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Outcomes of PCI in Relation to Procedural Characteristics and Operator Volumes in the United States

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ABSTRACT

BACKGROUND Professional guidelines have reduced the recommended minimum number to an average of 50 percutaneous coronary intervention (PCI) procedures performed annually by each operator. Operator volume patterns and associated outcomes since this change are unknown.

OBJECTIVES The authors describe herein PCI operator procedure volumes; characteristics of low-, intermediate-, and high-volume operators; and the relationship between operator volume and clinical outcomes in a large, contemporary, nationwide sample.

METHODS Using data from the National Cardiovascular Data Registry collected between July 1, 2009, and March 31, 2015, we examined operator annual PCI volume. We divided operators into low- (<50 PCIs per year), intermediate- (50 to 100 PCIs per year), and high- (>100 PCIs per year) volume groups, and determined the adjusted association between annual PCI volume and in-hospital outcomes, including mortality.

RESULTS The median annual number of procedures performed per operator was 59; 44% of operators performed <50 PCI procedures per year. Low-volume operators more frequently performed emergency and primary PCI procedures and practiced at hospitals with lower annual PCI volumes. Unadjusted in-hospital mortality was 1.86% for low-volume operators, 1.73% for intermediate-volume operators, and 1.48% for high-volume operators. The adjusted risk of in-hospital mortality was higher for PCI procedures performed by low- and intermediate-volume operators compared with those performed by high-volume operators (adjusted odds ratio: 1.16 for low versus high; adjusted odds ratio: 1.05 for intermediate vs. high volume) as was the risk for new dialysis post PCI. No volume relationship was observed for post-PCI bleeding.

CONCLUSIONS Many PCI operators in the United States are performing fewer than the recommended number of PCI procedures annually. Although absolute risk differences are small and may be partially explained by unmeasured differences in case mix between operators, there remains an inverse relationship between PCI operator volume and in-hospital mortality that persisted in risk-adjusted analyses. (J Am Coll Cardiol 2017;69:2913–24)

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ABBREVIATIONS AND ACRONYMS

ACC = American College of Cardiology

AHA = American Heart Association

NCDR = National Cardiovascular Data Registry

NPI = National Provider Identification

NSTEMI = non-ST-segment elevation myocardial infarction

PCI = percutaneous coronary intervention

SCAI = Society for Cardiovascular Angiography and Intervention

STEMI = ST-segment elevation myocardial infarction

UA = unstable angina

For various reasons, percutaneous coronary intervention (PCI) volumes have declined over the past decade, and many operators have observed a corresponding decline in number of procedures performed (1–3). The 2013 American College of Cardiology (ACC)/American Heart Association (AHA)/Society for Cardiovascular Angiography and Intervention (SCAI) clinical competency statement reduced the recommended minimum number of PCI procedures performed annually by each operator from 75 to 50, averaged over 2 years (4,5). Contemporary, nationwide patterns of operator volumes have not been described, and little is known about the characteristics of procedures performed by low-volume operators. Furthermore, while prior studies have examined the volume-outcome relationship (6–10), none have been nationally representative using clinical data or conducted after the change in recommendations. Importantly, operator volume recommendations were based on expert opinion that the increasing safety of PCI minimizes differences in outcomes across operators regardless of the number of procedures they perform, rather than on objective data.

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Using data from the nationally representative National Cardiovascular Data Registry (NCDR) CathPCI registry, which collects detailed information on >90% of PCI procedures performed in the United States, we aimed to: 1) assess median operator volumes of PCI procedures; 2) evaluate potential differences in patient and procedural characteristics for high-, intermediate-, and low-volume operators; and 3) determine the relationship between operator volumes and patient outcomes in a large, contemporary sample.

METHODS

The NCDR CathPCI registry, jointly administered by the ACC and SCAI, has been previously described (11). It collects data from consecutive patients undergoing PCI at >1,500 hospitals in the United States (~90% of PCI centers), recording information on patient and hospital characteristics, including patient presentation, lesion and procedural details, peri-procedural and discharge medications, and in-hospital outcomes (12). Variables collected are determined and defined by physician work groups; data collection forms and dictionaries are available online from NCDR. Data collected were subject to the NCDR's comprehensive data quality program, which includes data quality report specifications for capture and transmission, as well as auditing (13).

For this study, we included all PCI procedures entered into CathPCI using version 4 of the data collection form (July 1, 2009, through March 31, 2015); version 4 of the CathPCI data collection form was the first to include the National Provider Identification (NPI) number, which allows for unique identification of the operator for each PCI. We excluded any procedure missing an operator's NPI number, which was <1% of all PCIs in the database.

DEFINITIONS AND OUTCOMES. All study definitions were derived from the CathPCI data dictionary. The primary outcome for this analysis was in-hospital mortality, as recorded on the CathPCI data collection form. Secondary outcomes included bleeding events within 72 h of PCI (hemoglobin decrease ≥3 g/dl, transfusion of whole blood or packed red blood cells, or procedural intervention/surgery at the bleeding site), new need for dialysis, PCI success rate, and PCI procedure appropriateness. PCI success was defined as successful dilation of all lesions attempted. Appropriateness was based on the 2012 Appropriate Use Criteria for Coronary Revascularization, and was determined using a validated algorithm (14–16).

The total number of PCI procedures performed or attempted for each operator was counted using each operator's unique NPI number, and each operator's average annual volume was calculated by dividing the operator's total number of PCI procedures by the number of days the operator was active during the study period (date of last PCI procedure – date of first PCI procedure) and multiplying by 365. Because the NPI number is a unique identification carried across hospitals, operator volumes could be counted without regard to where procedures were performed.

As the ACC/AHA/SCAI clinical competence statement recommends that operators perform an average of ≥50 PCIs per year to maintain competence, operators performing <50 PCIs annually were defined as low-volume operators (4). Operators performing 50 to 100 and >100 PCIs per year were defined as intermediate- and high-volume operators, respectively. For a sensitivity analysis, extreme high- and low-volume operators were defined as those performing >413 PCIs (97.5th percentile of the volume distribution) and <26 PCIs (2.5th percentile of the distribution) annually, respectively.

Because the ACC/AHA/SCAI clinical competency statement defines low-volume operators as those performing <50 PCIs annually averaged over a 2-year