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Intravascular Imaging Use by Intermediate to High-Volume US Operators – A Medicare Data Analysis

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Keywords

intravascular imaging; percutaneous coronary intervention; practice variation

Introduction

Despite randomized trials¹ showing reduced target vessel failure and major adverse cardiovascular events with intravascular imaging (IVI) guided percutaneous coronary intervention (PCI), IVI is used in only 7.8% of all PCI in the United States.^{2,3} Operator variation in IVI use and characteristics of operators with low IVI use have not been previously studied.

We assessed variation in operator level IVI use nationally and its relationship to operator characteristics such as demographic characteristics, practice focus, PCI volume, and practice location using Centers for Medicare and Medicaid (CMS) data, with a focus on intermediate and high-volume operators.

Methods

Data source and study population

Using 2019 Medicare Provider Utilization and Payment (MPUP) Data, we identified PCI operators and obtained their PCI and IVI volumes using Current Procedural Terminology codes (Supplemental Material S1). We focused on operators with annual PCI volume 30.

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Ethics statement and patient consent

This study was exempt from institutional review board approval owing to the use of publicly available physician billing data.

Supplementary material

To access the supplementary material accompanying this article, visit the online version of the *Journal of the Society for Cardiovascular Angiography & Interventions* at [10.1016/j.jscai.2023.100977](https://doi.org/10.1016/j.jscai.2023.100977).

As Medicare beneficiaries account for approximately half of all PCI, an annual Medicare PCI volume of 30 equates to an overall PCI volume of 60, making our cohort representative of intermediate to high-volume operators based on prior cutoffs.⁴ This study was exempt from institutional review board approval.

Outcomes and covariates

IVI use was categorized as low or no IVI use (IVI to PCI ratio [IPR] of 0.0–0.30), intermediate (IPR 0.31–0.70) and high (IPR > 0.71). The lower cutoff was set at 0.30. As the MPUP data suppress Current Procedural Terminology codes with <10 billings, an operator with > 30 PCI and no IVI billing likely has >10 IVI and thus an IPR > 0.30.

Operator characteristics such as medical school graduation year, sex, and US census region were obtained by linking National Provider Identification number to CMS Physician Compare data. Hospital bed size was obtained by linking the CMS certification number for the facility listed as the primary affiliation for the operator in the 2019 Doctors and Clinicians National Downloadable Files to the 2019 Inpatient Prospective Payment System Impact File. PCI operators were categorized into 4 practice focus categories—PCI, PCI with peripheral, PCI with structural, and PCI with structural and peripheral.

Statistical analysis

Categorical variables were compared using χ^2 tests and continuous variables using Kruskal-Wallis tests. The generalized linear model with logit link used low/no imaging as a dependent variable. Covariate associations were reported using adjusted odds ratios and 95% CIs. Significance level was set at a 2-sided *P* value of .05. Analyses were performed using R Foundation 4.0.3.

Results

In 2019, 3386 operators performed > 30 PCIs on Medicare beneficiaries, with 219,271 total PCIs. Most operators were male (96.5%) with a median graduation year 1994 (IQR, 1986–2002) and median PCI volume 51 (IQR: 38–75).

IVI use was low/none among 77.8% operators, intermediate in 15.7%, and high in 6.5%. Supplemental Material S2 shows a table of operator characteristics by IPR category. Operators with low/no IVI use compared to high IVI use graduated earlier (median 1993 for low/no IVI use [IQR, 1985–2001] vs 2000 [IQR, 1988–2006]) and had a lower median facility bed size (311 [IQR, 199–466] vs median 364 [IQR, 223–572]), *P* < .01. Figure 1 shows generalized linear model results (characteristics linked for 96.4% operators). Operators in the Midwest and South were less likely to use IVI. Those graduating more recently or practicing at larger hospitals or hospitals in the West were more likely to use imaging, whereas operator volume and practice focus had no influence on imaging use.

Discussion

There is significant operator variation in IVI use in the United States with most operators using low/no IVI and some using IVI routinely. A recent study noted that operator variability

was an even stronger predictor for IVI use than any patient or procedural characteristic.³ To our knowledge, this is the first study associating specific physician characteristics with IVI use.

Operators graduating earlier had lower IVI use than newer operators. Operators who trained several years ago may have fewer avenues for hands-on learning and thus may be unable to adopt IVI, or there may be operator inertia to modify long-standing practice. Although recent graduates more likely used IVI, the majority still do not (54.5% with low/no imaging in youngest operator quartile). In a recent poll among graduating interventional fellows, half had no/rudimentary IVI training.⁵

Operators were less likely to use IVI at smaller hospitals, where IVI may not be available or have prohibitive costs. Additional factors include staff device training and software setup. Further, larger hospitals tend to be academic medical centers and more likely to use evidence-based technologies. Without individual level data, we cannot assess relative contribution of operator and site effects. However, a recent study showed that operators with high IVI use were less likely to utilize IVI at low versus high IVI use hospitals.³

Surprisingly, there was no relationship between higher PCI volume and imaging use as high PCI volume is often equated with higher quality, and there has been a long-standing focus on operator volume.⁴ It may be that some high-volume operators avoid IVI to reduce case time and increase throughput. But with evidence for IVI benefit, time saved may come at the cost of worse outcomes. Practice focus also had no influence on imaging use. Structural operators, who perform newer interventional procedures, were no more likely than those performing only PCI to use IVI—another relatively new technology.

Larger system reasons also influence low IVI adoption, including the Diagnosis Related Group-based fixed-price system that disincentivizes resource use and the weak American College of Cardiology/American Heart Association guideline recommendation for IVI, which was only upgraded to IIa in 2021.⁶

Although IVI guidance is beneficial, its routine use in noncomplex PCI is not well established. However, with the high prevalence of complex disease in contemporary PCI, our results suggest severe national IVI underutilization with significant operator variation.

Our study has limitations. First, we were only able to focus on intermediate and high-volume operators given data limitations. Second, as MPUP data report total annual billings, IVI and PCI may not be from the same procedure. Thus, we cannot account for diagnostic IVI use. Third, our results are limited to PCI in Medicare patients. However, IVI use in this population is expected to be higher given complex disease. Lastly, we cannot account for variation in anatomic complexity across operators.

Conclusion

Most operators do not use IVI in the United States. To increase IVI use, educational pathways must be strengthened for both established physicians and trainees. Reimbursement

changes must encourage IVI use. Guidelines should be updated, recognizing the data supporting IVI.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Declaration of competing interest

Mitsuaki Sawano received clinical research funding from Takeda Pharma outside of the submitted work. Jephtha Curtis has an institutional contract with the American College of Cardiology for his role as Senior Scientific Advisor of the NCDR.

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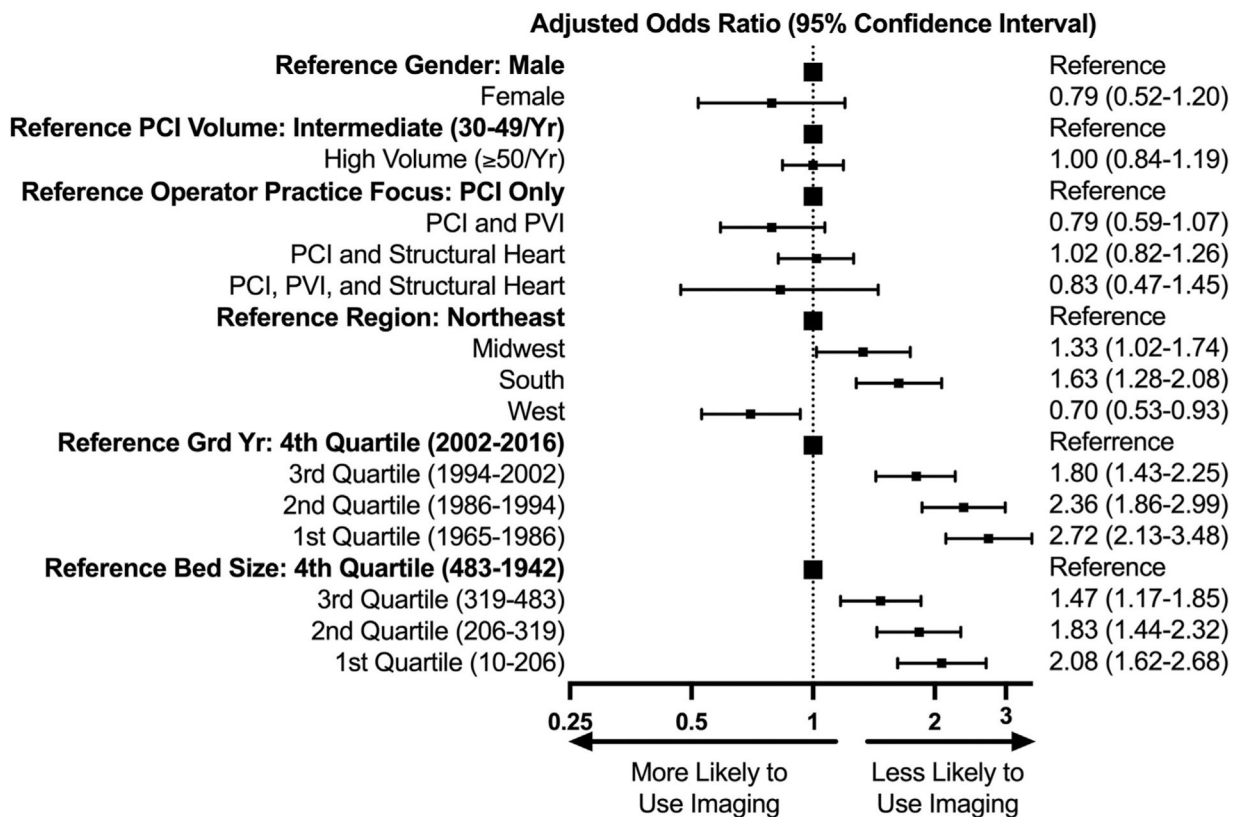


Figure 1. Forest plot of a logistic regression model with low-no imaging as the dependent variable and operator characteristics as independent variables (sex, PCI volume, operator practice focus, US census region, graduation year quartile, and hospital bed size quartile). PCI, percutaneous coronary intervention; PVI, peripheral vascular intervention.