similar to the primary prevention population, males and those with diabetes were more likely to receive guideline-recommended therapy. However, in the secondary prevention population, increasing age was associated with a lower odds of receiving guideline-recommended statin therapy.

Differences in statin utilization were seen by the provider type seeing the patient. Patients seen by cardiologists had higher rates of high-intensity statin utilization for both primary and secondary prevention, regardless of the statin intensity recommended for the patient (Figure 2). In multivariable modeling, there was no difference in the odds of receiving guideline-based statin therapy between patients seen by cardiologists and non-cardiology providers in the primary prevention practice. Yet among patients with ASCVD, those seen by cardiologists were more likely to receive guideline-recommended statin therapy, even after adjusting for other clinical factors (OR 1.43, 95% CI 1.12–1.83).

Overall, 26.7% of adults were on at least one type of non-statin lipid lowering agent, including 22.7% of those recommended for statins for primary prevention and 29.9% of those recommended for secondary prevention. There was no difference in non-statin use between those on appropriate statin vs those undertreated in primary or secondary prevention (Table 3). Adults who were not on a statin had higher LDL-C than those on guideline-recommended or lower-than-recommended intensity statins in both primary and secondary prevention groups (Supplemental Figure 1); these adults were also more likely to have an LDL-C ≥100 mg/dL (Figure 3). In the primary prevention group, LDL-C levels were slightly higher in adults on lower-than-recommended intensity statins compared with those on guideline-recommended intensity statins (median 88.0 vs. 84.0 mg/dL, p=<0.0001), but there was no difference in the proportion of those with LDL-C ≥100 mg/dL in the lower-than-recommended intensity compared with guideline-recommended statin intensity groups (43.3% vs. 42.9%, p = 0.85). Nonetheless, in patients with prior ASCVD, LDL-C levels were higher among adults on lower-than-recommended statin intensity compared with those on guideline-recommended statin intensity (median 86.0 vs. 78.0 mg/dL, p<0.001), and the proportion of adults with an LDL-C ≥100 mg/dL was higher in those on lower-than-recommended statin intensity compared with those treated according to the guidelines (31.7% vs. 21.4%, p<0.0001).

## Discussion

Despite recent changes to the 2013 ACC/AHA Guideline on the Treatment of Blood Cholesterol, our study of contemporary community practice found significant gaps in the utilization and dosing of statins. Up to 25% of adults seen in a PALM practice who met a guideline indication for a statin failed to receive any statin therapy, and less than half of adults were on the statin intensity recommended by the updated guidelines.

The rates of statin utilization in primary and secondary prevention in this study are higher than have been observed in population-based surveys. Our observed overall rate of statin therapy use (74.0%) was higher than that seen in population-based cross-sectional analyses from 2012 where less than half of eligible adults were on a statin.[7] Similarly, the rate of statin use among adults with prior ASCVD in PALM (83.7%) was higher than the 71% seen

in a national survey from 2003–2012[11]; this finding is most likely due to the fact that nationwide surveys include patients who are not on statins because they do not regularly seek medical care. In contrast, the PALM Registry evaluated statin use in patients attending clinic visits, with a large proportion of those from cardiology practices which had higher rates of appropriate statin utilization.

PALM revealed certain patient subgroups who were particularly likely to be undertreated relative to guideline recommendations. Consistent with other studies, women were less likely than men to receive guideline-recommended statin therapy for both primary and secondary prevention indications.[11,12] In addition, adults recommended for high-intensity statins were most likely to receive guideline-recommended treatment if they had prior CAD compared with prior stroke or peripheral arterial disease. While peripheral arterial disease and atherosclerotic cerebrovascular disease were considered “coronary heart disease equivalents” in the Adult Treatment Panel (ATP) III guideline and recognized as high-risk in the ATP II guideline,[13] these diseases appear to be under-recognized indications for high-intensity statin use, which has been demonstrated in other populations.[14]

We did not find consistent associations between age and statin utilization. In the primary prevention group, increasing age was associated with increasing propensity for treatment; however, the inverse was seen for secondary prevention, where older adults were less likely to be treated with a high-intensity statin or any statin. Importantly, we did not evaluate statin use for primary prevention in adults older than 75 years except for those with LDL ≥190 mg/dL because specific guidance within the guideline was lacking.

There were differences in treatment patterns in patients seen by cardiologists compared with non-cardiology practices, with patients recommended for statins for secondary prevention more likely to receive guideline-adherent statin therapy; this finding may be due to increased awareness and acceptance of the 2013 ACC/AHA Guideline among cardiologists. Given that primary care physicians are the front line for instituting both primary and secondary prevention measures, efforts to improve statin utilization nationwide need to include both primary care physicians and subspecialists.

The majority of statins used in both primary and secondary prevention were moderate-intensity statins. As a result, in both primary and secondary prevention, under-dosing was most commonly due to the use of moderate-intensity statins in adults who were recommended for high-intensity statins. One explanation for the lack of high-intensity statin use may be continued reliance on lipid targets, and provider disinclination to intensify statin therapy for adults who already have LDL-C levels <100 mg/dl. In the primary prevention group, LDL-C levels were similar between adults on guideline-recommended and lower-than-recommended intensity statins. Adoption of new guidelines often takes many years in clinical practice. To accelerate of uptake of the guidelines, provider and patient education should emphasize the potential additional benefits of statin intensification among high-risk adults who are on less than high-intensity statins, regardless of lipid levels.

As current guidelines emphasize, the decision to initiate statin therapy should include conversation between the patient and provider that includes patient preferences and reviews

patient risk of cardiovascular disease as well as the risks and benefits of statin therapy. Not all adults offered therapy may choose to initiate statins, and there is likely considerable variability in provider practices and patient preference. Future efforts to guide providers in the content of clinician patient risk discussions, in particular around statin intolerance, may help close some gaps in care. Tailored messaging to certain subgroups, for example those with prior stroke or PAD, may also help improve statin uptake.

Our study has several limitations. First, the PALM Registry is designed to reflect trends in contemporary practice and cannot address gaps in care due to lack of access to healthcare since subjects were recruited during their outpatient visits with cardiology, primary care, and endocrinology providers. Furthermore, we did not include patients seen by neurologists, who may have different practice patterns, particularly for those adults with prior stroke. Third, compared to general population providers, participating providers may have been more likely to focus on lipid levels. To minimize the effect of study participation on treatment patterns, we evaluated statin utilization at the start of the visit during which the patient was enrolled. Fourth, ten-year ASCVD risk was calculated using on-treatment lipid values for those on statins, as pretreatment lipid levels were unavailable. Thus, 10-year risk for those on-treatment risk reflects the lowest possible 10-year risk for this group. Of the 1,709 patients excluded because they did not meet a statin recommendation, 540 were on a statin but had a calculated 10-year risk <7.5%; therefore, our estimates of statin utilization among adults recommended for therapy for purposes of primary prevention may be slightly underestimated as we cannot determine what proportion of these adults had a 10-year risk ≥7.5% at the time of treatment initiation. However, we estimate the impact of this to be small; using estimated pre-treatment cholesterol based on a 50% LDL-C reduction for high intensity statins and 30% LDL-C reduction for other statins, we estimate that 100 of these adults may have had a 10-year risk over 7.5% using pre-treated LDL-C. Including these adults in the analysis would have increased the proportion overall of those on appropriate intensity statin from 42.4% to 43.2% (and to 38.1% from 36.0% in primary prevention). Finally, this study provides only a snapshot of lipid management practices at a single point in time. Providers may have later uptitrated statins in those on less than recommended doses or initiated statins at subsequent visits. However, given that this study was conducted over a year after the new guideline release, we believe this would have been sufficient time for providers to identify those who were newly eligible for statins or higher intensity statins in clinical practice.

## Conclusion

More than one year after the release of the 2013 ACC/AHA Guideline on the Treatment of Blood Cholesterol, many adults in clinical practice are still not receiving guideline-recommended statin therapy. Beyond expanding efforts to identify and treat high-risk adults, additional efforts should be made to identify adults who are already on a statin, but may benefit from statin intensification.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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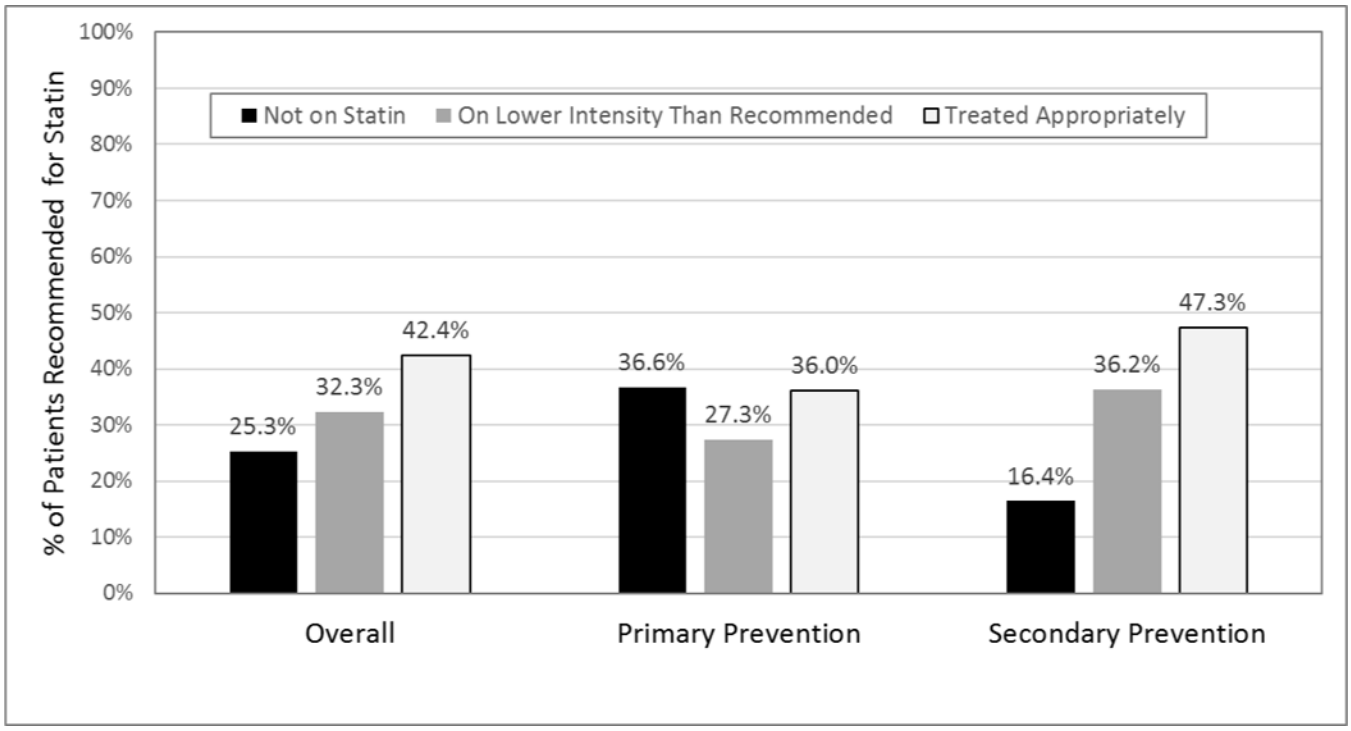


**Figure 1. Statin utilization in the PALM Registry in adults recommended for statin therapy**

This figure shows the proportion of adults on no statin, on lower-than-recommended statin intensity, and on appropriate intensity statin overall and by indication: primary prevention (no prior ASCVD) and secondary prevention (prior ASVD).

*ASCVD*, atherosclerotic cardiovascular disease; *PALM*, Provider Assessment of Lipid Management

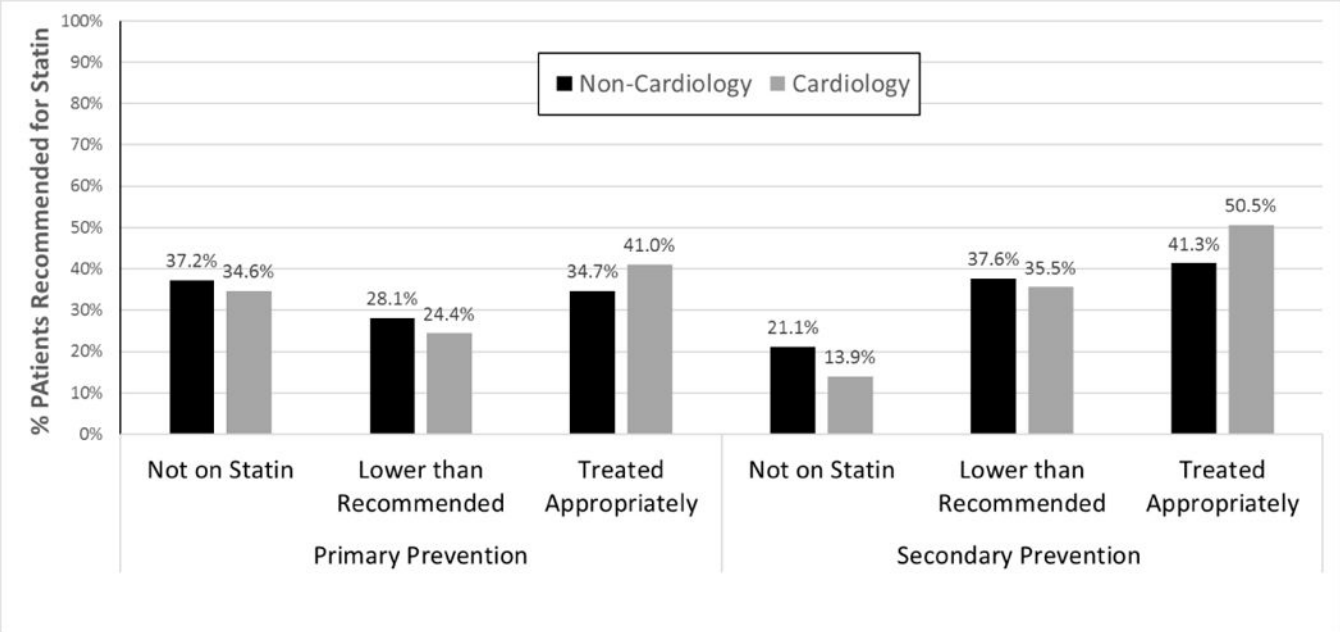


**Figure 2. Statin utilization in adults recommended for statin therapy by provider type**

This figure shows the proportion of adults on no statin, on lower-than-recommended statin intensity, and on appropriate intensity statin overall and by indication: primary prevention (no prior ASCVD) and secondary prevention (prior ASVD), and provider type (cardiology vs. non-cardiology).

*ASCVD*, atherosclerotic cardiovascular disease; *PALM*, Provider Assessment of Lipid Management

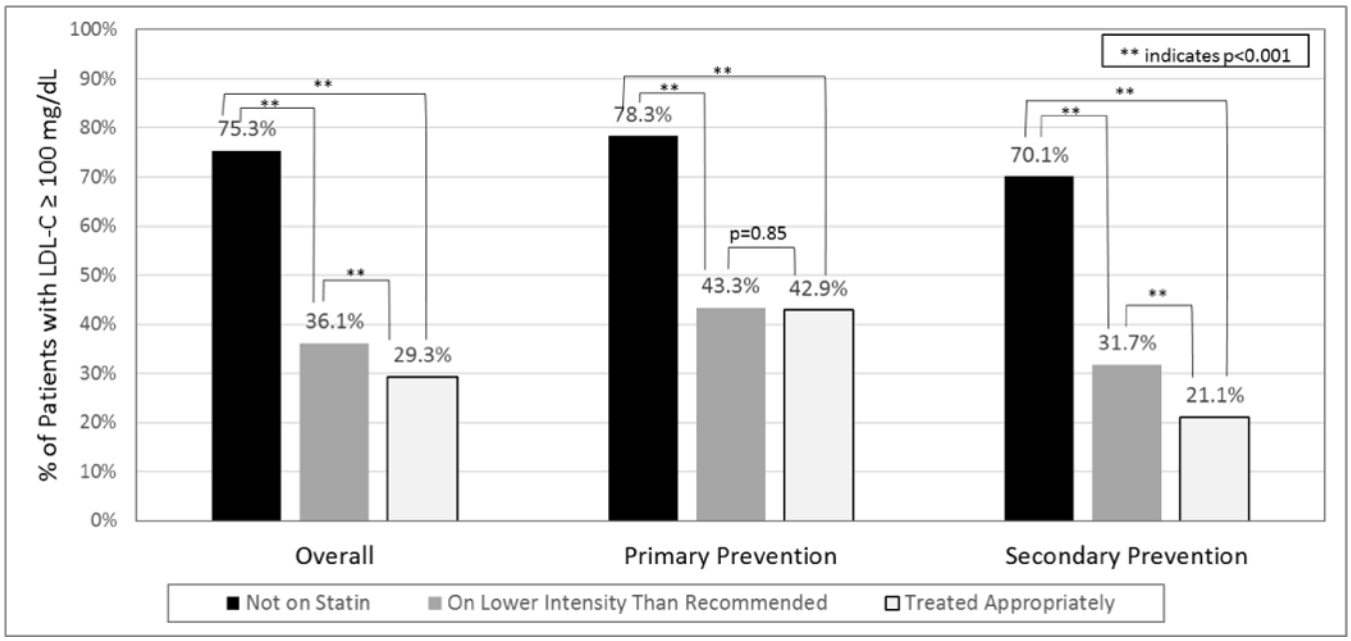


**Figure 3. Adults with LDL-C ≥100 mg/dL by risk group and statin utilization**

This figure shows the proportion of adults with LDL-C ≥100 mg/dL by treatment status and indication for treatment. P-values represent the difference between each proportion, with ** indicating p<0.001 using the Mantel-Haenszel chi-squared test. LDL-C indicates low-density lipoprotein cholesterol

*LDL-C*, low-density lipoprotein cholesterol

## Table I

Characteristics of adults recommended for statins in the PALM Registry

| | Overall n=5905 | Primary prevention n=2608 | Secondary prevention n=3297 |
|---|---|---|---|
| Age | 68.0 (61.0, 73.0) | 66.0 (58.0, 70.0) | 70.0 (64.0, 77.0) |
| Sex (% male) | 3,337 (56.5%) | 1,247 (47.8%) | 2,090 (63.4%) |
| Race | | | |
| White | 4,974 (84.2%) | 2,077 (79.6%) | 2,897 (87.9%) |
| Black | 795 (13.5%) | 470 (18.0%) | 325 (9.9%) |
| Asian | 118 (2.0%) | 49 (1.9%) | 69 (2.1%) |
| Other | 18 (0.3%) | 12 (0.4%) | 6 (0.2%) |
| Ethnicity: Hispanic | 647 (11.0%) | 415 (15.9%) | 232 (7.1%) |
| Insurance | | | |
| Private | 3,347 (56.8%) | 1,492 (57.4%) | 1,855 (56.4%) |
| Government | 2,413 (41.0%) | 1,017 (39.1%) | 1,396 (42.4%) |
| None | 131 (2.2%) | 91 (3.5%) | 40 (1.2%) |
| Education | | | |
| Middle school | 379 (6.9%) | 147 (6.1%) | 232 (7.5%) |
| High school | 1,662 (30.1%) | 751 (31.1%) | 911 (29.3%) |
| Some college | 1,493 (27.0%) | 640 (26.5%) | 853 (27.4%) |
| College graduate | 1,299 (23.5%) | 595 (24.7%) | 704 (22.6%) |
| Post-graduate degree | 691 (12.5%) | 278 (11.5%) | 413 (13.3%) |
| Income | 1,338 (25.7%) | 595 (26.1%) | 743 (25.3%) |
| <$35,000 | | | |
| $35,000–$74,999 | 1,226 (23.5%) | 582 (25.5%) | 644 (21.9%) |
| $75,000–$99,999 | 418 (8.0%) | 195 (8.6%) | 223 (7.6%) |
| > $100,000 | 708 (13.6%) | 329 (14.4%) | 379 (12.9%) |
| Refused | 1,525 (29.2%) | 579 (25.4%) | 946 (32.2%) |
| BMI ≥30 kg/m2 | 2,939 (50.0%) | 1,419 (54.8%) | 1,520 (46.3%) |
| Hypertension | 4,805 (81.4%) | 1,997 (76.6%) | 2,808 (85.2%) |
| Systolic BP | 129.0 (120.0, 140.0) | 130.0 (120.0, 140.0) | 128.0 (118.0, 140.0) |
| Diastolic BP | 76.0 (70.0, 81.0) | 78.0 (70.0, 82.0) | 73.0 (68.0, 80.0) |
| Prior CAD | 2,532 (42.9%) | 0 (0.0%) | 2,532 (76.8%) |
| Prior PAD | 502 (8.5%) | 0 (0.0%) | 502 (15.2%) |
| Prior stroke or TIA | 505 (8.6%) | 0 (0.0%) | 505 (15.3%) |
| Diabetes | 2,665 (45.1%) | 1,349 (51.7%) | 1,316 (39.9%) |
| GFR <60 ml/min | 1,426 (29.1%) | 424 (20.6%) | 1,002 (35.2%) |
| Any antihypertensive medication | 4,785 (81.0%) | 1,881 (72.1%) | 2,904 (88.1%) |
| Smoking | | | |
| Current smoker | 749 (12.7%) | 368 (14.1%) | 381 (11.6%) |
| Quit in past year | 99 (1.7%) | 42 (1.6%) | 57 (1.7%) |
| Quit >1 year ago | 2,195 (37.2%) | 758 (29.1%) | 1,437 (43.6%) |
| Never smoker | 2,861 (48.5%) | 1,440 (55.2%) | 1,421 (43.1%) |

| | Overall n=5905 | Primary prevention n=2608 | Secondary prevention n=3297 |
|---|---|---|---|
| Provider Type | | | |
| Cardiology | 2,696 (45.7%) | 541 (20.7%) | 2,155 (65.4%) |
| Primary Care/Other | 3,209 (54.3%) | 2,067 (79.3%) | 1,142 (34.6%) |

*BMI*, body mass index; *BP*, blood pressure; *CAD*, coronary artery disease; *GFR*, glomerular filtration rate; *PAD*, peripheral artery disease; *PALM*, Provider Assessment of Lipid Management; *TIA*, transient ischemic attack

Note: Percentages were calculated with non-missing patients only.

**Table II**

Statin intensity by indication and recommendation

| | Overall | | Primary prevention | | Secondary prevention | |
|---|---|---|---|---|---|---|
| **Statin intensity recommended** | **Moderate** | **High** | **Moderate** | **High** | **Moderate** | **High** |
| Overall | n=2459 | n=3446 | n=1464 | n=1144 | n=995 | n=2302 |
| Not on statin | 793(32.2%) | 703(20.4%) | 610(41.7%) | 345(30.2%) | 183 (18.4%) | 358 (15.6%) |
| On low intensity statin | 176(7.2%) | 237(6.9%) | 96 (6.6%) | 100 (8.7%) | 80 (8.0%) | 137 (6.0%) |
| On moderate intensity statin | 1118(45.5%) | 1495 (43.4%) | 620 (42.3%) | 517 (45.2%) | 498 (50.0%) | 978 (42.5%) |
| On high intensity statin | 372 (15.1%) | 1011 (29.3%) | 138 (9.4%) | 182 (15.9%) | 234 (23.5%) | 829 (36.0%) |

**Table III**

Characteristics of adults taking statins on dosing consistent with guideline recommendations

| | Primary prevention | | | Secondary prevention | | |
|---|---|---|---|---|---|---|
| | Undertreated* n=1668 | On recommended treatment† n=940 | p-value | Undertreated* n=1736 | On recommended treatment† n=1561 | p-value |
| Age | 66.0 (59.0, 70.0) | 66.0 (58.0, 70.0) | 0.87 | 68.0 (62.0, 74.0) | 74.0 (65.0, 80.0) | <0.0001 |
| Sex: male | 764 (45.8%) | 483 (51.4%) | 0.01 | 1,036 (59.7%) | 1,054 (67.5%) | <0.0001 |
| Race: black | 338 (20.3%) | 132 (14.0%) | <0.0001 | 196 (11.3%) | 129 (8.3%) | 0.004 |
| Ethnicity: Hispanic | 276 (16.6%) | 139 (14.8%) | 0.24 | 125 (7.2%) | 107 (6.9%) | 0.72 |
| Insurance | | | | | | |
| Private | 941 (56.4%) | 551 (59.1%) | 0.3238 | 970 (55.9%) | 885 (56.8%) | 0.60 |
| Government | 663 (39.8%) | 354 (37.9%) | . | 740 (42.7%) | 656 (42.1%) | . |
| None | 63 (3.8%) | 28 (3.0%) | . | 24 (1.4%) | 16 (1.0%) | . |
| Education | | | | | | |
| High school or less | 592 (39.1%) | 306 (34.2%) | 0.0157 | 595 (36.1%) | 548 (37.4%) | 0.45 |
| At least some college | 923 (60.9%) | 590 (65.8%) | . | 1,053 (63.9%) | 917 (62.6%) | . |
| Income | | | | | | |
| <$35,000 | 407 (28.5%) | 188 (22.1%) | 0.0008 | 416 (26.6%) | 327 (23.9%) | 0.1420 |
| $35,000-$74,999 | 358 (25.1%) | 224 (26.3%) | . | 357 (22.8%) | 287 (20.9%) | . |
| $75,000-$99,999 | 123 (8.6%) | 72 (8.5%) | . | 117 (7.5%) | 106 (7.7%) | . |
| > $100,000 | 178 (12.5%) | 151 (17.7%) | . | 188 (12.0%) | 191 (13.9%) | . |
| Obese (BMI ≥30 kg/m$^2$) | 915 (55.2%) | 504 (54.1%) | 0.60 | 845 (48.9%) | 675 (43.4%) | 0.002 |
| Diabetes | 1,003 (60.1%) | 346 (36.8%) | <0.0001 | 684 (39.4%) | 632 (40.5%) | 0.53 |
| Hypertension | 1,255 (75.2%) | 742 (78.9%) | 0.03 | 1,474 (84.9%) | 1,334 (85.5%) | 0.66 |
| Chronic kidney disease | 125 (7.5%) | 55 (5.9%) | 0.11 | 213 (12.3%) | 215 (13.8%) | 0.20 |
| 10-year risk (among primary prevention) | 16.0 (10.5, 24.2) | 12.7 (8.5, 18.6) | <0.0001 | n/a | n/a | n/a |
| Recommended high-intensity statin | 962 (57.7%) | 182 (19.4%) | <0.0001 | 1,473 (84.9%) | 829 (53.1%) | <0.0001 |
| LDL-C ≥190 mg/dL | 104 (6.2%) | 11 (1.2%) | <0.0001 | 41 (2.4%) | 8 (0.5%) | <0.0001 |
| Any non-statin lipid lowering therapy | 369 (22.3%) | 217 (23.4%) | 0.53 | 504 (29.3%) | 472 (30.6%) | 0.41 |
| Ezetimibe | 60 (3.6%) | 29 (3.1%) | 0.51 | 93 (5.4%) | 99 (6.4%) | 0.22 |
| Fibrate | 79 (4.7%) | 50 (5.4%) | 0.47 | 114 (6.6%) | 95 (6.1%) | 0.58 |
| Niacin | 20 (1.2%) | 26 (2.8%) | 0.003 | 58 (3.4%) | 67 (4.3%) | 0.16 |

| | Primary prevention | | | Secondary prevention | | |
|---|---|---|---|---|---|---|
| | Undertreated* n=1668 | On recommended treatment† n=940 | p-value | Undertreated* n=1736 | On recommended treatment† n=1561 | p-value |
| Fish Oil | 234 (14.1%) | 138 (14.8%) | 0.61 | 313 (18.1%) | 297 (19.1%) | 0.47 |
| Bile Acid Sequestrant | 12 (0.7%) | 2 (0.2%) | 0.09 | 14 (0.8%) | 10 (0.6%) | 0.58 |
| Red Yeast Rice Extract | 6 (0.4%) | 1 (0.1%) | 0.24 | 11 (0.6%) | 7 (0.5%) | 0.47 |
| Provider type | | | | | | |
| Cardiologist | 319 (19.1%) | 222 (23.6%) | 0.006 | 1,066 (61.4%) | 1,089 (69.8%) | <0.0001 |
| Non-Cardiologist | 1,349 (80.9%) | 718 (76.4%) | | 670 (38.6%) | 472 (30.2%) | |

*Undertreated is defined as not on a statin or on a lower-than-recommended intensity statin.

†On recommended treatment is defined as on treatment concordant with 2013 ACC/AHA recommendations.

*LDL-C*, low-density lipoprotein cholesterol; All other abbreviations can be found in Table I.

Note: Percentages were calculated with non-missing patients only. P-values were calculated by comparing only non-missing values.

## Table IV

Independent factors associated with guideline-recommended statin utilization*

| | OR | 95% CI | p-value |
|---|---|---|---|
| Male sex | 1.87 | (1.49–2.34) | <0.0001 |
| Hypertension | 1.87 | (1.41–2.36) | <0.0001 |
| Diabetes | 2.26 | (1.49–3.44) | 0.0001 |
| 10-year risk (per 5% increase)† | 0.88 | (0.81–0.95) | 0.0009 |
| Age (per 5-year increase) | 1.19 | (1.07–1.32) | 0.0014 |
| BMI ≥30 | 1.27 | (1.06–1.53) | 0.0009 |
| Prior ASCVD | | | |
| CAD vs. other ASCVD | 1.71 | (1.41–2.09) | <0.0001 |
| Male sex | 1.47 | (1.26–1.70) | <0.0001 |
| Diabetes | 1.30 | (1.09–1.55) | 0.0029 |
| Age (per 5 year increase) | 0.90 | (0.86–0.95) | <0.0001 |
| Cardiologist (vs. non-Cardiologist) | 1.43 | (1.12–1.83) | 0.004 |

*Multivariable models include adjustment for statin intensity recommended (high vs. moderate) in addition to characteristics listed above.

†10-year risk calculated per pooled cohort equations.

*ASCVD*, atherosclerotic cardiovascular disease; *CI*, confidence interval; *OR*, odds ratio; All other abbreviations can be found in Table I.