Does size matter?

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The article by Kim and colleagues¹ in this issue of the *Journal* is a data-filled retrospective study of coronary artery bypass grafting (CABG) surgery performed in the United States from 2007 to 2011. By using the National Inpatient Sample database, Kim and colleagues¹ analyzed all patients who underwent CABG during this period. From the use of CPT codes and a 20% sampling they estimated trends in procedural volume and rates of adverse in-hospital outcomes (death, stroke, bleeding, respiratory failure, myocardial infarction, shock, and acute renal failure). Multivariate propensity score-adjusted analysis was performed to compare outcomes for hospitals according to quartiles of CABG volume as well as data regarding the differentiating characteristics of low- versus high-volume centers. In the end, the study provides some details about the volume and results of CABG during a 4-year period in institutions with different volumes.

Kim and colleagues¹ found the frequency of CABG had decreased by 23.1% from 2007 to 2011 (from 370 cases per million adults to 285 cases per million adults), with the most marked decline at higher volume centers. Patients in the highest volume quartile were more likely to have a history of previous CABG, previous percutaneous coronary intervention, peripheral vascular disease, and concomitant valve surgery. The number of centers performing CABG increased from 240 to 245. The unadjusted incidences of in-hospital death (3.1% vs 2.7% vs 2.7% vs 2.6%, from lowest to highest quartile of volume; $P = .01$), respiratory failure (8.7% vs 7.8% vs 7.4% vs 6.7%; $P < .001$), and bleeding complications (3.2% vs 2.6% vs 2.9% vs 2.6%; $P < .001$) were higher in lower volume centers. Operation at the lowest volume CABG centers (in the first vs fourth quartile of volume) was associated with significantly greater odds of death, respiratory failure, and bleeding complications in both univariate and multivariate logistic regression analyses.

The study documents the well recognized fact that CABG volume significantly decreased during the study period and concludes that lower volume centers carry an increased risk of all-cause mortality and complications relative to high-volume institutions. The problem still resides with

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Central Message

Multiple factors, one of which is institutional volume, determine outcomes for cardiac surgery.

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the inherent inaccurate data provided by the use of the National Inpatient Sample database and the rather arbitrary differentiation between hospitals in the intermediate groups (quartiles 2 and 3). Furthermore, I could not find the N for the hospitals in each group and the frequency of out-migration of patients between various quartiles. Kim and colleagues¹ compare 13,000 patients in quartile 1 versus 111,000 patients in quartile 4, in which most institutions include urban, metropolitan academic institutions. Such a disparity in the denominator places low volume at increased risk for bad results, because a few deaths will be magnified in outcome analyses. The second and third quartiles are relatively equal at 33,000 and 49,000, respectively. The comparison data are inconsistent, because the rate of CABG per million is 18,000 for the lowest quartile and 140,000 for the highest volume centers. Does this represent overuse of the CABG procedure, or the fact that migration or referral of patients has occurred, artificially increasing that quartile's volume? Does the increase in referral volume come from the lowest quartile leaving those higher risk patients unable to travel or pay for referral expenses to be cared for in the lowest volume centers? Parenthetically, both quartiles 2 and 3 have relatively similar usage rates of CABG per million at 41,000 and 44,000, respectively. Finally, comparison of

outcomes between quartiles provides inconsistent observations, because if volume of the institution is indeed the main force behind driving better outcomes, then how do Kim and colleagues¹ explain their finding that quartile 3 had worse outcomes than quartile 2 with regard to death, bleeding, and acute renal failure? Furthermore, in the adjusted odds ratios between quartiles, comparison shows quartiles 2 and 3 to be virtually the same.

In the end, the study leaves the reader without the valuable information that could be used to plan better patient care. It does not answer many of the critical questions. What is the volume or institutional infrastructure necessary to provide optimal outcomes, and why do some high-volume centers not reach that goal? Do university

centers provide the sufficient volume to ensure that residents will have the experience necessary to safely practice (perhaps in a small-volume system)? Can high-volume, experienced surgeons still provide excellent results in smaller volume centers? The old adage that “size does matter” may be true, but Kim and colleagues¹ have raised more questions than they have answered, and further studies will be needed to clarify the correct answers.

Reference

1. Kim LK, Looser P, Swaminathan RV, Minutello RM, Wong SC, Girardi L, et al. Outcomes in patients undergoing coronary artery bypass graft surgery in the United States based on hospital volume, 2007 to 2011. *J Thorac Cardiovasc Surg.* 2016;151:1686-92.