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Practice Patterns Surrounding the Use of Tibial Interventions for Claudication in the Medicare Population

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Abstract

Objectives: There have been no data to support the use of tibial interventions in the treatment of claudication to date. We aimed to characterize the practice patterns surrounding tibial peripheral vascular interventions (PVI) in patients with claudication in the United States.

Methods: Using 100% Medicare fee-for-service claims from 2017 to 2019, we conducted a retrospective analysis of all patients undergoing an index PVI for claudication. Patients who had any previous PVI, acute limb ischemia, or chronic limb-threatening ischemia in the preceding 12 months were excluded. The primary outcome was the receipt or delivery of tibial revascularization during index PVI for claudication, defined as tibial PVI with or without concomitant femoropopliteal PVI. Univariable comparisons and a multivariable hierarchical logistic regression were used to assess patient and physician characteristics associated with the use of tibial PVI for claudication.

Results: Of 59,930 Medicare patients who underwent index PVI for claudication between 2017 and 2019, 16,594 (27.7%) received a tibial PVI (38.5% isolated tibial PVI and 61.5% tibial PVI with concomitant femoropopliteal PVI). Of 1,542 physicians included in the analysis, the median

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physician-level tibial PVI rate was 20.0% (IQR 9.1%–37.5%). Hierarchical logistic regression suggested that patient-level characteristics associated with tibial PVI for claudication included male sex (adjusted odds ratio [aOR] 1.23), increasing age (aOR 1.30–1.96), Black race (aOR 1.47), Hispanic ethnicity (aOR 1.86), diabetes (aOR 1.36), no history of hypertension (aOR 1.12), and never-smoking (aOR 1.64; all, $P < 0.05$). Physician-level characteristics associated with tibial PVI for claudication included early-career status (aOR 2.97), practice location in the West (aOR 1.75), high-volume PVI practice (aOR 1.87), majority practice in an ASC/OBL setting (aOR 2.37), and physician specialty; vascular surgeons had significantly lower odds of performing tibial PVI compared to radiologists (aOR 2.98) and cardiologists (aOR 1.67; all, $P < 0.05$). Average Medicare reimbursement per patient was dramatically higher for physicians performing high rates of tibial PVI (quartile 4 vs. quartile 1–3: \$12,023.96 vs. \$692.31 per patient, $P < 0.001$).

Conclusions: Tibial PVI for claudication are performed more commonly by non-vascular surgeons, in high-volume practices, and in high-reimbursement settings. This reveals a critical need to reevaluate the indications, education, and reimbursement policies surrounding these procedures.

Table of Contents Summary

More than a quarter of the 59,930 Medicare patients who underwent a peripheral vascular intervention for intermittent claudication underwent a tibial peripheral vascular intervention. Our findings reveal a critical need to standardize trainee education and clinical practice guidelines across specialties, and to reevaluate Medicare reimbursement policies surrounding the treatment of claudication.

Keywords

intermittent claudication; peripheral artery disease; peripheral vascular interventions; endovascular surgery; clinical guidelines; Centers for Medicare and Medicaid

Introduction:

The Society for Vascular Surgery (SVS) guidelines recommend initiating a trial of smoking cessation, risk factor modification, and supervised exercise therapy as first-line therapy for the treatment of intermittent claudication¹. After a period of 3 to 6 months, patients who continue to experience severe lifestyle-limiting claudication symptoms can be considered for revascularization. These recommendations are consistent across the SVS guidelines for lower extremity disease¹ and the American Heart Association (AHA)/American College of Cardiology (ACC) guidelines for claudication².

For patients with claudication who are considered for revascularization following conservative management, peripheral vascular interventions (PVI) have been shown to be most effective for aortoiliac occlusive disease, followed by femoropopliteal disease^{2, 3}. For isolated infrapopliteal artery disease in patients with claudication, the AHA/ACC guidelines consider the clinical usefulness of PVI to be “unknown”² due to a lack of evidence, while the SVS guidelines explicitly state, “Isolated infrapopliteal interventions are not recommended for patients with [intermittent claudication]”¹. This is due to there being

no clear relationship between the presence of tibial disease and claudication symptoms¹, and due to the anatomic durability of tibial PVI being demonstrably poor relative to more proximal interventions⁴.

There are significant variations in the practice patterns and technologies used in PVI for claudication. We have previously explored the use of femoropopliteal atherectomy for treating claudication and observed marked differences in its use according to practice location and physician specialty⁵. Given the variation in professional guidelines surrounding the efficacy of tibial interventions for claudication^{1,2}, we aimed to characterize the practice patterns surrounding tibial PVI in patients with claudication in the United States.

Methods:

Study Population

We used 100% Medicare fee-for-service claims from January 1, 2017 to December 31, 2019 to identify all patients who underwent an index PVI for claudication. Claudication was defined using International Classification of Diseases (ICD) codes (Supplemental Table 1). All patients with any prior PVI (n=31,116), acute limb ischemia (n=51,404), or chronic limb-threatening ischemia (n=174,205) in the preceding 12 months were excluded from analysis (total excluded n=219,723). We also excluded patients without a diagnosis of claudication (n=1,614), patients without 12 months of enrollment at the time of the index PVI (n=3,251), and patients missing any demographic information (n=14). Study approval was obtained from the Johns Hopkins Medicine Institutional Review Board.

Patient Characteristics

We used the Medicare Master Beneficiary Summary File⁶ to identify patient demographic characteristics including age, sex, race, and ZIP code, which was mapped to the Federal Information Processing Standard (FIPS) code using the sashelp.zipcode file (SAS Institute, Cary, North Carolina), and then the core-based statistical area (CBSA) code using the National Bureau of Economic Research's CBSA to FIPS County Crosswalk⁷. These linkages were used to classify the population density of residence for each patient, with an urban area defined as having ≥50,000 people and a rural area defined as population <50,000 people with no urban core⁵. We used median household income as a metric for socioeconomic status, characterized into quartiles per the Agency for Healthcare Research and Quality's 2018 estimates⁸.

We reviewed inpatient, outpatient, and carrier claims data to identify patients who underwent index PVI and identified those with claudication diagnosed in the preceding 12 months as the indication for the procedure. We defined comorbidities including diabetes, hypertension, end-stage renal disease, and ever-smoking based on a single inpatient diagnosis claim or at least two outpatient diagnosis claims more than 30 days apart.

Physician Characteristics

We used National Provider Identifier numbers to link physicians with the PVI procedures that they performed. We calculated the rate of index tibial PVI for claudication for all

physicians who performed >10 index PVI procedures during the study period, in accordance with our data use agreement with the Centers for Medicare and Medicaid Services. Each physician's rate of index tibial PVI was calculated using the number of tibial PVI performed for claudication (either isolated tibial PVI or tibial PVI with a concomitant femoropopliteal PVI) during the study period by a given physician and the total number of PVI performed for claudication during the study period by that same physician as the denominator. We evaluated the national distribution of index tibial PVI rates using a histogram and then classified physicians into quartiles based on their individual tibial PVI rates.

We used the Medicare Data on Provider Practice and Specialty⁶ and the Physician Compare National Downloadable File⁹ to identify physician demographics including sex, years since graduation from medical school, primary specialty, census region of practice location, and population density of practice location. Physician specialty is based on self-report to the Centers for Medicare & Medicaid Services and does not necessarily represent board certification. We calculated the overall percentage of services delivered in a freestanding ambulatory surgery center (ASC) or office-based laboratory (OBL) using summary statistics in the Medicare Data on Provider Practice and Specialty⁶. We also calculated the average Medicare-allowed payment (in USD) for index PVI procedures performed for claudication from 2017 to 2019 for each physician.

Outcome

The main outcome of the study was defined as any tibial PVI (either as an isolated intervention or with a concomitant femoropopliteal PVI) performed during a patient's index intervention for claudication. Femoropopliteal and tibial PVI were identified using CPT codes 37224–37227 and 37228–37235, respectively (Supplemental Table 2). Per CPT coding, procedures performed on the tibioperoneal trunk, anterior tibial artery, posterior tibial artery, and/or peroneal artery fall into the same category, which we classified as “tibial PVI.” Only the first limb treated for any given patient was included in the analysis.

Statistical Analysis

We described patient and physician characteristics using count (percentage) and mean \pm standard deviation or median (interquartile range), as appropriate. We used Chi-squared tests for categorical variables or Mood's median tests for continuous variables to assess differences in baseline characteristics of patients undergoing tibial PVI versus non-tibial PVI for claudication, and to compare characteristics of physicians performing the highest rates of tibial PVI (quartile 4) versus lower rates of tibial PVI (quartiles 1–3) for claudication.

Univariable logistic regression was used to assess the association of patient and physician characteristics with tibial PVI for claudication. A multivariable hierarchical logistic regression model including a random intercept for physician to account for patient clustering by physician was subsequently used to identify patient- and physician-level characteristics associated with the use of tibial PVI. Patient covariates (age, sex, ethnicity/race, smoking history, and other comorbid conditions) were assessed in the first level of the model, and physician covariates (sex, primary specialty, years in practice, location of practice, volume of PVI performed, and proportion of practice in an ASC/OBL setting) were assessed in the

second level of the model. All covariates were chosen *a priori* based on our previous work on this topic¹⁰.

Statistical analyses were performed using SAS Enterprise version 7.1 (SAS Institute, Cary, North Carolina). All results were deemed statistically significant at $P < 0.05$.

Results:

Patient Cohort

Of 59,930 Medicare patients who underwent index PVI for claudication between 2017 and 2019, 27.7% (n=16,594) received a tibial PVI. Among patients who received a tibial PVI, 38.5% (n=6,394) received an isolated tibial PVI and 61.5% (n=10,200) received a tibial PVI with a concomitant femoropopliteal PVI (Table 1). Of 17,081 tibial interventions performed in 16,594 patients, atherectomy was the most common (N=9,916, 59.8%), followed by angioplasty (N=6,122, 36.9%), stenting (N=542, 3.3%), and stenting with atherectomy (N=501, 3.0%). Additionally, 29.6% (n=4,908) of patients undergoing a tibial PVI received a multi-vessel tibial intervention, with atherectomy being the most common procedure performed on additional tibial vessels. Due to multiple procedure types on multiple vessels, the sum of tibial interventions totals to greater than 100%.

The median age of patients who underwent tibial PVI (75.3 years, IQR 69.3, 81.6 years) was higher than that of patients who underwent non-tibial PVI (73.6 years, IQR 68.7, 79.2 years) ($P < 0.001$). Patients undergoing tibial PVI were more frequently of non-Hispanic Black or Hispanic race/ethnicity, had end-stage renal disease and diabetes, and were less frequently smokers compared to patients who did not receive a tibial PVI (all, $P > 0.05$; Table 1). There were marked discrepancies in geographic residence between groups, with patients living in urban areas and in the Western region of the US receiving significantly more tibial PVI (both, $P < 0.001$; Table 1).

Physician Cohort

Of the 1,542 physicians who performed >10 PVI during the study period included in this study, the mean tibial PVI rate was $26.2 \pm 22.6\%$ and the median tibial PVI rate was 20.0% (IQR 9.1%, 37.5%) (Figure 1). The fewest number of PVI procedures performed by a single physician during the study period was 11 and the most was 550. Physicians with higher rates of tibial PVI (i.e., quartile 4, or tibial PVI rate 37.5%) more frequently practiced in the Western region, had a primary specialty of radiology, had a high-volume practice performing PVI for claudication, and delivered a high overall percentage of services in an ASC or OBL (all, $P < 0.001$; Table 2). There were no significant differences in physician sex, years since medical school graduation, or population density of practice location between the two groups (all, $P > 0.05$; Table 2). The average Medicare reimbursement per patient was dramatically higher for physicians performing high rates of tibial PVI compared to physicians performing lower rates of tibial PVI (quartile 4 v quartile 1–3: \$12,023.96 vs. \$692.31 per patient, $P < 0.001$).

Patient and Physician Characteristics Associated with Tibial PVI

After adjusting for patient and physician characteristics in a hierarchical logistic regression model, patient-level characteristics associated with tibial PVI for claudication included male sex (adjusted odds ratio [aOR] 1.23, 95% CI 1.16, 1.30), increasing age (aOR 1.30–1.96, 95% CI 1.22, 2.15), Black race (aOR 1.47, 95% CI 1.35, 1.60), Hispanic ethnicity (aOR 1.86, 95% CI 1.58, 2.20), and diabetes (aOR 1.36, 95% CI 1.29, 1.44). Patients with hypertension (aOR 0.89, 95% CI 0.81, 0.97), with a history of smoking (aOR 0.61, 95% CI 0.57, 0.65), and with increasing median household income (quartile 4 vs. quartile 1, aOR 0.88, 95% CI 0.88–0.98) were less likely to receive a tibial PVI (Table 3).

Physician-level characteristics associated with tibial PVI for claudication included early-career status (< 10 years since medical school graduation: aOR 2.97, 95% CI 2.02, 4.39), practice location in the West (vs. South, aOR 1.79, 95% CI 1.48, 2.16), high-volume PVI practice (aOR 1.86, 95% CI 1.59, 2.18), and increasing proportion of practice in an ASC/OBL setting (aOR 1.32 – 2.38, Table 3). Physician specialty was also significantly associated with tibial PVI for claudication: radiologists (aOR 2.94, 95% CI 2.26, 3.82), cardiologists (aOR 1.66, 95% CI 1.44, 1.91), and other specialties (aOR 1.37, 95% CI 1.05–1.78) were significantly more likely to perform a tibial PVI for claudication compared to vascular surgeons.

Discussion:

Our findings show that a large proportion of Medicare beneficiaries undergo tibial PVI for claudication. Since 2015, the SVS guidelines for lower extremity peripheral artery disease have recommended against the use of tibial interventions for claudication, and specifically isolated tibial interventions¹. Despite this, 27.7% of all Medicare patients undergoing PVI for claudication received a tibial intervention, and 38.5% of those tibial PVI were performed in isolation, without a concomitant femoropopliteal PVI. Furthermore, as many as 29.6% of patients undergoing a tibial PVI received a multi-tibial intervention. We found that most of these procedures were performed by radiologists and cardiologists rather than vascular surgeons. Our study is one of the first to characterize the practice patterns surrounding tibial interventions for claudication using national data.

Overall, there is a paucity of data summarizing practice patterns around tibial PVI for claudication. Data from the Vascular Study Group of New England between 2003 and 2018 suggested that tibial interventions were performed in 5.7% of cases for claudication, and that isolated tibial interventions were performed in 1.7% of patients¹¹. Data from the Vascular Quality Initiative during the same timeframe suggested that tibial interventions were performed in approximately 11% of PVI for claudication¹². Both of these tibial PVI frequencies are much lower than the 27.7% that we report. However, the previous analyses were limited to institutions that participate in quality registries. The Vascular Quality Initiative has grown substantially over time to include 938 medical centers in the United States¹³, but is still limited to voluntarily participating groups. Our analysis has a broader scope in that it captures 100% Medicare fee-for-service beneficiaries treated by any physician in the US, and in a more contemporary timeframe, during which endovascular interventions have become much more popular¹⁴. Notably, both prior analyses showed

that patients undergoing tibial interventions for claudication had a higher risk of major amputation compared to patients undergoing more proximal interventions^{11, 12}.

We found a few patient variables associated with tibial PVI for claudication. Patients of Black and Hispanic race/ethnicity had higher tibial PVI rates compared to White patients, as did patients with diabetes. In contrast, patients with a history of smoking had lower rates of tibial PVI. The racial/ethnic disparities we report are consistent with our previous analysis of PVI for claudication, which showed a higher rate of PVI for claudication in general for Black patients¹⁵. The associations of diabetes, end-stage renal disease, and never smoking with tibial PVI is consistent with the general patterns of disease, as diabetes and end-stage renal disease more frequently affect the infrapopliteal arteries in peripheral artery disease¹⁶, whereas smoking typically results in femoropopliteal atherosclerosis¹⁷.

We also identified several notable physician characteristics associated with tibial PVI. Specifically, physicians with high-volume PVI practices, those practicing in outpatient settings, and non-vascular surgeons were more likely to perform tibial PVI for claudication. The specialty differences we observed may reflect differing opinions across professional societies. In April 2022, the SVS released new appropriate use criteria (AUC) for the management of intermittent claudication¹⁸. These AUC determined that infrapopliteal interventions have greater risks than benefits for intermittent claudication, and should not be performed in isolation or downstream from femoropopliteal revascularization¹⁸. This was unanimously agreed upon by a multidisciplinary panel of physicians, including cardiologists nominated by the American College of Cardiology, radiologists nominated by the Society of Interventional Radiology, and vascular surgeons in the SVS¹⁸. Preceding this, the ACC, AHA, Society for Cardiovascular Angiography and Interventions (SCAI), Society of Interventional Radiology (SIR), and Society of Vascular Medicine (SVM) released AUC for peripheral artery interventions in 2018. The previous AUC used a different tone than the most recent AUC by the SVS, declaring that infrapopliteal PVI for claudication “may be appropriate” in special circumstances¹⁹. Of note, the SVS was not included in the 2018 committee, and did not formally endorse those criteria. Thus, the recently published AUC by the SVS explicitly emphasized the importance of multidisciplinary representation, drawing attention to the fact that there has been controversy surrounding the management of claudication. It will be important to evaluate if the practice patterns surrounding the use of tibial PVI for claudication will change in the coming years, following publication of the recent multispecialty AUC.

The association of high-volume PVI practices and outpatient-based practices with tibial PVI for claudication were also notable. Physicians performing as many as 82–100% of their total PVI cases in the ASC/OBL setting had greater odds of performing tibial PVI than physicians who performed most of their cases in a hospital-based setting. There was a clear incremental association of ASC/OBL practice volume with tibial PVI rate, and the average Medicare reimbursement per patient was dramatically higher for physicians performing a high volume of tibial PVI than for physicians performing lower volumes of tibial PVI. While indications for tibial PVI cannot be elucidated from our analysis, these findings suggest a possible financial incentive related to tibial interventions for claudication. We have similarly shown high rates of atherectomy for claudication in outpatient versus

hospital-based settings that are closely associated with reimbursement⁵. Another study using Medicare claims data also found higher rates of PVI being performed in outpatient versus in-hospital settings, also believed to be associated with Medicare reimbursement policies²⁰. Although the differences in total reimbursement can, in part, be explained by added facility fees that are reimbursed in the ASC/OBL setting but not the hospital-based setting, this does not explain the disproportionately high rate of PVI being performed in the ASC/OBL setting overall. Taken together, there may be an opportunity for a quality improvement initiative that directly addresses the use of low-value procedures in high reimbursement settings that are potentially not indicated.

Finally, we found that physicians earlier in their career had nearly three-fold greater odds of performing tibial PVI than their more senior counterparts. This could potentially be explained by endovascular interventions becoming increasingly common with time^{14, 21}, and/or the expansion of PVI to other (non-vascular) specialty training. Given the widespread use of PVI to treat claudication across a range of specialties, a common professional stance is critical to standardize the use of rapidly evolving endovascular technologies and their applications and indications for use.

Our study has a number of limitations. The analysis is limited to the Medicare population and may not reflect practice patterns surrounding tibial PVI for claudication in other patient populations. Our patient-level findings are also limited to the degree of detail that can be determined from CPT codes, such that the exact tibial vessel upon which the physician performed the procedure is unknown, as well as any additional details about anatomic pattern or severity of disease. For the same reason, we also could not ascertain the clinical reasoning that each physician had in performing tibial PVI. As noted above, the 2018 AUC by the AHA/ACC/SCAI/SIR/SVM deemed tibial interventions for claudication appropriate in special circumstances¹⁹, the details of which cannot be elucidated from claims data. Importantly, we focused on investigating practice patterns surrounding this procedure, rather than subsequent outcomes. Prior registry studies on the topic have reported higher rates of major amputation among patients who undergo tibial versus femoropopliteal interventions for claudication^{11, 12}, but a national study to investigate the long-term outcomes associated with tibial PVI for claudication is still needed to fully appreciate the implications of this study. Finally, because of the clear practice variance by specialty, future research exploring the National Radiology Data Registry for Interventional Radiology (NRDR) and National Cardiovascular Data Registry Peripheral Vascular Intervention RegistryTM (PVI RegistryTM) is also warranted.

Conclusion:

Tibial PVI is performed at high rates among Medicare patients with claudication. There are apparent practice discrepancies by specialty that likely reflect differing expert opinions on the utility of tibial PVI for claudication^{1, 2, 19} which have varied substantially until the recent publication of the 2022 SVS AUC¹⁸. Notably, we observed a higher rate of tibial PVI among physicians with high-volume PVI practices and majority practice in ASC/OBL settings. Overall, our data show widely varied practice patterns in the endovascular treatment

of claudication, suggesting a critical need for evidence-based education, guidelines, and reimbursement policies surrounding these practices.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Disclosure:

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ARTICLE HIGHLIGHTS**Type of Research:**

A retrospective analysis of 100% of Medicare fee-for-service claims collected between 2017 and 2019.

Key Findings:

Among 59,930 Medicare patients who underwent a peripheral vascular intervention (PVI) for claudication between 2017 and 2019, 16,594 (27.7%) underwent a tibial PVI. After adjusting for patient and physician characteristics and practice factors, physicians who did not identify as vascular surgeons, performed a high volume of PVI for claudication, and conducted most of their cases in high-reimbursement settings during the study period were significantly more likely to perform high rates of tibial PVI.

Take Home Message:

Tibial PVI is performed in more than a quarter of patients with claudication, most frequently by non-vascular surgeons in high-volume, high-reimbursement settings. This reveals a critical need to reevaluate the indications, education, and reimbursement policies surrounding these procedures.

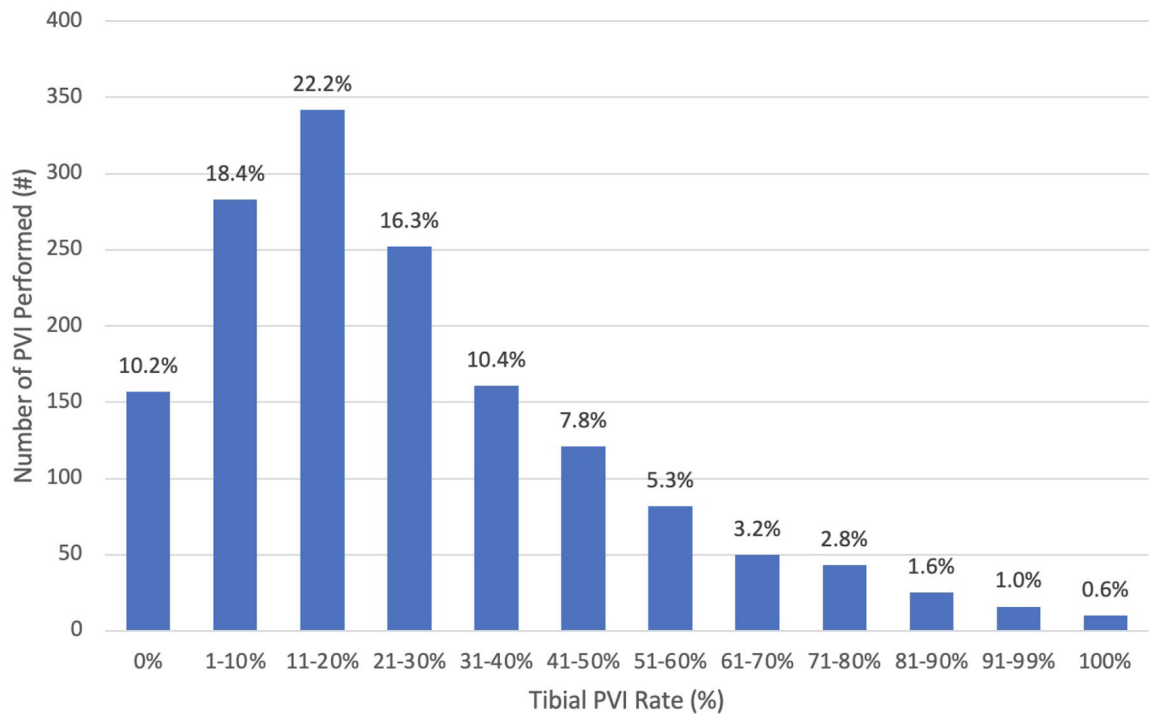


Figure 1. National distribution of physicians by their tibial peripheral vascular intervention rate for claudication among Medicare beneficiaries from 2017–2019 (N=1,542)

Table 1.

Characteristics of Medicare patients undergoing a tibial intervention vs. non-tibial intervention as their index intervention for claudication, 2017–2019

Patient characteristics		Non-tibial PVI (N=43,336)	Tibial PVI (N=16,594)	P-value
Age (years)	Median (IQR)	73.63 (68.66, 79.20)	75.33 (69.34, 81.61)	<0.001
	64	4,703 (10.85)	1,730 (10.43)	
	65–74	19,927 (45.98)	6,309 (38.02)	
	75–84	14,954 (34.51)	6,202 (37.37)	
	85	3,752 (8.66)	2,353 (14.18)	
Sex	Male	25,539 (58.93)	9,825 (59.21)	0.54
	Female	17,797 (41.07)	6,769 (40.79)	
Race	White	36,164 (83.45)	11,658 (70.25)	<0.001
	Black	5,045 (11.64)	2,707 (16.31)	
	Asian	361 (0.83)	281 (1.69)	
	Hispanic	680 (1.57)	1,338 (8.06)	
	Other or Unknown	1,086 (83.45)	610 (3.68)	
Comorbidities	ESRD	10,720 (24.74)	4,882 (29.42)	<0.001
	Diabetes	19,883 (45.88)	9,206 (55.48)	<0.001
	Hypertension	38,685 (89.27)	14,702 (88.60)	0.02
	Ever Smoking	15,144 (34.95)	3,606 (21.73)	<0.001
Population Density of Residence	Urban	33,836 (78.08)	13,449 (81.05)	<0.001
	Rural	9,500 (21.60)	3,145 (18.95)	
Census Region of Residence	Midwest	9,361 (21.60)	2,761 (16.64)	<0.001
	Northeast	6,102 (14.08)	1,532 (9.23)	
	South	21,862 (50.45)	7,810 (47.07)	
	West	5,974 (13.79)	4,447 (26.80)	
	Other	37 (0.09)	44 (0.27)	
Socioeconomic Status	1 st Quartile (\$0–45999)	12,510 (28.87)	5,934 (35.76)	<0.001
	2 nd Quartile (\$46000–60999)	13,869 (32.00)	5,166 (31.13)	
	3 rd Quartile (\$61000–81999)	9,826 (22.67)	3,290 (19.83)	
	4 th Quartile (\$82000+)	6,987 (16.12)	2,135 (12.87)	
	Unknown	144 (0.33)	69 (0.42)	

PVI is peripheral vascular intervention. IQR is interquartile range. ESRD is end-stage renal disease.

Table 2.

Characteristics of physicians * performing index PVI for claudication stratified by tibial PVI rate (< 37.5% vs. 37.5%)

Physician Characteristics		Index Tibial PVI Rate <37.5% (N=1,152)	Index Tibial PVI Rate 37.5% (N=390)	P-value
Sex	Male	1,125 (97.66)	381 (97.69)	0.97
	Female	27 (2.34)	9 (2.31)	
Years since medical school graduation	Median (IQR)	24 (18, 31)	23 (17, 32)	0.28
	10 years	25 (2.17)	20 (5.13)	
	11–20 years	357 (30.99)	135 (34.62)	
	21–30 years	434 (37.67)	109 (27.95)	
	31 years	318 (27.60)	118 (30.26)	
	Unknown	18 (1.56)	8 (2.05)	
Census region of practice location	Midwest	233 (20.23)	55 (14.10)	<0.001
	Northeast	150 (13.02)	40 (10.26)	
	South	645 (55.99)	209 (53.59)	
	West	124 (10.76)	85 (21.79)	
	Other	0	1 (0.26)	
Population density of practice location	Urban	1,066 (92.53)	355 (91.03)	0.34
	Rural	86 (7.47)	35 (8.97)	
Primary specialty	Vascular surgery	468 (40.63)	89 (22.82)	<0.001
	Cardiology	554 (48.09)	217 (55.64)	
	Radiology	51 (4.43)	55 (14.10)	
	Other	79 (6.86)	29 (7.44)	
Number of patients treated with PVI during the study period	Median (IQR)	17 (13, 25)	22 (15, 39)	<0.001
	11–15	486 (42.19)	106 (27.18)	
	16–24	368 (31.94)	102 (26.15)	
	23–550	298 (25.87)	182 (46.67)	
Overall percentage of services delivered in ASC or OBL	Median (IQR)	59.24 (32.96, 78.37)	79.18 (52.80, 94.47)	<0.001
	0%–38%	330 (28.65)	57 (14.62)	
	39%–64%	305 (26.48)	72 (18.46)	
	65%–83%	299 (25.95)	88 (22.56)	
	84%–100%	218 (18.92)	173 (44.36)	
Average Medicare reimbursement per patient (\$USD)	Median (IQR)	692.31 (562.61, 9,401.54)	12,023.96 (5,513.30, 14,430.02)	<0.001

* Included physicians who treated > 10 patients with index peripheral vascular intervention during the study period.

PVI is peripheral vascular intervention. IQR is interquartile range. ESRD is end-stage renal disease. ASC is ambulatory surgical center. OBL is office-based laboratory. USD is United States Dollars.

Table 3.

Hierarchical logistic regression model (OR, 95% CI) assessing patient- and physician-level characteristics associated with tibial PVI for claudication

Patient-level characteristics		Adjusted Odds Ratio (95% CI)
Age (years)	64	1.01 (0.92, 1.12)
	65–74	Ref
	75–84	1.30 (1.22, 1.38)
	85	1.96 (1.80, 2.15)
Sex	Male	Ref
	Female	0.81 (0.77, 0.86)
Race	White	Ref
	Black	1.47 (1.35, 1.60)
	Asian	1.02 (0.79, 1.32)
	Hispanic	1.86 (1.58, 2.20)
	Other or unknown	1.23 (1.04, 1.45)
ESRD	Yes	1.10 (1.03, 1.17)
	No	Ref
Diabetes	Yes	1.36 (1.29, 1.44)
	No	Ref
Hypertension	Yes	0.89 (0.81, 0.97)
	No	Ref
Ever-Smoking	Yes	0.61 (0.57, 0.65)
	No	Ref
Median Household Income (\$USD)	1 st Quartile (\$0–45999)	Ref
	2 nd Quartile (\$46000–60999)	0.94 (0.88, 1.01)
	3 rd Quartile (\$61000–81999)	0.90 (0.82, 0.97)
	4 th Quartile (\$82000+)	0.88 (0.80, 0.98)
	Unknown	0.24 (0.81, 1.90)
Physician-level characteristics		
Sex	Male	Ref
	Female	1.18 (0.77, 1.81)
Years since medical school graduation	10 years	2.97 (2.02, 4.39)
	11–20 years	1.21 (1.03, 1.43)
	21–30 years	0.79 (0.67, 0.92)
	31 years	Ref
Census region of practice location	Midwest	1.01 (0.85, 1.20)
	Northeast	0.84 (0.68, 1.03)
	South	Ref
	West	1.79 (1.48, 2.16)
Population density of practice location	Urban	Ref
	Rural	1.30 (1.03, 1.66)

Patient-level characteristics		Adjusted Odds Ratio (95% CI)
Primary specialty	Vascular surgery	Ref
	Cardiology	1.66 (1.44, 1.91)
	Radiology	2.94 (2.26, 3.82)
	Other	1.37 (1.05, 1.78)
Number of patients treated with PVI during the study period	11–15	Ref
	16–24	1.18 (1.01, 1.39)
	25–550	1.86 (1.59, 2.18)
Overall percentage of services delivered in ASC or OBL	0%–38%	Ref
	39%–64%	1.32 (1.10, 1.59)
	65%–83%	1.39 (1.15, 1.68)
	84%–100%	2.38 (1.97, 2.87)

OR is odds ratio. CI is confidence interval. PVI is peripheral vascular intervention. IQR is interquartile range. ESRD is end-stage renal disease. ASC is ambulatory surgical center. OBL is office-based laboratory.