

# The "occasional open heart surgeon" revisited

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**Objectives:** Case volume in cardiac surgery has been a concern since the term “the occasional open heart surgeon” was used more than 40 years ago, indicating one who performs cardiac surgery infrequently.

**Methods:** Risk-adjusted operative mortality (in-hospital or 30-day mortality) for isolated coronary artery bypass grafting procedures reported to the California CABG Outcomes Reporting Program for 2003–2004 was determined by surgeon and by hospital. Standard Society of Thoracic Surgeons item definitions were used. A total of 49,421 coronary artery bypass grafting (40,377 isolated) procedures were performed by 302 surgeons at 121 hospitals. Low-volume surgeons ( $n = 117$ ) were defined as performing a total of less than 1 coronary artery bypass grafting (isolated or nonisolated) procedure per week at all hospitals (mean  $\pm$  standard deviation,  $22 \pm 15/y$ ). High-volume surgeons ( $n = 185$ ) performed a total of 1 or more cases per week (mean  $\pm$  standard deviation,  $120 \pm 62/y$ ). Logistic regression and hierarchic analysis were used to compare volume cohorts.

**Results:** The overall risk-adjusted mortality rate was 3.62% for low-volume and 3.02% for high-volume surgeons. Analysis by surgeon per hospital produced 610 surgeon–hospital pairs. The lowest risk-adjusted mortality rates were found among surgeons performing more than 1 procedure per week at a single hospital (2.70%). When high-volume surgeons performed less than 1 procedure per week at a hospital, their mortality rates were similar to those of low-volume surgeons (3.39%–4.11%). High-volume surgeons performing procedures at multiple sites had higher mortality than high-volume surgeons working at a single institution.

**Conclusion:** A high-volume surgeon becomes an “occasional open heart surgeon” when working at multiple hospitals and performing a small volume of procedures at some of them. This study suggests that volume is not as important as processes of care in determining outcomes of coronary artery bypass grafting procedures and that system factors might be more important to outcomes than surgeon experience.

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The term “occasional open heart surgeon” was used by Eiseman and Spencer<sup>1</sup> in an editorial in *Circulation* in 1965. They quoted a survey conducted by the School of Public Health at Johns Hopkins that found that 41% of cardiac surgery teams performed less than 10 procedures per year. Over the ensuing decades, the relationship between volume and outcome has been extensively studied, often producing more questions than answers.

Provider volume has been shown to be a risk factor in a variety of complex surgical procedures.<sup>2–4</sup> In-hospital mortality was found to be lower in higher-volume facilities for abdominal aortic aneurysm resection, esophagectomy, pancreatic resection, and coronary artery bypass grafting (CABG), resulting in calls for volume thresholds of these procedures by purchaser groups, such as Leapfrog. Physician groups and hospitals dismissed these recommendations because of the variable statistical significance of the findings and the feasibility of volume-based referral. Furthermore, it appears that the volume–outcome conundrum is a moving target. Several recent studies have noted a weaker association in CABG<sup>5</sup> and abdominal aortic aneurysm.<sup>6</sup> Reports from the California CABG reporting programs show no statistical significance of

**Abbreviations and Acronyms**

CABG = coronary artery bypass grafting  
 RAMR = risk-adjusted mortality rate

hospital volume on risk-adjusted mortality for the years 2003–2004, whereas hospital volume as an independent variable was significant in previous reports.\*

Hospitals do not perform surgical procedures. Rather, surgeons perform them, but they perform them with a team of other caregivers. The relationship between these caregivers is critical in any procedure, but especially so in cardiac surgery. The collection of data on CABG surgery for public reporting on California hospitals and surgeons provides an opportunity to observe the relationships between providers and the systems in which they do their work. California has a large number of cardiac surgical programs, most of which are low volume, performing less than 300 “open heart” cases per year. Many of the cardiac surgeons are low volume, performing less than 100 procedures per year. The present study examines these low-volume providers to study the effect of diminishing numbers of CABG procedures in cardiac surgery in California.

**Materials and Methods**

Data collected through the California CABG Outcomes Reporting Program was reviewed. Mandatory reporting of all CABG procedures was begun in January 2003. Hospital-specific data from 2003 were released to the public in February 2006, and both hospital- and surgeon-specific data for the years 2003–2004 were released in July 2007. Data are collected by using Society of Thoracic Surgeons National Database formats; identical procedure and risk factor definitions were used, but a unique risk model was calculated for isolated CABG procedures. Mortality was determined by using the Society of Thoracic Surgeons National Database definition of “operative mortality”: death after surgical intervention in the hospital or within 30 days. Deaths were verified by means of linkage with the California death file. In addition, independent onsite abstraction of medical charts was performed at 57 hospitals for these data years.

A total of 49,421 CABG (40,377 isolated) procedures were performed by 302 surgeons at 121 hospitals during 2003–2004. Provider total CABG volume and its relation to outcome, as measured by means of operative mortality for isolated CABG, was analyzed by hospital, surgeon, and surgeon per hospital. Low-volume surgeons were defined as those performing a total of less than 1 CABG (isolated or nonisolated) procedure per week over the 2-year period. High-volume surgeons performed 1 or more CABG procedures per week. Very low volume was defined as less than 1 procedure performed per hospital per month. We adopted the state-published risk model and conducted further descriptive

analyses based on state-published hospital and surgeon risk-adjusted operative mortality results for 2003–2004. We then used a hospital-patient hierarchical prediction model to test the association between surgeon/hospital volume and risk-adjusted mortality. All data analyses were conducted with SAS 9.1.3 (SAS Institute, Inc, Cary, NC).

**Results****Procedure Volumes and Operative Mortality**

The number of CABG procedures performed by low-volume and high-volume surgeons during 2003–2004 is shown in Table 1. On average, high-volume surgeons performed more than 5 times as many procedures as low-volume surgeons.

Operative mortality for isolated CABG procedures performed by low-volume and high-volume surgeons during 2003–2004 is shown in Table 2. High-volume surgeons performed nearly 90% of the procedures. Overall, low-volume surgeons had higher risk-adjusted operative mortality compared with high-volume surgeons.

**Hospital Volume and Risk-adjusted Mortality Rate**

The relationship of individual hospital total CABG volume to isolated CABG risk-adjusted mortality rate (RAMR) for 2003–2004 is shown in Figure 1. Only 26 of 121 hospitals in California performed more than 500 CABG procedures (250/y) over the 2-year period. Although the highest RAMRs occurred at lower-volume sites, many low-volume hospitals had outcomes that were better than those of higher-volume programs. Overall, the relationship between volume and mortality for hospitals was not statistically significant (Pearson correlation coefficient,  $-0.105$ ;  $P = .253$ ).

**Surgeon Volume and RAMR**

The relationship of individual surgeon total CABG volume to isolated CABG RAMR for 2003–2004 is shown in Figure 2. The highest mortality rates occur among the lowest-volume surgeons ( $<100/y$ ), but many low-volume surgeons have low or zero RAMRs. As a result, individual surgeon volume was not significantly associated with RAMR (Pearson correlation coefficient,  $-0.096$ ;  $P = .095$ ).

**Surgeon Volume per Hospital and RAMR**

Most surgeons operated at more than 1 hospital. Low-volume surgeons operated at a mean of 2.4 hospitals (range, 1–6

**TABLE 1. CABG procedures performed by low- and high-volume surgeons, 2003–2004 (annualized, mean  $\pm$  SD)**

	N	All CABG	Isolated CABG
Low volume	117	22 $\pm$ 15	18 $\pm$ 13
High volume	185	120 $\pm$ 62	98 $\pm$ 53
Total	302	82 $\pm$ 69	67 $\pm$ 58

CABG, Coronary artery bypass grafting; SD, standard deviation.

\* <http://www.oshpd.ca.gov/HQAD/Outcomes/Studies/cabg/2003Report/2003Report.pdf>

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