Assessment of Patterns of Atherectomy Use

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BACKGROUND: Atherectomy has become the fastest growing catheter-based peripheral vascular intervention performed in the United States, and overuse has been linked to increased reimbursement, but the patterns of use have not been well characterized.

METHODS AND RESULTS: We used Blue Cross Blue Shield of Michigan Preferred Provider Organization and Medicare fee-for-service professional claims data from the Michigan Value Collaborative for patients undergoing office-based laboratory atherectomy in 2019 to calculate provider-specific rates of atherectomy use, reimbursement, number of vessels treated, and number of atherectomies per patient. We also calculated the rate that each provider converted a new patient visit to an endovascular procedure within 90 days. Correlations between parameters were assessed with simple linear regression. Providers completing ≥20 office-based laboratory atherectomies and ≥20 new patient evaluations during the study period were included. A total of 59 providers performing 4060 office-based laboratory atherectomies were included. Median professional reimbursement per procedure was $4671.56 (interquartile range [IQR], $2403.09–$7723.19) from Blue Cross Blue Shield of Michigan and $14,854.49 (IQR, $9414.80–$18,816.33) from Medicare, whereas total professional reimbursement from both payers ranged from $2452 to $6,880,402 per year. Median 90-day conversion rate was 5.0% (IQR, 2.5%–10.0%), whereas the median provider-level average number of vessels treated per patient was 1.20 (IQR, 1.13–1.31) and the median provider-level average number of treatments per patient was 1.38 (IQR, 1.26–1.63). Total annual reimbursement for each provider was directly correlated with new patient-procedure conversion rate (R²=0.47; P<0.001), mean number of vessels treated per patient (R²=0.31; P<0.001), and mean number of treatments per patient (R²=0.33; P<0.001).

CONCLUSIONS: A minority of providers perform most procedures and are reimbursed substantially more per procedure compared with most providers. Procedural conversion rate, number of vessels, and number of treatments per patient represent potential policy levers to curb overuse.

Key Words: atherectomy ■ endovascular ■ peripheral artery disease

The prevalence of peripheral artery disease (PAD) is increasing as the US population ages, posing a challenging societal and economic burden related to the disease and its treatment. Technologies over the past decade have led to a shift in PAD treatment modality such that most patients are now managed endovascularly. With more patients and advancing technology, the cost of PAD treatment has soared to >$25 billion annually. The substantial increase in costs led the Centers for Medicare and Medicaid Services to modify physician reimbursement for outpatient and office-based laboratory (OBL) peripheral vascular interventions (PVIs) in an effort to incentivize the shift of care to the outpatient setting. The increased reimbursement for office-based procedures was intended to allow for practices to cover the overhead expenses traditionally covered by the facility fee for facility-based procedures, with relative changes in reimbursement between...
Use patterns are also skewed toward a minority of providers, as recent analyses of Medicare claims data demonstrated that ≈50% of all Medicare payments for atherectomy were received by only 1% of vascular surgeons and 98% of these procedures were completed in the OBL setting. The practice patterns of these high OBL atherectomy users are not well characterized.

In this study, we sought to determine whether there was an association between reimbursement for OBL atherectomy and practice characteristics. We hypothesized that high users of OBL atherectomy not only performed more atherectomies overall, but that they converted more new patient evaluations to procedures, treated more vessels per patient, and billed for catheter deployment more times per patient.

**METHODS**

**Data Source and Population**

This study was deemed exempt from approval and informed consent by the institutional review board at the University of Michigan, Ann Arbor. Because of the sensitive nature of the data collected for this study, requests to access the data set from qualified researchers trained in human subject confidentiality protocols may be sent to the Michigan Value Collaborative. This report followed the Strengthening Reporting of Observational Studies in Epidemiology reporting guidelines for cohort studies.

In this retrospective cohort study, we used data from the Michigan Value Collaborative, a collaborative of 97 Michigan hospitals and 40 physician organizations that maintains a registry of complete claims payments for Medicare fee-for-service and Blue Cross Blue Shield of Michigan Preferred Provider Organization insurance products. This represents ≈60% of the insured population of Michigan. The method of data abstraction and patient sampling for the Michigan Value Collaborative has been described in detail previously.

**Study Population**

All adult patients having undergone atherectomy in the OBL setting were identified from claims data between January 1, 2019, and December 31, 2019. OBL atherectomy billing is unique to many other procedures in that multiple Current Procedural Terminology (CPT) codes for a patient can be submitted, including a separate CPT code for each arterial segment treated (femoral, popliteal, or tibial), and can be submitted twice in the setting of bilateral procedures. For each patient, we calculated the total number of vessels treated (minimum 1, if a single arterial segment is treated, to a maximum of 6 [ie, bilateral treatment of the femoral, popliteal, and tibial segments]). Additional CPT codes (CPT 37233 and CPT 37235)
can be submitted if multiple catheter deployments are completed on the tibial-peroneal segment, with no maximum number of code submissions per procedure. We therefore separately calculated, for each patient, the total number of arterial segments and the total number of treatments billed. We additionally categorized each patient’s procedural indication based on International Classification of Diseases, Tenth Revision (ICD-10), code. Patients with ICD-10 codes I70211, I70212, and I70213 were categorized as having intermittent claudication, those with ICD-10 codes I70221, I70222, and I70223 were categorized as having rest pain, and those with ICD-10 codes I70234, I70235, I70238, I70244, I70245, I70248, I70261, and I70262 were categorized as having tissue loss. These ICD-10 codes accounted for 90.8% of all diagnostic codes, with the remaining 9.2% belonging to a variety of other nonspecific PAD codes. Because we were interested in provider-level practice patterns, we aggregated all data at the provider level. Specifically, we calculated the total professional payment received for OBL atherectomy, the total number of new outpatient evaluations billed, the mean number of vessel segments treated per procedure, and the mean number of treatments billed per procedure for each provider. Using the total number of new outpatient evaluations billed, we calculated a conversion percentage for OBL atherectomy. This was defined as the proportion of all new patient evaluations billed that had a separate claim for OBL atherectomy within 90 days of their index evaluation. We also calculated the proportions of each provider’s total procedures that were performed for each indication (intermittent claudication, rest pain, or tissue loss), as described above. To avoid including providers who completed OBL atherectomies infrequently throughout the year, such that they may not represent the population of providers who routinely perform atherectomy, we chose to limit the analysis to all providers in the state of Michigan who billed the included insurance products for at least 20 OBL atherectomies and at least 20 new patient evaluations during the study period.

**Statistical Analysis**

Data analysis was conducted from January 2021 to April 2021. Categorical variables are presented as percentages, continuous variables as mean (SD), and payments as mean (SE). The Mann-Whitney U test was used for continuous variables, and χ² tests were performed for comparisons between categorical variables. All models were calculated with robust SEs. All statistical analyses were performed using STATA version 16.1/MP (Statacorp, College Station, TX). We used a 2-sided approach with α=0.05 as the significance level for all hypothesis testing.

**RESULTS**

**Provider Characteristics**

A total of 618 providers were identified within the data set who performed at least one stent or atherectomy, in either the OBL or non-OBL setting. A total of 250 of these providers performed procedures exclusively in the non-OBL setting, with a further 154 providers billing <$10,000 total for OBL stenting or atherectomy procedures combined. The mean number of atherectomy procedures completed by those who performed at least 1 atherectomy but under the 20 required to be included was 1.98.

After applying our exclusion criteria, a final cohort of 59 providers treating 4060 (86.9%) patients with atherectomy and 611 (13.1%) patients with stents were included in the analysis. The mean number of vessels treated per patient was 1.33±0.47, and the mean number of treatments per patient was 1.56±0.86.

Within our final cohort, the median proportion of a provider’s patients treated with atherectomy was 85.1% (interquartile range [IQR], 73.6%–92.9%). Provider characteristics are shown in the Table. All 59 included proceduralists were men, and most had an American

**Table. Characteristics of OBL Atherectomy Providers in Michigan, 2019**

| Provider characteristic | Value (n=59) |
|-------------------------|-------------|
| Sex, N (%)              |             |
| Men                     | 53 (100)    |
| Women                   | 0           |
| Primary specialty, N (%)|             |
| General surgery         | 1 (1.9)     |
| Interventional cardiology| 22 (41.5)  |
| Vascular surgery        | 28 (52.8)   |
| Unspecified             | 2 (3.5)     |
| Atherectomy volume (No. of procedures performed), median (IQR) | 40 (24–78) |
| OBL atherectomy professional payment from Medicare FFS, median (IQR), $ | 14,854 (8,414–18,816) |
| OBL atherectomy professional payment from BCBSM, median (IQR), $ | 4,671 (2,403–7,723) |
| Total professional billing for OBL atherectomy, median (IQR), $ | 501,435 (201,739–1,123,691) |
| New patient evaluations, median (IQR) | 192 (114–251) |
| Conversion to atherectomy within 90 d, median (IQR), % | 5.0 (2.5–10.0) |
| Average No. of arterial segments, median (IQR) | 1.2 (1.13–1.31) |
| Average No. of atherectomy treatments, median (IQR) | 1.39 (1.26–1.63) |

BCBSM indicates Blue Cross Blue Shield of Michigan; FFS, fee for service; IQR, interquartile range; and OBL, office-based laboratory.
Correlation of Practice Parameters

There was a strong and highly significant correlation between conversion percentage and total payment for OBL atherectomy at the provider level ($\beta=1.31\times10^2; R^2=0.47; P<0.001$). This relationship is shown in a scatterplot in Figure 2A. Similarly, there was a significant correlation between mean number of vessels treated per procedure and the total OBL atherectomy payment received ($\beta=3.9568\times10^3; R^2=0.31; P=0.004$). Mean number of treatments per procedure was also highly correlated with the total payment for OBL atherectomy ($\beta=3.051547; R^2=0.33; P=0.002$). Scatterplots of the relationship between mean number of vessels and mean number of treatments per procedure with the total payment received for OBL atherectomy at the provider level are shown in Figure 2B and 2C, respectively.

To assess the degree to which these results represent a group of providers who specialize in endovascular procedures and simply treat a higher volume of patients, we calculated the correlation between a provider’s stent volume and atherectomy volume and compared the parameters reported above as a function of total payment for stenting rather than atherectomy. We found no correlation between a provider’s stent volume and atherectomy volume ($P=0.54$; Figure 3A). Similarly, we found no significant correlation between total payment for stenting and a provider’s conversion percentage ($P=0.23$; Figure 3B), the mean number of vessels treated per patient ($P=0.92$; Figure 3C), or the mean number of treatments per patient ($P=0.45$; Figure 3D).

We then sought to investigate for the presence of a correlation between the proportion of patients each provider treated for each indication (intermittent claudication, rest pain, or tissue loss) and the proportion of their patients treated with atherectomy. We found no significant correlation between the proportion of patients with any of the procedural indications and the proportion of patients treated with atherectomy (Figure 4).

DISCUSSION

Using claims data available through a collaborative quality initiative, this study characterized the relationship between OBL atherectomy payment and provider practice patterns across the state of Michigan. Among a group of high-volume atherectomy providers, we found wide variation in the total payment received for both included payers (Medicare fee for service and Blue Cross Blue Shield of Michigan). Furthermore, we found significant variation in the mean payment for each OBL atherectomy procedure. In addition, there was a strong and highly statistically significant correlation between a provider’s conversion percentage, mean number of vessels per procedure, and mean number of treatments per procedure with the provider’s total payment received for OBL atherectomies. Atherectomy, particularly in the OBL setting, may be improperly incentivized financially, which could encourage overuse.

These results detail the intimate association between various practice parameters and reimbursement for OBL atherectomy. Similar results have been shown for other procedures, most notably endovenous ablation, where reimbursement in the OBL setting is disproportionately higher than the reimbursement for the ambulatory surgical center or inpatient setting. Atherectomy as well as endovenous ablation represent procedures for which volume has exploded in recent years, and this growth has almost exclusively been in the OBL setting. The dramatic increases in use for atherectomy have occurred despite any convincing data of superiority over less expensive stenting. A recent analysis of national Medicare claims data showed that providers who have high rates of...
atherectomy use, particularly for index femoropopliteal procedures, had significantly higher median average Medicare reimbursement per patient. Our results suggest that even among these providers, there is variation in the average reimbursement and that those providers with the highest reimbursement may be
achieved through the treatment of more vessels and
more catheter deployments per patient in addition to
converting a higher proportion of new patient evalua-
tions to procedures. As the total cost of outpatient pe-
ripheral vascular interventions continues to increase,
interests to curb atherectomy overuse and better align
financial incentives are critical.

There is also a need for a consensus around the ap-
propriate patients who may benefit from atherectomy.
There is a lack of high-quality data comparing the clin-
ical effectiveness as well as the cost-effectiveness of
atherectomy with alternative PVI strategies, such as
stenting. Cost-effectiveness, in particular, is difficult to
determine given this lack of clinical effectiveness data
combined with the complex reimbursement structures
surrounding PVIs, depending on the location of ser-
vice. In the face of climbing spending in the US health
care system for PVIs, particularly in the OBL setting,
our findings offer several potential solutions to the problem of overuse. OBL atherectomy
is unique with respect to insurance billing procedures
in that providers have the opportunity to submit and be
paid for multiple CPT codes on the same patient in the
same encounter. Given that each leg, each vessel, and
each catheter deployment can be separately billed, the
professional payments for a single OBL atherectomy
encounter can balloon quickly and may incentivize pro-
viders to maximize the number of catheter deployments
rather than to optimize treatment outcomes. Controlling
these billing procedures, either by eliminating the option
of multiple CPT code submissions for a single encounter or
limiting the number of code submissions, represents
an attractive option to curb costs and overuse.

Alternatively, these findings may be the results of
preferential referrals to specialists who provide a
unique service and therefore cater to a specific type
of anatomic lesion that other vascular providers may
not deem amenable to treatment using their own non-
atherectomy procedural expertise. There are no data
available currently to guide which lesions warrant the

Figure 2. Correlation between practice parameters and total professional payment for atherectomy.
A. Scatterplot for conversion percentage, defined as the proportion of patients with separate claims for office-based atherectomy
within 90 days of their initial evaluation, and total payment received for office-based atherectomy. B. Scatterplot for the mean number
of vessels billed and total payment received for office-based atherectomy. C. Scatterplot for the mean number of treatments billed
and the total payment received for office-based atherectomy. Best-fit lines are shown with 95% CIs.
use of atherectomy relative to other currently available techniques. However, anecdotally, many peripheral vascular interventionalists believe that particularly calcified lesions or those that involve a long segment of the femoropopliteal system are not well suited for stenting or angioplasty alone and therefore referrals based on these beliefs may explain at least some of the effect seen with our analysis. Furthermore, additional unmeasurable factors may be affecting practice variation, including differential training, marketing, or patient preferences, all of which cannot be assessed in the current study.

This study should be interpreted within the context of several limitations in addition to those mentioned above. We do not have a complete picture of a provider’s practice, only details on their use of OBL atherectomy in patients with either Medicare fee-for-service or Blue Cross Blue Shield of Michigan Preferred Provider Organization products. We also do not have access to patient outcomes after atherectomy. We used commercial and Medicare fee-for-service claims data that lack any clinical details around patient symptoms, anatomy, severity of disease, or other important characteristics. It remains possible that the correlation we find between atherectomy use patterns and reimbursements may, for example, represent a set of providers who preferentially referred patients who are somehow preselected to require atherectomy over alternative PVI strategies. Despite a lack of clinical data, it is unlikely that the variation in provider-level atherectomy use can be explained by differences in patient case mix (comorbidities and disease severity) as there is no consensus as to how patient case mix variables should drive procedural use patterns. A recent study by Hicks et al of the broader national Medicare population suggests that patients with less severe disease marked by only claudication symptoms alone actually have a 50% higher odds of receiving atherectomy as their index procedure compared with patients with chronic limb-threatening ischemia. Furthermore, we
found no significant correlation between the parameters investigated and total billing for stent placement. Although clinical data would enrich this analysis, the above findings are nonetheless compelling.

**CONCLUSIONS**

As the prevalence and cost of PAD continue to increase, identification of atherectomy overuse and mechanisms to curb it are essential. Our results suggest that payment for OBL atherectomy is correlated with conversion percentage, the average number of vessels treated, and the average number of catheter deployments per patient across providers. These parameters could potentially identify atherectomy overusers and represent potential levers by which payers may curb overuse.

**Affiliations**

Section of General Surgery, Department of Surgery (C.S.B., R.E.E., M.J.E.); Center for Healthcare Outcomes and Policy, Institute for Healthcare Policy and Innovation (C.S.B., R.E.E., J.M.Y., J.D.S., M.C., M.J.E., N.H.O.) and Section of Vascular Surgery, Department of Surgery (M.A.C., P.K.H., N.H.O.), University of Michigan, Ann Arbor, MI.

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