Journal of the American College of Cardiology
© 2013 by the American College of Cardiology Foundation
Published by Elsevier Inc.

Vol. 62, No. 1, 2013
ISSN 0735-1097/$36.00
http://dx.doi.org/10.1016/j.jacc.2013.04.018

Socioeconomic Disparities in the Use of Cardioprotective Medications Among Patients With Peripheral Artery Disease

An Analysis of the American College of Cardiology's NCDR PINNACLE Registry

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Objectives The aim of this paper was to examine disparities in the use of cardioprotective medications in the treatment of peripheral artery disease (PAD) by socioeconomic status (SES).

Background PAD is associated with increased cardiovascular risk and is more prevalent among those of lower SES. However, the use of guideline-recommended secondary preventive measures for the treatment of PAD across diverse income subgroups and the influence of practice site on potential treatment disparities by SES are unknown.

Methods Within the National Cardiovascular Disease Registry (NCDR) PINNACLE Registry, 62,690 patients with PAD were categorized into quintiles of SES, as defined by the median income of each patient's zip code. The association between SES and secondary preventive treatment with antiplatelet and statin medications was evaluated using sequential hierarchical modified Poison models, adjusting first for practice site and then for clinical variables.

Results Compared with the highest SES quintile (median income: >$60,868), PAD patients in the lowest SES quintile (median income: <$34,486) were treated less often with statins (72.5% vs. 85.8%; RR: 0.84; 95% CI: 0.83 to 0.86; $p < 0.001$) and antiplatelet therapy (79.0% vs. 84.6%; RR: 0.93; 95% CI: 0.91 to 0.94; $p < 0.001$). These differences were markedly attenuated after controlling for practice site variation: statins (adjusted RR: 0.97; 95% CI: 0.95 to 0.99; $p = 0.003$) and antiplatelet therapy (adjusted RR: 0.98; 95% CI: 0.97 to 1.00; $p = 0.012$). Additional adjustment for patients' clinical characteristics had minimal impact, with slight further attenuation with statins (adjusted RR: 1.00: 95% CI: 0.99 to 1.01; $p = 0.772$) and antiplatelet therapy (adjusted RR: 1.00; 95% CI: 0.99 to 1.01; $p = 0.878$).

Conclusions Among PAD patients, the practice site at which patients received care largely explained the observed SES differences in treatment with guideline-recommended secondary preventive medications. Future efforts to reduce treatment disparities in these vulnerable populations should target systems improvement at practices serving high proportions of patients with low SES. (J Am Coll Cardiol 2013;62:51–7) © 2013 by the American College of Cardiology Foundation

The Institute of Medicine has challenged the U.S. health care system to minimize disparities in treatment and to provide equitable access to evidence-based therapies to all patients (1). Although there have been numerous studies investigating disparities in the care of cardiac patients (2–4), research on disparities in peripheral arterial disease (PAD)

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Abbreviations and Acronyms

PAD = peripheral artery disease

SES = socioeconomic status

have been limited (5–9), even though PAD affects over 7 million Americans (10) and disproportionately affects those of lower socioeconomic status (SES) (11,12). Equitable access to inexpensive, guideline-recommended secondary preventive therapies has the potential to improve cardiovascular outcomes in this vulnerable population (13–17), but whether treatment rates differ across income groups remains unknown. Given that PAD is associated with increased cardiovascular risk and mortality (18–22), illuminating current practice patterns by SES for evidence-based secondary preventive strategies is particularly important in defining opportunities to better improve care.

Accordingly, we examined PAD treatment rates by SES within the American College of Cardiology's (ACC) National Cardiovascular Disease Registry (NCDR) PINNACLE Registry, which prospectively captures information on the clinical care of outpatients, including the use of guideline-recommended secondary preventive therapies. Given the potential variability in care across clinics, we explicitly sought to examine both the variations in secondary preventive treatment of PAD by SES and whether treatment differences by SES were explained at the site level, with the hope that our findings would not only identify potential disparities by income but also define targets for future interventions to reduce disparities in PAD care.

Methods

Study population. The PINNACLE Registry was launched in 2008 and represents the first national, prospective, office-based, quality-improvement registry of cardiovascular patients in the United States (23,24). Among participating practices, patient data were collected at the point of care for a variety of cardiovascular conditions, including coronary artery disease, heart failure, atrial fibrillation, and PAD. Participation in this quality-improvement initiative is voluntary.

For the purposes of this study, we identified 66,282 patients with a diagnosis of PAD enrolled from 61 practices between July 1, 2010, and June 30, 2011. Within the PINNACLE Registry, PAD was defined by one of the following self-identified criteria by patients: 1) claudication, either with exertion or at rest; 2) amputation for arterial vascular insufficiency; 3) vascular reconstruction, bypass surgery, or percutaneous intervention to the extremities (excluding dialysis fistulas and vein stripping); 4) documented aortic aneurysm with or without repair; or 5) positive noninvasive test (e.g., ankle brachial index $\leq$0.9, ultrasound, magnetic resonance, computed tomography) or diagnostic angiographic stenosis of $>$50% in any major peripheral artery (e.g., renal, subclavian, femoral, iliac). We excluded 2,945 patients from whom information on SES was missing (zip code data were not available). Our final study cohort comprised 62,690 PAD patients from 61 sites. For the analyses in this study, as patients may have had multiple visits in the PINNACLE Registry, we used information from the first visit to represent each patient only once.

SES and processes of care. The key independent variable was patients' SES, which was defined by the median income of the patient's zip code of residence. This approach to categorize levels of socioeconomic status has been used in previous reports of various disease conditions (25–27). The primary study outcome was treatment with two secondary preventive medications: an antiplatelet agent (aspirin or clopidogrel) and a statin, both of which are Class I indications for PAD by the ACC/American Heart Association (AHA) PAD guidelines and PAD performance measures (28,29). Patients with documented contraindications to antiplatelet therapy (e.g., history of gastrointestinal bleeding) or statins were excluded from the analysis of each treatment. Moreover, for the analyses of antiplatelet therapy, we further excluded 9,295 patients already on warfarin therapy given that warfarin may influence the use of antiplatelet therapy.

Statistical analysis. Patients were categorized into quintiles of SES, with quintile 1 representing the lowest SES and quintile 5 the highest. Baseline differences across quintiles of SES were then compared using the Mantel-Haenszel trend test for categorical variables and the linear trend test for continuous variables.

Separate multivariable hierarchical modified Poison models were used to assess the relationship between SES and treatment with antiplatelet therapy and statins. We employed two-level hierarchical models to adjust for clustering of patients within practices, with individual practices modeled as random effects and other patient characteristics modeled as fixed effects within each practice (30). This approach allowed us to control for measured and unmeasured

Cardiovascular Data Registry (NCDR). The views expressed in this manuscript represent those of the author(s), and do not necessarily represent the official views of the NCDR or its associated professional societies, identified at www.ncdr.com. The PINNACLE Registry is an initiative of the American College of Cardiology Foundation. Bristol-Myers Squibb and Pfizer Inc. are Founding Sponsors of the PINNACLE Registry. Dr. Patel has received research grants from Johnson & Johnson, the National Heart, Lung and Blood Institute (NHLBI), AstraZeneca, Medtronic, and Maquet; is a consultant/advisory board member for Bayer Healthcare, Genzyme, Ortho-McNeil-Janssen, Pleuristem, and Baxter. Dr. Jones has received research grants from AstraZeneca and Bristol-Myers Squibb. Dr. Bhatt is on the advisory board of Elsevier Practice Update Cardiology, Medscape Cardiology; is on the Board of Directors of the Boston VA Research Institute, Society of Chest Pain Centers; is the Chair of the American Heart Association Get With The Guidelines Science Subcommittee; has received honoraria from American College of Cardiology (Editor, Clinical Trials, Cardiosource), Duke Clinical Research Institute (clinical trial steering committees), Slack Publications (Chief Medical Editor, Cardiology Today's Intervention), WebMD (CME steering committees); is the Senior Associate Editor, *Journal of Invasive Cardiology*; is on the Data Monitoring Committees of Population Health Research Institute; has received research grants from Amarin, AstraZeneca, Bristol-Myers Squibb, Eisai, Ethicon, Medtronic, Sanofi Aventis, The Medicines Company; and has received unfunded research from FlowCo, PLx Pharma, and Takeda. Dr. Spertus has grants and contracts with the ACCF, NIH, NHLBI, ACCF, Lilly, Gilead, Amorcyte, Genentech; consulting with Janssen, Genentech, United Healthcare, Amgen; copyrights of the SAQ, KCCQ, PAQ; and equity in Health Outcomes Sciences. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

Manuscript received March 7, 2013; accepted April 17, 2013.

between-practice confounding, as the use of hierarchical models ensured that patients with similar SESs were compared with each other from the same practice.

To better understand the extent of the practice-site variation in accounting for treatment differences by SES, we performed a 2-step sequential adjustment. First, we adjusted for practice site only, to assess the extent to which differences by SES were attenuated. This step allowed us to understand whether treatment differences by SES persisted when patients of different SESs within the same site were compared. Next, we additionally controlled for clinical characteristics, including age, sex, insurance status, diabetes, dyslipidemia, history of MI, history of revascularization in the previous 12 months, history of congestive heart failure, and history of stroke.

For each analysis, the null hypothesis was evaluated at a 2-sided significance level of 0.05, with 95% confidence intervals (CIs) calculated using robust SEs. All analyses were performed with SAS version 9.3 (SAS Institute, Cary, North Carolina) and R version 2.10.0.

Results

The baseline characteristics of the 62,690 PAD patients by SES quintiles are summarized in Table 1. There was no difference in baseline characteristics of patients among practices categorized by tertiles of mean patient income (Table 2). The median number of patients per site was 151 (interquartile range [IQR]: 16 to 1,328) patients per site. Patients in the lowest SES quintile were from zip codes with median household incomes of <$34,486 annually, while those in the highest quintiles were from zip codes with annual median household incomes of >$60,868.

The median age of the overall cohort was 70.0 (IQR: 62.0–78.0) years, and 62.4% were men. Nearly 60% of patients had private insurance, and only 4.2% were uninsured. There were high prevalences of coronary artery disease (85.4%), dyslipidemia (81.5%), and hypertension (83.3%) in the cohort. Nearly one third of patients were diabetic and one quarter were active smokers. Finally, 30.3% of patients had undergone coronary artery bypass surgery, whereas 41.4% had undergone percutaneous coronary intervention within the previous year.

Compared with patients in the highest SES quintiles, patients in the lower SES quintiles were slightly younger, more frequently female, and less likely to have private health insurance. Patients in lower SES quintiles were also more likely to have undergone percutaneous coronary intervention in the previous year and to be active smokers, and were less likely to have undergone coronary artery bypass surgery in the previous year and to have had a prior stroke. Lastly, rates of dyslipidemia, diabetes, hypertension, congestive heart failure, and prior myocardial infarction were clinically similar across quintiles.

Use of cardioprotective therapy. Treatment rates with statins decreased in a graded fashion going from higher to lower SES: 85.8% in quintile 5 to 72.5% in quintile 1 (Table 3). Compared with patients in the highest SES quintile, PAD patients in the lowest SES quintile were 16% less likely to be treated with statins (unadjusted rate ratio [RR]: 0.84; 95% CI: 0.83 to 0.86; $p < 0.0001$). Notably, sites with higher mean incomes among its patients had greater

Table 1 Baseline Demographic and Clinical Characteristics of the Study Cohort, Stratified by Socioeconomic Status

Characteristic	Socioeconomic Status: Quintile 1 (n = 12,521)	Quintile 2 (n = 12,513)	Quintile 3 (n = 12,565)	Quintile 4 (n = 12,511)	Quintile 5 (n = 12,580)	All Patients (N = 62,690)	p Value*
Patient income, range,† US$	4,583–34,486	34,486–41,117	41,118–50,371	50,372–60,868	60,869–200,001	4,583–200,001	<0.001
Age, median (IQR), yrs	69.0 (61.0–78.0)	71.0 (62.0–79.0)	70.0 (62.0–78.0)	71.0 (63.0–79.0)	71.0 (63.0–79.0)	70.0 (62.0–78.0)	<0.001
Male, %	60.6	62.8	62.5	61.7	64.2	62.4	<0.001
Insurance category,‡ n (%)							
Private	54.5	63.3	59.7	58.7	61.0	59.4	<0.001
Public	41.1	33.0	37.2	37.9	35.2	36.9	<0.001
None	4.5	3.7	3.1	3.4	3.8	3.7	<0.001
Comorbidity, n (%)							
CAD	86.9	86.2	86.6	83.6	83.5	85.4	<0.001
Dyslipidemia	77.2	80.8	82.1	82.7	84.5	81.5	<0.001
Diabetes mellitus	33.4	34.0	32.2	31.5	32.2	32.7	<0.001
Hypertension	82.3	85.2	84.4	82.3	82.4	83.3	0.010
Stroke or TIA	11.5	24.1	25.2	16.4	18.0	19.0	<0.001
MI	30.9	29.9	31.8	28.7	31.5	30.6	0.982
CABG in previous 12 months	23.29	25.4	33.8	33.2	35.8	30.3	<0.001
PCI in previous 12 months	47.0	48.8	43.0	33.7	34.7	41.4	<0.001

*Continuous variables compared using linear trend test; categorical variables compared using Mantel-Haenszel trend test. †Calculated as the median household income per year in each patient's zip code. ‡*Public insurance* refers to Medicare, Medicaid, military, and state insurance.

CABG = coronary artery bypass grafting; CAD = coronary artery disease; IQR = interquartile range; MI = myocardial infarction; PCI = percutaneous coronary intervention; TIA = transient ischemic attack; USD = US dollars.

Table 2 Baseline Demographic and Clinical Characteristics Within Practices, by Tertile of Mean Patient Income

Characteristic	Mean Income: Tertile 1 (n = 20)	Tertile 2 (n = 20)	Tertile 3 (n = 21)	All Patients (N = 61)	p Value*
Age, yrs	68.7 (66.3–71.7)	71.1 (68.4–72.5)	70.6 (69.5–72.0)	70.3 (68.3–72.2)	0.16
Male, %	57.8 (53.1–62.9)	62.8 (55.4–69.1)	60.6 (55.4–65.2)	60.6 (55.4–66.1)	0.81
Insurance category,† %					
Private	46.9 (26.0–69.4)	45.6 (34.5–74.9)	44.8 (24.7–68.2)	45.5 (25.0–72.9)	0.69
Public	50.0 (23.7–69.3)	32.8 (21.3–65.1)	47.1 (28.4–68.8)	45.9 (23.0–68.8)	0.48
None	2.9 (0.0–9.7)	2.4 (0.9–7.6)	3.3 (1.0–5.9)	2.6 (0.8–7.5)	0.47
Comorbidity, n (%)					
CAD	84.9 (70.5–95.8)	83.9 (76.6–98.4)	77.3 (60.4–91.1)	83.2 (70.0–94.6)	0.05
Dyslipidemia	75.0 (60.4–88.7)	86.4 (74.2–92.3)	78.8 (74.9–92.0)	79.8 (71.4–90.9)	0.17
Diabetes mellitus	40.0 (30.7–50.0)	30.3 (17.4–37.5)	33.9 (29.2–41.4)	33.9 (27.0–43.6)	0.58
Hypertension	90.2 (78.4–100)	87.6 (75.8–98.3)	82.1 (78.4–92.1)	85.3 (78.3–97.0)	0.19
Stroke or TIA	7.8 (2.7–11.7)	7.0 (1.6–11.8)	7.0 (3.6–9.0)	7.2 (3.1–11.0)	0.88
MI	27.1 (9.6–51.7)	22.4 (10.6–39.2)	26.0 (11.2–30.4)	26.0 (10.0–40.0)	0.14
CABG in previous 12 months	8.0 (4.4–21.7)	2.4 (0.021.4)	12.4 (1.5–31.4)	6.8 (1.2–29.1)	0.56
PCI in previous 12 months	24.3 (8.3–50.0)	14.3 (3.4–51.4)	18.8 (7.2–47.2)	19.3 (7.1–50.0)	0.92

Values are median (IQR). *Continuous variables compared using linear trend test; categorical variables compared using Mantel-Haenszel trend test. †*Public insurance* refers to Medicare, Medicaid, military, and state insurance.
Abbreviations as in Table 1.

percentages of patients prescribed a statin medication (weighted correlation coefficient: 0.48) (Fig. 1). After adjustment for the practice at which a patient received care, treatment differences by SES were markedly attenuated (adjusted RR for quintile 1 vs. 5: 0.97; 95% CI: 0.97 to 0.99; p = 0.003). Further adjustment for clinical variables was associated with only a small attenuation of differences by SES (fully adjusted RR: 1.00; 95% CI: 0.99 to 1.01; p = 0.772). A similar pattern was observed for quintiles 2, 3, and 4 (Table 4).

Rates of any antiplatelet treatment were lowest among those in quintile 1 (79.0%, vs 84.6% in quintile 5) (Table 3). Compared with patients in the highest SES quintile, patients in the lowest SES quintile were 7% less likely to be treated with any antiplatelet medication (unadjusted RR: 0.93; 95% CI: 0.91 to 0.94; p < 0.0001). As with statin treatment, sites with a higher median income among its patients had greater percentages of patients prescribed an antiplatelet agent (weighted correlation coefficient: 0.30) (Fig. 2). After adjustment for the practice at which a patient received care, treatment differences by SES were nearly eliminated (adjusted RR: 0.98; 95% CI: 0.97 to 1.00; p = 0.012). Further adjustment for the clinical characteristics of patients had minimal effect on attenuation of effect between the quintiles of SES (fully adjusted RR: 1.00; 95% CI: 0.99 to 1.01; p = 0.878) (Table 4).

Table 3 Medication* Treatment Rates, Stratified by Socioeconomic Status†

Medication	Socioeconomic Status: Quintile 1 (n = 12,521)	Quintile 2 (n = 12,513)	Quintile 3 (n = 12,565)	Quintile 4 (n = 12,511)	Quintile 5 (n = 12,580)	All Patients (N = 62,690)	p Value‡
Any antiplatelet: clopidogrel and/or aspirin	79.0	83.0	84.8	83.1	84.6	82.9	<0.001
Statin	72.5	77.6	83.2	81.5	85.8	80.1	<0.001

*Medications described among those eligible (without contraindication). †Stratified by range of patient income (in USD) (calculated as the median household income per year in each patient's zip code), as follows: quintile 1 = 4,583–34,486; quintile 2 = 34,486–41,117; quintile 3 = 41,118–50,371; quintile 4 = 50,372–60,868; and quintile 5 = 60,869–200,001. ‡Continuous variables compared using linear trend test; categorical variables compared using Mantel-Haenszel trend test unless otherwise noted.
KW = Kruskal-Wallis test; other abbreviations as in Table 1.

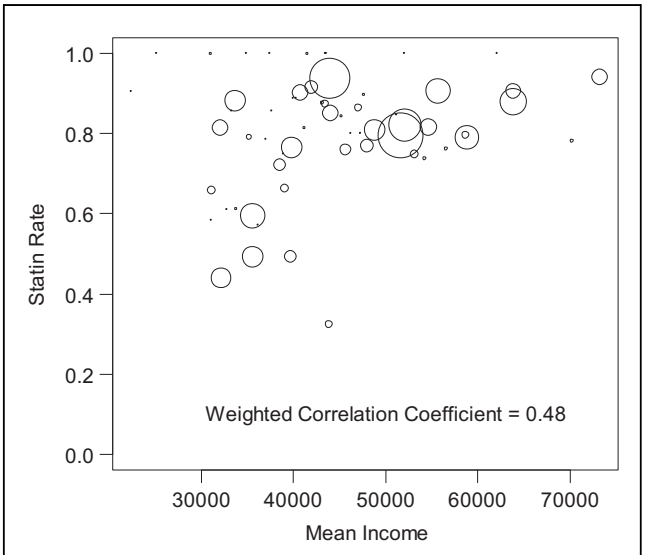

Figure 1 **Correlation Between SES and Statin Treatment Rates**

The size of circles is a weighted representation of the number of patients with peripheral artery disease (PAD) at a practice. SES = socioeconomic status, defined by the median income of each patient's zip code.

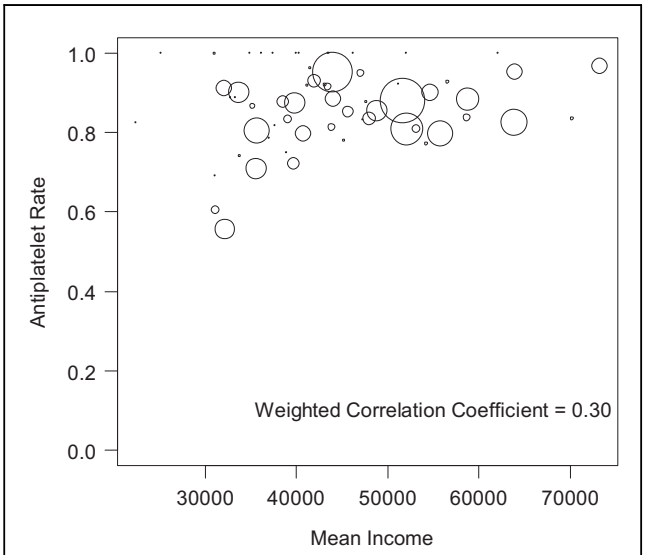

Figure 2 **Correlation Between SES and Antiplatelet Treatment Rates**

The size of circles is a weighted representation of the number of patients with PAD at a practice. Abbreviations as in Figure 1.

Discussion

Among outpatients with PAD, we found that treatment with antiplatelet and statin therapies differed by SES. These differences, however, were largely explained by the clinical practice at which patients received care. Our findings suggest that initiatives to reduce disparities in medication treatment for PAD should target practices with high proportions of low-SES patients.

Studies from different populations have demonstrated that cardiovascular risk factors and disease disproportionately affect those of lower SES (31–36), and among patients with

Table 4 **Association of Socioeconomic Status* With PAD Treatment**

	Unadjusted		Adjusted for Practice Site		Further Adjusted for Clinical Characteristics†	
Treatment/Quintile	RR (95% CI)	p Value	RR (95% CI)	p Value	RR (95% CI)	p Value
Statin therapy						
Quintile 5	[Reference]	–	[Reference]	–	[Reference]	–
Quintile 4	0.95 (0.94–0.96)	<0.001	0.98 (0.97–1.00)	0.0134	0.98 (0.97–1.00)	0.007
Quintile 3	0.97 (0.96–0.98)	<0.001	0.98 (0.97–1.00)	0.0124	0.99 (0.98–1.00)	0.172
Quintile 2	0.90 (0.89–0.91)	<0.001	0.98 (0.95–1.00)	0.0341	0.99 (0.97–1.01)	0.327
Quintile 1	0.84 (0.83–0.86)	<0.001	0.97 (0.95–0.99)	0.0029	1.00 (0.99–1.01)	0.772
Any antiplatelet‡						
Quintile 5	[Reference]	–	[Reference]	–	[Reference]	–
Quintile 4	0.99 (0.98–1.00)	0.022	1.00 (0.99–1.01)	0.556	1.01 (1.00–1.01)	0.237
Quintile 3	1.00 (0.99–1.01)	0.946	0.99 (0.98–1.01)	0.347	1.00 (0.99–1.01)	0.788
Quintile 2	0.98 (0.97–0.99)	<0.0001	1.00 (0.99–1.01)	0.794	1.01 (1.00–1.02)	0.071
Quintile 1	0.93 (0.91–0.94)	<0.0001	0.98 (0.97–1.00)	0.012	1.00 (0.99–1.01)	0.878

*Stratified by range of patient income (in USD) (calculated as the median household income per year in each patient's zip code), as follows: quintile 1 = 4,583–34,486; quintile 2 = 34,486–41,117; quintile 3 = 41,118–50,371; quintile 4 = 50,372–60,868; and quintile 5 = 60,869–200,001. †Clinical characteristics adjusted model: model adjusted for practice, age, sex, history of myocardial infarction, revascularization in the previous 12 months, insurance, congestive heart failure, diabetes, stroke, dyslipidemia, and tobacco use. ‡Excluding patients on warfarin.

CI = confidence interval; PAD = peripheral artery disease; RR = relative risk.

cardiac disease, those with lower SES experience higher morbidity and mortality (4,37–40). Patient-level risk factors, such as increased health-risk behaviors, may account for some of the increased morbidity and mortality seen in patients of low SES (4,41). However, identifying factors beyond patient risk factors and behaviors (36), which are not easily modifiable, is crucial to quality initiatives that address the Institute of Medicine mandates to improve outcomes and reduce disparities. For instance, several studies have reported variation in compliance with evidence-based therapies for other cardiac conditions by SES, and may partly explain the association between lower SES and worse outcomes (37,42,43). However, these prior studies have not examined differences in treatments of PAD by SES. Moreover, they have not examined the extent to which the site at which a patient receives his or her care influences treatment rates.

The present study expands on findings of other disparities research and focuses on PAD, in which outcomes research has been limited. Prior studies of disparities in PAD have focused on rates of utilization of lower extremity revascularization by SES or reported rates of optimal medical therapy by insurance status (5–9). This present study confirms findings similar to those in other cardiac disease states, in that the use of secondary preventive treatments for PAD was lower among those of low SES. This finding highlights an important gap in the quality of care of patients with PAD, especially because the cost of aspirin and generic statins is low and should not pose significant barriers to patient access to these evidence-based therapies.

The present analysis further contributes to disparities research by highlighting the central role of the practice at which patients receive their care in explaining treatment differences by SES. We found that disparities in medication use between the highest and lowest SESs were markedly attenuated after adjustment for site-level variation; this finding suggests that differences in medication use were predominately explained by differences in sites that largely treat patients of low SES compared with sites caring for largely higher-SES patients. We believe these findings serve as an important paradigm for future efforts to reduce disparities in care, which will need to target clinical practices as intervention units and go beyond patient-level interventions. For PAD, future studies are needed to determine whether system-wide improvements at the practice level (e.g., identification of patients with PAD, initiation of secondary prevention medications, and physician education) or resource interventions at practices with high proportions of low-SES patients (e.g., electronic medical systems, decision aids) will reduce disparities in treatment by SES. Quality-improvement initiatives that provide feedback to sites by providing reports benchmarking performance of the site in relation to pre-specified goals or national averages for select performance metrics may help change behavior at a site.

Study limitations. First, we relied on patient diagnoses for PAD, which were self-reported by practices. It is possible that some patients were not classified as having PAD; however, we believe any misclassification would have been nondifferential and are unlikely to have influenced our findings. Moreover, we were unable to examine severity of PAD, as we did not have physiological (e.g., ankle-brachial index) or angiographic data on all patients. Similarly, we were unable to analyze the variability in use of medication by the specific PAD diagnosis (i.e., surgery vs. noninvasive test) Second, we defined SES by median income in each patient's residential zip code, which is a common strategy in previous studies (25–27), and did not examine other socioeconomic variables, such as educational level, which were not available in the PINNACLE registry. Third, our study was conducted among cardiology practices participating in PINNACLE, a quality-improvement registry; therefore, treatment rates by SES may differ in nonparticipating practices, including primary care centers. Given voluntary enrollment in this quality-improvement initiative, it is possible that the rates of medication use are higher than expected in nonparticipating sites. We did not adjust for race in the clinical model given that it was frequently missing (nearly 50% of patients had missing data on this variable); however, most of the variation in treatment between the SES groups could be accounted for by practice-level variation. Furthermore, although it is possible that the differences in therapies by SES could be mediated by some, but not all, physicians within a practice, the current PINNACLE registry does not provide information on provider characteristics sufficient to allow us to currently examine this possibility. Regardless, further education and resources geared at practices with high proportions of low-SES patients have the potential to improve compliance to therapies indicated for PAD. Finally, we were unable to examine longitudinal outcomes in this study.

Conclusions

Among patients with PAD, treatment with evidence-based antiplatelet and statin therapies differed by patients' SES. These differences, however, were largely explained by the clinical practice at which patients received care, suggesting variation in treatment patterns across centers. Future efforts to reduce treatment disparities by SES in PAD and to improve outcomes in these vulnerable populations should target practices serving high proportions of patients of low SES.

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Key Words: disparities ■ medications ■ peripheral artery disease ■ secondary prevention.