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The California Report on Coronary Artery Bypass Graft Surgery 2005 Hospital Data

California CABG Outcomes Reporting Program

Office of Statewide Health Planning and Development

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Additional copies of the report can be obtained through the OSHPD Web site (www.oshpd.ca.gov).

PREFACE

December 2007

We are pleased to share with you the third public release of data from the state's mandatory heart bypass surgery reporting program. This report focuses on hospital performance in 2005 and provides the risk-adjusted mortality rates and performance ratings for all 120 state-licensed facilities that performed isolated coronary artery bypass graft (CABG) surgery during that year. Isolated CABG surgery means that no other major heart procedure such as valve repair was performed at the same time. In 2005, the overall operative mortality rate was 3.08%, the same rate recorded for the 2003-2004 period. New to this report are mortality trend lines that show the performance of hospitals from 2003-2005 along with trends in use of the internal mammary artery, an important evidence-based indicator of surgery quality.

This information is intended for cardiac patients and their families to use in developing treatment plans with their doctors. It is also intended for hospitals to use in developing quality improvement activities and for organizations that purchase health coverage for their members. The clinical data collected and used to generate these findings are accurate and valid and the analytical methods rigorous. However, note that data after 2005 are not included, and hospital practices may have changed since then.

We commend the hospitals in California and the Clinical Advisory Panel that oversees the program for their hard work and dedication in completing this public report. The Office of Statewide Health Planning and Development continues to work with hospitals, physicians, and professional surgical societies to ensure that our reports are accurate, fair, and contribute to improved cardiac surgical care for all residents of the Golden State.

David M. Carlisle, M.D., Ph.D.
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EXECUTIVE SUMMARY

The *California Report on Coronary Artery Bypass Graft Surgery, 2005 Hospital Data* presents findings from analyses of data collected from California's 120 state-licensed hospitals that performed adult isolated coronary artery bypass graft (CABG) surgery[1] during 2005.

The report uses risk-adjusted operative mortality to evaluate hospital performance. Risk adjustment is a statistical technique that allows for fair comparison of hospital outcomes even though some hospitals have sicker or healthier patients than average. Operative mortality includes all deaths that occur during the hospitalization in which the CABG surgery was performed along with any deaths within 30 days after the surgery, no matter where they occur.

This report also provides hospital-level information on internal mammary artery (IMA)[2] usage, an additional measure of surgical quality, and examines the relationship between the number of surgeries that hospitals perform and their mortality rates. New to this report are charts that show hospital trends in risk-adjusted mortality rates and IMA usage from 2003-2005. There were 16,939 isolated CABG surgeries reported in 2005, making the California CABG Outcomes Reporting Program (CCORP) the largest public reporting program on CABG surgery outcomes in the United States.

Key findings from this report are:

- There were 522 operative deaths among 16,939 isolated CABG surgeries in 2005. The operative mortality rate for isolated CABG surgery in California was 3.08% for 2005, compared to 2.91% for 2003 and 3.29% for 2004. Nationally, the Society of Thoracic Surgeons (STS) reported 2.3%[3] for the same time period. However, participation in STS is voluntary and STS does not verify hospital reported deaths by linking with state vital statistics death files as CCORP does.

- The risk-adjusted operative mortality rate for California hospitals ranged from 0% to 11.49%, revealing wide variation in CABG surgery outcomes after adjusting for patients' pre-operative health conditions. However, 114 of 120 hospitals (95%) performed within their expected range compared to the state's overall mortality rate.

---

[1] Isolated CABG surgery refers to heart bypass surgery without other major surgery, such as heart or lung transplantation, valve repair, etc., performed concurrently with the bypass procedure. See Appendix A for a detailed clinical definition of isolated CABG.

[2] The internal mammary artery (IMA) is an artery that supplies blood to the front chest wall and the breasts. It is a paired artery, with one running on each side of the body. Evidence shows that the IMA, when grafted to a coronary artery, is less susceptible to obstruction over time and remains fully open longer than vein grafts.

[3] Society of Thoracic Surgeons: *Spring 2007 Report - Adult Cardiac Database Executive Summary*, September 27, 2007. (http://www.sts.org/sections/stsnationaldatabase/publications/executive/article.html)

- Three of the 120 hospitals performed significantly **"Better"** than the state average, and three hospitals performed **"Worse"** than the state average. These hospitals are presented below in alphabetical order:

Hospitals with "Better" Performance Ratings, 2005

Hospital	Region
Alta Bates Summit Medical Center - Summit Campus	San Francisco Bay Area and San Jose
Lakewood Regional Medical Center	Greater Los Angeles
Mercy Medical Center - Redding	Sacramento Valley and Northern California

Hospitals with "Worse" Performance Ratings, 2005

Hospital	Region
Citrus Valley Medical Center – IC Campus	Greater Los Angeles
Los Angeles Co USC Medical Center	Greater Los Angeles
Torrance Memorial Medical Center	Greater Los Angeles

Other major findings in this report include:

- Internal Mammary Artery (IMA) usage is a nationally-endorsed measure of quality for heart bypass surgery. Most patients are able to receive an IMA bypass and very low hospital usage rates are associated with poorer care. Clinical research shows that use of the IMA graft in CABG surgery promotes long-term graft patency and patient survival. In 2005 California hospitals had an average IMA usage rate of 92%, with a range from 60% to 100%. The IMA rate for 113 hospitals was deemed acceptable (within 2 standard deviations of the statewide average), but seven hospitals had statistically significantly lower IMA usage rates. These hospitals are presented below in alphabetical order:

Hospitals with "Low" IMA Performance Ratings, 2005

Hospital	Region
Anaheim Memorial Medical Center	Orange County
Downey Regional Medical Center	Greater Los Angeles
Lancaster Community Hospital	San Fernando Valley, Antelope Valley, Ventura & Santa Barbara
Los Angeles Co USC Medical Center	Greater Los Angeles
Presbyterian Intercommunity Hospital	Greater Los Angeles
Sutter Medical Center of Santa Rosa	San Francisco Bay Area and San Jose
USC University Hospital	Greater Los Angeles

- In California, utilization of percutaneous coronary interventions (PCIs), such as angioplasty with stent insertion, has increased by 36% from 1997 to 2006. Meanwhile, the number of isolated CABG surgeries has dropped by 43% during the same period. More information is included in Section VII.

- No significant association was found between the number of CABG surgeries that hospitals perform annually and their risk-adjusted mortality rates. This finding is consistent with analyses presented in the last two public reports, in which no significant relationship between hospital patient volume and outcomes was detected. These analyses are presented in Section VII.

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Important contributions were made by a host of individuals in each of the hospitals who dedicated their time and resources to collect and prepare the data for analysis. Hospitals provided ongoing feedback on the design of the program, which was vital to its success. Members of the CCORP Clinical Advisory Panel also made vital contributions, providing oversight and policy guidance in data collection and analysis, as well as presentation of results. The California Department of Public Health provided vital statistics files needed for identifying post-surgery deaths after discharge. CCORP also benefited from collaboration with the Society of Thoracic Surgeons and its California Chapter to coordinate and improve data collection efforts.

CCORP reflects the efforts and significant contributions of numerous individuals, including:

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I. INTRODUCTION

This report is a public disclosure of the quality of care provided by hospitals performing coronary artery bypass graft (CABG) surgery in California during 2005. It is the third heart bypass surgery report developed by the Office of Statewide Health Planning and Development (OSHPD) in implementing state legislation (Senate Bill 680, Chapter 898, Statutes of 2001) and covers all of California's 120 state licensed hospitals where this procedure is performed.

This report uses risk-adjusted operative mortality as the outcome measure. Operative mortality is defined as patient death occurring in the hospital after CABG surgery, regardless of the length of stay, or death occurring anywhere after hospital discharge but within 30 days of the CABG surgery. Use of operative mortality as the outcome, instead of in-hospital mortality, avoids potential manipulation of outcomes through discharge practices and holds hospitals accountable for patients who died at home shortly after discharge or who were transferred and died in other facilities. The national Society of Thoracic Surgeons (STS) also uses operative mortality as its primary outcome measure for CABG surgery quality reporting although STS does not verify deaths following patient discharge. The National Quality Forum (NQF), which serves as the national body for vetting quality measures, has endorsed the STS operative mortality measure for CABG surgery.[4]

In this report, the operative mortality rate is adjusted statistically to account for variation in the health condition of patients before CABG surgery. The report is intended to encourage hospitals to examine their surgical practices and make changes to improve the quality of care. This report also provides patients and their families with important information they may use when making decisions about CABG surgery.

Prior to this publication, all hospitals listed in this report were provided an opportunity to review a preliminary version of the report showing their results and to provide a comment letter to OSHPD for inclusion in this report. One statement was submitted by a single hospital and is included at the end of the report (Appendix C). This statement may help readers better understand the concerns of some healthcare providers regarding the information released in this report.

[4] National Quality Forum (NQF), National Voluntary Consensus Standards for Hospital Care: Additional Priority Areas, 2005-2006, Washington, DC: NQF; 2006.

II. CORONARY ARTERY DISEASE AND BYPASS SURGERY

During 2005, 115,324 Californians with coronary artery disease (CAD) were admitted to hospitals, which represented 7.3% of all adult non-maternal admissions. Heart disease was the leading cause of adult, non-maternal admissions to hospitals in California.[5]

Coronary artery disease is a chronic disease in which cholesterol and fat solidify and form plaque along the linings of the coronary arteries. This process is called atherosclerosis or hardening of the arteries. If plaque continues to build up, blood vessels can become partially or completely blocked so the heart does not receive enough oxygen, leading to angina (chest pain) or even myocardial infarction (heart attack).

The two most common procedures for the treatment of coronary artery disease are percutaneous coronary intervention (PCI), which includes drug-eluting stents, and coronary artery bypass graft (CABG) surgery. Despite recent large increases in the number of PCI procedures performed, CABG surgery is more frequently recommended for patients with extensive coronary disease, reduced left ventricular function, and disease involving the major artery to the heart muscle (called the “left main coronary artery”).

During CABG surgery, the surgeon uses arteries or veins from another part of the body (e.g., the saphenous vein from the leg) to reroute blood around a blockage in the coronary arteries. This allows oxygen-rich blood to flow freely to nourish the heart muscle. Surgeons may create single or multiple grafts for patients, depending on how many blood vessels and main branches are blocked. In most patients, the preferred initial graft for CABG surgery is the internal mammary artery since it maintains blood flow better over time and is associated with better long-term patient survival.

Study Population

Under state mandate, California-licensed hospitals are required to report all isolated and non-isolated CABG surgeries to the California CABG Outcomes Reporting Program (CCORP). Isolated CABG surgery is defined as CABG surgery performed without other major heart procedures, such as valve repair, during the same surgery (see Appendix A for the CCORP definition of isolated CABG surgery).

In 2005, there were 21,342 adult CABG surgeries performed in California; of these, 16,939 (79.4%) were isolated CABG surgeries, and 4,403 (20.6%) were non-isolated CABG surgeries. The study population for this report consists of all adult patients who underwent isolated CABG surgery and were discharged in 2005. Isolated CABG surgery cases were selected as the study population because the uniformity of the surgical process allows adequate pre-operative risk adjustment for patient conditions. Non-isolated CABG cases were not used to determine hospital performance ratings in this report.

[5] Data source: OSHPD, Patient Discharge Data, 2003 and 2004. Patients were identified with CAD if the principal diagnosis was coded as ICD-9-CM 410.0 - 414.9.

III. DATA

The primary data source for this report is the 2005 clinical registry data collected by CCORP from reporting hospitals. These data were linked to vital statistics data from the California Department of Public Health to identify patients who died at home or at facilities other than the operating hospital within the 30 days following CABG surgery.

The CCORP clinical data registry draws on a subset of data elements collected by the Society of Thoracic Surgeons (STS) for their National Database of Cardiac Surgery. However, some data elements are exclusive to CCORP. Although the STS and CCORP data definitions are virtually identical, CCORP provides additional clarifications to assist hospitals with coding. The data elements collected by CCORP in 2005 and their definitions can be found in Appendix B.

Data Quality Review and Verification

The data submitted by each hospital were reviewed for completeness and errors. A two-step process was followed to verify data submissions, prior to a hospital medical chart audit.

Step 1: Data Quality Reports

Data quality reports compare hospital-specific prevalence rates for each preoperative risk factor to the state average. Hospitals are provided summary reports for review and data correction which may include checks for invalid, missing, and abnormally high or low risk factor values.

Step 2: Data Discrepancy Reports

Data discrepancy reports compare the CCORP data to the OSHPD Patient Discharge Data (PDD) files, requiring hospitals to account for discrepancies between the two data sources via chart review. This includes cross checking at the patient level to verify that: 1) all CABG surgeries discharged in 2005 were reported; 2) all *Isolated* CABG surgery in-hospital deaths were reported; *3)* coding of *Discharge Status* was consistent; 4) coding of *Cardiogenic Shock* was consistent; and 5) coding of *Status of the Procedure* "Emergent/Salvage" was consistent.[6]

Hospital Medical Chart Audit

A preliminary risk model was developed using 2005 data that passed through the data quality review and verification processes described above to identify outlier hospitals (i.e., "Better" or "Worse" performers). The primary candidates for data audit were hospitals identified as preliminary outliers, near outliers, or those with problems in over-reporting or under-reporting of risk factors. The 2005 data audit included 18 hospitals and a total of 1,268 records (15% of all hospitals and nearly 8% of all isolated CABG surgery cases in 2005). On-site medical chart reviews were conducted by trained, independent auditors under contract to OSHPD. All isolated CABG deaths at the selected hospitals were audited and high risk patients were over-sampled. The number of cases selected within a hospital was proportional to the isolated CABG volume of the hospital, but generally fell within a range of 40 to 160 cases. If a hospital performed less than 40 isolated CABG surgeries per year, all surgeries were audited.

[6] The ICD9-CM 785.51 presenting at the admission was used to verify coding of cardiogenic chock in CCORP data, and the ICD9-CM for CPR (99.60, 99.63) presenting on the anastomosis date or within 2 days before the anastomosis date was used to verify coding of "Emergent/Salvage" status of the procedure.

Key findings from the 2005 hospital medical chart audit include:

- The accuracy of hospital submitted data improved modestly from 2004 to 2005. The percentage of data corrections resulting from the audit dropped from 10.1% in year 2004 to 9.0% in year 2005. In 2003, the comparable number was 12.5%.

- The audit found that 99.5% of all reported isolated CABG cases were correctly coded as isolated. There were six isolated CABG cases reported to CCORP which the auditors found to be non-isolated.

- Auditors were unable to confirm a diagnosis of *Hepatic Failure* for 7 cases that were submitted to CCORP. *Hepatic Failure* is a risk factor that exists for less than 0.5% of isolated CABG surgery patients, has very strict reporting requirements, and is difficult to code without complete laboratory documentation. After consulting with the CCORP clinical panel, it was determined that *Hepatic Failure* should be removed from the risk model.

- As a result of consistently poor coding of *Angina Type* during this and previous audits, this variable was excluded from the risk-adjustment model.

- For most of the hospitals audited, few risk factors were reported as missing.

At the end of the data correction process, the audited data were incorporated into the CCORP data for developing the public report and a summary of the audit report was sent to hospitals for review. All six “better” or “worse” outlier hospitals identified in this report were audited.

IV. 2005 RISK MODEL FOR ADJUSTING HOSPITAL OPERATIVE MORTALITY RATES

Whether patients recover quickly, have complications, or die following CABG is in part a result of the medical care they receive. However, it is difficult to compare outcomes among providers in assessing performance because patients treated at different hospitals often vary in the severity of their pre-operative clinical conditions.

To make fair comparisons of outcomes among different providers, it is necessary to adjust for the differences in the case mix of patients across hospitals. CCORP "levels the playing field" by taking into account the pre-operative condition of each patient. Hospitals that handle more complex cases get a larger risk-adjustment weighting in the risk model, while hospitals that handle less complex cases get a smaller weighting. Thus, hospitals treating sicker patients are not at a disadvantage when their performance is compared with other hospitals.

CCORP used a multivariable logistic regression model to determine the relationship between each of the demographic and pre-operative risk factors and the probability of operative mortality. Multivariable logistic regression models relate the probability of death to the risk factor (e.g., *Patient Age*) while controlling for all other risk factors in the model.

The risk model was developed in two steps. In the first step, the 16,939 isolated CABG surgery cases were evaluated for missing data; 15,981 of these had no missing data in any field and were used for the risk model parameter estimation. The 958 (5.7%) isolated CABG cases with missing data fields were removed to ensure that the effects of risk factors were estimated based on the most complete data available. To generate the hospital-specific results shown in this report, missing values for these 958 records were imputed (after risk model parameter estimation) by replacing them with the lowest risk category of the same variable (e.g., *Left main stenosis* ≤50%, *Chronic Lung Disease=None*). CCORP assigned the lowest risk value based on the following rationale: 1) some hospitals may leave data fields blank by design when the risk factor is absent or the value was normal); 2) to maintain consistency with other major cardiac reporting programs that also replace missing data with the lowest-risk or normal value; and 3) assigning values for missing data in this way creates an incentive for more complete reporting by hospitals. After imputing the missing values, the parameters of the risk model were applied to all cases to estimate each patient's probability of death. These probabilities were then added to estimate each hospital's expected mortality. The risk model based on the 2005 dataset is presented in Table 1.

GUIDE TO INTERPRETATING THE 2005 LOGISTIC REGRESSION RISK MODEL

Coefficient	The coefficient for each explanatory factor represents the effect that factor has on a patient's probability of dying (in the hospital or within 30 days) following bypass surgery. If the value is positive, it means that the characteristic is associated with an increased risk of death compared to not having the characteristic, while controlling for the effect of all other factors. If the coefficient is negative, having that characteristic is associated with a lower risk of death compared to not having it. The larger the value (whether positive or negative), the greater the effect or weight this characteristic has on the risk of dying. For example, the coefficient for "Congestive Heart Failure" in the 2005 model is 0.24 and statistically significant at the $p<0.05$ level. This value is positive, so it indicates that CABG patients with congestive heart failure are at an increased risk of dying compared to patients who do not have the disease.
Standard Error	The standard error is the standard deviation of the sampling distribution of an estimate. It measures the statistical reliability of that estimate.
p-value	The p-value is a measure of the statistical significance of the coefficient compared to the reference category. Commonly, p-values of less than 0.05 are considered statistically significant. The smaller the p-value, the more likely the effect of a factor is real, rather than due to chance.
Significance	When the p-value of a coefficient is less than 0.05, it is deemed statistically significant at the 0.05 level and is denoted with one star (*) in the significance column. Two stars (**) indicate statistical significance at the 0.01 level and three stars (***) indicate statistical significance at the 0.001 level. All statistical tests are two-tailed tests.
Odds Ratio	An odds ratio is another way of characterizing the impact of each risk factor on operative mortality. Mathematically, the odds ratio is the antilogarithm of the coefficient value. The larger the odds ratio (above 1.0), the greater the impact that risk factor has on the risk of dying. An odds ratio of 1.0 means the factor has no effect. An odds ratio less than 1.0 means that the factor decreases the risk of dying. For example, the odds ratio for congestive heart failure (CHF) in the 2005 model is 1.28. This means that for patients with CHF, the odds of dying is about 28% higher compared to patients without CHF, assuming all other risk factors are the same.

Table 1: Logistic Regression Risk Model for Operative Mortality, 2005

Risk Factor		Coefficient	Standard Error	P-value	Significance	Odds Ratio
Intercept		-9.567	0.533	<.0001	***	
Age		0.048	0.005	<.0001	***	1.049
Gender	Male			Reference		
	Female	0.449	0.106	<.0001	***	1.567
Race	Caucasian			Reference		
	Non-Caucasian	0.200	0.107	0.061		1.222
Body Mass Index	18.5-39.9			Reference		
	<18.5	0.340	0.357	0.342		1.404
	>=40.0	0.684	0.235	0.004	**	1.981
Status of Procedure	Elective			Reference		
	Urgent	0.383	0.135	0.005	**	1.467
	Emergent	0.940	0.226	<.0001	***	2.559
	Emergent/Salvage	2.876	0.519	<.0001	***	17.748
Last Creatinine Level Preop (mg/dl)		1.223	0.156	<.0001	***	3.399
Hypertension		-0.058	0.138	0.676		0.944
Peripheral Vascular Disease		0.498	0.116	<.0001	***	1.645
Cerebrovascular Disease		0.039	0.127	0.761		1.039
Diabetes		-0.058	0.106	0.581		0.943
Chronic Lung Disease	None, Mild			Reference		
	Moderate	0.372	0.173	0.031	*	1.450
	Severe	0.660	0.179	0.000	***	1.935
Immunosuppressive Treatment		0.651	0.237	0.006	**	1.917
Arrhythmia Type	None			Reference		
	Atrial Fibrillation/Flutter	0.561	0.152	0.000	***	1.752
	Heart Block	0.604	0.272	0.026	*	1.829
	Sustained VT/VF	0.523	0.228	0.022	**	1.686
Myocardial Infarction	None			Reference		
	21 or more days ago	0.287	0.147	0.051		1.333
	8-20 days ago	0.321	0.216	0.137		1.378
	1-7 days ago	0.305	0.134	0.023	*	1.357
	Within 24 Hours	0.616	0.213	0.004	**	1.852
Cardiogenic Shock		0.444	0.219	0.043	*	1.559
Congestive Heart Failure		0.244	0.119	0.040	*	1.276
NYHA Class IV		0.460	0.111	<.0001	***	1.585
Prior Cardiac Surgery	None			Reference		
	One or more	0.725	0.173	<.0001	***	2.065
Prior PCI Interval	No Prior PCI			Reference		
	> 6 HRS	0.208	0.130	0.108		1.232
	≤ 6 HRS	0.205	0.344	0.552		1.227
Ejection Fraction		-0.015	0.004	<.0001	***	0.985
Left Main Disease (% Stenosis)		0.002	0.003	0.518		1.002
Number of Diseased Vessels	None, One, or Two			Reference		
	Three or more	0.410	0.142	0.004	**	1.507
Mitral Insufficiency	None, Trivial, Mild			Reference		
	Moderate	0.416	0.170	0.014	*	1.515
	Severe	0.738	0.416	0.076		2.092

Notes: Last creatinine level preop (mg/dl), ejection fraction, and percent left main stenosis were all modeled using piecewise linear transformations.
* significant at the 0.05 level (two-tailed test), ** significant at the 0.01 level (two-tailed test),
*** significant at the 0.001 level (two-tailed test)

Discrimination

Models that distinguish well between patients who die and those who survive are said to have good discrimination. A commonly used measure of discrimination is the C-statistic (also known as the area under the Receiver Operating Characteristic (ROC) curve. For all possible pairs of patients, where one dies and the other survives surgery, the C-statistic describes the proportion of pairs where the patient who died had a higher predicted risk of death than the patient who lived. The C-statistic ranges from 0.5 to 1, with higher values indicating better discrimination. For the 2005 risk model, the C-statistic was 0.821. In recently published studies of CABG operative mortality using logistic regression models (including those from New Jersey, New York and Pennsylvania), the C-statistic ranged from 0.798 to 0.815. In comparison, the CCORP 2005 risk model appears to discriminate slightly better than other programs that produce risk-adjusted outcomes data for isolated CABG surgery.

Calibration

Calibration refers to the ability of a model to match predicted and observed mortality across the entire spectrum of the data. A model in which the number of observed deaths matches closely with the number of deaths predicted by the model demonstrates good calibration. Good calibration is essential for accurate risk adjustment. A common measure of calibration is the Hosmer-Lemeshow χ^2 test, which compares observed and predicted outcomes over deciles of risk. The p-value of the Hosmer-Lemeshow test statistic for the risk model is 0.317, indicating a nonsignificant likelihood of poor calibration. That is, the predicted mortality was consistent with actual mortality in the data.

Another way to test model calibration is to partition the data and compare observed events (death) with predicted events (death) by risk group. As presented in Table 2, the first row shows the patients in the lowest risk group (i.e., their predicted mortality was less than 10%). Among the 15,066 patients in this group, 324 patients died, but the model predicted 309.7 patient deaths. Assuming a Poisson distribution for a binary outcome, the predicted range of deaths for this group is 289.7 to 361.3. The observed number of 324 deaths falls within the range of expected deaths. In fact, examination of all the risk groups shows no risk group had deaths outside of the expected range and no systematic underestimates or overestimates of mortality at the extreme. More importantly, for the high risk groups (3 thru 10) the number of predicted deaths was either close to or slightly higher than the observed number of deaths, which indicates the model gives credit to providers who treat high-risk patients.

Table 2: Calibration of 2005 Risk Model

Risk Group	Predicted Mortality	N	Observed Deaths	Predicted Deaths	Difference	95% CI of Predicted Deaths
1	<0.10	15,066	324	309.7	14.3	(289.7, 361.3)
2	0.10 – 0.19	631	84	86.0	-2.0	(67.0, 104.0)
3	0.20 – 0.29	172	35	40.8	-5.8	(24.4, 48.7)
4	0.30 – 0.39	58	16	20.4	-4.4	(9.1, 26.0)
5	0.40 - 0.49	23	13	10.2	2.8	(6.9, 22.2)
6	0.50 – 0.59	10	3	5.5	-2.5	(0.6, 8.8)
7	0.60 – 0.69	10	4	6.5	-2.5	(1.1, 10.2)
8	0.70 – 0.79	7	5	5.3	-0.3	(1.6, 11.7)
9	0.80 – 0.89	1	1	0.9	0.1	(0.0, 5.6)
10	0.90 – 1.00	3	3	2.8	0.2	(0.6, 8.8)
Total		15,981	488	488	0	

V. RISK-ADJUSTED OPERATIVE MORTALITY RESULTS AND HOSPITAL PERFORMANCE RATINGS

The risk-adjusted mortality rate (RAMR) represents the best estimate of what the provider's mortality rate would have been if the provider had a patient case mix identical to the statewide mix. Thus, this rate is comparable among providers since the differences in patient severity of illness have been accounted for. The RAMR is computed, first by dividing the provider's observed mortality by the provider's expected mortality rate based on the risk model to get the observed/expected (O/E) ratio. If the O/E ratio is greater than one, the provider has a higher mortality than expected based on its patient mix; if the O/E ratio is less than one, the provider has a lower mortality rate than expected. The O/E ratio is then multiplied by the overall state mortality rate (3.08% for 2005) to obtain the provider's risk-adjusted mortality rate.

To minimize the risk of misinterpretation of differences caused by chance variation, the performance rating is based on a comparison of the 95% confidence interval (CI) of each provider's RAMR to the California state average mortality rate.[7] This was done because a point estimate of the RAMR based on a small number of cases can be attributed to chance. Thus, we treated 2005 data as a sample, from which we inferred the range within which each hospital's true performance was likely to fall. As shown in Tables 3, if the entire 95% CI of a provider's risk-adjusted mortality is below the state average mortality rate, indicating the provider's RAMR is significantly lower than the state average, the performance rating is **"Better,"** if the entire 95% CI of a provider's RAMR is above the state average mortality rate, indicating the provider's risk-adjusted mortality is significantly higher than the state average, the performance rating is **"Worse,"** if the state average mortality rate is within the 95% CI of a provider's RAMR, the performance rating is **"Not Different"** (blank in the column).

2005 Hospital Risk-Adjusted Operative Mortality Results

Table 3 presents the risk-adjusted results for each hospital for 2005. The table is sorted by geographic region and contains, for each hospital, the total number of CABG surgeries performed (isolated and non-isolated combined), the number of isolated CABG surgeries, the number of observed isolated CABG deaths, the observed mortality rate, the expected mortality rate predicted by the risk model, the risk-adjusted mortality rate and the 95% CI of the RAMR, and the associated hospital performance rating.

Among the 16,939 isolated CABG surgeries performed in 2005, 522 patients died in-hospital or within 30 days of the surgery date, reflecting an overall operative mortality rate of 3.08% in California. The observed mortality rates among hospitals ranged from 0% to 10.00%. The expected mortality rates, which are generated by the model and measure patient severity of illness, were between 0.53% and 5.90%. The risk-adjusted mortality rates, which measure hospital performance, ranged from 0% to 11.49%.

Based on the 95% confidence intervals for risk-adjusted mortality rates, 114 of 120 hospitals (95%) performed within the expected range compared to the state's overall mortality rate (denoted by a blank space in the performance rating column of Table 3), 3 hospitals performed significantly **"Better"** than the state average, and 3 hospitals performed significantly **"Worse"**

[7] The Poisson exact probability method was used for computation of 95% confidence interval for the risk-adjusted mortality rate. (Buchan Iain, *Calculating Poisson Confidence Interval in Excel*, January 2004)

than the state average. The hospital marked with two asterisks (**) in Table 3 submitted a statement regarding this report. The letter is presented in Appendix C.

GUIDE TO INTERPRETING TABLE 3	
All CABG Cases	The total number of isolated and non-isolated CABG cases submitted to CCORP for 2005. Non-isolated CABG cases are not used in calculating performance ratings.
Isolated CABG Cases	The number of isolated CABG cases submitted to CCORP during the time period indicated. Only isolated CABG cases are used in calculating performance ratings.
Isolated CABG Deaths	The actual number of operative deaths for isolated CABG cases for the time period indicated. The number of deaths includes: (1) all deaths that occur during the hospitalization in which the CABG surgery was performed, even after 30 days, and (2) all deaths occurring within 30 days after the CABG surgery.
Observed Mortality Rate	The ratio of the number of isolated CABG deaths and the isolated CABG cases multiplied by 100: Observed Mortality Rate = Number of Isolated CABG Deaths/Isolated CABG Cases X 100.
Expected Mortality Rate	The ratio of the expected number of operative deaths predicted for a provider (after adjusting for its patient population) and the number of Isolated CABG cases multiplied by 100: Expected Mortality Rate = Number of Expected Deaths/Number of Isolated CABG Cases X 100.
Risk-Adjusted Mortality Rate (95% CI)	The Risk-Adjusted Mortality Rate (RAMR) is obtained by multiplying the observed overall California mortality rate (CAMR) by a hospital's O/E ratio: (CAMR X O/E ratio). The 95% confidence interval represents the confidence we have in the estimate for the RAMR. The lower and upper confidence limits are calculated using exact Poisson 95% confidence interval calculations.
Performance Rating	The performance rating is based on a comparison of each provider's risk-adjusted mortality rate and the California observed mortality rate. This is a test of statistical significance. A hospital is classified as "Better" if the entire 95% confidence interval of the RAMR falls below the California observed mortality rate (3.08% for 2005). A hospital is classified as "Worse" if the entire 95% confidence interval of the RAMR is higher than the California observed mortality rate. A hospital is classified as "Not Different" (performance rating is blank) if the California mortality rate falls within the confidence interval of the hospital's risk-adjusted mortality rate.

Table 3: Hospital Risk-Adjusted Operative Mortality Results by Region, 2005

Region	Hospital	All CABG Cases*	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (%, RAMR)	95%CI for RAMR	Performance Rating*
State of California		21,342	16,939	522	3.08				
Sacramento Valley & Northern California Region	Enloe Medical Center	188	142	6	4.23	3.52	3.70	(1.36, 8.04)	
	Mercy General Hospital	1,021	672	13	1.93	1.63	3.66	(1.95, 6.26)	
	Mercy Medical Center-Redding	185	137	0	0.00	2.86	0.00	(0.00, 2.90)	Better
	Mercy San Juan Hospital	156	113	4	3.54	3.01	3.63	(0.99, 9.29)	
	Rideout Memorial Hospital	159	111	3	2.70	2.26	3.68	(0.76, 10.74)	
	Shasta Regional Medical Center	92	75	1	1.33	4.72	0.87	(0.02, 4.84)	
	St. Joseph Hospital - Eureka	92	68	3	4.41	4.22	3.22	(0.66, 9.42)	
	Sutter Memorial Hospital	531	399	11	2.76	2.49	3.41	(1.70, 6.10)	
	UCD Medical Center	149	113	2	1.77	2.22	2.46	(0.30, 8.88)	
San Francisco Bay Area & San Jose	Alta Bates Summit Medical Center - Summit Campus	791	664	11	1.66	3.01	1.69	(0.84, 3.03)	Better
	California Pacific Medical Center - Pacific Campus	119	79	5	6.33	4.15	4.70	(1.53, 10.97)	

* A hospital is classified as "Better" if the upper 95% CI of the RAMR falls below the California observed mortality rate (3.08). A hospital is classified as "Worse" if the lower 95% CI of the RAMR is higher than the California observed mortality rate. A hospital's performance is considered "Not Different" from the state average (rating is blank) if the California mortality rate falls within the 95% CI of the RAMR.

Table 3: Hospital Risk-Adjusted Operative Mortality Results by Region, 2005

Region	Hospital	All CABG Cases*	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (%, RAMR)	95%CI for RAMR	Performance Rating*
State of California		21,342	16,939	522	3.08				
	Doctors Medical Center - San Pablo Campus	50	42	0	0.00	5.75	0.00	(0.00, 4.70)	
	Dominican Hospital	90	79	3	3.80	4.30	2.72	(0.56, 7.95)	
	El Camino Hospital	87	67	0	0.00	1.85	0.00	(0.00, 9.15)	
	Good Samaritan Hospital - San Jose	183	146	5	3.42	3.40	3.10	(1.01, 7.23)	
	John Muir Medical Center - Walnut Creek Campus	21	19	0	0.00	2.00	0.00	(0.00, 29.87)	
	Kaiser Foundation Hospital (Geary San Francisco)	714	526	9	1.71	1.90	2.78	(1.27, 5.28)	
	Marin General Hospital	70	56	1	1.79	2.61	2.11	(0.05, 11.73)	
	Mills – Peninsula Health Center	75	47	2	4.26	4.96	2.65	(0.32, 9.55)	
	Mt. Diablo Medical Center	259	211	4	1.90	3.01	1.94	(0.53, 4.96)	
	O'Connor Hospital	110	94	6	6.38	2.96	6.65	(2.44, 14.47)	
	Queen of the Valley Hospital	213	174	4	2.30	3.57	1.98	(0.54, 5.07)	

* A hospital is classified as "Better" if the upper 95% CI of the RAMR falls below the California observed mortality rate (3.08). A hospital is classified as "Worse" if the lower 95% CI of the RAMR is higher than the California observed mortality rate. A hospital's performance is considered "Not Different" from the state average (rating is blank) if the California mortality rate falls within the 95% CI of the RAMR.

Table 3: Hospital Risk-Adjusted Operative Mortality Results by Region, 2005

Region	Hospital	All CABG Cases*	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (%, RAMR)	95%CI for RAMR	Performance Rating*
State of California		21,342	16,939	522	3.08				
	Regional Medical of San Jose	7	6	0	0.00	0.53	0.00	(0.00, 100.0)	
	Salinas Valley Memorial Hospital	177	167	1	0.60	2.02	0.91	(0.02, 5.09)	
	San Ramon Regional Medical Center	68	57	1	1.75	2.18	2.48	(0.06, 13.79)	
	Santa Clara Valley Medical Center	65	60	0	0.00	1.13	0.00	(0.00, 16.74)	
	Santa Rosa Memorial Hospital	70	61	2	3.28	2.59	3.90	(0.47, 14.08)	
	Sequoia Hospital	224	124	5	4.03	3.17	3.92	(1.27, 9.13)	
	Seton Medical Center	273	251	11	4.38	3.61	3.74	(1.87, 6.69)	
	St. Helena Hospital	129	116	6	5.17	5.67	2.81	(1.03, 6.11)	
	St. Mary's Medical Center, San Francisco	44	30	1	3.33	1.89	5.43	(0.14, 30.25)	
	Stanford University Hospital	179	117	4	3.42	2.94	3.59	(0.98, 9.18)	
	Sutter Medical Center of Santa Rosa	112	80	3	3.75	2.47	4.68	(0.96, 13.67)	

* A hospital is classified as "Better" if the upper 95% CI of the RAMR falls below the California observed mortality rate (3.08). A hospital is classified as "Worse" if the lower 95% CI of the RAMR is higher than the California observed mortality rate. A hospital's performance is considered "Not Different" from the state average (rating is blank) if the California mortality rate falls within the 95% CI of the RAMR.

Table 3: Hospital Risk-Adjusted Operative Mortality Results by Region, 2005

Region	Hospital	All CABG Cases*	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (%, RAMR)	95%CI for RAMR	Performance Rating*
State of California		21,342	16,939	522	3.08				
	UCSF Medical Center	129	108	2	1.85	3.61	1.58	(0.19, 5.71)	
	Washington Hospital - Fremont	141	119	8	6.72	4.53	4.57	(1.97, 9.00)	
Central California	Bakersfield Heart Hospital	208	169	7	4.14	2.80	4.55	(1.83, 9.38)	
	Bakersfield Memorial Hospital	241	211	9	4.27	2.52	5.23	(2.39, 9.91)	
	Community Medical Center - Fresno	162	149	7	4.70	2.99	4.84	(1.94, 9.96)	
	Dameron Hospital	59	54	4	7.41	3.72	6.14	(1.67, 15.70)	
	Doctors Medical Center - Modesto Campus	337	271	9	3.32	1.90	5.38	(2.46, 10.20)	
	Fresno Heart Hospital	264	228	3	1.32	2.34	1.73	(0.36, 5.06)	
	Kaweah Delta Hospital	346	289	14	4.84	4.87	3.07	(1.68, 5.14)	
	Marian Medical Center	129	103	5	4.85	3.05	4.91	(1.59, 11.45)	
	Memorial Medical Center of Modesto	312	261	5	1.92	2.41	2.45	(0.80, 5.71)	

* A hospital is classified as "Better" if the upper 95% CI of the RAMR falls below the California observed mortality rate (3.08). A hospital is classified as "Worse" if the lower 95% CI of the RAMR is higher than the California observed mortality rate. A hospital's performance is considered "Not Different" from the state average (rating is blank) if the California mortality rate falls within the 95% CI of the RAMR.

Table 3: Hospital Risk-Adjusted Operative Mortality Results by Region, 2005

Region	Hospital	All CABG Cases*	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (%, RAMR)	95%CI for RAMR	Performance Rating*
State of California		21,342	16,939	522	3.08				
	San Joaquin Community Hospital	78	70	3	4.29	2.79	4.74	(0.98, 13.84)	
	St. Agnes Medical Center	360	318	14	4.40	3.63	3.74	(2.04, 6.27)	
	St. Josephs Medical Center of Stockton	266	242	5	2.07	3.04	2.10	(0.68, 4.89)	
San Fernando Valley, Antelope Valley, Ventura & Santa Barbara	Antelope Valley Hospital Medical Center	45	39	2	5.13	1.54	10.28	(1.24, 37.11)	
	Community Memorial Hospital of San Buenaventura	142	119	3	2.52	4.03	1.93	(0.40, 5.64)	
	Encino Tarzana Regional Medical Center	135	103	0	0.00	3.53	0.00	(0.00, 3.12)	
	French Hospital Medical Center	127	88	0	0.00	2.06	0.00	(0.00, 6.27)	
	Glendale Adventist Medical Center- Wilson Terrace	140	124	2	1.61	2.35	2.12	(0.26, 7.64)	
	Glendale Memorial Hospital and Health Center	144	107	7	6.54	3.01	6.70	(2.69, 13.80)	
	Lancaster Community Hospital	12	12	0	0.00	1.96	0.00	(0.00, 48.28)	
	Los Robles Regional Medical Center	128	101	3	2.97	3.33	2.75	(0.57, 8.03)	

* A hospital is classified as "Better" if the upper 95% CI of the RAMR falls below the California observed mortality rate (3.08). A hospital is classified as "Worse" if the lower 95% CI of the RAMR is higher than the California observed mortality rate. A hospital's performance is considered "Not Different" from the state average (rating is blank) if the California mortality rate falls within the 95% CI of the RAMR.

Table 3: Hospital Risk-Adjusted Operative Mortality Results by Region, 2005

Region	Hospital	All CABG Cases*	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (%, RAMR)	95%CI for RAMR	Performance Rating*
State of California		21,342	16,939	522	3.08				
	Northridge Hospital Medical Center	122	97	5	5.15	5.05	3.15	(1.02, 7.34)	
	Providence Holy Cross Medical Center	116	93	0	0.00	2.18	0.00	(0.00, 5.61)	
	Providence St. Joseph Medical Center	74	55	3	5.45	2.41	6.96	(1.43, 20.33)	
	Santa Barbara Cottage Hospital	205	148	6	4.05	4.11	3.04	(1.11, 6.61)	
	Sierra Vista Regional Medical Center	60	49	2	4.08	5.71	2.20	(0.27, 7.95)	
	St. John's Regional Medical Center	158	121	3	2.48	3.65	2.10	(0.43, 6.12)	
	Valley Presbyterian Hospital	22	18	1	5.56	2.10	8.15	(0.21, 45.36)	
	West Hills Regional Medical Center	46	42	1	2.38	4.03	1.82	(0.05, 10.13)	
Greater Los Angeles	Beverly Hospital	22	22	0	0.00	2.16	0.00	(0.00, 23.95)	
	Brotman Medical Center	14	8	0	0.00	2.10	0.00	(0.00, 67.64)	
	Cedars Sinai Medical Center	244	144	5	3.47	3.35	3.19	(1.04, 7.44)	

* A hospital is classified as "Better" if the upper 95% CI of the RAMR falls below the California observed mortality rate (3.08). A hospital is classified as "Worse" if the lower 95% CI of the RAMR is higher than the California observed mortality rate. A hospital's performance is considered "Not Different" from the state average (rating is blank) if the California mortality rate falls within the 95% CI of the RAMR.

Table 3: Hospital Risk-Adjusted Operative Mortality Results by Region, 2005

Region	Hospital	All CABG Cases*	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (%, RAMR)	95%CI for RAMR	Performance Rating*
State of California		21,342	16,939	522	3.08				
	Centinela Hospital Medical Center	90	78	3	3.85	3.60	3.29	(0.68, 9.61)	
	Citrus Valley Medical Center – IC Campus	146	120	10	8.33	3.08	8.34	(4.00, 15.34)	Worse
	Downey Regional Medical Center	88	84	3	3.57	2.88	3.82	(0.79, 11.17)	
	Garfield Medical Center	134	122	3	2.46	3.80	2.00	(0.41, 5.83)	
	Good Samaritan Hospital - Los Angeles	216	164	8	4.88	4.45	3.38	(1.46, 6.66)	
	Huntington Memorial Hospital	180	120	7	5.83	4.16	4.32	(1.74, 8.90)	
	Kaiser Foundation Hospital (Sunset Los Angeles)	1,043	880	24	2.73	2.83	2.97	(1.90, 4.41)	
	Lakewood Regional Medical Center	152	124	0	0.00	3.11	0.00	(0.00, 2.95)	Better
	Little Company of Mary Hospital	91	60	6	10.00	5.27	5.85	(2.14, 12.72)	
	Long Beach Memorial Medical Center	310	253	3	1.19	2.79	1.31	(0.27, 3.82)	
	Los Angeles Co Harbor - UCLA Medical Center	129	111	2	1.80	2.13	2.60	(0.32, 9.40)	

* A hospital is classified as "Better" if the upper 95% CI of the RAMR falls below the California observed mortality rate (3.08). A hospital is classified as "Worse" if the lower 95% CI of the RAMR is higher than the California observed mortality rate. A hospital's performance is considered "Not Different" from the state average (rating is blank) if the California mortality rate falls within the 95% CI of the RAMR.

Table 3: Hospital Risk-Adjusted Operative Mortality Results by Region, 2005

Region	Hospital	All CABG Cases*	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (%, RAMR)	95%CI for RAMR	Performance Rating*
State of California		21,342	16,939	522	3.08				
	Los Angeles Co USC Medical Center	105	91	6	6.59	1.77	11.49	(4.21, 25.00)	Worse
	Methodist Hospital of Southern California	121	109	5	4.59	3.63	3.89	(1.26, 9.08)	
	Presbyterian Intercommunity Hospital	105	92	3	3.26	3.95	2.54	(0.52, 7.43)	
	Santa Monica - UCLA Medical Center	34	27	2	7.41	3.03	7.54	(0.91, 27.22)	
	St. Francis Medical Center	51	45	2	4.44	3.06	4.47	(0.54, 16.15)	
	St. John's Hospital and Health Center	88	77	0	0.00	2.51	0.00	(0.00, 5.88)	
	St. Mary Medical Center	73	61	4	6.56	5.90	3.42	(0.93, 8.76)	
	St. Vincent Medical Center	141	121	5	4.13	3.57	3.57	(1.16, 8.33)	
	Torrance Memorial Medical Center	158	100	10	10.00	3.75	8.21	(3.94, 15.09)	Worse
	UCLA Medical Center	153	80	2	2.50	3.63	2.12	(0.26, 7.65)	
	USC University Hospital**	145	79	3	3.80	3.59	3.26	(0.67, 9.51)	

* A hospital is classified as "Better" if the upper 95% CI of the RAMR falls below the California observed mortality rate (3.08). A hospital is classified as "Worse" if the lower 95% CI of the RAMR is higher than the California observed mortality rate. A hospital's performance is considered "Not Different" from the state average (rating is blank) if the California mortality rate falls within the 95% CI of the RAMR.

Table 3: Hospital Risk-Adjusted Operative Mortality Results by Region, 2005

Region	Hospital	All CABG Cases*	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (%, RAMR)	95%CI for RAMR	Performance Rating*
State of California		21,342	16,939	522	3.08				
	White Memorial Medical Center	124	112	5	4.46	2.63	5.23	(1.70, 12.21)	
Inland Empire, Riverside & San Bernardino	Desert Regional Medical Center	259	209	5	2.39	2.61	2.83	(0.92, 6.60)	
	Eisenhower Memorial Hospital	202	166	5	3.01	2.90	3.20	(1.04, 7.46)	
	Loma Linda University Medical Center	418	310	4	1.29	2.42	1.65	(0.45, 4.21)	
	Pomona Valley Hospital Medical Center	189	164	4	2.44	3.52	2.14	(0.58, 5.47)	
	Riverside Community Hospital	244	211	9	4.27	2.95	4.46	(2.04, 8.45)	
	San Antonio Community Hospital	83	70	1	1.43	3.89	1.13	(0.03, 6.31)	
	St. Bernardine Medical Center	535	469	19	4.05	3.88	3.22	(1.94, 5.03)	
	St. Mary Regional Medical Center	222	177	9	5.08	2.63	5.96	(2.72, 11.31)	
Orange County	Anaheim Memorial Medical Center	210	174	6	3.45	3.21	3.31	(1.21, 7.19)	
	Fountain Valley Regional Hospital	116	108	5	4.63	3.43	4.16	(1.35, 9.70)	

* A hospital is classified as "Better" if the upper 95% CI of the RAMR falls below the California observed mortality rate (3.08). A hospital is classified as "Worse" if the lower 95% CI of the RAMR is higher than the California observed mortality rate. A hospital's performance is considered "Not Different" from the state average (rating is blank) if the California mortality rate falls within the 95% CI of the RAMR.

Table 3: Hospital Risk-Adjusted Operative Mortality Results by Region, 2005

Region	Hospital	All CABG Cases*	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (%, RAMR)	95%CI for RAMR	Performance Rating*
State of California		21,342	16,939	522	3.08				
	Hoag Memorial Hospital Presbyterian	293	211	4	1.90	2.48	2.35	(0.64, 6.02)	
	Irvine Regional Hospital and Medical Center	35	31	0	0.00	2.60	0.00	(0.00, 14.11)	
	Mission Hospital Regional Medical Center	195	174	3	1.72	2.36	2.25	(0.46, 6.56)	
	Saddleback Memorial Medical Center	139	119	2	1.68	3.41	1.52	(0.18, 5.49)	
	St. Joseph Hospital - Orange	158	124	5	4.03	2.08	5.98	(1.94, 13.96)	
	St. Jude Medical Center	184	160	7	4.38	3.48	3.88	(1.56, 7.99)	
	UC Irvine Medical Center	88	64	2	3.13	3.05	3.15	(0.38, 11.39)	
	West Anaheim Medical Center	37	35	2	5.71	3.98	4.43	(0.54, 15.98)	
	Western Medical Center Hospital - Anaheim	133	125	3	2.40	2.25	3.29	(0.68, 9.62)	
	Western Medical Center - Santa Ana	100	89	2	2.25	1.91	3.62	(0.44, 13.06)	
Greater San Diego	Alvarado Hospital Medical Center	104	90	1	1.11	2.31	1.48	(0.04, 8.25)	

* A hospital is classified as "Better" if the upper 95% CI of the RAMR falls below the California observed mortality rate (3.08). A hospital is classified as "Worse" if the lower 95% CI of the RAMR is higher than the California observed mortality rate. A hospital's performance is considered "Not Different" from the state average (rating is blank) if the California mortality rate falls within the 95% CI of the RAMR.

Table 3: Hospital Risk-Adjusted Operative Mortality Results by Region, 2005

Region	Hospital	All CABG Cases*	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (%, RAMR)	95%CI for RAMR	Performance Rating*
State of California		21,342	16,939	522	3.08				
	Palomar Medical Center	101	83	3	3.61	1.45	7.69	(1.58, 22.45)	
	Scripps Green Hospital	121	96	2	2.08	3.00	2.14	(0.26, 7.73)	
	Scripps Memorial Hospital - La Jolla	474	328	9	2.74	3.73	2.27	(1.04, 4.30)	
	Scripps Mercy Hospital	168	138	1	0.72	2.08	1.07	(0.03, 5.98)	
	Sharp Chula Vista Medical Center	218	180	11	6.11	4.63	4.07	(2.03, 7.27)	
	Sharp Grossmont Hospital	190	152	7	4.61	3.53	4.02	(1.62, 8.28)	
	Sharp Memorial Hospital	258	163	4	2.45	2.10	3.60	(0.98, 9.20)	
	Tri-City Medical Center	141	108	2	1.85	1.44	3.97	(0.48, 14.32)	
	UCSD Medical Center	75	65	3	4.62	1.83	7.77	(1.60, 22.69)	
	UCSD Medical Center - La Jolla, John M. & Sally B. Thornton Hospital	84	51	1	1.96	2.74	2.20	(0.06, 12.28)	

* A hospital is classified as "Better" if the upper 95% CI of the RAMR falls below the California observed mortality rate (3.08). A hospital is classified as "Worse" if the lower 95% CI of the RAMR is higher than the California observed mortality rate. A hospital's performance is considered "Not Different" from the state average (rating is blank) if the California mortality rate falls within the 95% CI of the RAMR.

2003-2005 Hospital Risk-Adjusted Operative Mortality Rates Over Time

To help the reader put hospital performance in a historical context, Figure 1 presents each hospital's risk-adjusted operative mortality rate over time. All 120 hospitals except one (San Jose Medical Center) have performed CABG surgery for all three years between 2003 and 2005.

Figure 1 shows that, for the majority of hospitals, the risk-adjusted mortality rates did not demonstrate a consistent direction from year to year. At low volume hospitals especially, the mortality rate might be expected to vary considerably from year to year because of the inherent imprecision in calculating rates using low numbers. However, 16 hospitals had mortality rates below the state average and 19 hospitals had rates higher than the state average throughout the three-year period.

Figure 1: Risk-Adjusted Operative Mortality Rates by Hospital Over Time: 2003-2005

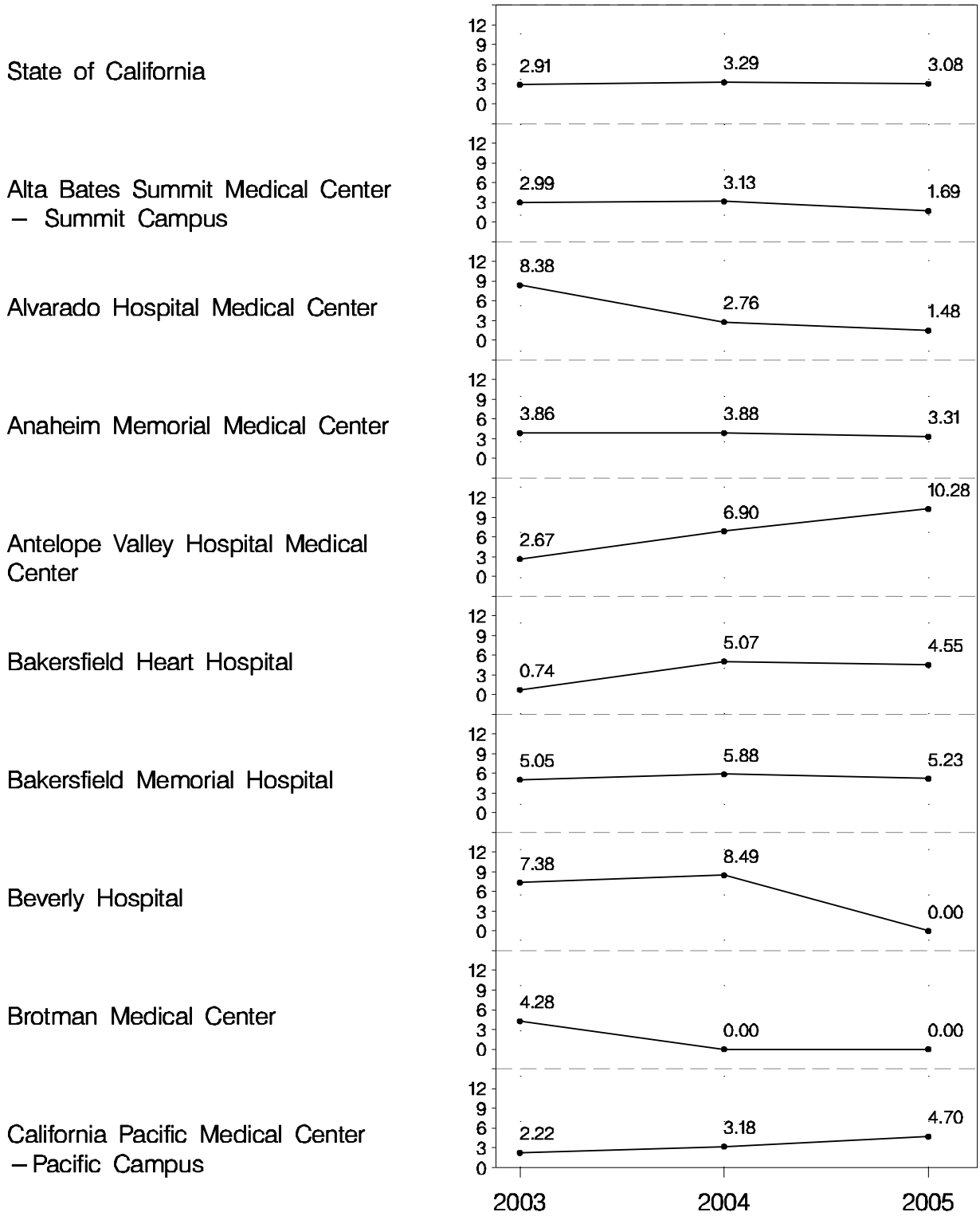


Figure 1: Risk-Adjusted Operative Mortality Rates by Hospital Over Time: 2003-2005 (Cont'd)

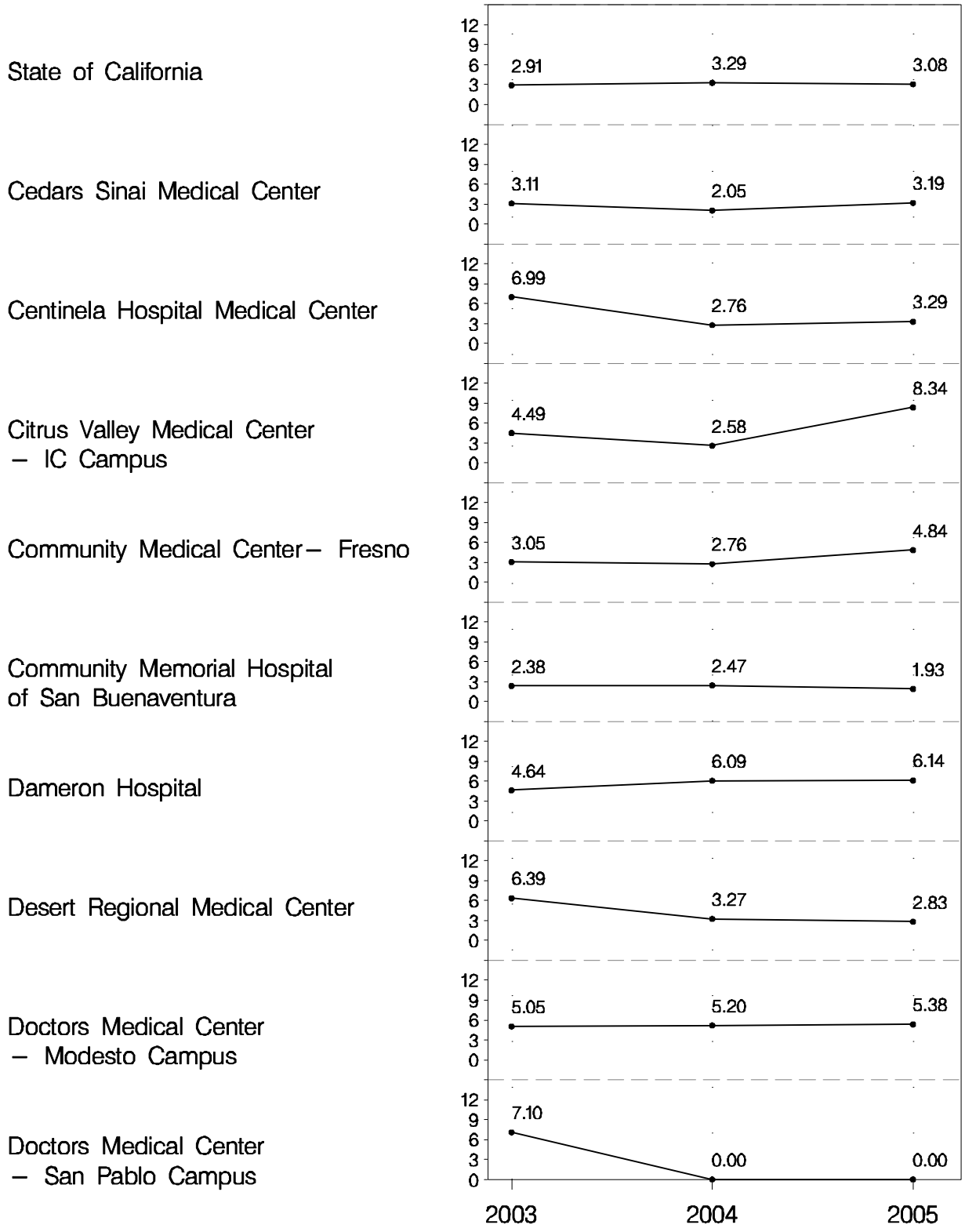


Figure 1: Risk-Adjusted Operative Mortality Rates by Hospital Over Time: 2003-2005 (Cont'd)

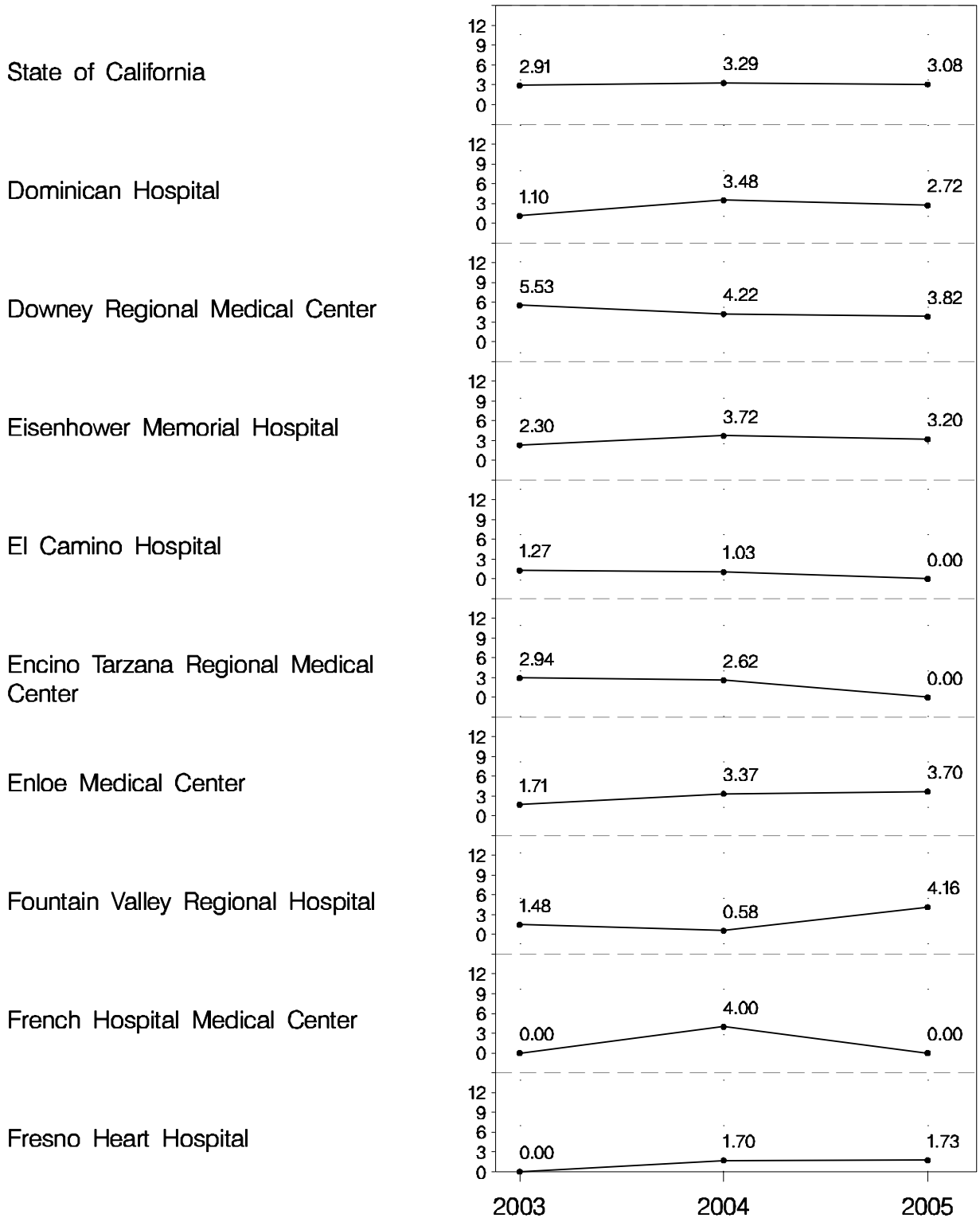


Figure 1: Risk-Adjusted Operative Mortality Rates by Hospital Over Time: 2003-2005 (Cont'd)

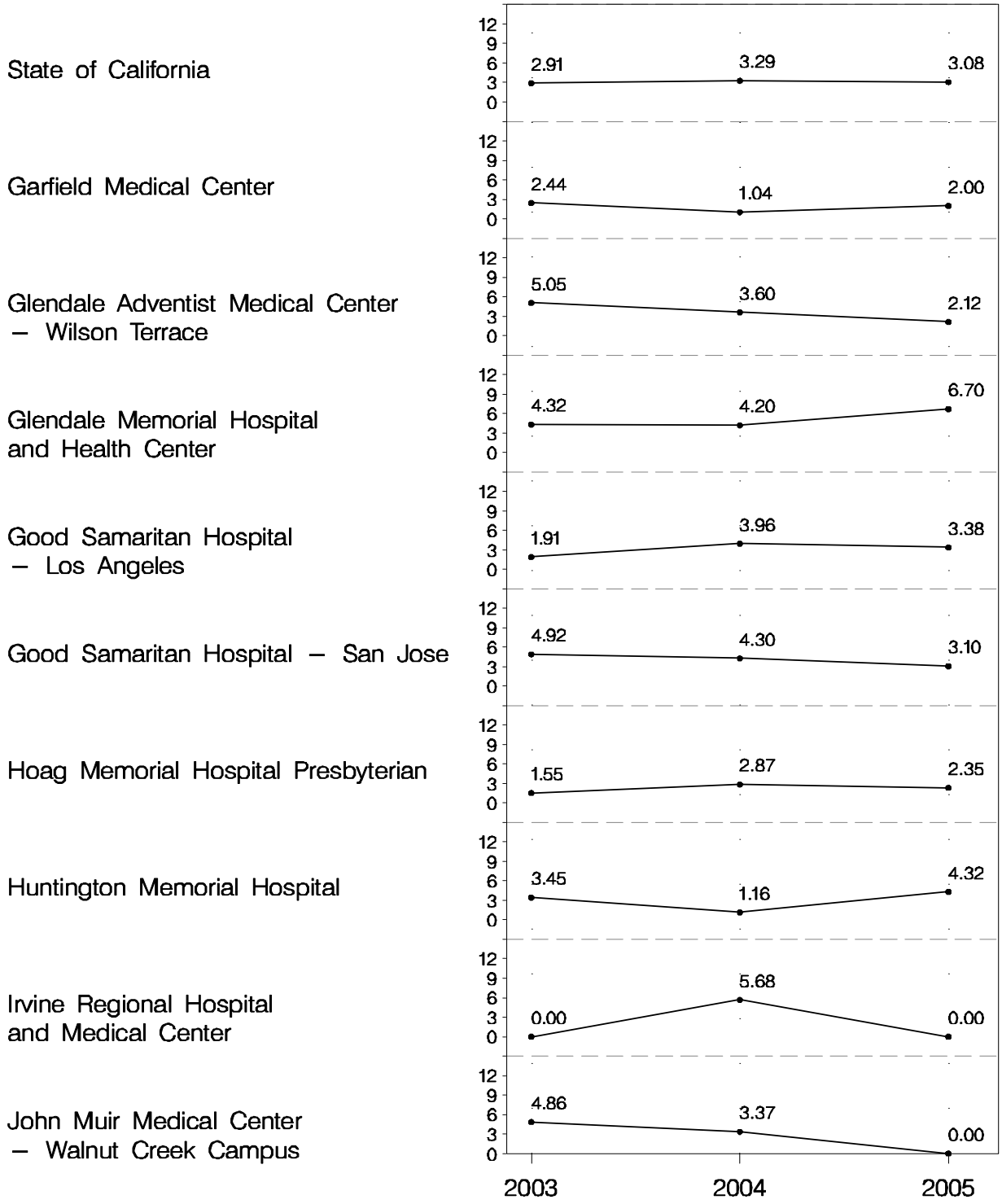


Figure 1: Risk-Adjusted Operative Mortality Rates by Hospital Over Time: 2003-2005 (Cont'd)

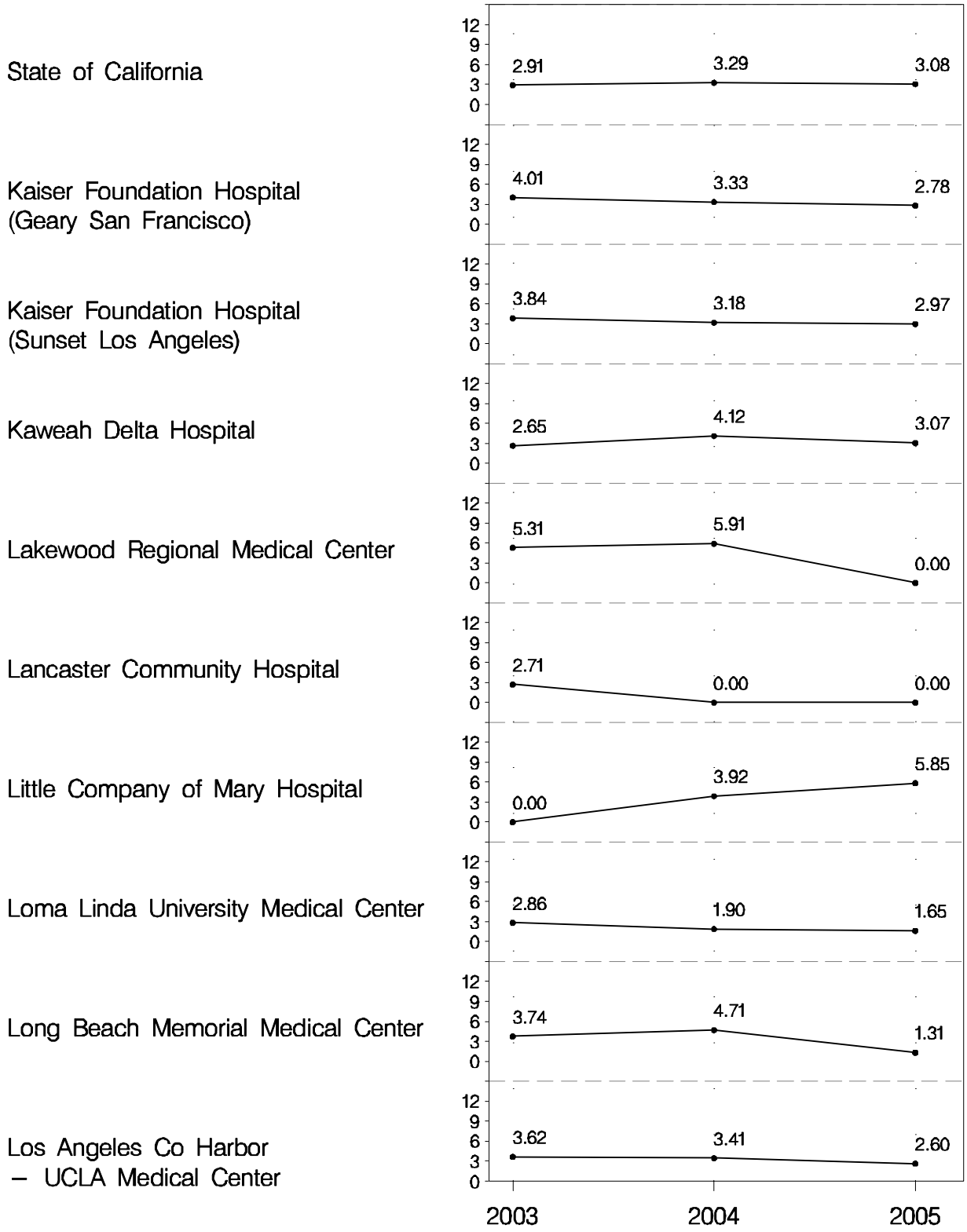


Figure 1: Risk-Adjusted Operative Mortality Rates by Hospital Over Time: 2003-2005 (Cont'd)

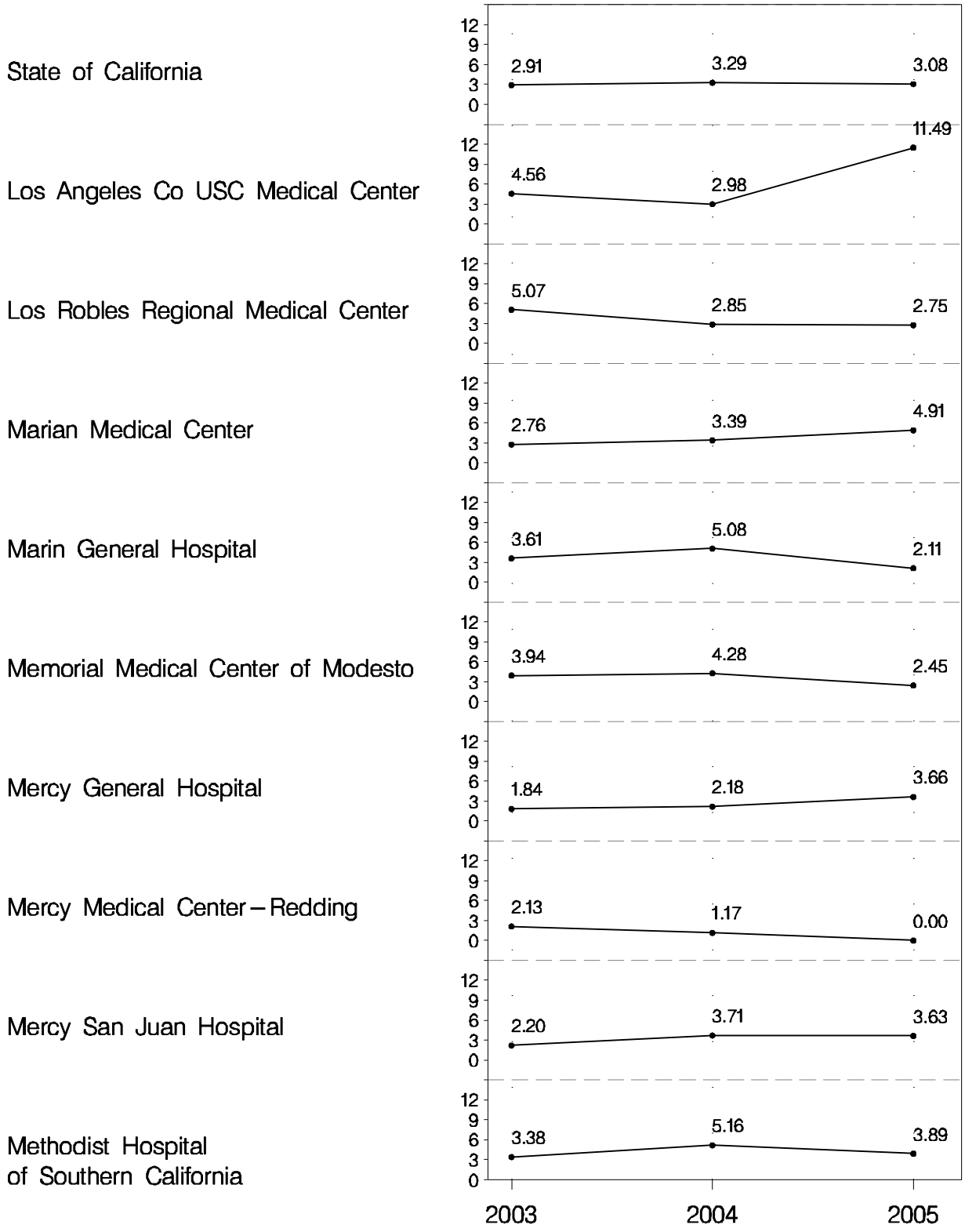


Figure 1: Risk-Adjusted Operative Mortality Rates by Hospital Over Time: 2003-2005 (Cont'd)

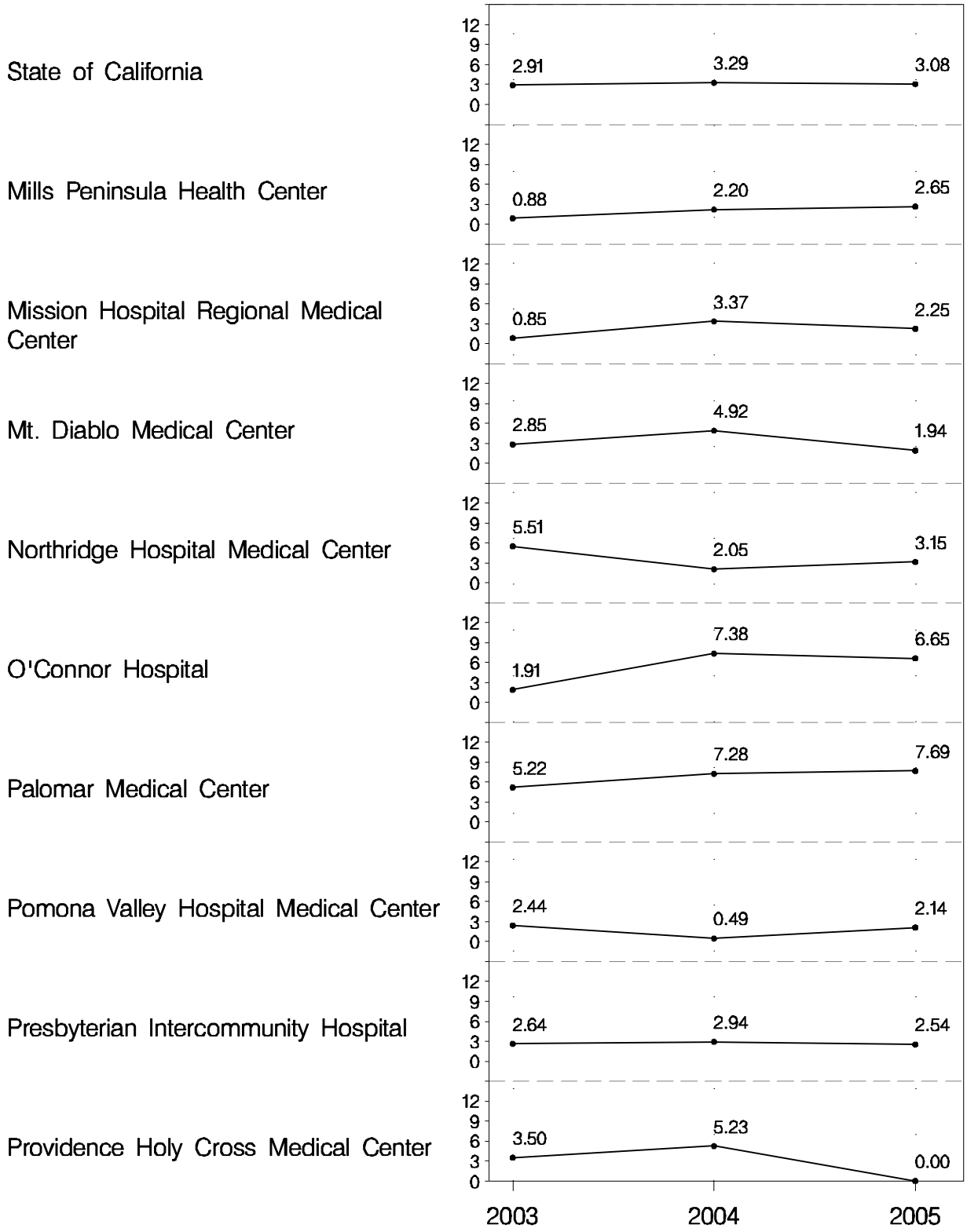


Figure 1: Risk-Adjusted Operative Mortality Rates by Hospital Over Time: 2003-2005 (Cont'd)

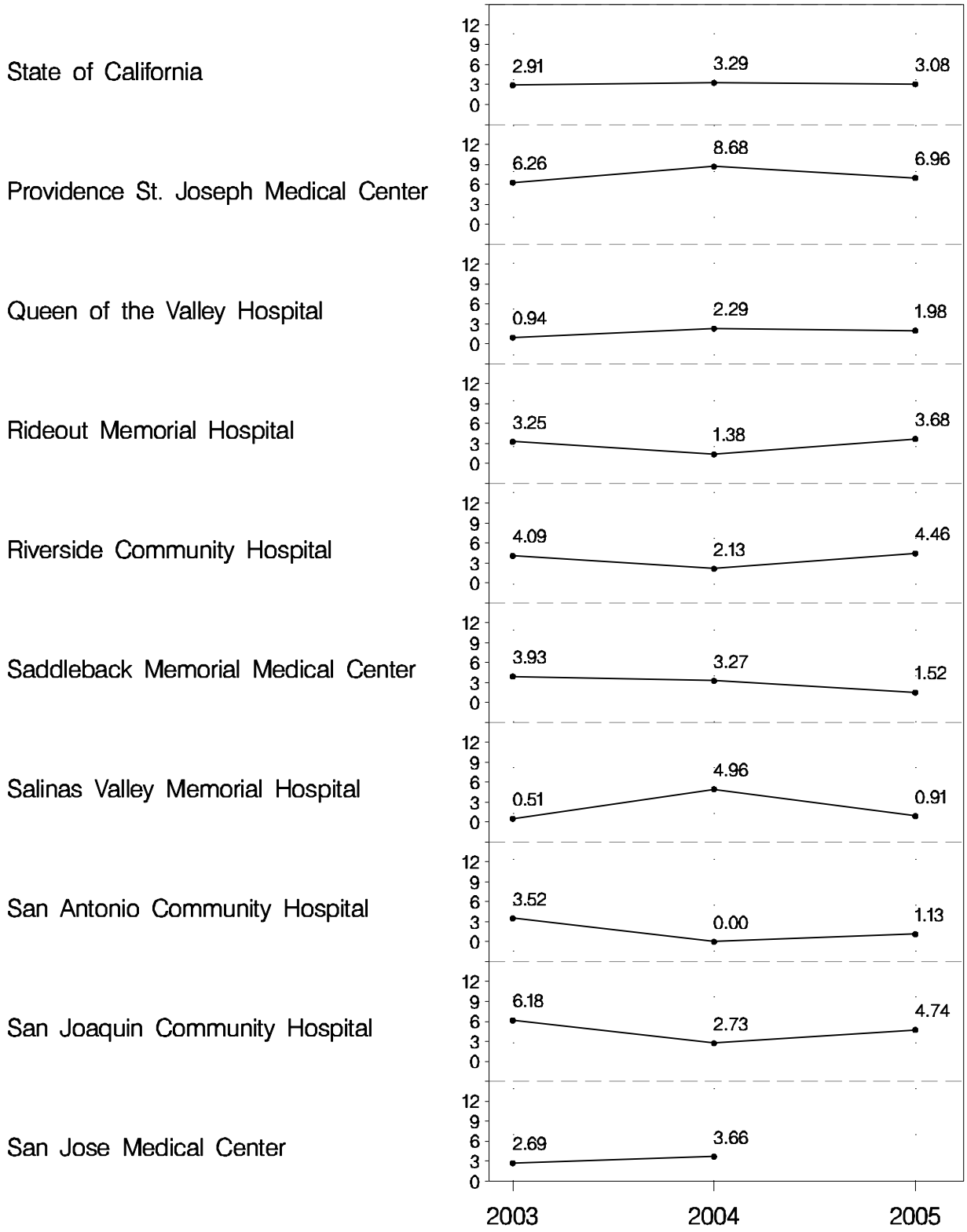


Figure 1: Risk-Adjusted Operative Mortality Rates by Hospital Over Time: 2003-2005 (Cont'd)

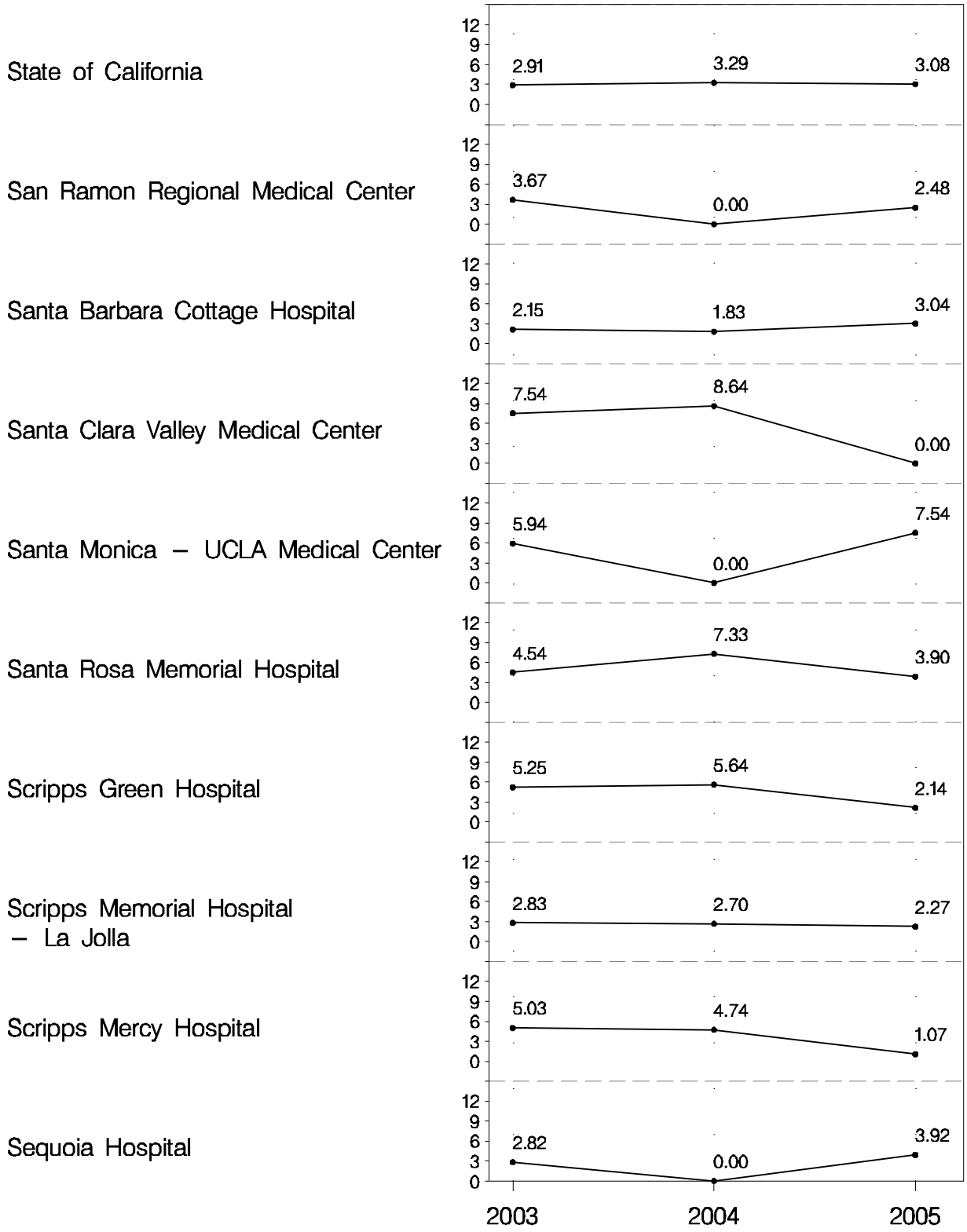


Figure 1: Risk-Adjusted Operative Mortality Rates by Hospital Over Time: 2003-2005 (Cont'd)

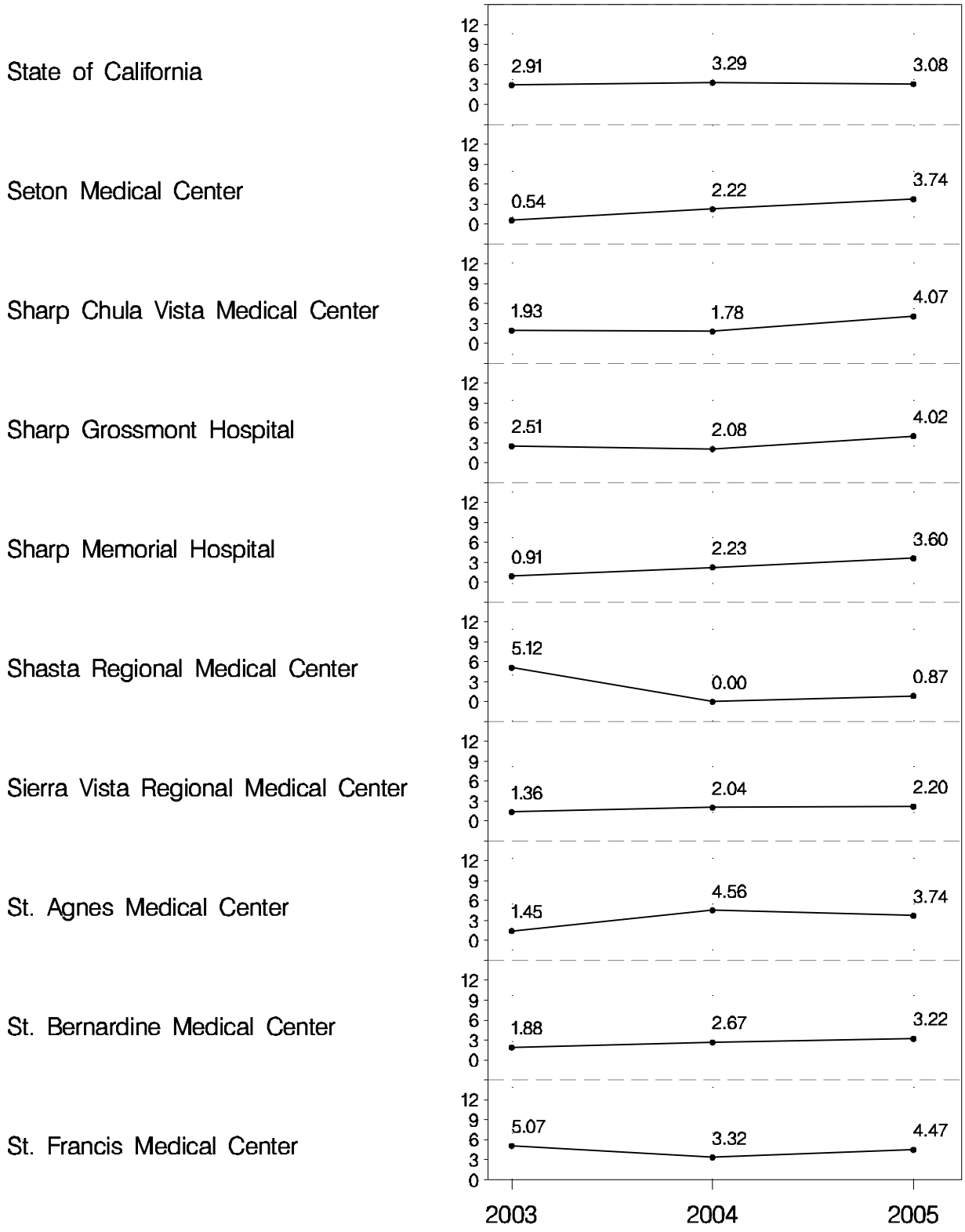


Figure 1: Risk-Adjusted Operative Mortality Rates by Hospital Over Time: 2003-2005 (Cont'd)

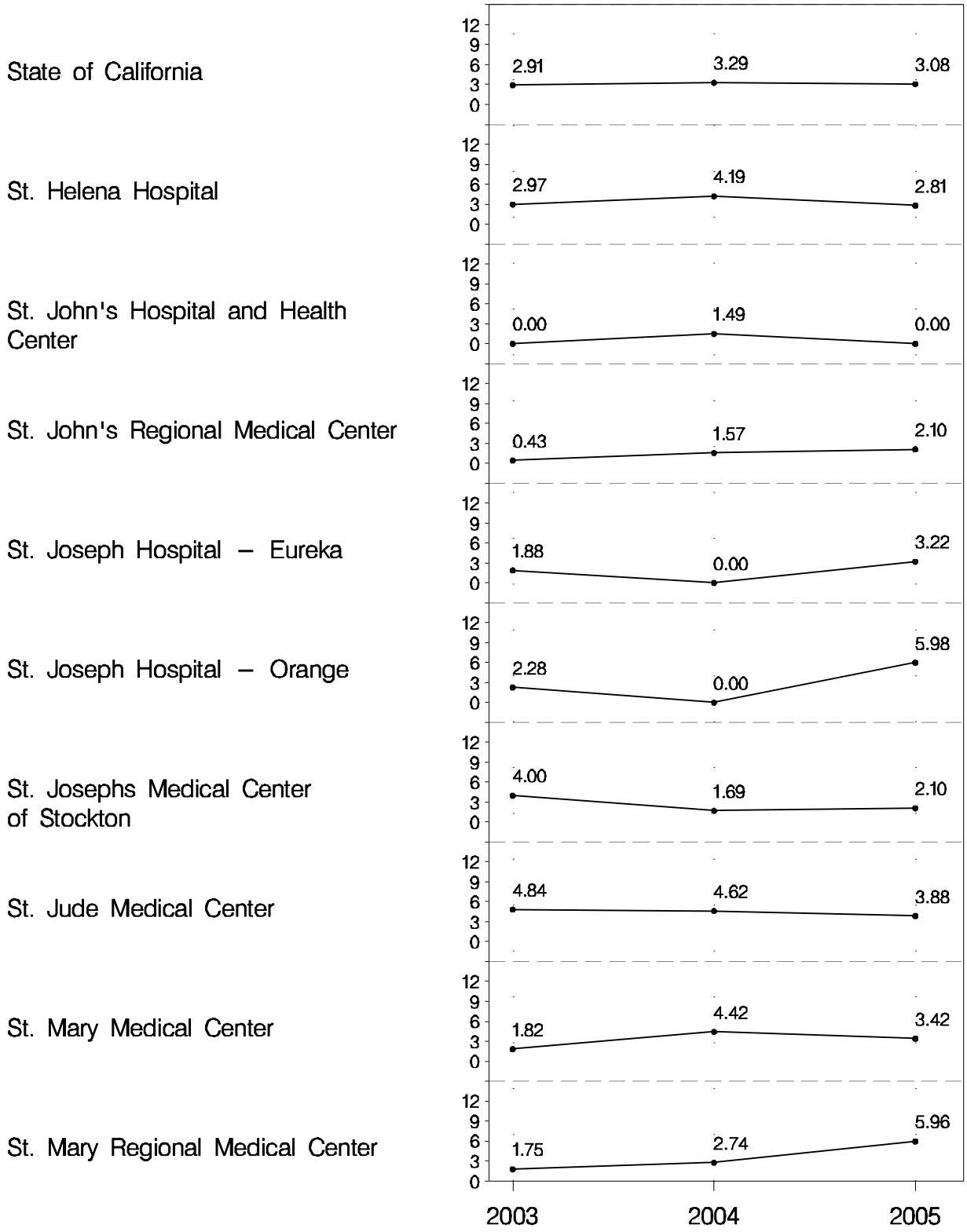


Figure 1: Risk-Adjusted Operative Mortality Rates by Hospital Over Time: 2003-2005 (Cont'd)

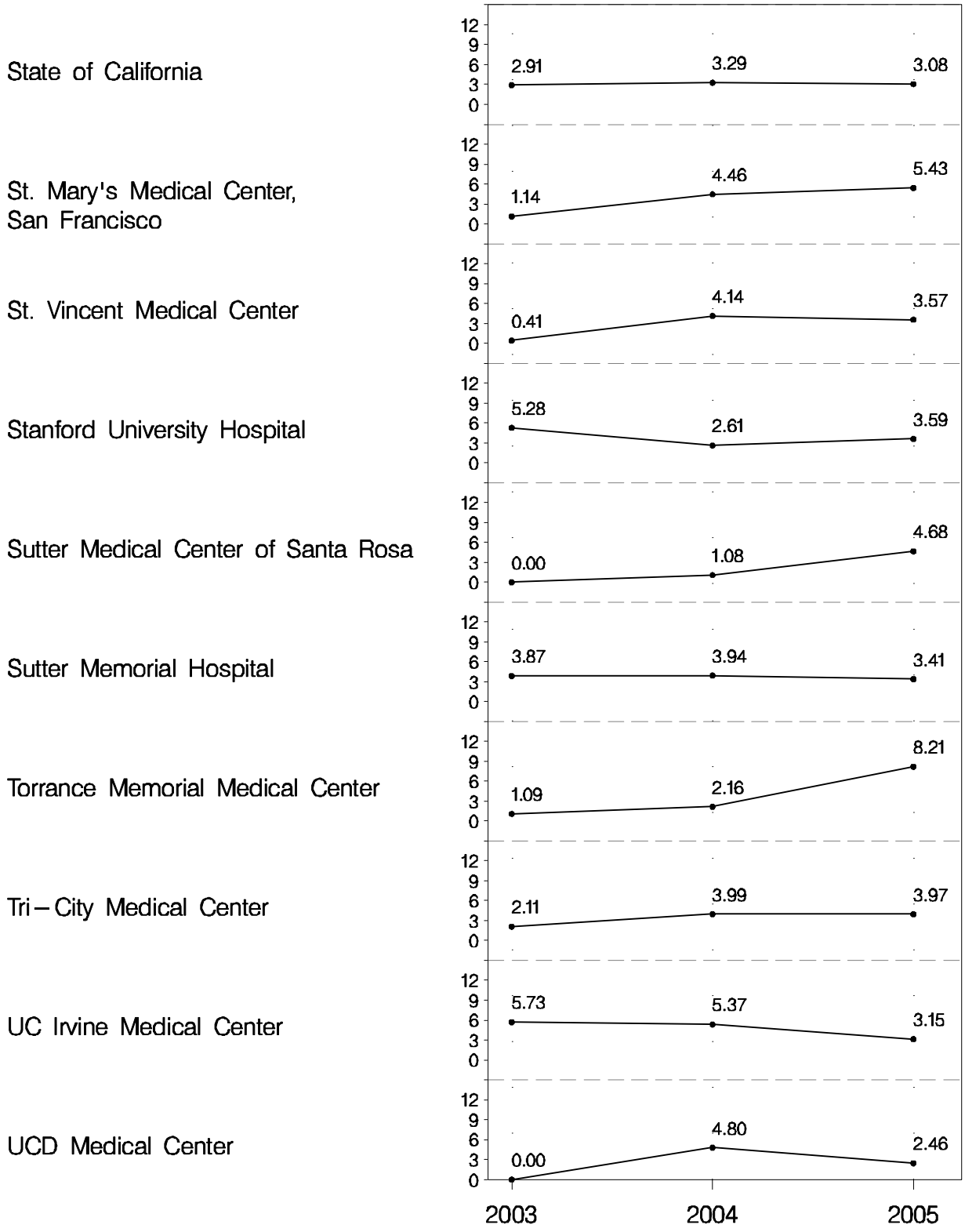


Figure 1: Risk-Adjusted Operative Mortality Rates by Hospital Over Time: 2003-2005 (Cont'd)

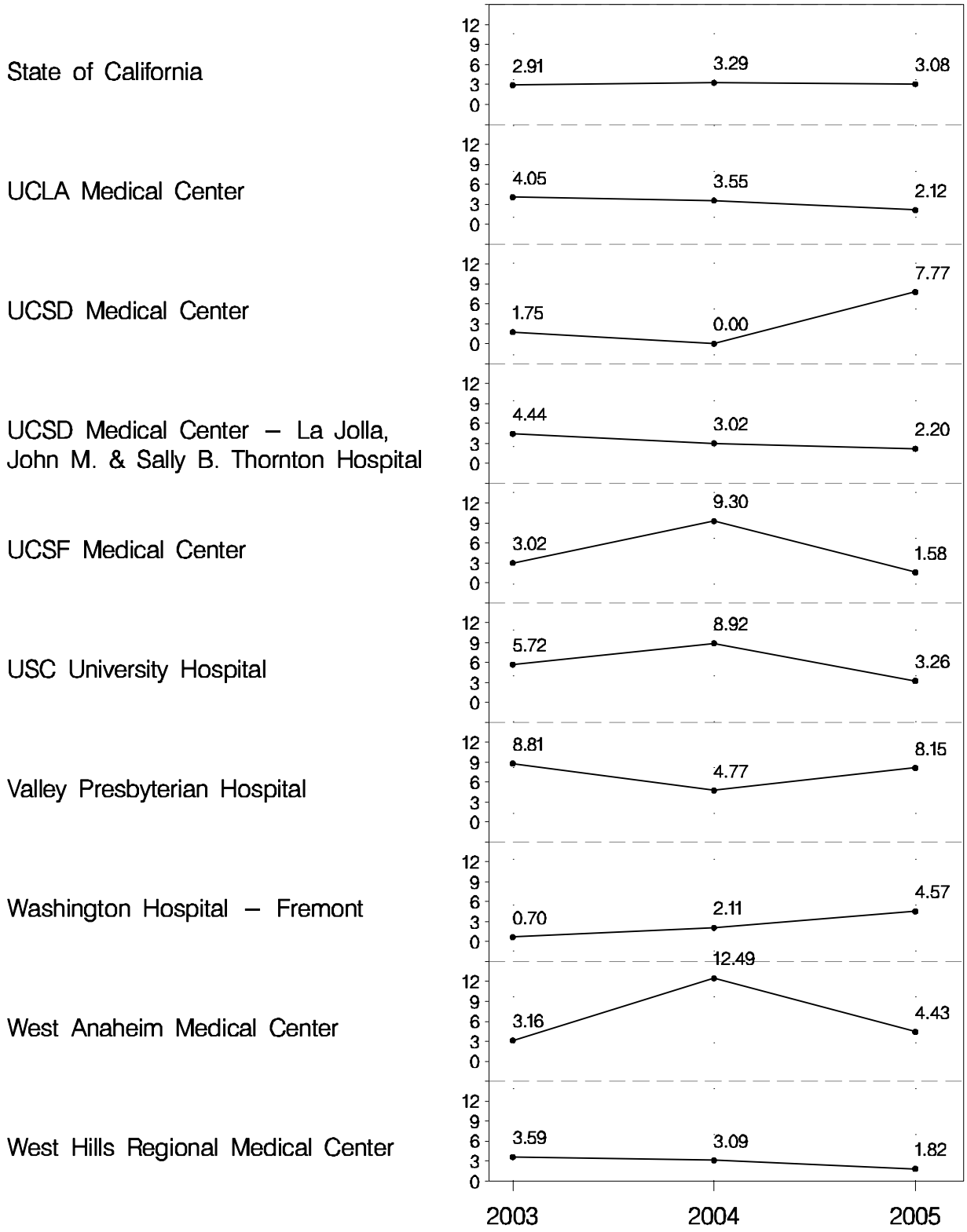
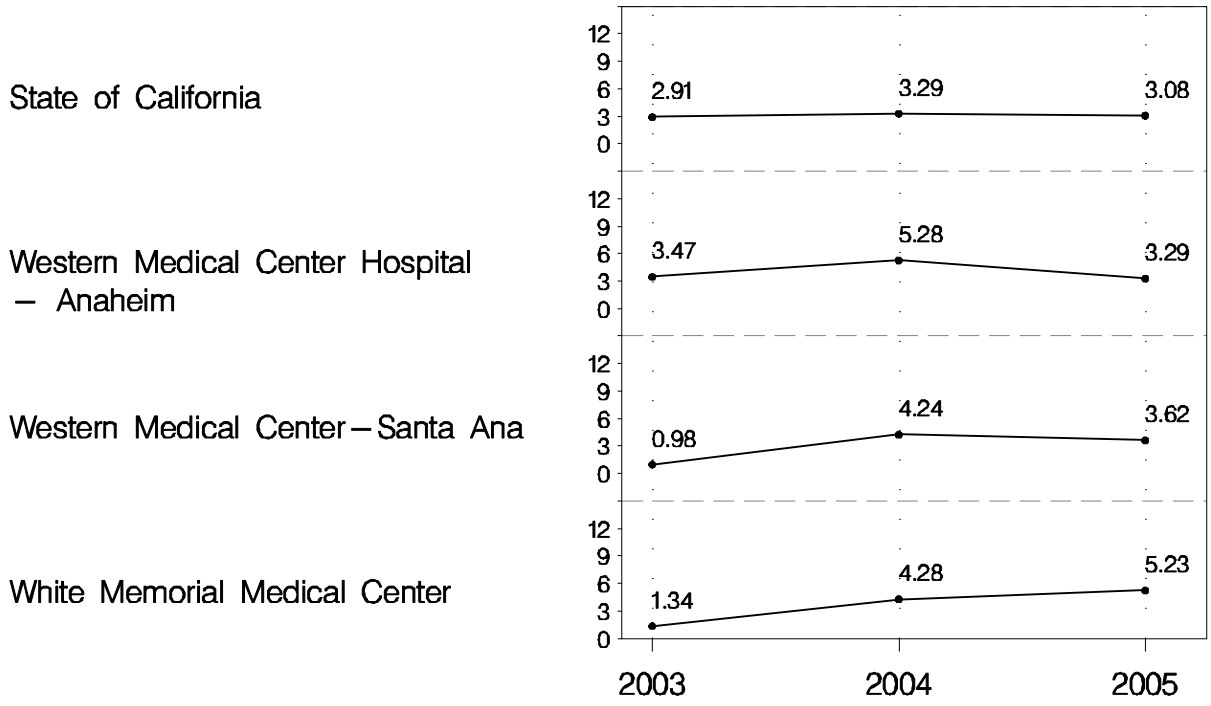


Figure 1: Risk-Adjusted Operative Mortality Rates by Hospital Over Time: 2003-2005 (Cont'd)



VI. 2005 INTERNAL MAMMARY ARTERY USAGE BY HOSPITAL: A PROCESS MEASURE OF QUALITY

A widely accepted definition of healthcare quality regards quality as having three dimensions: process, structure, and outcomes.[8] In the past, OSHPD has focused on the outcome of mortality in its public reporting. Risk-adjusted mortality rates provide a benchmark for provider performance comparison and can be used for investigation of internal processes and structures that contribute to high rates. However, benchmarking processes of care provides a more immediate path to improvement in patient care since it involves measurement of the care patients actually receive. If diagnostic and therapeutic strategies with clear links to outcome are monitored, some quality problems can be detected long before demonstrable outcome differences occur.

In most cases of first-time isolated CABG surgery where the operative status is elective or urgent, the surgeon has the option of using the internal mammary artery (IMA, also known as the internal thoracic artery). The IMA and especially the left IMA is considered the preferred conduit for CABG surgery of the left anterior descending (LAD) coronary artery. A number of healthcare quality advocates recommend public reporting of IMA usage rates for CABG surgery.

Currently, the Leapfrog Evidence-Based Hospital Referral program endorses 80% hospital adherence to IMA use. The National Quality Forum (NQF) does not endorse a specific rate but states that the goal is to raise the IMA usage rates of hospitals with low utilization. STS states that the IMA should be given primary consideration in every CABG surgery patient.

Table 4 provides hospital results for IMA usage for 2005. Only first-time isolated CABG surgeries where the operative status is elective or urgent are included for IMA usage computation. Seven hospitals received a **"Low"** rating for 2005. A **"Low"** rating indicates that a hospital had less than 78.49% IMA utilization (2 standard deviations (0.071 x 1.96) below the hospital statewide average IMA usage rate of 92.41%). No high ratings were provided since there is no consensus on what constitutes an optimal rate of usage.

The clinical literature strongly supports use of the IMA to promote long-term graft patency and patient survival, but recent research also suggests a reduction in immediate, operative mortality associated with use of the internal mammary artery as opposed to saphenous vein revascularization.[9]

Multivariable analyses performed by CCORP also confirmed use of the IMA as an independent predictor of operative survival for first-time isolated CABG surgery patients whose status was not emergent. In addition, there is a negative correlation between hospital risk-adjusted operative mortality rates ($r=-0.14$, $p=0.111$) and IMA usage rates which, while not significant, points in the expected causal direction, where hospitals with lower mortality rates have higher IMA usage rates on average.

[8] Donabedian A. Evaluating the Quality of Medical Care. The Milbank Quarterly, Vol 83, No.4, 2005 (pp. 691-729).

[9] Ferguson TB Jr, Coombs LP, Peterson ED. Internal thoracic artery grafting in the elderly patient undergoing coronary artery bypass grafting: room for process improvement? J Thoracic Cardiovascular Surgery 2002: 123(5): 869-80.

GUIDE TO INTERPRETING IMA USAGE RESULTS	
Isolated CABG surgeries	Includes only first-time isolated CABG surgeries where the operative status was elective or urgent. This number will generally be smaller than the total isolated CABG cases performed by the hospital.
IMA Usage Rate	The ratio of the number of CABG surgeries with IMA grafts (including left IMA, right IMA and bilateral IMA) and selected first-time isolated CABG cases multiplied by 100: Percent IMA use=(Number of IMA grafts used for first-time isolated CABG surgeries/Number of first-time isolated CABG cases) x 100.
Rating	A blank rating indicates that the IMA Usage Rate is acceptable. A Low rating indicates that the IMA Usage Rate for a hospital is less than 78.49%, i.e., two standard deviations (0.071 X 1.96) below the hospital statewide average IMA usage rate (92.41%). No high ratings are provided since there is no consensus on what constitutes an optimal rate of usage.

Table 4: Hospital Results for Usage of the Internal Mammary Artery By Region, 2005

Region	Hospital	Isolated CABG Surgeries*	IMA Usage Rate	Rating**
State of California		15,163	92.41%	
Sacramento Valley & Northern California Region	Enloe Medical Center	122	93.44%	
	Mercy General Hospital	637	94.66%	
	Mercy Medical Center-Redding	109	94.50%	
	Mercy San Juan Hospital	100	98.00%	
	Rideout Memorial Hospital	101	100.00%	
	Shasta Regional Medical Center	41	90.24%	
	St. Joseph Hospital - Eureka	63	84.13%	
	Sutter Memorial Hospital	379	95.51%	
	UCD Medical Center	105	97.14%	
San Francisco Bay Area & San Jose	Alta Bates Summit Medical Center - Summit Campus	605	97.02%	
	California Pacific Medical Center - Pacific Campus	67	95.52%	
	Doctors Medical Center - San Pablo Campus	40	95.00%	
	Dominican Hospital	68	89.71%	
	El Camino Hospital	67	95.52%	
	Good Samaritan Hospital - San Jose	118	99.15%	
	John Muir Medical Center - Walnut Creek Campus	18	94.44%	
	Kaiser Foundation Hospital (Geary San Francisco)	500	94.40%	
	Marin General Hospital	51	94.12%	
	Mills - Peninsula Health Center	42	97.62%	
	Mt. Diablo Medical Center	163	84.66%	
	OConnor Hospital	83	97.59%	
	Queen of the Valley Hospital	147	99.32%	
	Regional Medical of San Jose	6	100.00%	
	Salinas Valley Memorial Hospital	154	95.45%	
	San Ramon Regional Medical Center	51	98.04%	
	Santa Clara Valley Medical Center	60	93.33%	
	Santa Rosa Memorial Hospital	54	85.19%	
	Sequoia Hospital	100	99.00%	
	Seton Medical Center	239	96.23%	
	St. Helena Hospital	96	92.71%	
	St. Marys Medical Center, San Francisco	28	96.43%	
	Stanford University Hospital	106	97.17%	
	Sutter Medical Center of Santa Rosa	73	60.27%	Low
	UCSF Medical Center	99	95.96%	
	Washington Hospital - Fremont	106	97.17%	
Central California	Bakersfield Heart Hospital	157	93.63%	

Table 4: Hospital Results for Usage of the Internal Mammary Artery By Region, 2005

Region	Hospital	Isolated CABG Surgeries*	IMA Usage Rate	Rating**
State of California		15,163	92.41%	
	Bakersfield Memorial Hospital	190	92.11%	
	Community Medical Center - Fresno	141	92.20%	
	Dameron Hospital	47	80.85%	
	Doctors Medical Center - Modesto Campus	247	93.52%	
	Fresno Heart Hospital	211	94.79%	
	Kaweah Delta Hospital	267	94.76%	
	Marian Medical Center	94	98.94%	
	Memorial Medical Center of Modesto	236	87.71%	
	San Joaquin Community Hospital	66	86.36%	
	St. Agnes Medical Center	264	88.64%	
	St. Josephs Medical Center of Stockton	225	92.89%	
San Fernando Valley, Antelope Valley, Ventura & Santa Barbara	Antelope Valley Hospital Medical Center	35	80.00%	
	Community Memorial Hospital of San Buenaventura	106	99.06%	
	Encino Tarzana Regional Medical Center	89	97.75%	
	French Hospital Medical Center	83	95.18%	
	Glendale Adventist Medical Center - Wilson Terrace	111	97.30%	
	Glendale Memorial Hospital and Health Center	93	91.40%	
	Lancaster Community Hospital	7	71.43%	Low
	Los Robles Regional Medical Center	89	93.26%	
	Northridge Hospital Medical Center	86	95.35%	
	Providence Holy Cross Medical Center	79	86.08%	
	Providence St. Joseph Medical Center	47	97.87%	
	Santa Barbara Cottage Hospital	138	92.03%	
	Sierra Vista Regional Medical Center	43	100.00%	
	St. Johns Regional Medical Center	108	98.15%	
	Valley Presbyterian Hospital	16	93.75%	
	West Hills Regional Medical Center	38	94.74%	
Greater Los Angeles	Beverly Hospital	21	90.48%	
	Brotman Medical Center	7	100.00%	
	Cedars Sinai Medical Center	128	99.22%	
	Centinela Hospital Medical Center	64	95.31%	
	Citrus Valley Medical Center - IC Campus	106	83.02%	
	Downey Regional Medical Center	77	75.32%	Low
	Garfield Medical Center	117	85.47%	
	Good Samaritan Hospital - Los Angeles	138	95.65%	
	Huntington Memorial Hospital	109	88.07%	
	Kaiser Foundation Hospital (Sunset Los Angeles)	820	95.12%	
	Lakewood Regional Medical Center	120	90.83%	

Table 4: Hospital Results for Usage of the Internal Mammary Artery By Region, 2005

Region	Hospital	Isolated CABG Surgeries*	IMA Usage Rate	Rating**
State of California		15,163	92.41%	
	Little Company of Mary Hospital	50	100.00%	
	Long Beach Memorial Medical Center	232	93.97%	
	Los Angeles Co Harbor - UCLA Medical Center	104	95.19%	
	Los Angeles Co USC Medical Center	88	73.86%	Low
	Methodist Hospital of Southern California	102	88.24%	
	Presbyterian Intercommunity Hospital	82	62.20%	Low
	Santa Monica - UCLA Medical Center	9	100.00%	
	St. Francis Medical Center	44	88.64%	
	St. Johns Hospital and Health Center	69	92.75%	
	St. Mary Medical Center	51	84.31%	
	St. Vincent Medical Center	104	94.23%	
	Torrance Memorial Medical Center	90	97.78%	
	UCLA Medical Center	23	91.30%	
	USC University Hospital	74	77.03%	Low
	White Memorial Medical Center	98	88.78%	
Inland Empire, Riverside & San Bernardino	Desert Regional Medical Center	190	91.05%	
	Eisenhower Memorial Hospital	139	95.68%	
	Loma Linda University Medical Center	287	90.59%	
	Pomona Valley Hospital Medical Center	130	96.92%	
	Riverside Community Hospital	169	87.57%	
	San Antonio Community Hospital	57	84.21%	
	St. Bernardine Medical Center	414	91.55%	
	St. Mary Regional Medical Center	147	91.84%	
Orange County	Anaheim Memorial Medical Center	158	78.48%	Low
	Fountain Valley Regional Hospital	96	90.63%	
	Hoag Memorial Hospital Presbyterian	189	94.18%	
	Irvine Regional Hospital and Medical Center	29	96.55%	
	Mission Hospital Regional Medical Center	158	100.00%	
	Saddleback Memorial Medical Center	100	99.00%	
	St. Joseph Hospital - Orange	112	100.00%	
	St. Jude Medical Center	146	91.10%	
	UC Irvine Medical Center	60	96.67%	
	West Anaheim Medical Center	28	92.86%	
	Western Medical Center Hospital - Anaheim	116	86.21%	
	Western Medical Center - Santa Ana	84	92.86%	
Greater San Diego	Alvarado Hospital Medical Center	79	96.20%	
	Palomar Medical Center	76	90.79%	
	Scripps Green Hospital	88	97.73%	
	Scripps Memorial Hospital - La Jolla	296	90.88%	

Table 4: Hospital Results for Usage of the Internal Mammary Artery By Region, 2005

Region	Hospital	Isolated CABG Surgeries*	IMA Usage Rate	Rating**
State of California		15,163	92.41%	
	Scripps Mercy Hospital	133	97.74%	
	Sharp Chula Vista Medical Center	164	96.34%	
	Sharp Grossmont Hospital	144	94.44%	
	Sharp Memorial Hospital	145	89.66%	
	Tri-City Medical Center	97	92.78%	
	UCSD Medical Center	57	100.00%	
	UCSD Medical Center - La Jolla, John M. & Sally B. Thornton Hospital	37	100.00%	

*Only includes first-time isolated CABG surgeries where the operative status was elective or urgent.

**Low rank: IMA Usage Rate for a hospital is less than 78.49%, i.e., two standard deviations (0.071 x 1.96) below the hospital statewide average IMA usage rate (92.41%).

2003-2005 IMA Usage by Hospital Over Time

To provide readers with historical context for hospital performance on this measure, Figure 2 presents trends in hospital IMA usage rates over time. All 120 hospitals except one (San Jose Medical Center) performed CABG surgery from 2003 to 2005. Figure 2 presents IMA usage rates by hospital for these three years. It is encouraging to see that statewide the IMA usage rate has steadily increased from 89.3% in 2003 to 90.1% in 2004 and to 92.4% in 2005. However, the trend in IMA usage rates varies among hospitals. There were 53 hospitals that had rates consistently higher than the state average for each of the three years while 22 hospitals had rates lower than the state average during the same period.

Figure 2: Usage of the Internal Mammary Artery by Hospital Over Time: 2003-2005

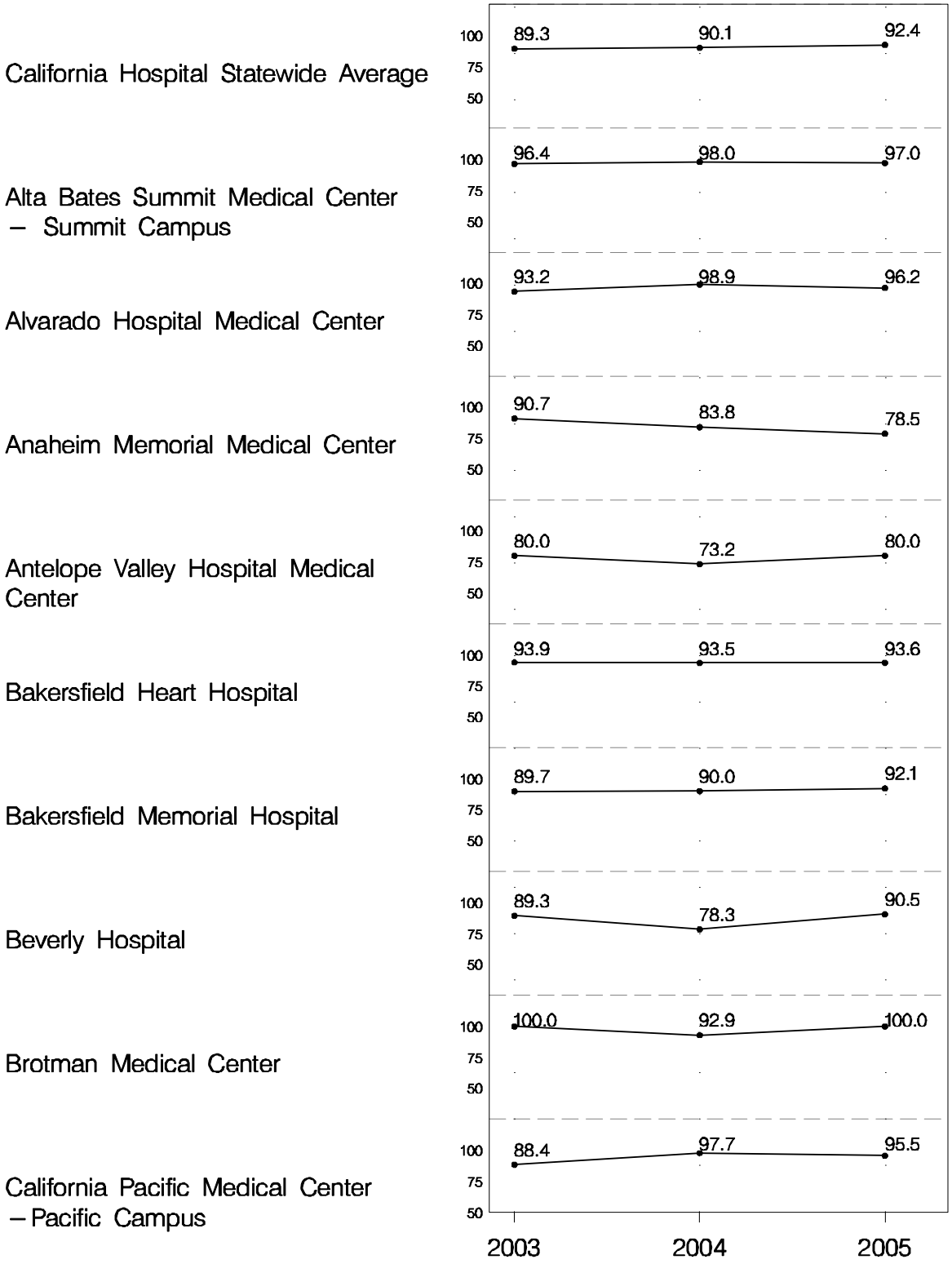


Figure 2: Usage of the Internal Mammary Artery by Hospital Over Time: 2003-2005 (Cont'd)

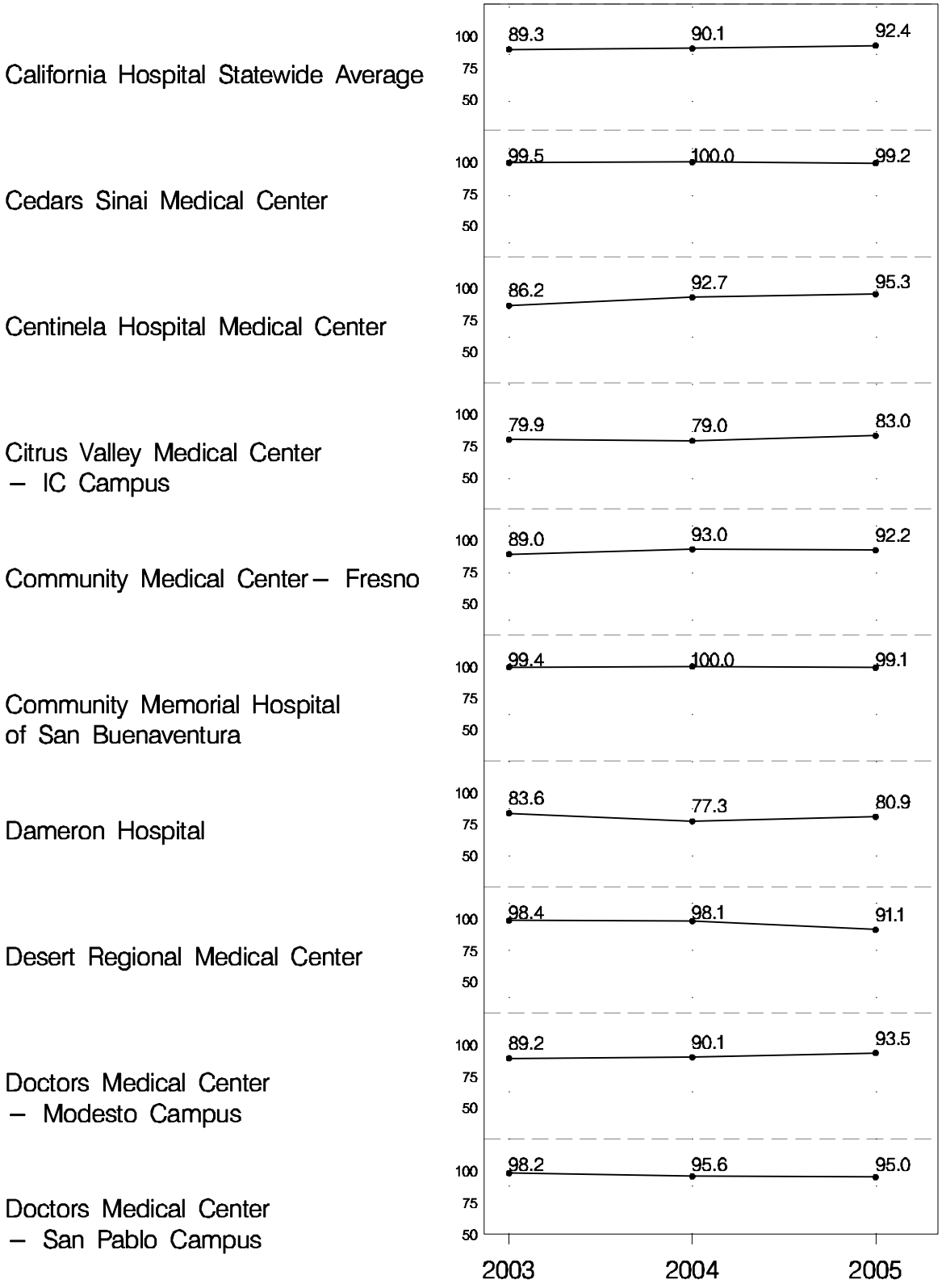


Figure 2: Usage of the Internal Mammary Artery by Hospital Over Time: 2003-2005 (Cont'd)

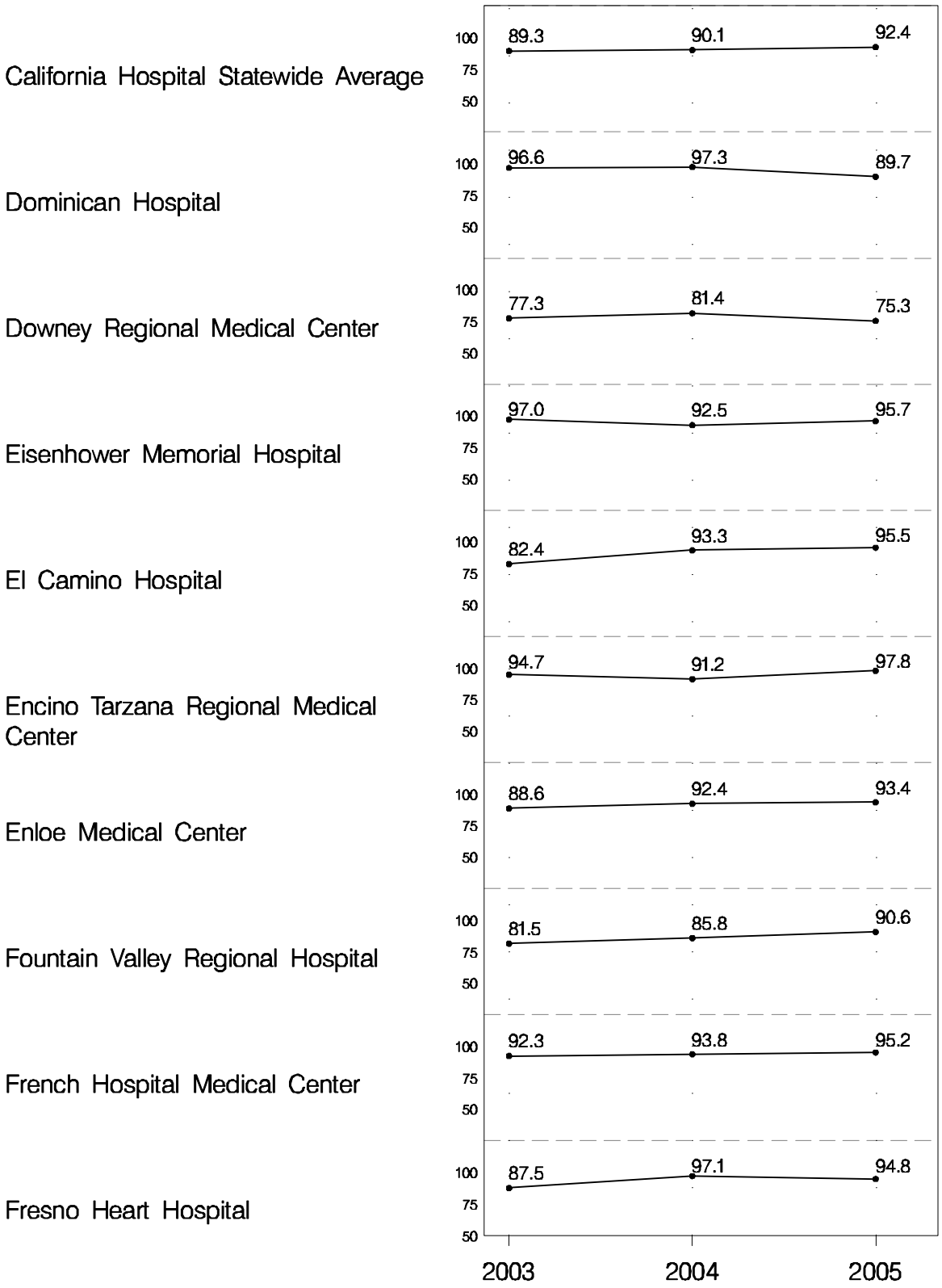


Figure 2: Usage of the Internal Mammary Artery by Hospital Over Time: 2003-2005 (Cont'd)

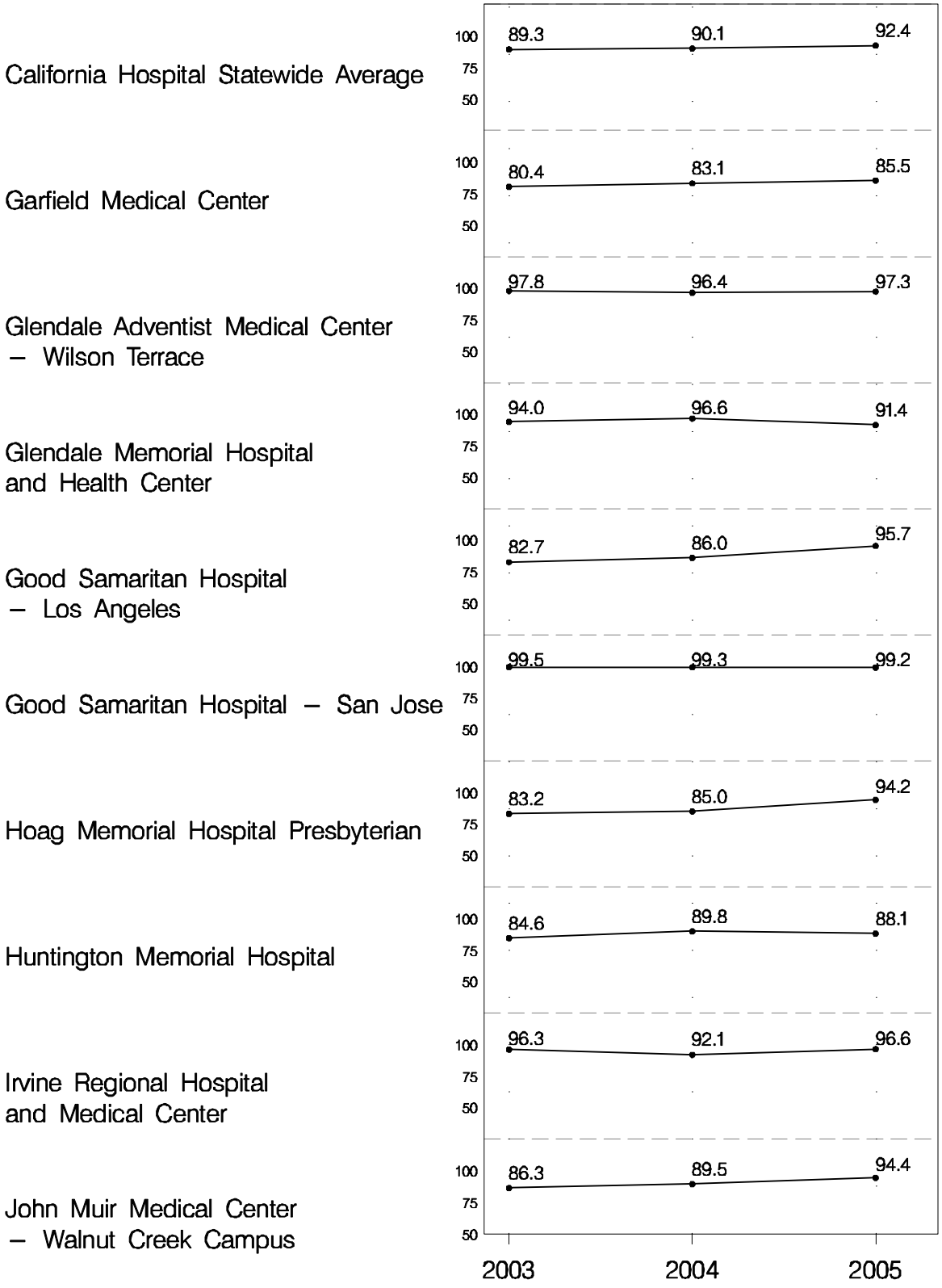


Figure 2: Usage of the Internal Mammary Artery by Hospital Over Time: 2003-2005 (Cont'd)

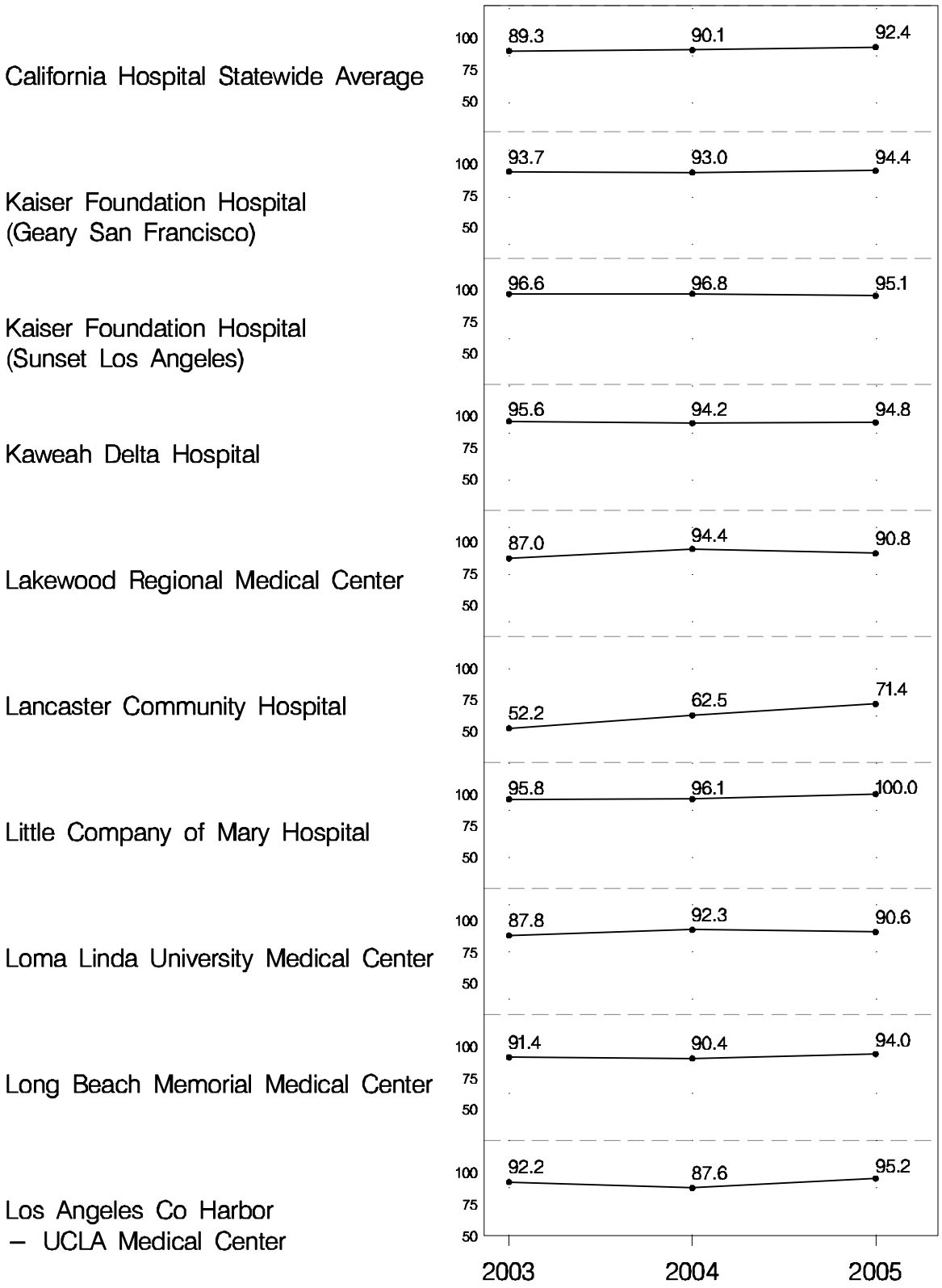


Figure 2: Usage of the Internal Mammary Artery by Hospital Over Time: 2003-2005 (Cont'd)

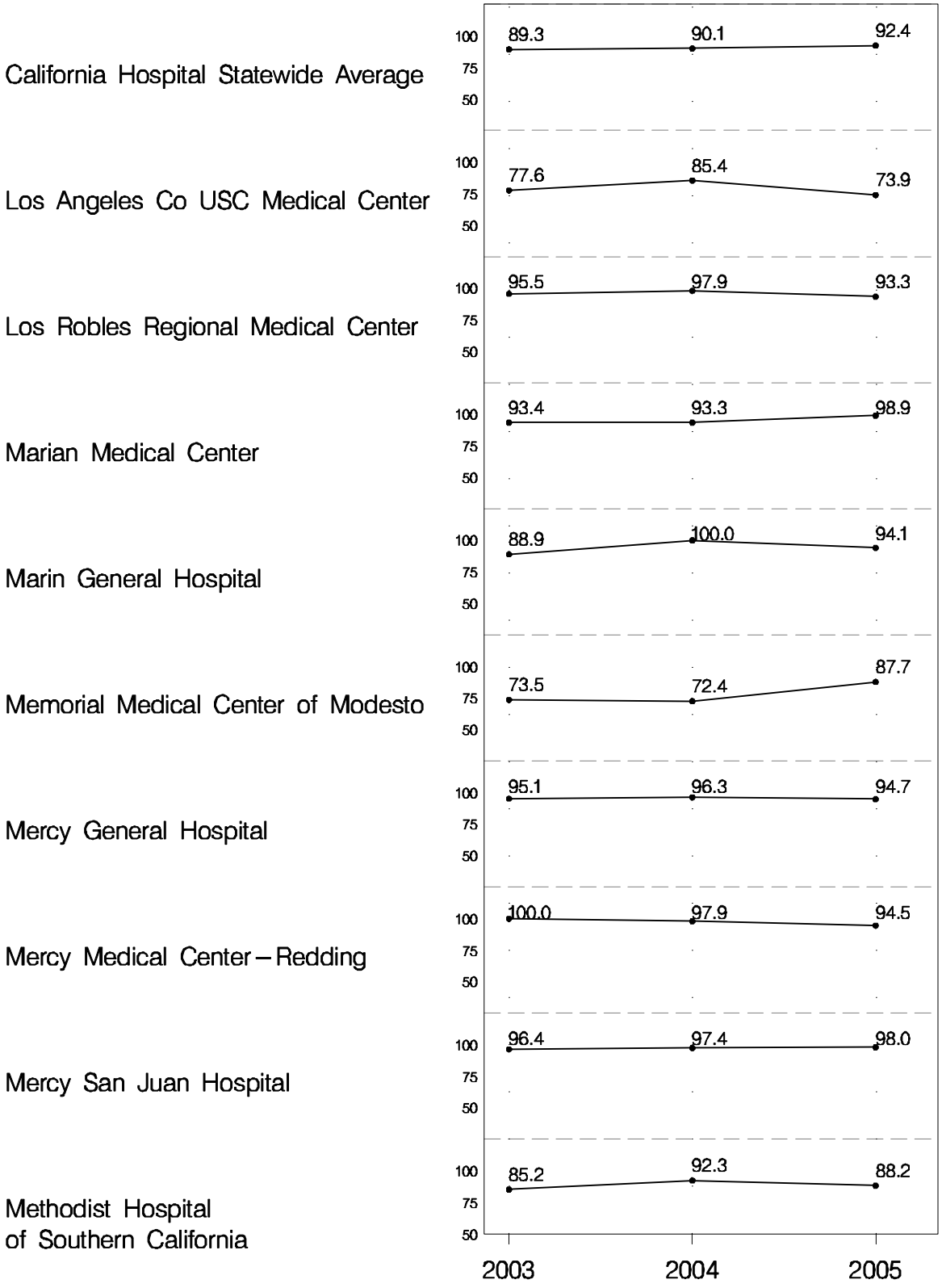


Figure 2: Usage of the Internal Mammary Artery by Hospital Over Time: 2003-2005 (Cont'd)

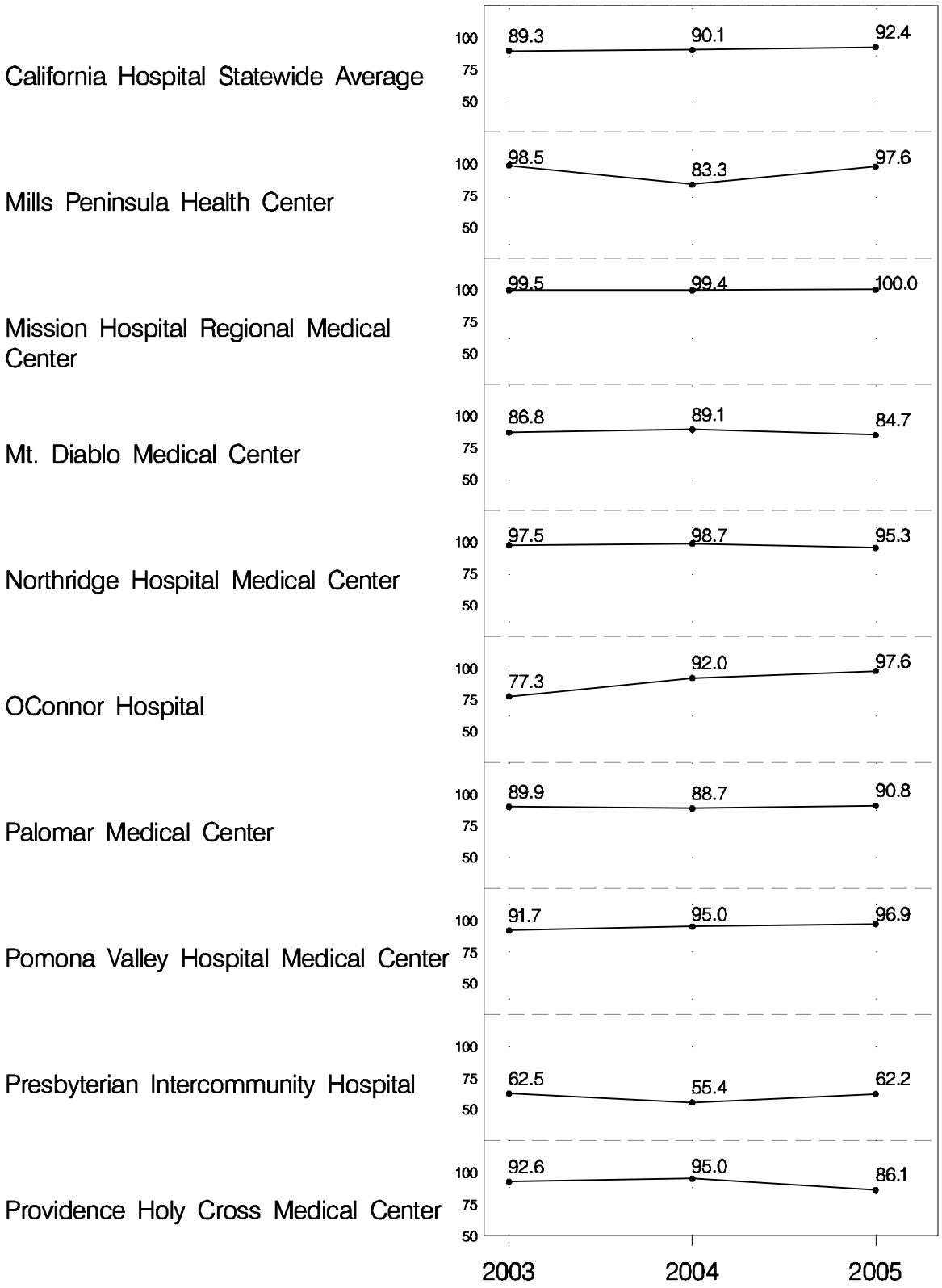
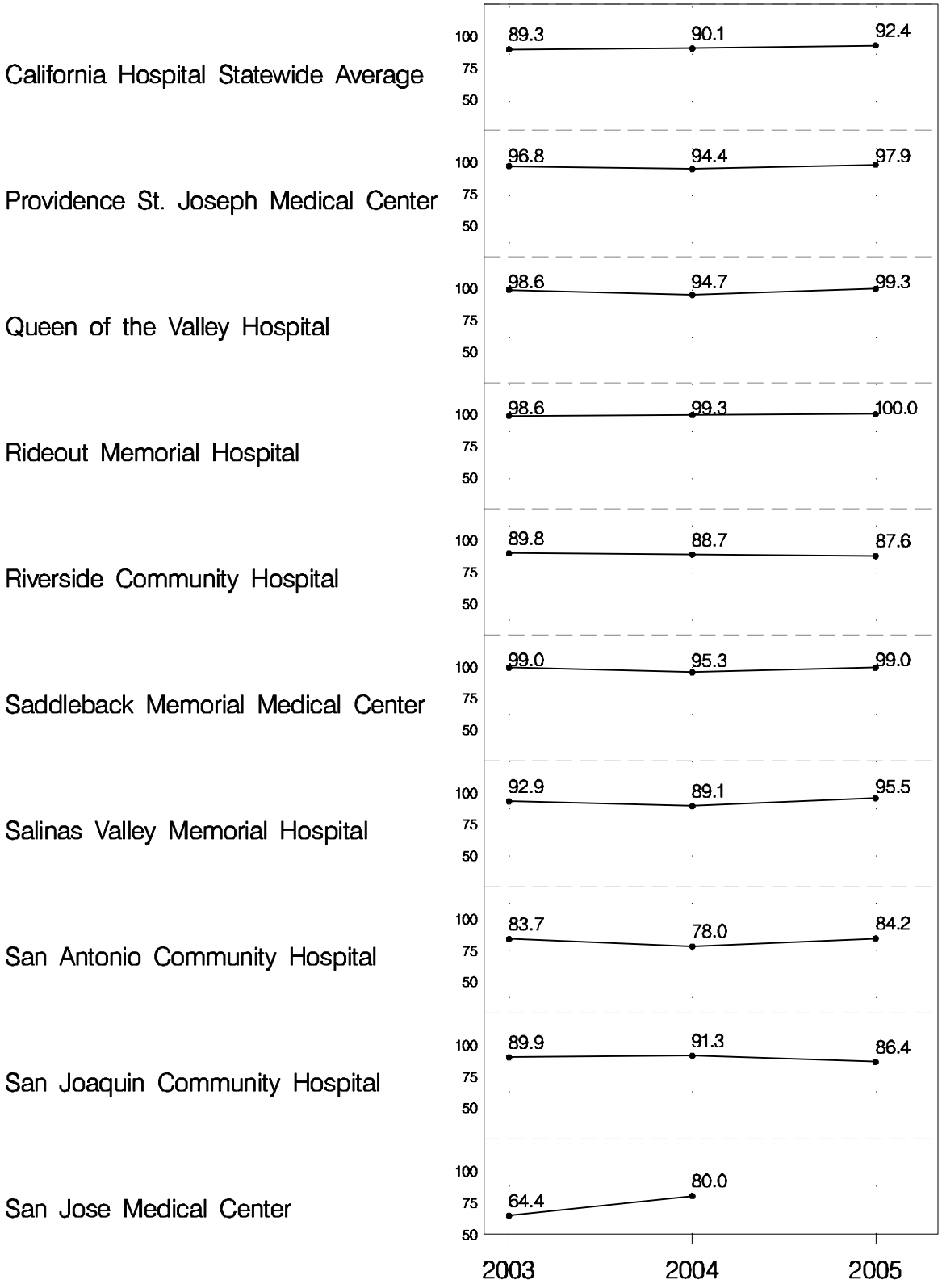


Figure 2: Usage of the Internal Mammary Artery by Hospital Over Time: 2003-2005 (Cont'd)



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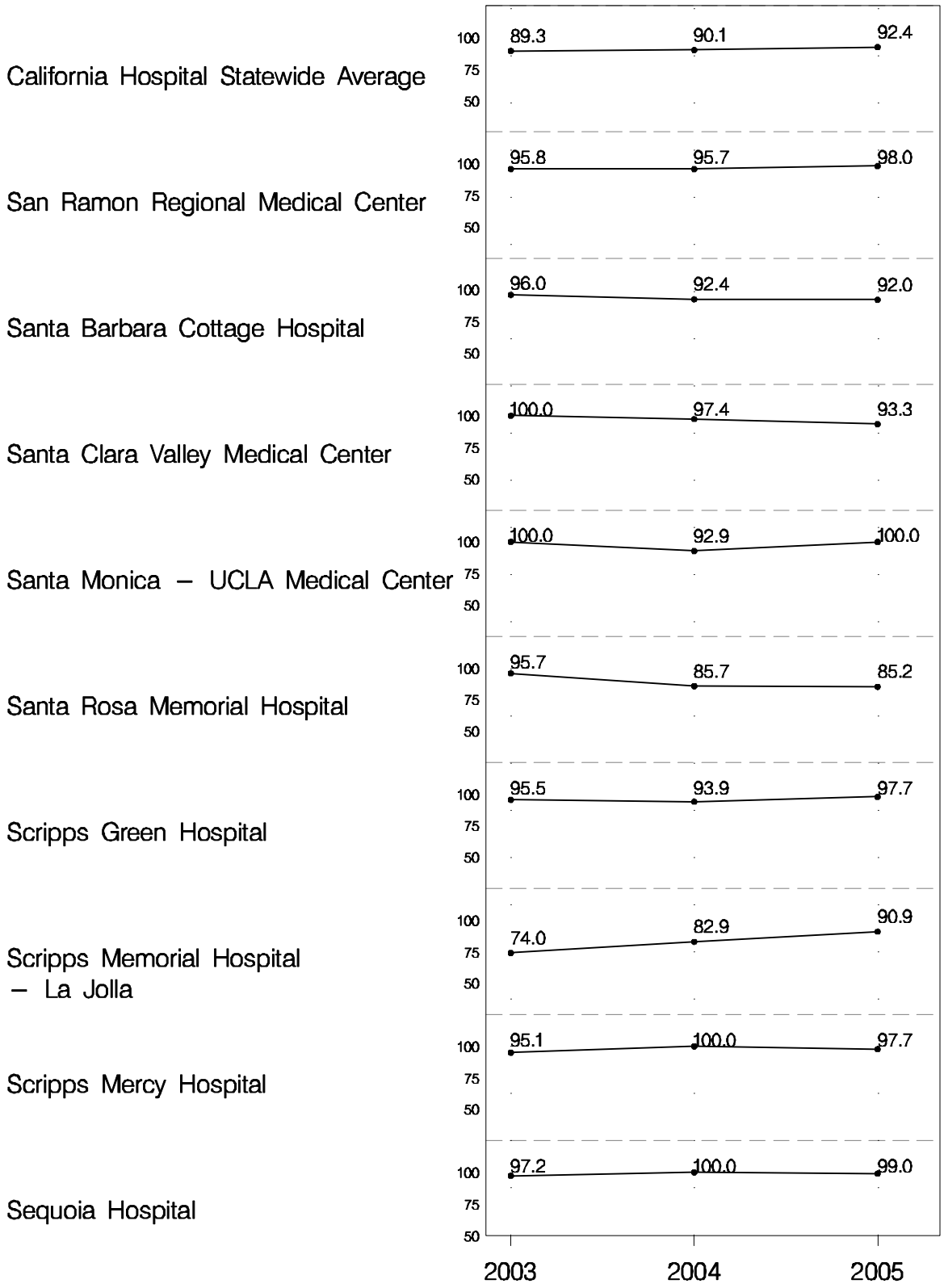


Figure 2: Usage of the Internal Mammary Artery by Hospital Over Time: 2003-2005 (Cont'd)

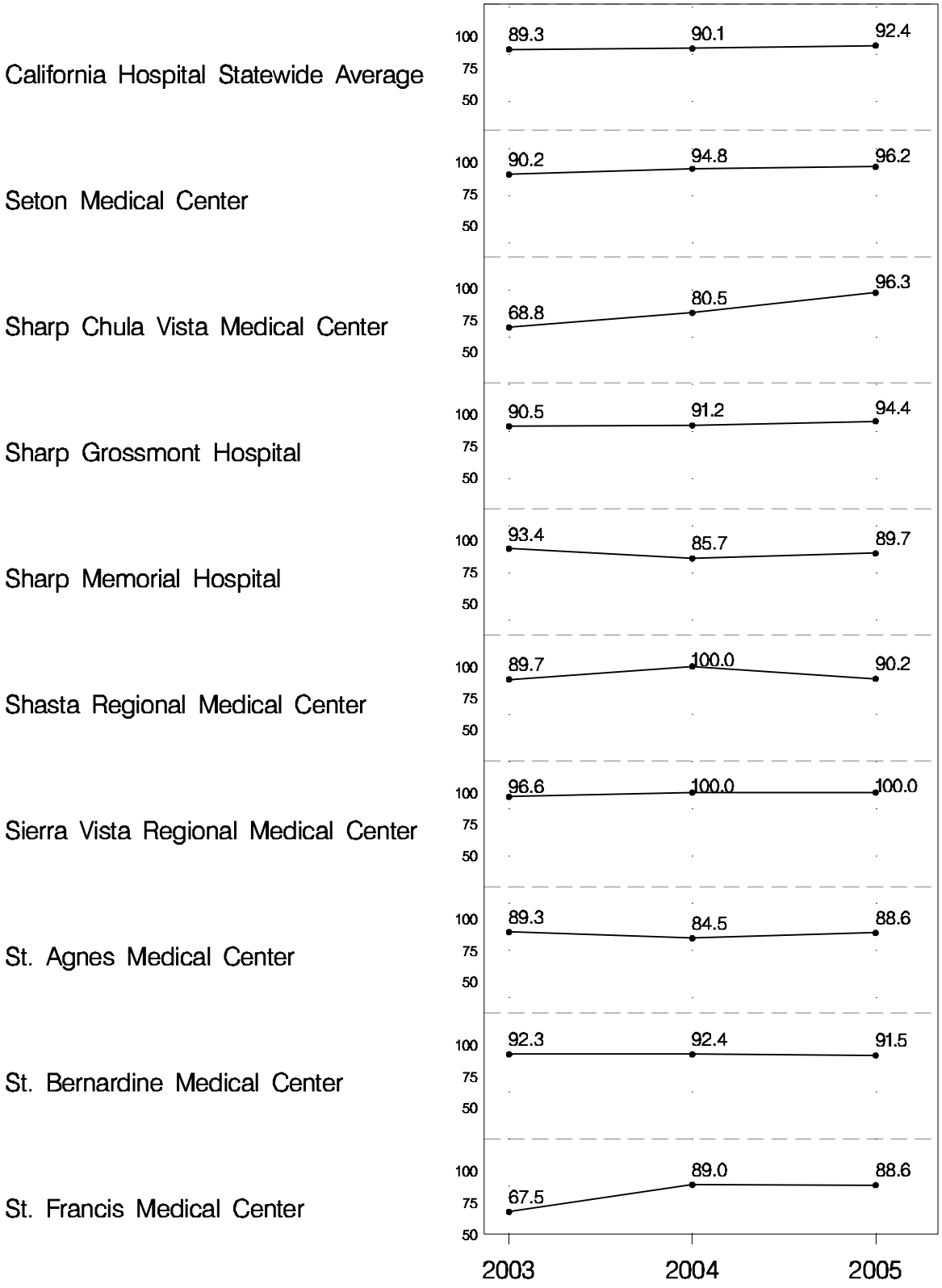


Figure 2: Usage of the Internal Mammary Artery by Hospital Over Time: 2003-2005 (Cont'd)

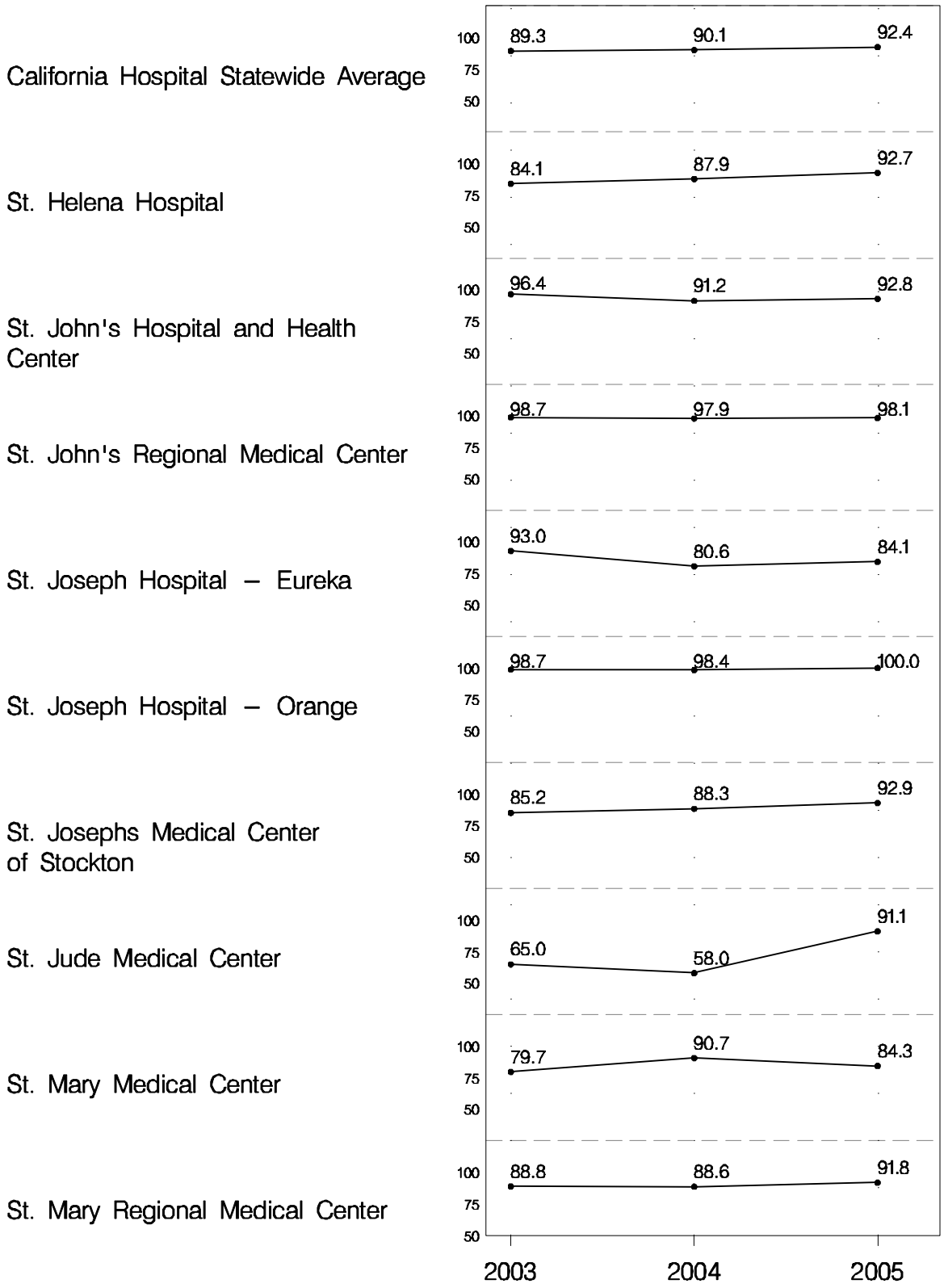


Figure 2: Usage of the Internal Mammary Artery by Hospital Over Time: 2003-2005 (Cont'd)

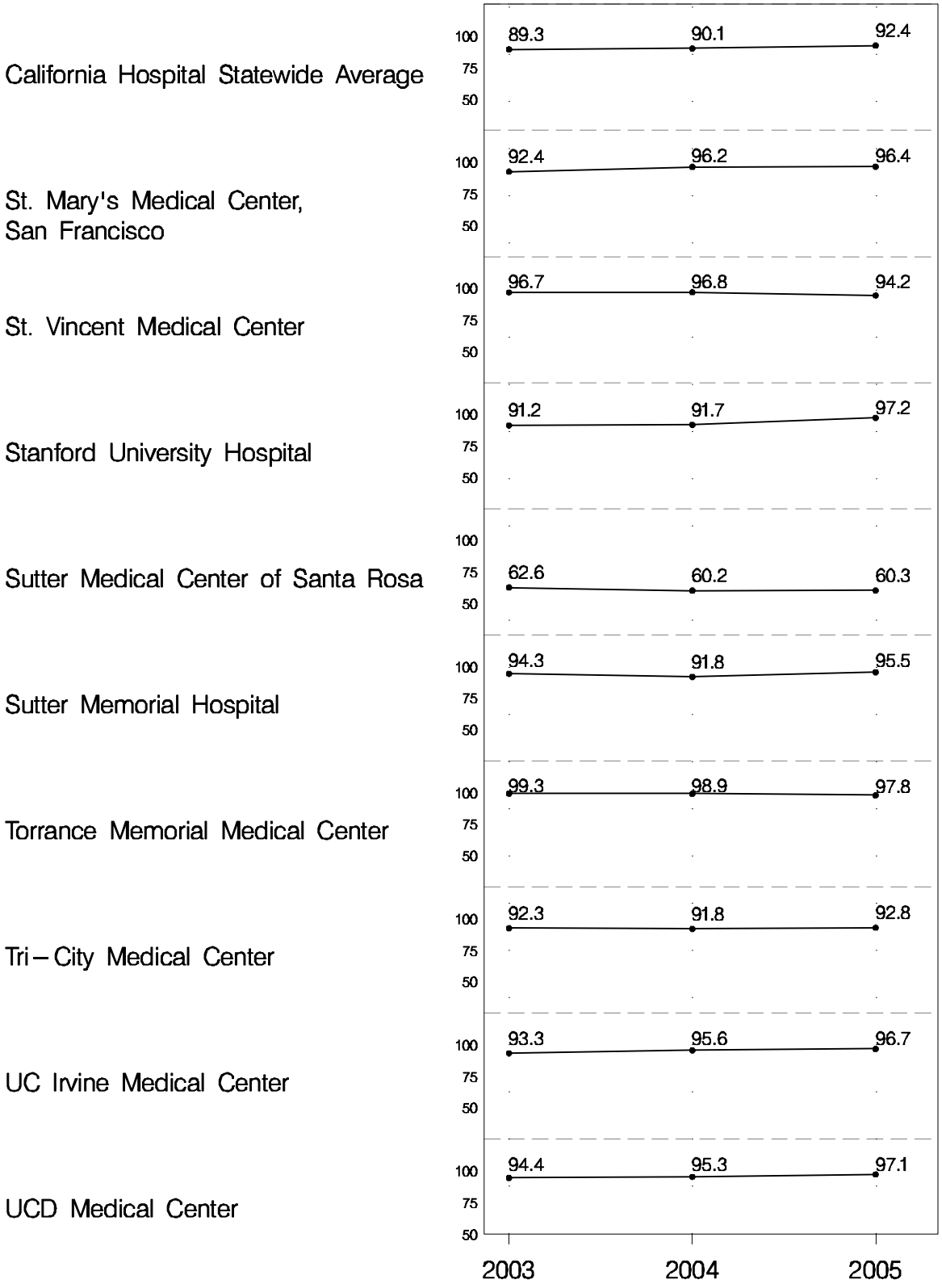


Figure 2: Usage of the Internal Mammary Artery by Hospital Over Time: 2003-2005 (Cont'd)

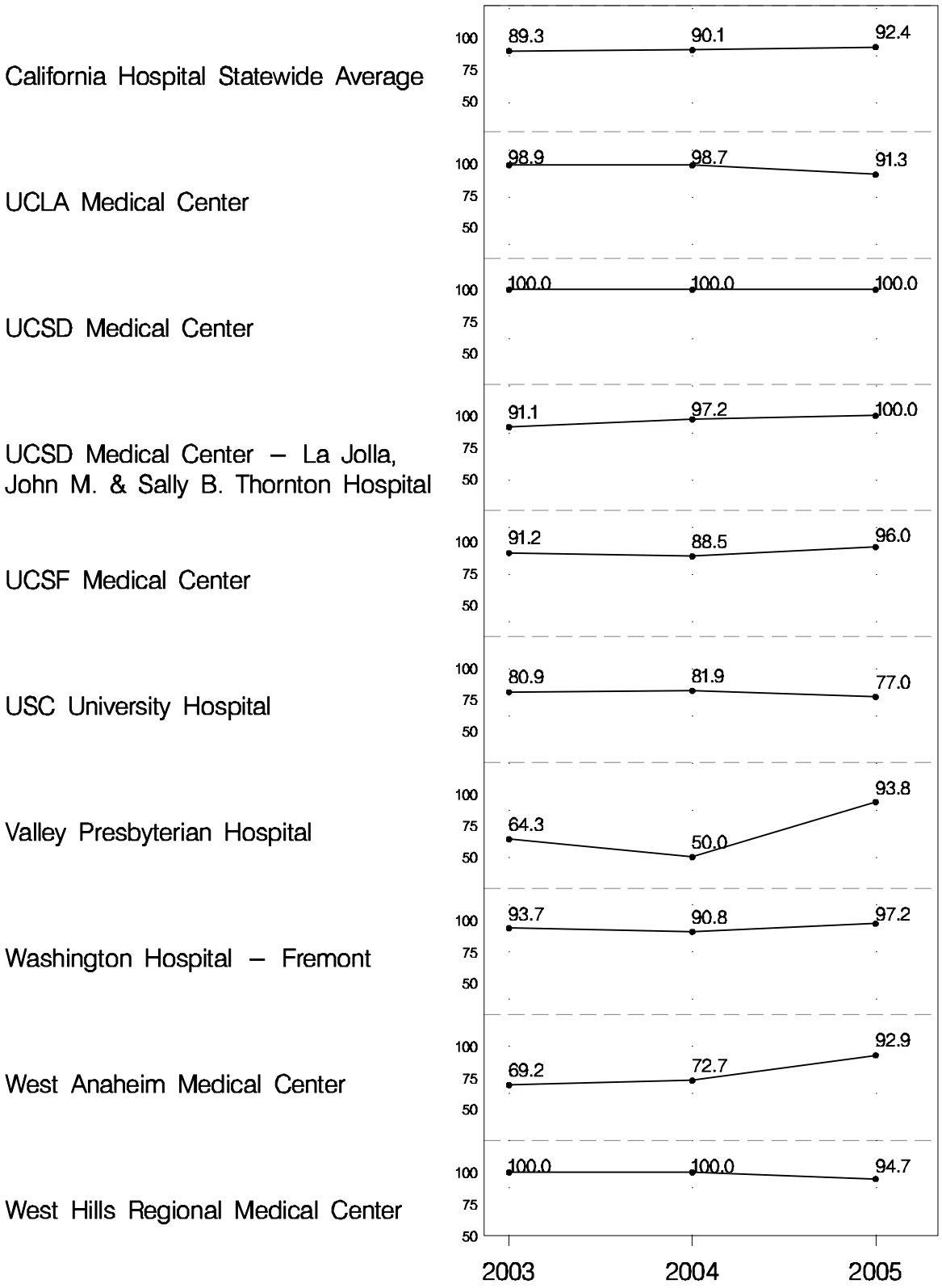
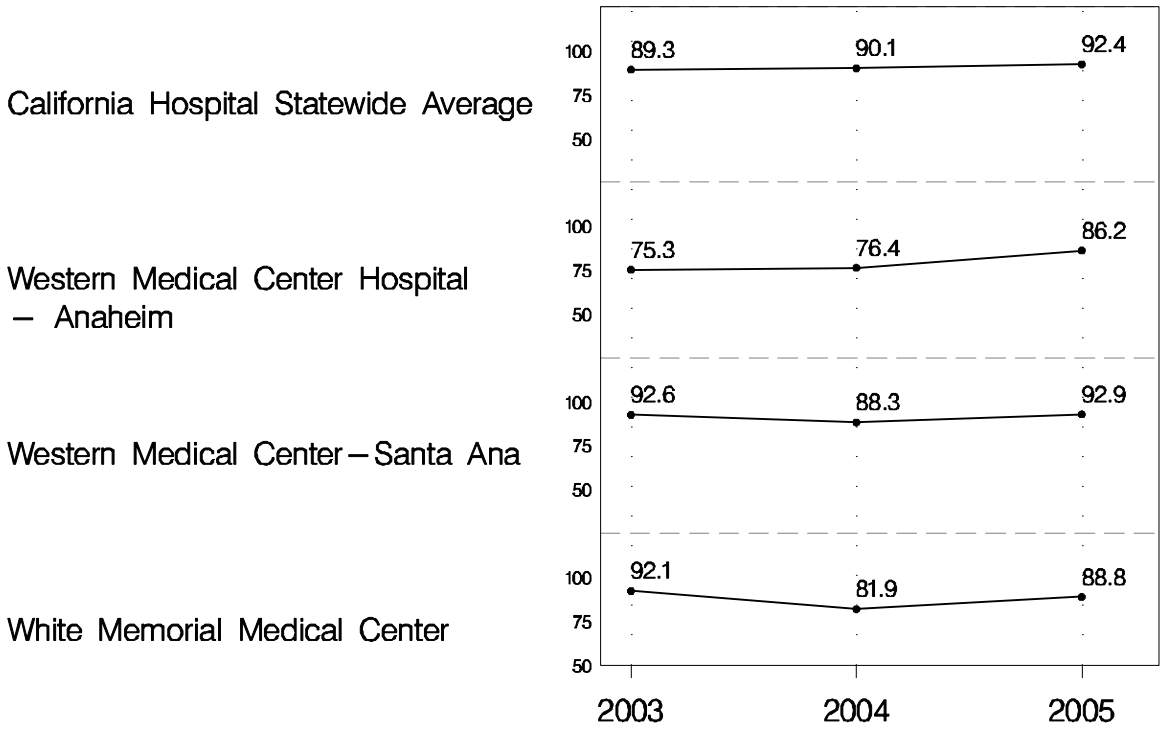


Figure 2: Usage of the Internal Mammary Artery by Hospital Over Time: 2003-2005 (Cont'd)



VII. THE RELATIONSHIP BETWEEN CORONARY ARTERY BYPASS GRAFT SURGERY VOLUME AND OUTCOMES

The "volume-outcome" association refers to the relationship between the quantity of care that a hospital or physician provides and the quality of care that patients receive. In general, researchers have found that the higher the number of patients a hospital or physician treats with a specific condition, the better, on average, are the patients' health outcomes. This volume-outcome relationship has been extensively studied for patients receiving CABG surgery. While most studies have found that hospitals performing more CABG surgeries have better outcomes, more recent data and analyses are less consistent in their support of a clinically relevant relationship.[10,11,12] Further, in the previous CCORP reports no relationship was found between hospital CABG surgery volume and risk-adjusted CABG surgery mortality.[13] This may be due to a decline in CABG surgery mortality in recent years. Also the procedure has become more standardized based on practice guidelines.

2005 Hospital Volume-Outcome Analyses

The following analyses were conducted to examine the hospital and surgeon volume-outcome relationship in CABG surgery using the CCORP data from 2005. The primary goal of these analyses is to use the most current methodological techniques to determine whether hospitals performing more procedures have lower risk-adjusted operative mortality than hospitals performing fewer procedures in California.

To accomplish this, a patient-level risk-adjusted mortality prediction model was first developed using a hierarchical or multi-level technique. Hierarchical models are increasingly used in health services research to analyze multi-level data, particularly when analyses are intended to assess the impact of hospital's CABG volume on patient-level outcomes. All of the independent variables included in the patient-level risk adjustment model were included in the hospital analyses.

Two definitions of volume were considered for both the hospital volume-outcome analyses. First, "isolated CABG volume" was analyzed to assess whether there was an association between isolated CABG volume and isolated CABG mortality. Second, "total CABG volume," which includes both isolated and non-isolated CABG surgeries, was analyzed to assess whether there was an association between total CABG volume and isolated CABG mortality.

The first analysis evaluated whether a linear relationship exists between hospital CABG volume and mortality. In this analysis, hospital annual volume (calendar year 2005) for both isolated and total volume was separately included as continuous independent variables in the hierarchical logistic regression models. Second, to evaluate whether different threshold

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[10] Peterson ED, Coombs LP, DeLong ER, Haan CK, Ferguson TB. Procedural volume as a marker of quality for CABG surgery. JAMA 2004;291(2):195-201.

[11] Shahian DM, Normand SL, Torchiana DF, Lewis SM, Pastore JO, Kuntz RE, et al. Cardiac surgery report cards: comprehensive review and statistical critique. Ann Thorac Surg 2001;72(6):2155-68.

[12] Glance LG, Dick AW, Mukamel DB, Osler TM. Is the hospital volume-mortality relationship in coronary artery bypass surgery the same for low-risk versus high-risk patients? Ann Thorac Surg 2003;76(4):1155-62.

[13] Parker JP, Li Z, Danielsen B, Marcin J, Dai J, Mahendra G, Steimle AE. ***The California Report on Coronary Artery Bypass Graft Surgery 2003 Hospital Data,*** Sacramento, CA: California Office of Statewide Health Planning and Development, February 2006.

volumes or volume categories were associated with higher or lower mortality, hospitals were grouped into volume categories depending upon their annual number of isolated and total CABG procedures.

Results

The 2005 CCORP CABG database contains detailed patient-level clinical data on 16,939 isolated CABG surgery procedures in 120 hospitals. The average annual hospital isolated CABG surgery volume was 141 cases, with a range among individual hospitals of 6 to 880. The overall operative mortality rate was 3.08%, and the average annual hospital operative mortality rate was 3.22%, with a range among individual hospitals of 0% to 10.00%.

In the hierarchical model, when hospital isolated CABG volume was entered into the analysis as a continuous variable, there was no association with risk-adjusted operative mortality (coefficient: -0.037, standard error (SD): 0.032, p-value: 0.244, odds ratio (OR): 0.964 and 95% confidence internal (CI): 0.906 to 1.025 for every additional 100 patients). Similarly, when hospital total CABG volume was entered into the analysis as a continuous variable, there was no association with risk-adjusted operative mortality (coefficient: -0.027, SD: 0.025, p-value: 0.287, OR: 0.973 and 95% CI: 0.927 to 1.022 for every additional 100 patients).

Table 5 presents the summary statistics when hospital isolated CABG volume was categorized into quartiles (<200, 200-299, 300-599, >=600) and dichotomized (>=450 and <450; >=250 and <250; and >=100 and <100). The quartiles were chosen because these volumes were used in the previous California volume-outcome reports. The split point of 450 procedures per year was chosen because of the past volume recommendations by The Leapfrog Group (www.leapfroggroup.org), and the split point of 100 was chosen because of the past volume recommendations by the American College of Cardiology and the American Heart Association (ACC/AHA Practical Guidelines). The data presented in Table 5 show that, while there is a suggestion of lower CABG surgery mortality among higher volume hospitals, none of the associations is statistically significant.

Table 5: Hospital Isolated CABG Volume Groups and Risk-Adjusted Mortality*, 2005

Volume Group	Hospitals (n=120) N (%)	Patients (n=16,939) N (%)	OR (95% CI)
>=600	3 (3)	2,216 (13)	0.785 (0.493, 1.250)
300-599	6 (5)	2,350 (14)	0.841 (0.582, 1.217)
200-299	12 (10)	2,848 (17)	0.893 (0.657, 1.215)
<200	99 (83)	9,525 (56)	Reference
>=450	5 (4)	3,211 (19)	0.852 (0.591, 1.227)
<450	115 (96)	13,728 (81)	Reference
>=250	14 (12)	5,891 (35)	0.870 (0.674, 1.121)
<250	106 (88)	11,048 (65)	Reference
>=100	70 (58)	13,924 (82)	0.967 (0.750, 1.246)
<100	50 (42)	3,015 (18)	Reference

* A hospital-level random effects analysis was done to account for clustering of similar patients within individual hospitals and the variation in mortality due to unmeasured hospital attributes.

Table 6 presents the summary statistics when hospital total CABG volume was categorized into quartiles (<200, 200-299, 300-599, >=600) and dichotomized (>=450 and <450; >=250 and <250; and >=100 and <100). Similarly to the data presented in Table 5, there is a suggestion of an association between lower CABG surgery mortality among the highest volume hospitals; however, none of the associations are statistically significant. In conclusion, we did not find any statistical evidence that risk adjusted mortality is any different at hospitals conducting more or fewer total CABG surgeries.

Table 6: Hospital Total CABG Volume Groups and Risk-Adjusted Mortality*, 2005

Volume Group	Hospitals (n=120) N (%)	Patients (n=21,342) N (%)	OR (95% CI)
>=600	4 (3)	3,569 (17)	0.806 (0.528, 1.231)
300-599	9 (8)	3,623 (17)	0.879 (0.634, 1.219)
200-299	19 (16)	4,519 (21)	1.029 (0.787, 1.345)
<200	88 (73)	9,631 (45)	Reference
>=450	7 (6)	5,109 (24)	0.840 (0.611, 1.154)
<450	113 (94)	16,233 (76)	Reference
>=250	20 (17)	9,064 (42)	0.799 (0.636, 1.003)
<250	100 (83)	12,278 (58)	Reference
>=100	84 (70)	19,162 (90)	1.044 (0.769, 1.417)
<100	36 (30)	2,180 (10)	Reference

* A hospital-level random effects analysis was done to account for clustering of similar patients within individual hospitals and the variation in mortality due to unmeasured hospital attributes.

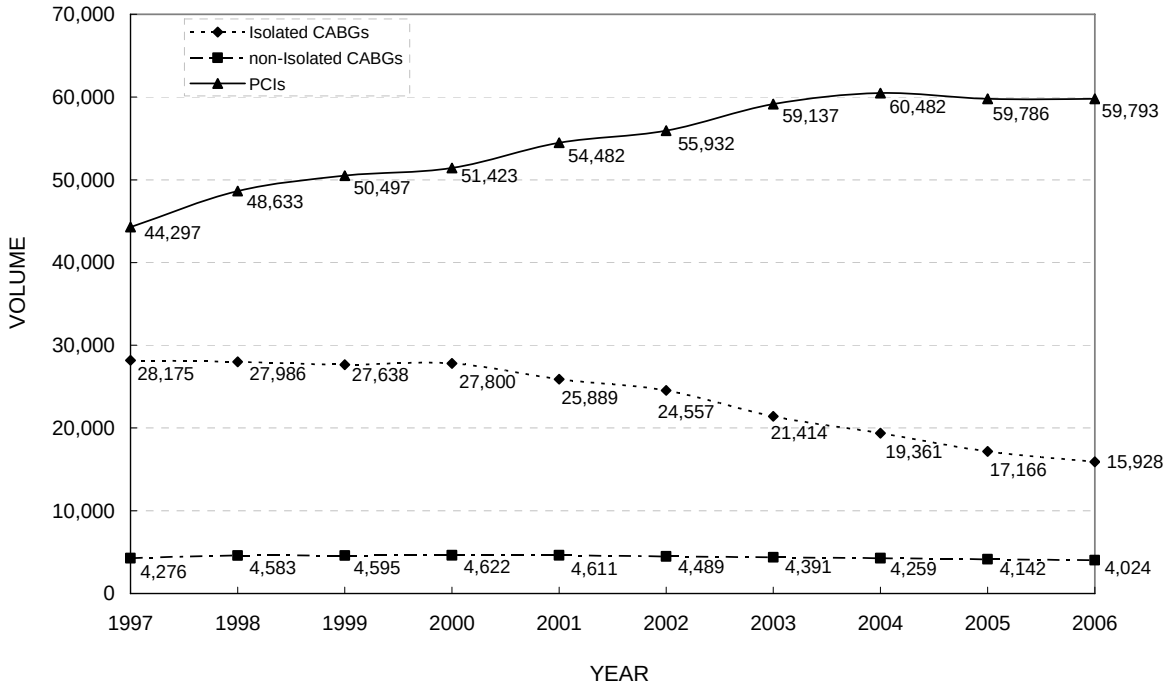
Utilization of Cardiac Intervention Procedures

Isolated CABG volume has declined in recent years while percutaneous coronary intervention (PCI) volume has increased. Figure 3 shows change in the use of the two revascularization procedures over time using data from OSHPD's Patient Discharge Data with patient hospitalizations as the unit of analysis. It shows that utilization of PCIs in California has grown from 44,297 procedures in 1997 to 59,793 procedures in 2006—an increase of 35%. Increased use of drug-eluting stents and related CMS reimbursement policy changes in 2002 have been largely responsible for this rapid growth. Meanwhile the number of isolated CABG surgeries has dropped from 28,175 to 15,928 —a decrease of 43%.[14] However, non-isolated CABG surgery volume has remained relatively constant at an average of 4,400 cases per year.

Medical innovations such as the CABG procedure, Percutaneous Transluminal Coronary Angioplasty (PTCA), and intra-coronary stents, refined during the past 30 years have contributed to improved survival for heart attack patients. The introduction of the intra-coronary stent insertion procedure (small wire cylinders that hold a narrow artery open) in clogged arteries is rapidly replacing angioplasty without stents because of lower rates of re-narrowing of opened arteries (restenosis) associated with intracoronary stents. New technologies and improved adjunctive medical therapy are making PCI a viable alternative to CABG for many patients. The advantages associated with PCI have been widely noted: PCI involves a shorter hospital stay, is suitable for most patients, and can be repeated and performed without anesthesia by a cardiologist. On the other hand, CABG surgery is associated with lower rates of repeat revascularization, less overall angina, and lower long-term mortality. A more comprehensive approach to examining and reporting on the quality of revascularization procedures in California would include PCI and its outcomes.

[14] The numbers cited for isolated CABG and PCI volume come from the OSHPD Patient Discharge Data (PDD) and the number of isolated CABGs differs from what is cited earlier in this report for the CCORP registry. Since OSHPD does not maintain a PCI data registry only the PDD provides a consistent source of numbers for both procedures.

Figure 3: California Isolated CABG, Non-Isolated CABG, PCI Volume, 1997-2006



APPENDIX A: CLINICAL DEFINITION OF ISOLATED CABG SURGERY FOR 2005

Definition/Description:
When any of the procedures listed in Section A is performed concurrently with the coronary artery bypass surgery, the surgery will be considered non-isolated and the data element coded "No." It is not possible to list all procedures because cases can be complex and clinical definitions are not always precise. When in doubt, the data abstractor should first seek an opinion from the responsible surgeon and then consult CCORP.

Section A (Excluded):

- Any aortic aneurysm repair (abdominal or thoracic)
- Aorta-iliac-femoral bypass
- Aorta-renal bypass
- Aorta-subclavian-carotid bypass
- Caval-pulmonary artery anastomosis
- Coronary artery fistula
- Endarterectomy of aorta
- Excision of aneurysm of heart
- Extracranial-intracranial (EC-IC) vascular bypass
- Head and neck, intracranial endarterectomy
- Heart transplantation
- Implantation of cardiomyostimulation system [Note: Refers to cardiomyoplasty systems only, not other heart-assist systems such as pacemakers or internal cardiac defibrillators (ICDs)]
- Mastectomy for breast cancer (not simple breast biopsy)
- Full surgical Maze procedures. Requires that the left atrium be opened to create the "maze" with incisions. Does not include "mini" Maze procedures limited to pulmonary vein isolation and/or amputation of the left atrial appendage.
- Operations on structures adjacent to heart valves (papillary muscle, chordae tendineae, traebeculae carneae cordis, annuloplasty, infundibulectomy)
- Other open heart surgeries, such as aortic arch repair, pulmonary endarterectomy
- Repair of atrial and ventricular septa, excluding closure of patent foramen ovale
- Repair of certain congenital cardiac anomalies, excluding closure of patent foramen ovale (e.g., tetralogy of fallot, atrial septal defect (ASD), ventricular septal defect (VSD), valvular abnormality)
- Resection of a lobe or segment of the lung (e.g., lobectomy or segmental resection of lung). Does not include simple biopsy of lung nodule in which surrounding lung is not resected, biopsy of a thoracic lymph node, or excision or stapling of an emphysematous bleb.
- Thoracic endarterectomy (endarterectomy on an artery outside the heart)
- Amputation of any extremity (e.g., foot or toe)
- Valve repairs or replacements
- Ventriculectomy

If a procedure listed in Section B is performed concurrently with the coronary artery bypass surgery, the surgery will be considered an isolated CABG and the data element coded "Yes," unless a procedure listed in Section A is performed during the same surgery. These particular

procedures are listed because the Office has received frequent questions regarding their coding.

Section B (Included):

- Coronary endarterectomy
- Internal cardiac defibrillators (ICDs)
- Fem-fem cardiopulmonary bypass (a form of cardiopulmonary bypass that should not be confused with aortofemoral bypass surgery listed in Section A)
- Pacemakers
- Pericardiectomy and excision of lesions of heart
- Repair/restoration of the heart or pericardium
- Transmyocardial laser revascularization (TMR)
- Thymectomy
- Thyroidectomy

APPENDIX B: CCORP DATA ELEMENT DEFINITIONS

Data Element	Definition
Facility Identification Number	The six-digit facility identification number assigned by the Office of Statewide Health Planning and Development.
Isolated CABG: Yes; No.	Answer 'No' if any of the procedures listed below were performed during coronary artery bypass graft surgery. *(See Appendix A for full definition)*
Responsible Surgeon Name (3 separate fields): Surgeon Last Name; Surgeon First Name; Surgeon Middle Initial	Responsible surgeon means the principle surgeon who performs a coronary artery bypass procedure. If a trainee performs this procedure, then the responsible surgeon is the physician responsible for supervising this procedure performed by the trainee. In situations in which a responsible surgeon cannot otherwise be determined, the responsible surgeon is the surgeon who bills for the coronary artery bypass procedure.
Responsible Surgeon CA License Number	California physician license number of responsible surgeon, assigned by the Medical Board of California of the Department of Consumer Affairs.
Medical Record Number	Patient medical record number at the hospital where surgery occurred.
Date of Birth: mm/dd/yyyy	Patient date of birth.
Date of Surgery: mm/dd/yyyy	Patient date of surgery for the CABG procedure.
Date of Discharge: mm/dd/yyyy	Patient date of discharge.
Discharge Status: Alive; Dead.	Patient status upon discharge from the hospitalization in which surgery occurred.
Date of Death: mm/dd/yyyy	Patient date of death.
Race: Caucasian; Black; Hispanic; Asian; Native American; Other.	Patient race or ethnicity.
Gender: Male; Female.	Patient gender.
Patient Age (calculated)	Patient age in years, at time of surgery. This should be calculated from the Date of Birth and

Data Element	Definition
	the Date of Surgery, according to convention used in the USA (the number of birth date anniversaries reached by the date of surgery).
Height: Real number 3.2 digits (e.g., 999.99)	Height of the patient in centimeters. Valid values are between 20 and 251 cm.
Weight: Real number 3.2 digits (e.g., 999.99)	Weight of the patient in kilograms. Valid values are between 10 and 250 kg.
Status of the Procedure: Emergent/Salvage; Emergent; Urgent; Elective.	The status that best describes the clinical status of the patient at the time of surgery. **Emergent/Salvage:** The patient is undergoing cardiopulmonary resuscitation en route to the operating room or prior to anesthesia induction. **Emergent:** The patient's clinical status includes any of the following: a. Ischemic dysfunction (any of the following): (A) Ongoing ischemia including rest angina despite maximal medical therapy (medical and/or intra-aortic balloon pump (IABP)); (B) Acute Evolving Myocardial Infarction within 24 hours before surgery; or (C) pulmonary edema requiring intubation. b. Mechanical dysfunction (either of the following): (A) shock with circulatory support; or (B) shock without circulatory support. **Urgent:** ALL of the following conditions are met: a. Not elective status b. Not emergent status c. Procedure required during same hospitalization in order to minimize chance of further clinical deterioration. d. Worsening, sudden chest pain; congestive heart failure (CHF); acute myocardial infarction (AMI); coronary anatomy; (IABP); unstable angina (USA) with intravenous (IV) nitroglycerin; rest angina, valve dysfunction; or aortic dissection. **Elective:** The patient's status has been stable in the days or weeks prior to the operation. The procedure could be deferred without increased risk of compromised cardiac outcome.
Last Creatinine Level Preop (mg/dl): Real number 2.1 digits (e.g., 99.9)	The most recent creatinine level prior to surgery. A creatinine level should be collected on all patients for consistency, even if they have no prior history. Valid values are between 0.1 and 30 mg/dl.
Dialysis: Yes; No.	The patient is on dialysis preoperatively.
Diabetes: Yes; No.	The patient has a history of diabetes, regardless

Data Element	Definition
	of duration of disease or need for anti-diabetic agents.
Peripheral Vascular Disease: Yes; No.	The patient has a history at any time prior to surgery of Peripheral Vascular Disease, as indicated by claudication either with exertion or rest; amputation for arterial insufficiency; aorto-iliac occlusive disease reconstruction; peripheral vascular bypass surgery, angioplasty, or stent; documented abdominal aortic aneurysm (AAA), AAA repair, or stent; positive non-invasive testing documented. Excludes Cerebrovascular Disease.
Cerebrovascular Disease: Yes; No.	The patient has a history at any time prior to surgery of Cerebrovascular Disease, documented by any one of the following: unresponsive coma > 24 hours; cerebrovascular accident (CVA) (symptoms > 72 hours after onset); reversible ischemic neurological deficit (RIND) (recovery within 72 hours of onset); transient ischemic attack (TIA) (recovery within 24 hours of onset); non-invasive carotid test with > 75% occlusion; or prior carotid surgery.
Cerebrovascular Accident: Yes; No.	The patient has a history, at any time prior to surgery, of a central neurologic deficit persisting more than 72 hours. (i.e., extremity weakness or loss of motion, loss of consciousness, loss of speech, field cuts). Chart documentation of a prior diagnosis of CVA or stroke is sufficient.
Cerebrovascular Accident Timing: Recent (<=2 weeks); Remote (>2 weeks).	Events occurring within two weeks of the surgical procedure are considered recent; all others are considered remote.
Chronic Lung Disease: No; Mild; Moderate; Severe.	Specify if the patient has chronic lung disease and the severity level according to the following classification: **No**: No chronic lung disease present. **Mild**: Forced expiratory volume in one second (FEV1) 60% to 75% of predicted, and/or on chronic inhaled or oral bronchodilator therapy. **Moderate**: FEV1 50-59% of predicted, and/or on chronic steroid therapy aimed at lung disease. **Severe**: FEV1 <50% predicted, and/or room air partial pressure of oxygen (pO2) < 60 or room air partial pressure of carbon dioxide (pCO2) > 50.
Hypertension: Yes; No.	The patient has a diagnosis of hypertension, documented by one of the following: a.

Data Element	Definition
	Documented history of hypertension diagnosed and treated with medication, diet and/or exercise. b. Blood pressure > 140 systolic or > 90 diastolic on at least 2 occasions. c. Currently on antihypertensive medication.
Immunosuppressive Treatment: Yes; No.	Patient has used any form of immunosuppressive therapy (i.e., systemic steroid therapy) within 30 days preceding the operative procedure. Does not include topical applications and inhalers.
Hepatic Failure: Yes; No.	The patient has cirrhosis, hepatic failure, acute hepatitis or “shock liver” and has a bilirubin greater than 2 mg/dl and a serum albumin less than 3.5 grams/dl.
Arrhythmia: Yes; No.	A preoperative arrhythmia present within two weeks of the procedure, by clinical documentation of any one of the following: Atrial fibrillation/flutter requiring medication; Heart block; Sustained Ventricular Tachycardia; or Ventricular Fibrillation requiring cardioversion and/or intravenous amiodarone.
Arrhythmia Type: Sust VT/VF; Heart Block; AFib/Flutter.	The type of arrhythmia is present within two weeks of the procedure is: Sustained Ventricular Tachycardia or Ventricular Fibrillation requiring cardioversion and/or intravenous amiodarone; Heart Block; and Atrial fibrillation/flutter requiring medication.
Myocardial Infarction: Yes; No.	Refers to any myocardial infarction (MI) in the past. **For MIs prior to the current hospitalization** for which detailed records are not available, chart documentation in which a clinician caring for the patient diagnosed an MI is sufficient. **For MIs during the current hospitalization** for which detailed records are available, conditions A and B below must all be met: A) The patient must have been diagnosed with a myocardial infarction (ST elevation or non ST elevation) by a clinician caring for patient. B) At least 1 of the 3 following biochemical indicators for detecting myocardial necrosis must be present: 1) Troponin T or I: a. Maximal concentration of troponin T or I exceeding the MI

Data Element	Definition
	diagnostic limit (99th percentile of the values for a reference control group, as defined in section C) on at least one occasion during the first 24 hours after the index clinical event. 2) CK-MB: a. Maximal value of CK-MB more than two times the upper limit of normal on at least one occasion during the first 24 hours after the index clinical event. b. Maximal value of CK-MB, preferable CK-MB mass, exceeding 99th percentile of the values for a reference control group, as defined in section C, on two successive samples during the first 24 hours after the index clinical event. 3) Total CK: a. In the absence of availability of a troponin or CK-MB assay, total CK more than two times the upper limit of normal (99th percentile of the values for a reference control group, as defined in *), or the B fraction of CK may be employed, but these last two biomarkers are considerably less satisfactory than CK-MB. * Reference control values (MI diagnostic limit and upper limit of normal): 1) Reference values must be determined in each laboratory by studies using specific assays with appropriate quality control, as reported in peer-reviewed journals. Acceptable imprecision (coefficient of variation) at the 99th percentile for each assay should be defined as less than or equal to 10 percent. Each individual laboratory should confirm the range of reference values in their specific setting.
Myocardial Infarction Timing: <=6 Hrs; >6 Hrs but <24 Hrs; 1 to 7 Days; 8 to 21 Days; >21 Days.	Time period between the last documented myocardial infarction and the CABG surgery.
Cardiogenic Shock: Yes; No.	The patient, at the time of procedure, is in a clinical state of hypoperfusion according to either of the following criteria: 1. Systolic blood pressure (BP) < 80 mm hg and/or Cardiac Index (CI) < 1.8 despite maximal treatment. 2. Intravenous inotropes and/or intra-aortic balloon pump (IABP) necessary to maintain Systolic BP > 80 mm hg and/or CI > 1.8.
Angina: Yes; No.	The patient has ever had angina pectoris.
Angina Type: Stable; Unstable.	The type of angina present within 24 hours prior to CABG surgery is: Stable: Angina not meeting unstable criteria below. Unstable: Requires continuous hospitalization from the episode until

Data Element	Definition
	surgery and one of the following: 1) Angina at rest. 2) New onset angina in past 2 months of at least Canadian Cardiovascular Society (CCS) Class III. 3) Increasing angina in past 2 months - angina that has become more frequent, longer in duration, or lower in threshold; and increased by greater than or equal to 1 CCS class to at least CCS Class III severity.
CCS Classification: No Angina = Class 0; Class I; Class II; Class III; Class IV.	Canadian Cardiovascular Society (CCS) Classification. This classification represents level of functional status related to frequency and intensity of angina. The CCS may not be the same as the NYHA classification for the same evaluation time period. Code the highest class leading to episode of hospitalization and/or intervention: **0**=No angina. **I**= Ordinary physical activity, such as walking or climbing the stairs does not cause angina. Angina may occur with strenuous, rapid or prolonged exertion at work or recreation. **II**= There is a slight limitation of ordinary activity. Angina may occur with moderate activity such as walking or climbing stairs rapidly, walking uphill, walking or stair climbing after meals or in the cold, in the wind, or under emotional stress, or walking more than two blocks on the level, and climbing more than one flight of stairs at normal pace under normal conditions. **III**= There is marked limitation of ordinary physical activity. Angina may occur after walking one or two blocks on the level or climbing one flight of stairs under normal conditions at a normal pace. **IV**= There is inability to carry on any physical activity without discomfort; angina may be present at rest.
Congestive Heart Failure: Yes; No.	The patient has symptoms that occurred within 2 weeks prior to surgery. This does not include patients with chronic or stable non-symptomatic compensated congestive heart failure (CHF). The patient has one or more of the following: Paroxysmal nocturnal dyspnea (PND), Dyspnea on exertion (DOE) due to heart failure, Chest X-Ray (CXR) showing pulmonary congestion; and Pedal edema or dyspnea and receiving diuretics or digoxin.
NYHA Classification: Class I; Class II; Class III; Class IV.	New York Heart Association (NYHA) Classification represents the overall functional

Data Element	Definition
	status of the patient in relationship to both congestive heart failure and angina. The NYHA may not be the same as the CCS classification for the same evaluation period. Code the highest level leading to episode of hospitalization and/or procedure: **I**= Patients with cardiac disease but without resulting limitation of physical activity. Ordinary physical activity does not cause undue fatigue, palpitation, dyspnea, or anginal pain. **II**= Patients with cardiac disease resulting in slight limitation of physical activity. They are comfortable at rest. Ordinary physical activity results in fatigue, palpitations, dyspnea, or anginal pain. **III**= Patients with cardiac disease resulting in marked limitation of physical activity. They are comfortable at rest. Less than ordinary physical activity results in fatigue, palpitations, dyspnea, or anginal pain. **IV**= Patients with cardiac disease resulting in inability to carry on any physical activity without discomfort. Symptoms of cardiac insufficiency or of the anginal syndrome may be present even at rest. If any physical activity is undertaken, discomfort is increased.
Number of Prior Cardiac Operations Requiring Cardiopulmonary Bypass	Prior to this operation, the number of cardiac surgical operations performed on this patient utilizing cardiopulmonary bypass. Valid values are between 0 and 9.
Number of Prior Cardiac Operations Without Cardiopulmonary Bypass	Prior to this operation, the number of cardiac surgical operations performed on this patient without cardiopulmonary bypass. Valid values are between 0 and 9.
Prior PCI: Yes; No.	Percutaneous coronary intervention (PCI) was done at any time prior to this surgical procedure (which may include during the current admission). PCI includes percutaneous transluminal coronary angioplasty (PTCA), intracoronary fibrinolysis without PTCA, laser recanalization, stent implantation, rheolysis with angiojet, brachytherapy, and other catheter-based percutaneous recanalization techniques.
Interval from prior PCI to Surgery: <=6 Hrs; > 6 Hrs.	The time between prior percutaneous coronary intervention (PCI) and surgical repair of coronary occlusion:<=6 hours; > 6 hours.

Data Element	Definition
Ejection Fraction (%): Integer length 2	The percentage of blood emptied from the ventricle at the end of the contraction. Use the most recent determination prior to intervention. Enter a percentage in the range of 5-90.
Ejection Fraction Method: LV Gram; Radionucleotide; Estimate; ECHO.	Method of obtaining ejection fraction measurement information: **LV Gram:** Left Ventriculogram. **Radionucleotide:** MUGA Scan. **Estimate:** From other calculations, based upon available clinical data. **ECHO:** Echocardiogram.
Left Main Disease (% Stenosis): Integer length 3	Percentage of compromise of vessel diameter in any angiographic view. Valid values are between 0 and 100.
Number of Diseased Coronary Vessels: None; One; Two; Three.	The number of major coronary vessel systems (Left anterior descending (LAD) system, Circumflex system, and/or Right system) with >50% narrowing in any angiographic view. NOTE: Left main disease (>50%) is counted as TWO vessels (LAD and Circumflex). For example, left main and right coronary artery (RCA) would count as three total.
Mitral Insufficiency: None; Trivial; Mild; Moderate; Severe.	Indicate if there is evidence of mitral valve regurgitation and if so, the severity level.
Internal Mammary Artery(ies) Used as Grafts: Left IMA; Right IMA; Both IMAs; No IMA.	Internal Mammary Artery(ies) (IMA) used for grafts, if any.
Cardiopulmonary Bypass Used: Yes; No.	Use of Cardiopulmonary Bypass (CPB) at any time during the procedure.
Conversion to Cardiopulmonary Bypass: Yes; No.	The patient needed to be placed on cardiopulmonary bypass (CPB) after the off-pump procedure was attempted.
Primary Incision: Full Sternotomy; Partial Sternotomy; Transverse Sternotomy; Right Vertical Parasternal; Left Vertical Parasternal; Right Anterior Thoracotomy; Left Anterior Thoracotomy; Posterolateral Thoracotomy; Xiphoid; Epigastric; Subcostal.	The primary incision used as the initial intention for treatment.
Cardioplegia: Yes; No.	Cardioplegia was used.

APPENDIX C: HOSPITAL RESPONSES

Each hospital included in this report was provided with a preliminary report containing the risk-adjustment model, explanatory materials, and the results for all hospitals. Hospitals were given a 60-day review period for submitting statements to OSHPD that must be included in this report by law. A letter was received from only one hospital and is included in this appendix.

The hospital's primary concern was with their "Low" performance rating on use of the internal mammary artery (IMA), a process measure of surgical quality. They argued that there were many legitimate factors that accounted for their hospital having a lower rate than other hospitals. Most of these reasons were related to the high volume of referral patients from other facilities that were more severely ill.

The approach CCORP uses to calculate the IMA usage rate does take into account some of the specific risk factors mentioned in the letter. For example, emergency cases, cardiogenic shock cases, and "re-do" CABG surgeries are excluded from calculation of the IMA usage rate. CCORP encourages all hospitals and surgeons to use the IMA graft as the conduit of choice when appropriate.

USC
UNIVERSITY
HOSPITAL

October 24, 2007

Holly Hoegh, Ph.D.
Manager, Clinical Data Programs
Office of Statewide Health Planning and Development
818 K Street, Room 200
Sacramento, CA 95814

Dear Dr. Hoegh,

This letter is in response to the 2005 CCORP Hospital Results for Usage of the Internal Mammary Artery (IMA) Report in which the internal mammary usage rating was designated as low for USC University Hospital. While we acknowledge that the IMA usage rate of 77.03% is lower than other hospitals, we feel there are several factors that account for this finding.

The IMA usage rate records whether the internal mammary artery was used or not, however does not account for the reason why the internal mammary artery was not used. The cases in which the internal mammary artery was not used had documented reasons of obesity, markedly aged, underlying cancer, cardiogenic shock, arterio-venous fistula in the left arm, and the anatomy and or quality of both the internal mammary and or the bypass vessels did not warrant use of the IMA. Some cases were re-do procedures, and one case was emergent.

At USC University hospital the majority of the isolated coronary artery bypass patients are referred from other facilities for higher level of care considerations.

Our approach at USC University hospital is to use the IMA whenever the clinical condition of the patient and anatomy for the bypass surgery is favorable to use the IMA. We are proud of the care that we provide to critically ill patients who have been referred for our clinical expertise.

Sincerely,

Vaughn A. Starnes, M.D.
Hastings Distinguished Professor and Chairman
Department of Cardiothoracic Surgery
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Additional copies of The California Report on Coronary Artery Bypass Graft Surgery can be obtained by contacting HIRC at (916) 326-3802 or HIRCWeb@oshpd.ca.gov