VII. HOSPITAL VOLUME AND CORONARY ARTERY BYPASS GRAFT SURGERY OUTCOMES

A number of studies have found a statistically significant relationship between the annual number of bypass surgeries a hospital performs and mortality (Farley, 1992; Hannan et al., 1989; Hannan et al. 1991; Showstack et al., 1987; Dudley et al., 2000). On average, hospitals that perform a higher volume of coronary bypass procedures tend to achieve better outcomes– meaning they tend to have a lower death rate from the operation as compared to lower volume hospitals.

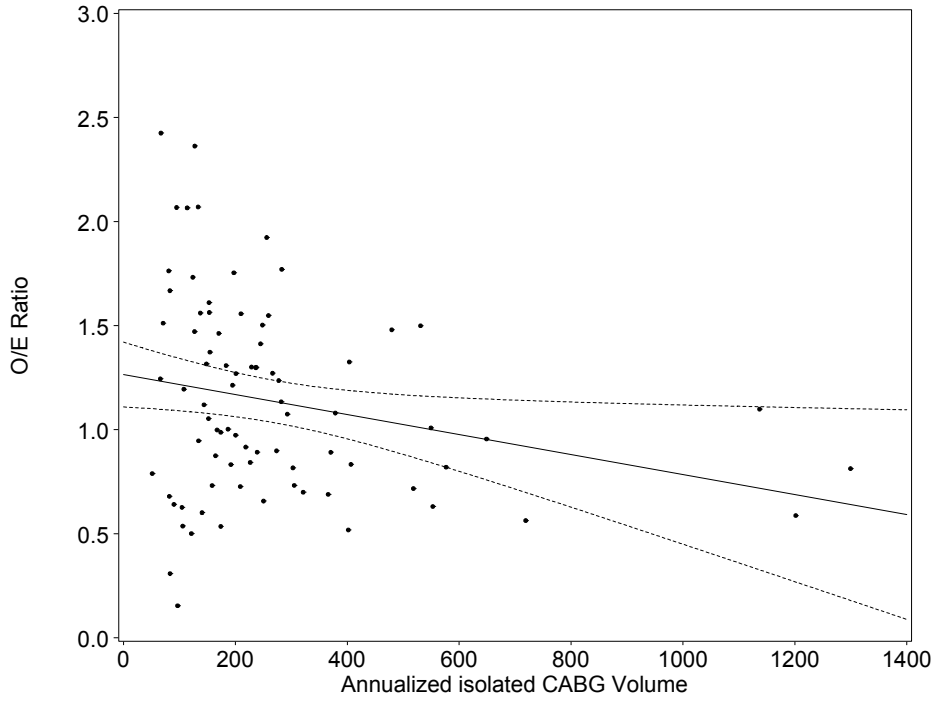
The CCMRP data provides a unique opportunity to examine whether there is a relationship between surgical volume and outcome as measured by in-hospital mortality. This is particularly important given the large proportion of low volume institutions that exist in California as compared to other states, such as New York, where the volume outcome relationship has been examined. Out of 33 hospitals performing bypass surgery in New York during 1999, 16 (48.5% of all hospitals) performed 500 or more cases annually as compared to 10 out of 119 in California (8.4% of all hospitals). Only 7 hospitals in New York (21%) performed fewer than 300 cases annually, as compared to 95 (80%) in California.

Risk-adjusted outcomes data are a better measure of a hospital's performance than the volume of cases, particularly since some small volume hospitals are able to achieve good outcomes. However, in the absence of outcomes data—which is the case for 49 of the 119 California hospitals that do CABG, as well as for most hospitals nationally—the annual volume of bypass surgeries a hospital performs is one of the few proxy measures of performance available to the public. The Leapfrog Group (2002) is using CABG volume as one of its markers of patient safety in the absence of outcome results.

Figure 7 shows the relationship between annual CABG volume and average hospital outcomes over a three-year period in California. For hospitals that did not submit three years of complete data, results and case counts were annualized. Hospital outcomes are captured by the *Observed to Expected Ratio*, or the O/E ratio (refer to Section IV for a description of the O/E ratio). Each dot in the figure identifies a single hospital. For example, the dot near the upper left corner of the figure represents a hospital whose mean annual volume was 67 CABG cases for 1997-1999, with an O/E ratio of 2.45. The rightmost dot in the figure represents a hospital that averaged 1,300 cases per year and had an O/E ratio of 0.84.

A regression line through these points has a slightly negative slope. The slope is statistically significant (two-tailed test, p-value=0.03). The graph shows wide variation in performance among lower volume hospitals (i.e., those with fewer than 300 cases annually) as compared with higher volume hospitals.

Figure 7: The Relationship Between Isolated CABG Volume and Hospital Outcomes CCMRP Hospitals, 1997-1999



To understand the effects of size at an aggregate level, hospitals were assigned to approximate quartile groupings based on their annualized volume. Rather than calculating O/E Ratios for each hospital separately, we aggregated calculations across hospitals in each grouping. Table 10 displays details of allocating hospitals to four groups based on the average annual number of isolated bypass surgeries performed. Using the predicted values from our fitted model, we calculated the expected mortality based on our model and compared it to the observed mortality for each volume group.

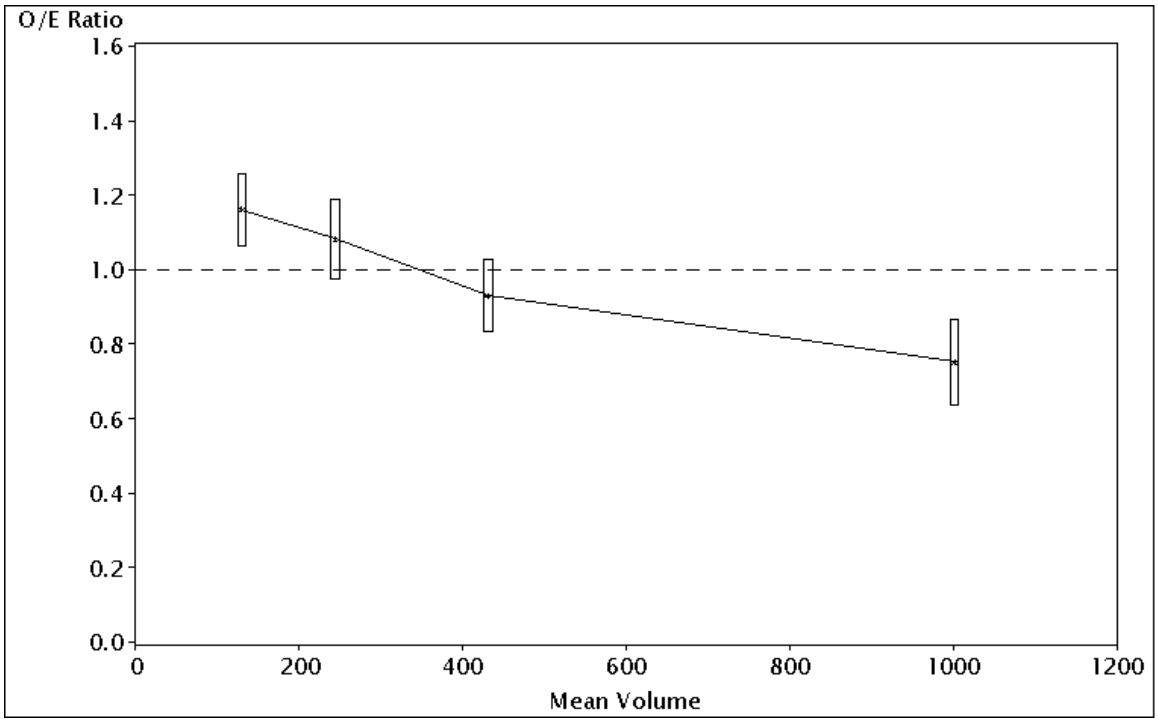
Table 10: CCMRP Hospitals by Volume, 1997-1999

Average Volume per Year	Number of Hospitals	Mean Annualized Volume	Total Number of Cases in 1997-1999*	Percent of Cases in 1997-1999
< 200	40	130	11,603	23.29
200 to 299	21	245	10,979	22.04
300 to 599	15	431	14,657	29.42
>=600	5	1001	12,584	25.26
Total	81	269	49,823	100.00

Note: The mean annualized volume multiplied by the number of hospitals in each volume group is generally larger than the total number of cases submitted by hospitals for 1997-1999 since some hospitals had partial-year 1997-1998 data submissions.

Figure 8 shows the O/E ratio and 95% confidence limits for each of the four volume groups. The O/E ratio is 1.15 (95% CL: 1.07-1.26) for the first group of hospitals with annualized volumes below 200 cases, 1.09 (95% CL: 0.99-1.20) for the second group with annualized volumes of 200 to 299 cases, 0.92 (95% CL: 0.84-1.03) for the third group, and 0.75 (95% CL: 0.64-0.87) for the highest volume group. The figure shows significantly better outcomes for the third and fourth volume groups when compared to the first group (<200 cases annually). In addition, the fourth volume group has significantly better outcomes than the second group (200 to 299 cases annually).

Figure 8: Relationship Between Average CABG Volume and Average Hospital Outcomes, 1997-1999



The analysis of the 1997-1999 CCMRP data supports findings from other studies that risk-adjusted in-hospital mortality and volume are related. While it is true that, on average, smaller volume hospitals tend to perform worse than larger hospitals and experience wide variation in performance, Figure 7 also shows that a number of smaller volume hospitals were able to achieve good outcomes. In the All Quarters analysis, three low volume hospitals did achieve good outcomes, performing "better than expected." Finally, this analysis has not attempted to assess the relative importance of volume as a predictor of in-hospital mortality. Such information would be a valuable contribution to current policy discussions.