ORIGINAL RESEARCH

Guideline Recommended Medical Therapy for Cardiovascular Diseases in the Obese: Insights From the Veterans Affairs Clinical Assessment, Reporting, and Tracking (CART) Program

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***Background*—**Stigma against the obese is well described in health care and may contribute to disparities in medical decision-making. It is unknown whether similar disparity exists for obese patients in cardiovascular care. We evaluated the association between body mass index (BMI) and prescription of guideline-recommended medications in patients undergoing elective percutaneous coronary intervention.

***Methods and Results*—**Using data from the Veterans Affairs Clinical Assessment, Reporting, and Tracking System Program, we identified patients undergoing elective percutaneous coronary intervention from 2007 to 2012, stratifying them by category of BMI. We described rates of prescription for class I guideline recommended medications for each BMI category (normal, overweight, and obese). Multivariable logistic regression assessed the association between BMI category and medication prescription. Seventeen thousand thirty-seven patients were identified, with 35.3% having overweight BMI, and 50.8% obese BMI. Obese patients were more likely than normal BMI patients to be prescribed β-blockers (OR 1.34), statins (OR 1.39), or ACE/ARB (odds ratio [OR] 1.52; all significant) when indicated. Overweight patients were more likely than normal BMI patients to be prescribed statins (OR 1.29) and angiotensin-converting enzymes/angiotensin II receptor blockers (OR 1.41) when indicated. There was no association between BMI category and prescription of anticoagulants.

***Conclusions*—**Over 85% of patients undergoing elective percutaneous coronary intervention in the Veterans Affairs are overweight or obese. Rates of guideline-indicated medication prescription were <70% among all patients, and across BMI categories, with an association between increased BMI and greater use of guideline-recommended medications. Our findings offer a possible contribution to the obesity paradox seen in many cardiovascular conditions. **(*J Am Heart Assoc*. 2016;5:e003120 doi: 10.1161/JAHA.115.003120)**

Key Words: cardiovascular disease • medication therapy • obesity • prevention

Obesity is a rising epidemic in the United States, with the proportion of obese Americans exceeding one third of the population (34.9%) in 2012.[1] Stigma against the obese is well described,[2] characterized by negative provider attitudes[3,4] and disparities in preventative care such as colorectal cancer screening.[5–8] Despite the growing proportion of patients that are obese, there are limited data on whether similar disparities exist in preventive cardiovascular care.

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Obesity is associated with the development of cardiovascular diseases,[9–13] and the prevalence of obese patients presenting for cardiovascular care is increasing.[14] Current and prior guidelines for cardiovascular care recommend the use of specific medical therapies for established atherosclerotic disease and its equivalents, heart failure (HF), atrial fibrillation (AF), and myocardial infarction (MI)[15–24] to reduce morbidity and mortality. A treatment difference in use of guideline-recommended medications in the overweight and obese would represent a missed opportunity for secondary prevention. Thus, understanding the relationship between body mass index (BMI) status and optimal medical therapy is important to ensure that a population at high risk for cardiovascular events is receiving optimal care.

The objective of this study was to evaluate the association between BMI and prescription of guideline-recommended medical therapy for cardiovascular disease. Specifically, we assessed rates of guideline-recommended medication prescription for patients with prior diagnoses of coronary artery

disease (CAD) and its equivalents, prior MI, HF, and AF among patients referred for elective percutaneous coronary intervention (PCI) in the Veterans Affairs (VA) Healthcare System. Then we evaluated whether rates of guideline-recommended medication prescription varied by BMI categories of obese, overweight, and normal. As obesity has been associated with lower rates of preventative care in other fields, we hypothesized that patients with higher BMI would be less likely to receive guideline-recommended preventive medical therapy for cardiovascular diagnoses.

Methods

Data Sources

Data for this analysis were obtained from the VA Clinical Assessment, Reporting, and Tracking System (CART) Program, which is a national clinical quality program for all cardiac catheterization laboratories in the VA Health Care system. This program uses a software application embedded within the VA electronic health record to capture and compile standardized patient and procedural data elements for all coronary procedures performed in any VA catheterization lab, and has been described previously.[25] Participation in CART is mandatory and universal in all VA cardiac catheterization labs. CART elements are completed by providers immediately prior to the coronary procedure as part of the precatheterization assessment. If there are missing data, then administrative data are used to define the covariate using either 1 inpatient diagnosis or 2 separate outpatient diagnoses within 2 years prior to the procedure. These data elements are derived from the National Cardiovascular Data Registry data definitions,[26] with periodic quality assessments for completeness, accuracy, and validity.[27]

Study Cohort

We identified all patients undergoing elective PCI within the VA from 2007 to 2012. We excluded urgent or emergent procedures to ensure prior exposure to the healthcare system with opportunity for evaluation and implementation of guideline-recommended medical therapy. We chose to evaluate medication prescription at the time of presentation for elective PCI because at that time point, multiple providers would have evaluated each patient prior to the procedure (eg, referring internists and cardiologists prior to presentation to the catheterization laboratory), again ensuring contact with the healthcare system and opportunity for evaluation and implementation of guideline-recommended medical therapy. Given our primary interest in the effect of being overweight and obese and the known morbidity of underweight patients,[28] we excluded underweight patients (BMI <18.5; N=229).

We obtained key clinical, historical, and demographic data from elements captured in CART for each patient undergoing elective PCI, including height and weight for calculation of BMI. We also obtained patient-linked prescription information from the VA Corporate Data Warehouse[29] for β-blockers, angiotensin-converting enzyme inhibitors/angiotensin receptor blockers (ACEs/ARBs), statins, and warfarin in the preprocedural period. All active medication prescriptions are automatically input into CART during the precatheterization assessment, obtained from the electronic health record and Corporate Data Warehouse, immediately prior to any coronary procedure.

Exposure

The primary exposure was having a BMI higher than normal, with the referent group being patients with a normal BMI. BMI was calculated using methods and definitions set forth by the World Health Organization,[30] obtaining height and weight data at the time of angiography and PCI from CART. We categorized patients into 3 categories by BMI in accordance with the World Health Organization International Classification of adult underweight (BMI <19), overweight, and obesity: normal (BMI 19–25), overweight (>25–30), or obese (>30).[30]

Outcomes

The primary outcomes were the prescription rates of individual class I guideline-recommended medication classes for cardiovascular diagnoses. We defined patients as "β-blocker eligible" if they had a history of HF or prior MI prior to PCI, "statin eligible" if they had a diagnosis of CAD or a CAD equivalent (diabetes mellitus, peripheral arterial disease, or cerebrovascular disease) prior to PCI, "anticoagulant eligible" if they had a history of AF and a $CHADS_2$ score of >1 (defined by the presence of 1 or more components of the $CHADS_2$ score in the patient's history: HF, hypertension, age ≥70 years of age, diabetes mellitus, or history of cerebrovascular disease[31]) prior to PCI, and "ACE or ARB eligible" if they had a history of HF[15–19,21] prior to PCI. Patients were deemed not eligible for specific medications if they had documented contraindications. We assessed rates of prescription for each medication among those patients determined eligible.

As aspirin is often obtained over the counter and may be incompletely captured in VA data, prescription of aspirin was not assessed. Individual diagnoses of known CAD, CAD equivalents, prior MI, HF, or AF were obtained from CART data elements. Each individual data element and clinical diagnosis captured in CART is recorded immediately prior to any coronary procedure performed in a VA cardiac catheterization laboratory as part of a required precatheterization assessment performed by providers, informed by direct patient evaluation as well as review of the electronic health record.

Prescription was defined as the presence of an active outpatient prescription for a medication within the indicated class of medicines (β-blocker, statin, ACE, or ARB, anticoagulant) at the time of elective PCI. Secondary outcomes were the presence of the combination of β-blocker and statin prescriptions in patients with a history of MI, and for the combination of β-blocker and ACE/ARB prescriptions in patients with a history of HF.

Covariates

We obtained demographic, clinical, and historical data for each patient from the CART database. These included age, sex, history of CAD, AF, HF, chronic obstructive pulmonary disease, cerebrovascular disease, diabetes mellitus, hypertension, prior MI, obstructive sleep apnea, and tobacco use. These covariates were chosen based on clinical reasoning and to adjust for various confounders that may impact provider decision-making in medication prescription, and were included in the regression models.

Statistical Analysis

Patient demographic, historical, and clinical features were compared between BMI groups using the Student *t* test and χ^2 test. We determined odds ratios (ORs) for the presence of guideline-recommended medical therapy for each BMI classification and calculated adjusted ORs for the presence of guideline-recommended therapy prescription prior to PCI, using multivariable logistic regression models to adjust for demographic and clinical covariates. Covariates were chosen based on external judgment. ORs were calculated across BMI classifications for administration of each medication or composite of medications to those patients with indications of CAD, HF, and AF with a $CHADS_2$ score >1. Unadjusted and adjusted ORs across BMI classifications were similarly calculated for subgroups of patients with and without prior PCI. Using multivariable logistic modeling, the ORs were adjusted for key demographic, historical, and clinical features. Statistical analysis was performed using SAS version 9.4 (SAS Institute, Cary, NC). This study was approved by the Colorado Multiple Institutional Review Board, with waiver of subject consent.

Results

Patient Cohort

There were 17 037 patients undergoing elective PCI in the VA Health Care System from 2007 to 2012. Of these, 13.9% had a normal BMI (19–25 kg/m^2), 35.3% were overweight (BMI 25–30 kg/m^2), and 50.8% of patients were obese (BMI >30 kg/m^2). Within the cohort, 7278 (n=42.7%) had a prior PCI. Overweight and obese patients were more likely to have a history of CAD, AF, sleep apnea, hypertension, and diabetes mellitus. Patients with a normal BMI were more likely to have a history of HF, be current tobacco users, have lung disease,

Table 1. Baseline Characteristics of the Patient Cohort, by BMI

	Body Mass Index Classification			
	Normal (N=2361)	Overweight (N=6016)	Obese (N=8660)	*P* Value
Age, y	66.0	65.1	63.3	<0.001
Male (%)	98.1	98.6	98.4	0.301
BMI, mean	22.9	27.6	35.4	<0.001
History of coronary artery disease, %	76.4	79.1	77.6	0.006
Atrial fibrillation	8.2	9.4	8.3	0.042
Heart failure	22.9	20.5	16.5	<0.001
Chronic obstructive pulmonary disease	35.6	26.2	24.9	<0.001
Cerebrovascular disease	19.2	14.8	16.2	<0.001
Diabetes mellitus	24.7	57.6	36.2	<0.001
Hypertension	82.6	93.5	87.3	<0.001
History of myocardial infarction	29.9	27.1	26.9	0.014
Obstructive sleep apnea	5.3	29.9	11.1	<0.001
History of stroke or transient ischemic attack	9.6	7.4	7.4	<0.001
Current tobacco use	71.6	61.6	63.4	<0.001

BMI indicates body mass index.

Table 2. Prescription Rates of Guideline-Recommended Medication Indications by BMI

	Medication Prescription Rates by Body Mass Index, Unadjusted (N Indicated, [% Receiving Rx])					
	β-Blocker	Statin	ACE/ARB	Anticoagulant	β-Blocker+Statin	β-Blocker+ACE/ARB
Overall	6598 (69.5)	16 055 (66.7)	3308 (62.7)	1172 (59.3)	4666 (56.7)	3308 (49.7)
Normal BMI	1028 (64.0)	2195 (59.1)	540 (53.0)	149 (55.0)	705 (49.2)	540 (43.5)
Overweight BMI	2187 (68.2)	5610 (66.0)	992 (62.7)	371 (54.4)	1618 (56.5)	992 (47.3)
Obese BMI	3383 (72.0)	8250 (69.1)	1776 (65.7)	652 (63.0)	2343 (59.2)	1776 (52.9)

ACE indicates angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; BMI, body mass index.

and have prior cerebrovascular disease, and prior MI or prior cerebrovascular accident (Table 1).

Medications by Indication

Within the overall cohort, 6598 patients (38.7%) had an indication for a β-blocker (HF, prior MI), 16 055 (94.2%) had an indication for a statin (CAD or CAD equivalent), 3308 (19.4%) had an indication for an ACE or ARB (HF history), and 1172 (6.9%) had an indication for oral anticoagulation (AF with $CHADS_2$ score of >1). Rates of medication prescriptions by indications ranged from 59.3% to 69.5% (Table 2). Composite rates for indicated combinations of medications were 56.7% for β-blocker and statin concomitant prescription (prior MI) and 49.7% for β-blocker and ACE-I/ARB concomitant prescription (history of HF).

Among patients with a guideline indication for use, unadjusted rates of β-blocker, statin, ACE/ARB, and anticoagulant prescription were lowest among normal BMI individuals. The proportion of β-blocker use increased in each progressive category of BMI (normal 64.0%, overweight 68.2%, and obese 72.0%). Statin use (normal 59.1%, overweight 66.0%, and obese 69.1%), ACE/ARB use (normal weight 53.0%, overweight 62.7%, and obese 65.7%), and anticoagulant use (normal 55.0%, overweight 54.4%, and obese 63.0%) increased with each progressive BMI category. Similarly, combinations of β-blocker and statin (normal 49.2%, overweight 56.5%, and obese 59.2%) and of β-blocker and ACE/ARB (normal 43.5%, overweight 47.3%, and obese 52.9%) were higher within the higher BMI categories than in the normal BMI individuals.

Adjusted ORs for Medications by Indication

After adjustment for cardiovascular risk factors, comorbidities, and demographic characteristics, overweight and obese patients were more likely than their normal BMI counterparts to be prescribed statins and ACE/ARBs when indicated (overweight: OR 1.29, 95% CI 1.16–1.43; obese: 1.39, 95% CI 1.26–1.55). They were also more likely to receive ACE/ARB therapy when indicated (overweight: OR 1.41, 95% CI 1.14–1.75; obese: OR 1.52, 95% CI 1.23–1.87). Obese patients were more likely to be prescribed β-blocker therapy than their normal BMI counterparts (OR 1.34, 95% CI 1.14–1.57), while overweight patients had no significant difference in odds of β-blocker use. BMI was not associated with prescription of anticoagulants. Patients with an obese BMI were more likely to receive appropriate combinations of medications than normal BMI patients. Similarly, overweight patients were more likely to be prescribed β-blocker and statin combinations, but not β-blocker and ACE/ARB combinations (Figure and Table 3).

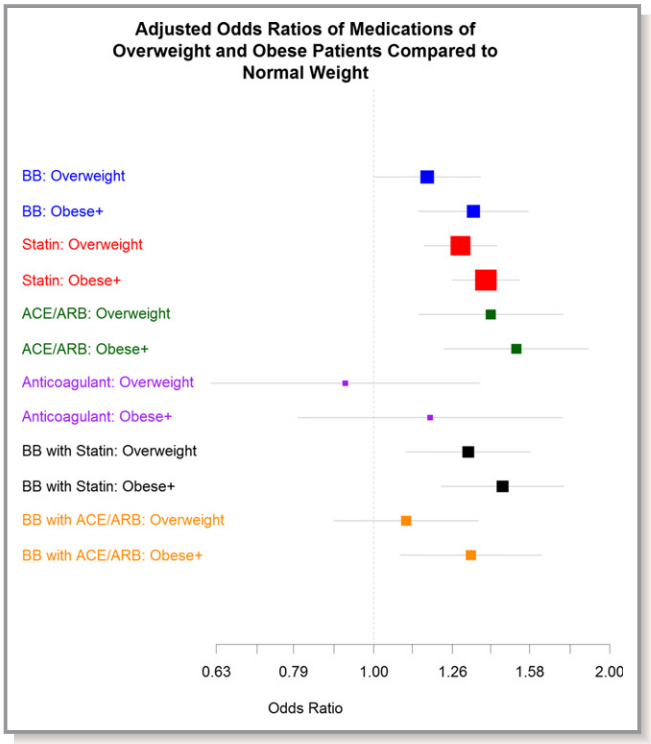

Figure. Adjusted odds ratios for prescription of guideline-indicated medical therapy by body mass index. ACE indicates angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; BB, Beta blockers.

Table 3. Adjusted Odds Ratios for Prescription of Guideline-Indicated Medical Therapy by BMI Category

	Adjusted Odds Ratio to Receive Medication by Body Mass Index (Odds Ratio, [95% CI])					
	β-Blocker	Statin	ACE/ARB	Anticoagulant	β-Blocker+Statin	β-Blocker+ACE/ARB
Normal BMI	Referent	—	—	—	—	—
Overweight BMI	1.17 (1.00, 1.37)	1.29 (1.16, 1.43)	1.41 (1.14, 1.75)	0.92 (0.62, 1.36)	1.32 (1.10, 1.58)	1.10 (0.89, 1.37)
Obese BMI	1.34 (1.14, 1.57)	1.39 (1.26, 1.55)	1.52 (1.23, 1.87)	1.18 (0.80, 1.76)	1.46 (1.22, 1.74)	1.33 (1.08, 1.64)

ACE indicates angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; BMI, body mass index.

Discussion

The objective of this study was to evaluate the impact of BMI on the likelihood of receiving guideline-recommended medical therapy among patients with known cardiovascular disease. We found that there was an association between obesity and higher likelihood of receiving guideline-recommended medical therapy for CAD or its equivalent, prior MI, or HF. Furthermore, there was an association between being overweight and a higher likelihood of receiving ACE/ARB and statin therapy for known CAD or its equivalent, MI, or HF. Finally, the likelihood of receiving guideline-indicated anticoagulation for AF was similar across BMI classes.

Prior studies of the relationship between BMI and use of preventative measures in medicine have found inequities in the care for obese patients. Evaluations in primary prevention measures have demonstrated an association between obese and overweight BMI and lower rates of referral for cervical and breast cancer screening.[5,7,8,32,33] Obesity has also been associated with a lower likelihood of receiving colorectal cancer screening.[6] Secondary prevention measures have also demonstrated disparities in care for obese patients. In a study assessing treatment of psychiatric illnesses, obese patients were found to be less likely to receive recommended psychotherapy in conjunction with medications, and less likely to receive a recommended duration of therapy[34] than individuals with a normal BMI. While these studies are compelling in their demonstrations of disparate care for obese patients, they also identified obese patients' perception of the healthcare system as a barrier to receiving appropriate care: patients can avoid using the healthcare system due to stigma felt during interactions with providers.[5,35] However, these prior evaluations are limited by an inability to control for limited access to care, whether due to patient preference or to more traditional access barriers, as well as by cohort size. Our study is distinct from prior work, identifying a cohort that has established contact with the healthcare system in order to be referred for elective PCI, and leverages the large number of patients within the VA healthcare system to strengthen the cohort size. Our findings are distinct from these prior studies by demonstrating an association between overweight and obese patients and higher rates of receiving guideline-recommended medications for CAD, MI, and HF.

Our analysis is the first to our knowledge to assess the relationship between BMI and guideline-recommended preventative medication use across the cardiovascular diagnoses of CAD, HF, MI, and AF, and is novel in the homogeneity of the cohort with regard to access to care and stage of evaluation. Our findings of an association between obese and overweight patients and a higher likelihood of receiving guideline-indicated therapy run counter to the initial hypothesis that obesity would be associated with therapeutic disparities. This incongruence in care patterns across medical disciplines is likely multifactorial. One potential reason is likely the aforementioned hesitance to undergo evaluation and care due to perceived stigma against the obese and overweight from the healthcare system and practitioners,[2,4,8,35,36] resulting in fewer opportunities to establish and optimize medical therapy. As referral for PCI ensures contact with the healthcare system, this may explain the differences from prior analyses. Further analysis of overall utilization of the healthcare system by overweight and obese patients and its impact on quality care may address this question. A second possibility is that certain disciplines focusing on conditions associated with overweight and obese patients (eg, cardiology or endocrinology) may provide less stigma against the obese and overweight during interactions, resulting in increased patient satisfaction and likelihood to present for care. Third, the incorporation of cardiovascular guidelines into quality metrics for physicians may carry enough influence to counter disparities seen in other disciplines. Evaluations of relationships between obesity and medical management in disciplines with guidelines incorporated into quality measures, such as diabetes management and care, are necessary to explore the effects that quality measures may play.

Our finding of increased rates of guideline-recommended medical therapy in the obese and overweight as compared to those patients with normal BMI is also novel, and merits exploration. A recent analysis of provider bias in clinical decision making demonstrated differences in treatment for sex, based on implicit assumptions from history and appearance.[37] It is possible that obesity is a trait that is similarly

visible and overt, prompting implicit associations for providers, serving as a reminder of morbidity and inciting providers to act more aggressively in strategies for risk reduction. Qualitatively assessing provider attitudes and the implicit associations present when encountering an obese patient could help explore the underpinnings of this treatment gap.

Finally, our findings also carry further importance and novelty in consideration of the "obesity paradox." Among patients with cardiovascular diseases including MI, hypertension, AF, and congestive heart failure, obesity has been consistently associated with improved survival[38–41] despite its association with increased all-cause mortality in patients without cardiovascular disease.[42,43] Proposed explanations for this association have included both physiologic and methodologic mechanisms.[38] Our findings offer another possible mechanism, through a difference in care favoring the obese. These differential rates of prescription serve as another potential contributor to the observed obesity paradox in cardiovascular disease states.

Our study should be reviewed in light of several limitations. First, as this was a retrospective observational analysis, causality cannot be inferred and confounders may be present. We performed robust statistical adjustment for a wide variety of covariates in order to minimize the potential effects of measurable confounders. Second, our study assessed for the presence of a prescription for each of the recommended medications, and did not evaluate whether or not patients are actually taking the medications. While we did not assess percent days covered as a measure for adherence to medication, this study was intended to evaluate providers' practice patterns more so than patient adherence or patient outcomes, which is represented by the assessed prescription patterns. Third, intolerances that were not listed as allergies could not be ascertained, and so patients with undocumented intolerances may have been misclassified in the analysis, artificially inflating the proportion of patients missing guideline-indicated medications. Fourth, the study cohort comprised patients undergoing elective PCI from 2007 to 2012, possibly reflecting differences in guideline-recommended therapy from current practice. However, national societal guidelines for HF and AF have been stable in their recommendation since prior to the study period,[16,21] and contemporaneous clinical trial data and other clinical practice guidelines for diabetes mellitus, coronary, and peripheral arterial and cerebrovascular disease supported the use of statin therapy in these patients.[20,22–24] Fifth, we are limited by a lack of data on ejection fraction, and are thus unable to discern between HF with preserved ejection fraction and HF with reduced ejection fraction. Sixth, the majority of prior evaluations have focused on procedures, while our analysis evaluated medication prescription. It is possible that treatment differences remain for the obese, with practitioners avoiding procedural referrals for the obese but not medication prescription. Finally, our findings in this cohort may not be generalizable to other populations not well represented in the VA. Further studies in other populations, specifically women and minorities, are needed to improve the strength of these conclusions.

Conclusions

Our study found that there was an association between overweight and obese patients and a higher likelihood of receiving prescriptions for guideline-indicated cardiovascular medications prior to elective PCI when compared to their normal-weight counterparts. This analysis is unique in its large cohort size, and its ability to identify an at-risk population, with similar access to care, at a common time point in care: prior to elective PCI. Additionally, while prior studies have evaluated the role of BMI in inpatient medication administration and discharge medications following PCI, this is the first analysis to our knowledge to assess the impact of BMI on outpatient secondary preventative therapy in cardiovascular disease processes.

These findings demonstrate an association between obesity and prescription of guideline-recommended medical therapy, and offer a possible contribution to the obesity paradox seen in MI, HF, and AF. These data also demonstrate a gap in delivery of appropriate secondary prevention therapy to veterans with cardiovascular diseases. Further study into improving delivery of these evidence-based therapies is warranted.

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Disclosures

None.

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