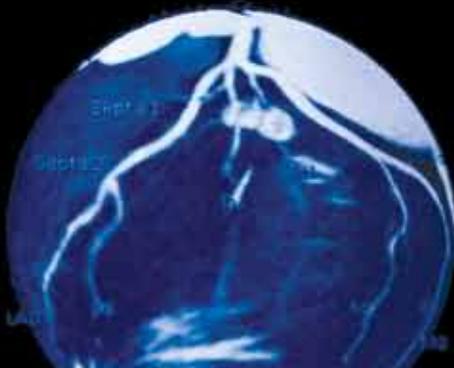
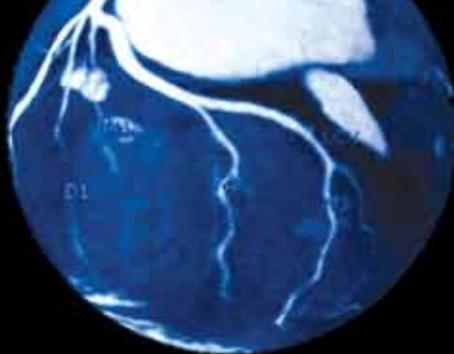


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**CCORP**

APRIL 2012



# The California Report on Coronary Artery Bypass Graft Surgery

2009 Hospital Data

California CABG Outcomes Reporting Program

THE CALIFORNIA REPORT ON  
CORONARY ARTERY  
BYPASS GRAFT SURGERY

2009 Hospital Data

**April 2012**

Edmund G. Brown Jr., Governor  
State of California

Diana S. Dooley, Secretary  
Health and Human Services Agency

Stephanie Clendenin, Acting Director  
Office of Statewide Health Planning and Development





## PREFACE

April 2012

We are pleased to share with you the seventh public release of data from the State's mandatory heart bypass surgery reporting program, the California CABG Outcomes Reporting Program. This report provides quality ratings for 119 state-licensed hospitals that performed isolated coronary artery bypass graft (CABG) surgery during 2009. The performance ratings are based on three key risk-adjusted outcomes: operative mortality, post-operative stroke, and unplanned hospital readmission. This is our first report to rate hospitals on their unplanned readmissions, a problem that results in increased costs to the healthcare system and has recently received considerable national attention. In addition, we report an important process measure of surgical quality: the use of the internal mammary artery during CABG surgery.

Isolated CABG surgery means that no other major procedure, such as valve repair or carotid endarterectomy, was performed at the same time as the bypass surgery. In 2009, the statewide operative mortality rate was 1.90%, a continued reduction from the 2.24% rate in 2008 and the 2.90% rate in 2003, the first year of mandatory reporting.

This information is intended for cardiac patients and their families who are developing treatment plans with their doctors. It is also intended for hospitals and surgeons who are developing quality improvement activities and for organizations that purchase health coverage for their members. The 2009 clinical data analysis produced accurate and valid findings; however, cardiac surgeon or hospital practices may have changed since the 2009 data were collected by OSHPD.

We commend the hospitals and cardiac surgeons in California and the California CABG Outcomes Reporting Program (CCORP) Clinical Advisory Panel, which oversees this program, for their hard work, dedication, and support of this public reporting program. 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.

Stephanie Clendenin  
Acting Director  
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## EXECUTIVE SUMMARY

The California Coronary Artery Bypass Graft (CABG) Outcomes Reporting Program is the largest public reporting program on CABG surgery outcomes in the United States.

The *California Report on Coronary Artery Bypass Graft Surgery, 2009 Hospital Data* presents findings from analyses of data collected from 119 California-licensed hospitals performing adult isolated CABG<sup>1</sup> surgeries during 2009. Hospital results for risk-adjusted mortality, risk-adjusted readmissions and internal mammary artery utilization are based only on 2009 data, and hospital results for risk-adjusted post-operative stroke are based on combined 2008 and 2009 data.

The three outcomes measures, operative mortality, readmission and post-operative stroke, are risk-adjusted and help hospitals, physicians, patients and payers evaluate hospital performance. Risk-adjustment is a statistical technique that allows for fair comparison of hospital outcomes even though some hospitals have sicker patients than average. In this report, operative mortality includes all deaths that occur during the hospitalization in which the CABG surgery was performed (regardless of length of stay) and any deaths within 30 days after the surgery (no matter where they occur). Post-operative stroke is defined as a central neurologic deficit that did not resolve within 24 hours after surgery. A readmission was counted only if the patient, within 30 days of being discharged from the hospital where the CABG was performed, was readmitted with a condition that was likely related to the CABG surgery. Readmissions for other reasons were excluded.

Using 2009 data, this report also provides hospital-level information on internal mammary artery (IMA)<sup>2</sup> usage—an important measure of surgical quality.

### Key findings from this report are:

#### 2009 Mortality Findings by Hospital:

- There were 252 operative deaths among 13,260 isolated non-salvage CABG surgeries. Patients undergoing cardiopulmonary resuscitation (CPR) on the way to the operating room (salvage cases) were excluded from the report results.
- The operative mortality rate for isolated CABG surgery in California was 1.90% compared to 2.24% for 2008. This represents a 35% reduction in the operative mortality rate since 2003 (2.91%), the first year of mandated public reporting.
- There was significant variation, from 0% to 13.01%, in hospital operative mortality rates after adjusting for patients' pre-operative health. Despite such variation, 116 of 119

<sup>1</sup> 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. For a complete definition of isolated CABG, see [http://www.oshpd.ca.gov/HID/SubmitData/CCORP\\_CABG/2006AbstractTrain.pdf](http://www.oshpd.ca.gov/HID/SubmitData/CCORP_CABG/2006AbstractTrain.pdf).

<sup>2</sup> The internal mammary artery (IMA) supplies blood to the front chest wall and the breasts. It is a paired artery, with one running on each side of the inner chest. 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.

hospitals (97%) performed at a rate that did not differ significantly from the statewide average.

- One hospital performed statistically significantly “**Better**” than the state average in terms of risk-adjusted operative mortality, and two hospitals performed “**Worse**” than the state average (shown in the following table alphabetically):

<b>Hospitals with “Better” Performance Ratings Based on Risk-Adjusted Operative Mortality Rates, 2009</b>	
<b>Hospital</b>	<b>Region</b>
Scripps Memorial Hospital - La Jolla	Greater San Diego
<b>Hospitals with “Worse” Performance Ratings Based on Risk-Adjusted Operative Mortality Rates, 2009</b>	
<b>Hospital</b>	<b>Region</b>
Scripps Mercy Hospital	Greater San Diego
West Hills Regional Medical Center	San Fernando Valley, Antelope Valley, Ventura & Santa Barbara

2008-2009 Post-Operative Stroke Findings:

- 384 of the 27,217 patients (1.41%) who underwent isolated CABG surgery experienced a post-operative stroke, similar to the national rate of 1.4% reported by the Society of Thoracic Surgeons.<sup>3</sup>
- There is wide variation in post-operative stroke rates among hospitals after adjusting for patients’ pre-operative health. Hospital risk-adjusted post-operative stroke rates ranged from 0% to 8.87%, and 114 of 121 hospitals (94%) performed at a rate that did not differ significantly from the statewide average.
- Three hospitals performed “**Better**” than the state average on post-operative stroke, and four hospitals performed “**Worse**” than the state average (shown in the following table alphabetically):

<sup>3</sup> Shahian DM, O'Brien SM, Filardo G, et al. The Society of Thoracic Surgeons 2008 cardiac surgery risk models: part 1—coronary artery bypass grafting surgery. *Ann Thorac Surg* 2009; 88:S2-22.

<b>Hospitals with “Better” Performance Ratings Based on Risk-Adjusted Post-Operative Stroke Rates, 2008-2009</b>	
<b>Hospital</b>	<b>Region</b>
Alta Bates Summit Medical Center - Summit Campus	San Francisco Bay Area & San Jose
St. Bernardine Medical Center	Inland Empire, Riverside & San Bernardino
St. Joseph's Medical Center of Stockton	Central California

<b>Hospitals with “Worse” Performance Ratings Based on Risk-Adjusted Post-Operative Stroke Rates, 2008-2009</b>	
<b>Hospital</b>	<b>Region</b>
Bakersfield Memorial Hospital	Central California
Good Samaritan Hospital - San Jose	San Francisco Bay Area & San Jose
Providence Tarzana Medical Center	San Fernando Valley, Antelope Valley, Ventura & Santa Barbara
Scripps Memorial Hospital - La Jolla	Greater San Diego

2009 Hospital Readmission Findings:

- 1,565 of the 11,823 patients (13.24%) who underwent isolated CABG surgery and were discharged alive experienced a hospital readmission within 30 days of the surgery.
- There is wide variation in the readmission rates among hospitals performing CABG surgery after adjusting for patients' pre-operative conditions. Hospital risk-adjusted readmission rates ranged from 0% to 29.77% and 117 of 119 hospitals (98%) performed at a rate that did not differ significantly from the statewide average.
- One hospital performed “**Better**” than the state average on hospital readmissions, and one hospital performed “**Worse**” than the state average (shown in the following table alphabetically):

<b>Hospitals with “Better” Performance Ratings Based on Risk-Adjusted Readmission Rates, 2009</b>	
<b>Hospital</b>	<b>Region</b>
Queen of the Valley Hospital	San Francisco Bay Area & San Jose

<b>Hospitals with “Worse” Performance Ratings Based on Risk-Adjusted Readmission Rates, 2009</b>	
<b>Hospital</b>	<b>Region</b>
San Joaquin Community Hospital	Central California

2009 Internal Mammary Artery (IMA) Usage Findings:

- The IMA is the preferred conduit for CABG surgery of the left anterior descending (LAD) artery. Hospitals with high rates of IMA use are providing high quality care to their patients. California had a 96.2% IMA usage rate in 2009 compared to 89.6% for 2003.<sup>4</sup>
- Five California hospitals had IMA usage rates that were significantly lower than the state average and were given “**Low**” performance ratings. There is no consensus on what an optimum usage rate should be, so performance ratings were not given for very high rates. Those hospitals with “**Low**” performance ratings are listed in the following table alphabetically:

<b>Hospitals with “Low” IMA Usage, 2009</b>	
<b>Hospital</b>	<b>Region</b>
Antelope Valley Hospital Medical Center	San Fernando Valley, Antelope Valley, Ventura & Santa Barbara
Lancaster Community Hospital	San Fernando Valley, Antelope Valley, Ventura & Santa Barbara
Shasta Regional Medical Center	Sacramento Valley & Northern California Region
Sutter Medical Center of Santa Rosa	San Francisco Bay Area & San Jose
Tri-City Medical Center	Greater San Diego

<sup>4</sup> The increase in the statewide IMA usage rate from 93.7% in 2007 to 95.9% in 2008 and 96.2% in 2009 is partly due to excluding from the denominator patients who did not have the left anterior descending (LAD) artery bypassed. This was a new exclusion criterion for 2008 and after. If not used, the statewide IMA usage rate would be 94.4% for 2008 and 94.8% for 2009.

## ACKNOWLEDGMENTS

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This report represents the contributions of many individuals. Hospital staff dedicated time and resources to collect, report, and review the data for analysis. Hospitals provided ongoing feedback on the design of the program, which is vital to its success, and members of the CCORP Clinical Advisory Panel provided oversight and policy guidance for data collection and analysis. The Healthcare Information Division and the Healthcare Information Resource Center within the division provided expertise in report concept, editing and design. 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 quality.

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Additional copies of this report can be obtained through the OSHPD Web site ([www.oshpd.ca.gov](http://www.oshpd.ca.gov)).

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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 in 2009. It is the seventh heart bypass surgery report developed by the California CABG Outcomes Reporting Program (CCORP) of the Office of Statewide Health Planning and Development (OSHPD) in compliance with California Health and Safety Code Sections 128745-128750. This report includes all 119 California state-licensed hospitals that performed this procedure.

The three key outcome measures reported are: risk-adjusted operative mortality, post-operative stroke and hospital readmission. 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, instead of in-hospital mortality, avoids potential manipulation of outcomes through discharge practices and holds hospitals accountable for patients who died at home or in other facilities shortly after discharge. The National Quality Forum (NQF), which serves as the national body for vetting quality measures, has endorsed the national Society of Thoracic Surgeons (STS) operative mortality measure for CABG surgery.<sup>5</sup> CCORP uses the STS definition of operative mortality, but also verifies deaths following patient discharge using death files from the California Department of Public Health. Post-operative stroke is defined as a central neurologic deficit that did not resolve within 24 hours after surgery. Hospital readmission counts only if the patient, within 30 days of being discharged after CABG surgery, was readmitted to any hospital with a principal diagnosis indicating a heart-related condition, an infection or a complication that was likely related to the CABG surgery. Readmissions for other reasons are not included in the analysis. California adopted the diagnosis categories and associated ICD-9-CM codes used by the Pennsylvania Healthcare Cost Containment Council for readmissions and extends its thanks to the Council for making these available (see Appendix A for the list of codes).

In this report, all three outcome measures are adjusted statistically to account for variation in the health status of patients prior to CABG surgery.

This report is intended to encourage hospitals and surgeons to examine their surgical practices and to make necessary changes to improve their quality of care. Patients, their families, and healthcare purchasers may use this information when making decisions about CABG surgery.

OSHPD provided all hospitals listed in this report an opportunity to review their results prior to publication and to submit a statement for inclusion in this report. Three hospitals submitted statements and they are included in Appendix B. These statements may help readers understand the concerns of some healthcare providers regarding the information released about them.

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<sup>5</sup> National Quality Forum. National voluntary consensus standards for cardiac surgery, Washington, DC: National Quality Forum, January 2005.

## II. CORONARY ARTERY DISEASE AND BYPASS SURGERY

In 2009, 112,651 Californians were admitted to hospitals for treatment of coronary artery disease.<sup>6</sup> This represents approximately 5% of all adult non-maternal admissions.

Coronary artery disease is a chronic condition in which cholesterol and fat solidify, forming plaque along the linings of the coronary arteries. This process is called atherosclerosis or hardening of the arteries. If plaque continues to accumulate, blood vessels may become partially or completely blocked, preventing the heart from receiving enough oxygen and leading to angina (chest pain) or even myocardial infarction (heart attack).

The two most common procedures for treatment of coronary artery disease are percutaneous coronary intervention (PCI), which includes angioplasty and insertion of stents, and CABG surgery. CABG surgery is more frequently recommended for patients with extensive coronary disease, reduced left ventricular function, and disease involving the left main coronary artery.

During CABG surgery, the surgeon uses arteries or veins from another part of the body (e.g., the internal mammary artery or the saphenous vein from the leg) to serve as a conduit for coronary bypass grafts and 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 because it maintains better blood flow over time and is associated with better long-term patient survival.

### Study Population

Under state law, 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 procedures, such as valve repair or carotid endarterectomy, during the same surgery. CCORP's detailed definition of isolated CABG surgery can be found at:

[http://www.oshpd.ca.gov/HID/SubmitData/CCORP\\_CABG/TrainingManual\\_2008\\_Final.pdf](http://www.oshpd.ca.gov/HID/SubmitData/CCORP_CABG/TrainingManual_2008_Final.pdf)

In 2009, there were 17,211 adult CABG surgeries performed in California. Of these, 13,260 (77%) were isolated CABG surgeries and 3,951 (23%) were non-isolated CABG surgeries. The study population for this report consisted of all adult patients who underwent isolated CABG surgery and were discharged in 2009. For post-operative stroke, the population also included those patients who were discharged in 2008. Isolated CABG surgery cases were selected as the study population because 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.

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<sup>6</sup> Data source: OSHPD, Patient Discharge Data, 2009. Patients were identified with coronary artery disease 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 2009 clinical data registry collected by CCORP from 119 reporting hospitals. These data are linked to death records from the California Department of Public Health to identify patients who died at home or at facilities other than the operating hospital within 30 days following CABG surgery. These data are also linked to OSHPD's Patient Discharge Data (PDD) to identify patients who were discharged alive, but were readmitted to a hospital within 30 days of CABG surgery.

The CCORP clinical registry primarily relies on a subset of data elements collected by the Society of Thoracic Surgeons (STS) for their National Database of Cardiac Surgery. However, a few data elements are exclusive to CCORP. Although STS and CCORP data definitions are generally identical, CCORP provides additional clarifications to assist hospitals with coding. All data elements collected by CCORP in 2009 and their definitions can be found at the OSHPD Web site:

[http://www.oshpd.ca.gov/HID/SubmitData/CCORP\\_CABG/Format-FileSpecs30.pdf](http://www.oshpd.ca.gov/HID/SubmitData/CCORP_CABG/Format-FileSpecs30.pdf)

#### Data Quality Review and Verification

CCORP reviews the data submitted by each hospital for completeness and errors. Using a three-step data quality review and verification process, CCORP asks hospitals to check data quality, data discrepancies, and potential risk-factor coding problems.

##### **Step 1: Data Quality Reports**

*Data quality reports* compare individual hospital rates for each pre-operative risk factor to the state average and list individual cases for hospital review and correction (e.g., checks for invalid, missing, and abnormally high or low risk factor values).

##### **Step 2: Data Discrepancy Reports**

*Data discrepancy reports* compare the CCORP clinical registry data to OSHPD's hospital administrative data source, the Patient Discharge Data (PDD). Hospitals are asked to review and account for discrepancies between the two data sources via patient medical chart review to verify that: 1) all CABG surgeries discharged in 2009 were reported; 2) all CABGs were accurately coded as isolated or non-isolated CABG surgery; 3) all isolated CABG surgery in-hospital deaths were reported; 4) coding of *Discharge Status* was consistent; 5) *Resuscitation* occurred prior to CABG surgery; and 6) coding of *Post-operative Complications* (including strokes) was consistent.

##### **Step 3: Risk-Factor Coding Reports**

*Risk-factor coding reports* compare each hospital's data to prior years of data and to the PDD and medical chart audit findings to identify possible under-reporting and over-reporting of risk factors. CCORP requests hospitals to review and, when necessary, correct poorly coded data elements.

## Hospital Medical Chart Audit

After completing the quality review and verification process, CCORP develops a preliminary risk model for operative mortality and post-operative stroke to help identify candidate hospitals for an on-site medical chart audit. Candidate selection for the 2009 audit was based on results of the preliminary model which identified “**Better**” or “**Worse**” hospital performers and on data quality reports which identified problems in over- and under-reporting. A small number of hospitals were also randomly selected for audit.

The 2009 audit included 18 hospitals and a total of 1,291 patient records (15% of all hospitals and approximately 8% of all CABG surgery cases in 2009). On-site medical chart reviews were conducted by trained, independent auditors under contract to OSHPD. All isolated CABG deaths or post-operative strokes at selected hospitals were audited and high-risk patients were sampled at a higher rate. The number of patient records 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 selected hospital performed less than 40 isolated CABG surgeries per year, all surgeries were audited. An audit summary was sent to each hospital for review and comment and/or correction.

Key findings from the 2009 hospital medical chart audit include:

- Auditors found 6 non-isolated CABG cases that should have been coded as isolated and 5 isolated CABG cases that should have been coded as non-isolated.
- Discharge status was coded correctly for all isolated and non-isolated CABG records audited.
- Percent agreement is a simple method to determine agreement between hospital abstractors and auditors for more common risk factors and outcomes.
  - In 2009, percent agreement for 42 audited categorical variables ranged from 74% to 100%.
  - Thirty-nine variables exceeded 80% agreement including 35 that exceeded 90% agreement.
  - Percent agreement was low for Mitral Insufficiency (74%), Chronic Lung Disease (77%) and Status of Procedure (80%).
- For rare risk factors and outcomes such as *Arrhythmia Type*, *Immunosuppressive Treatment* and all *Complications*, a high percent agreement may simply be due to the absence of the risk factor or outcome in most patients. In these cases, the Kappa statistic is a better measure of agreement and should be used to identify potential coding problems. Kappa values range between 0 (no agreement) and 1 (perfect agreement). For example, the percent agreement for *Immunosuppressive Treatment* was quite high at 97%, while the Kappa value was only 0.49 showing only moderate agreement between hospital abstractors and auditors.
- “Status of procedure” was coded correctly for 80% of audited isolated CABG surgeries. This variable tended to be under-coded rather than over-coded.
- The percent agreement was 90% or above for all post-operative complications, but as these are relatively rare events, percent agreement is not the best indicator of quality of coding. Kappa values for these outcomes ranged from moderate to excellent (0.48-0.85). Post-operative stroke which is publically reported had a strong Kappa value of 0.83.

Individual audit summary reports were sent to audited hospitals for review. The audited data replaced hospital-submitted data to generate the final results for this report. All outlier hospitals in 2009 were audited either in 2009 or in previous years.

## IV. RISK MODEL FOR ADJUSTING HOSPITAL OPERATIVE MORTALITY RATES, 2009

Whether patients recover quickly, have complications, or die following CABG surgery is, in part, a result of the medical care they receive. However, it is difficult to compare outcomes and assess surgical performance because patients treated at different hospitals or by different surgeons often vary in the severity of their pre-operative clinical conditions. This section explains the development and validation of CCORP's risk model that accounts for the variation in patient severity of illness.

To make fair comparisons of care delivered by different healthcare providers, it is necessary to adjust for the differences in severity of illness (case mix) of patients across providers. CCORP "levels the playing field" by considering the pre-operative condition of each patient. Providers that handle more complex cases receive a larger risk-adjustment weight in the risk model, and providers that handle less complex cases receive a smaller weight. Thus, hospitals and surgeons treating sicker patients are not at a disadvantage when their performance is compared with other hospitals or surgeons.

CCORP used a multivariable logistic regression model to estimate 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.

To develop the risk model, the 13,260 isolated (non-salvage) CABG surgery cases in 2009 were evaluated for missing data (12,860 cases had no missing data in any field and were used for the risk model parameter estimation). The 400 (3%) 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 results shown in this report, missing values for these 400 records were imputed (after risk model parameter estimation) by replacing them with the lowest risk category of the same variable (e.g., chronic lung disease = *None*). CCORP assigned the lowest risk value based on the following rationale: 1) some hospitals leave data fields blank by design when the risk factor is absent or the value is normal; 2) to maintain consistency with other major cardiac reporting programs that 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. CCORP summed these probabilities to estimate the expected mortality for each hospital. The risk model, based on the 2009 data, is presented in Table 1 with statistically significant risk factors identified in bolded text.

<b>GUIDE TO INTERPRETING TABLE 1: LOGISTIC REGRESSION RISK MODEL FOR OPERATIVE MORTALITY, 2009</b>	
Coefficient	The coefficient for each explanatory factor represents the effect that factor has on a patient's likelihood 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 of the other factors. If the coefficient is negative, having that characteristic is associated with a lower risk of death compared to not having that characteristic. The larger the value (whether positive or negative), the greater the effect or weight this characteristic has on the risk of dying. For example, note that the coefficient for "prior cardiac surgery" is 1.175 and is statistically significant. This value is positive, so it indicates that CABG patients with prior cardiac surgery are at an increased risk of dying compared to patients who did not have prior cardiac surgery.
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.
Odds Ratio	An odds ratio is another way of characterizing the impact of each factor on operative mortality. Mathematically, the odds ratio is the antilogarithm of the coefficient value. The larger the odds ratio, the greater the impact that characteristic has on the risk of dying. An odds ratio close to 1.0 means the effect of the factor is close to neutral. For example, the odds ratio for prior cardiac surgery is 3.24. This means that for patients with "prior cardiac surgery", the odds of dying is about 224% higher compared to patients without prior cardiac surgery, assuming all other risk factors are the same.

**Table 1: Logistic Regression Risk Model for Operative Mortality, 2009**

Risk Factor		Coefficient	Standard Error	p-value	Odds Ratio
Intercept		-9.810	0.735	<.0001	
Patient Age (Years)		<b>0.047</b>	<b>0.007</b>	<b>&lt;.0001</b>	<b>1.049</b>
Gender	<b>Female vs. Male</b>	<b>0.530</b>	<b>0.144</b>	<b>0.0002</b>	<b>1.699</b>
Race	Non-White vs. White	0.019	0.144	0.897	1.019
Body Mass Index	18.5-39.9	Reference			
	< 18.5	0.820	0.436	0.060	2.271
	>=40	-0.320	0.406	0.431	0.726
Status of the Procedure	Elective	Reference			
	Urgent	-0.089	0.181	0.625	0.915
	<b>Emergent</b>	<b>0.744</b>	<b>0.319</b>	<b>0.020</b>	<b>2.104</b>
Last Creatinine PreOp (mg/dl)		<b>1.285</b>	<b>.283</b>	<b>&lt;.0001</b>	<b>3.616</b>
Hypertension		0.240	0.240	0.319	1.271
Peripheral Vascular Disease		0.0552	0.169	0.744	1.057
Cerebrovascular Disease		0.0815	0.243	0.737	1.085
Cerebrovascular Accident Timing	No CVA	Reference			
	> 2 weeks	0.130	0.300	0.666	1.139
	≤ 2 weeks	1.015	0.781	0.194	2.759
Chronic Lung Disease	None/Mild	Reference			
	Moderate	-0.013	0.265	0.962	0.987
	Severe	0.105	0.271	0.698	1.111
Immunosuppressive Treatment		<b>1.0011</b>	<b>0.270</b>	<b>0.0002</b>	<b>2.721</b>
Arrhythmia Type	Afib/Flutter	0.249	0.194	0.199	1.283
	Heart Block	0.418	0.442	0.345	1.519
	Sust VT/VF	0.235	0.296	0.427	1.265
Timing of Myocardial Infarction	No MI	Reference			
	21+ days ago	0.051	0.208	0.805	1.053
	8-21 days ago	-0.043	0.311	0.889	0.958
	<b>1-7 days ago</b>	<b>0.369</b>	<b>0.186</b>	<b>0.047</b>	<b>1.447</b>
	<b>&lt;24 Hours</b>	<b>0.646</b>	<b>0.285</b>	<b>0.024</b>	<b>1.907</b>
Cardiogenic Shock		<b>0.683</b>	<b>0.316</b>	<b>0.031</b>	<b>1.979</b>
Heart Failure		0.314	0.184	0.089	1.368
NYHA Class IV		0.386	0.222	0.081	1.472
Prior Cardiac Surgery	None	Reference			
	<b>One or more</b>	<b>1.175</b>	<b>0.234</b>	<b>&lt;.0001</b>	<b>3.240</b>
Interval from Prior PCI to Surgery	No prior PCIs	Reference			
	Prior PCI > 6 HRS	0.128	0.162	0.431	1.136
	Prior PCI ≤ 6 HRS	0.328	0.377	0.385	1.388
Ejection Fraction		<b>-0.013</b>	<b>0.005</b>	<b>0.011</b>	<b>0.987</b>
Left Main Stenosis (%)		<b>0.009</b>	<b>0.004</b>	<b>0.023</b>	<b>1.009</b>
Number of Diseased Coronary Vessels	None, One, or Two	Reference			
	Three	-0.024	0.163	0.882	0.976
Mitral Insufficiency	None, Trivial, Mild	Reference			
	Moderate/Severe	0.352	0.202	0.082	1.421
Resuscitation		0.346	0.677	0.609	1.413

**Bolded text** indicates statistical significance.

Note: "Last Creatinine PreOp" and "Ejection Fraction" and "Left Main Stenosis" were modeled using piecewise linear transformations.

## Discrimination

Risk 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. C-statistics range from 0.5 to 1, with higher values indicating better discrimination. For the 2009 risk model, the C-statistic was 0.805. In recently published CABG surgery mortality reports by other states (New Jersey, New York, and Pennsylvania), the C-statistic ranged from 0.791 to 0.836, which is similar to the 2009 CCORP model.

## Calibration

Calibration refers to the ability of a risk model to match predicted mortality with observed mortality. 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  $\chi^2$  test, which compares observed and predicted outcomes over deciles of risk. The p-value of the Hosmer-Lemeshow test statistic for this 2009 risk model is 0.328, indicating adequate 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 deaths with predicted deaths in each of 10 risk groups. The 10 risk groups are created by sorting all observations by the predicted risk of death and then dividing the sorted observations into deciles of approximately equal size. As presented in Table 2, Risk Group 10 shows the patients in the highest risk group. Among the 1,316 patients in this group, 113 patients died, but the model predicted 118.3 patient deaths. Assuming a Poisson distribution for a binary outcome, the predicted range of deaths for Risk Group 10 is 97.0 to 139.6. The observed number of 113 deaths falls within the range of predicted deaths. In fact, none of the 10 risk groups had either significantly fewer or significantly more deaths than were predicted by the model. Overall, the risk model shows no systematic underestimation or overestimation of mortality at the extremes.

**Table 2: Calibration of Risk Model for Operative Mortality, 2009**

Risk Group	Isolated CABG cases	Observed deaths	Predicted deaths	Difference	95%CI of predicted deaths
1	1,326	0	3.48	3.5	(0, 7.1)
2	1,325	6	5.49	-0.5	(0.9, 10.1)
3	1,325	8	7.19	-0.8	(1.9, 12.4)
4	1,325	4	9.04	5.0	(3.1, 14.9)
5	1,327	12	11.20	-0.8	(4.6, 17.8)
6	1,326	16	14.27	-1.7	(6.9, 21.7)
7	1,325	18	18.55	0.6	(10.1, 27.0)
8	1,325	27	25.33	-1.7	(15.5, 35.2)
9	1,325	48	39.17	-8.8	(26.9, 51.4)
10	1,316	113	118.27	5.3	(97.0, 139.6)
Total	13,245	252	252.00	0	

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

### Process for Calculating RAMR and Performance Rating

The risk-adjusted mortality rate (RAMR) represents the best estimate of what a healthcare provider's mortality rate would have been if the provider had a patient case mix identical to the statewide average. Thus, this rate is comparable among providers because it accounts for the differences in patient severity-of-illness.

The RAMR is computed, first by dividing the provider's observed mortality by the provider's expected mortality (obtained from the risk model calculation) 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 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 (1.90% for 2009) to obtain the provider's risk-adjusted mortality rate.

However, because a provider's point estimate of the RAMR can be attributed to chance, this report determines the performance rating not based on a point estimate of the RAMR, but based on a comparison of the 95% confidence interval (CI) of each provider's RAMR to the California average mortality rate.<sup>7</sup> CCORP treated the 2009 data as a sample, and inferred a range within which each provider's true performance was likely to fall. As shown in Table 3, if the upper 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, then the provider's performance rating is "**Better.**" If the lower 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, then the performance rating is "**Worse.**" If the state average mortality rate is within the 95% CI of a provider's RAMR, then the performance rating is "**Not Different**" and left blank.

<sup>7</sup> The Poisson Exact Probability method is used for computing the 95% confidence interval for the risk-adjusted mortality rate. (Buchan Iain, *Calculating Poisson Confidence Interval in Excel*, January 2004).

<b>GUIDE TO INTERPRETING TABLE 3: HOSPITAL RISK-ADJUSTED OPERATIVE MORTALITY RESULTS</b>	
All CABG Cases	The total number of isolated and non-isolated CABG cases submitted to CCORP for 2009. 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. All patients in salvage operative status are excluded from the isolated CABG cases, thus only isolated CABG cases without salvage operative status 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, including those occurring 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 risk adjusting for their patient population) and the 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 California observed mortality rate by a provider's O/E ratio. The 95% confidence interval represents the confidence in the estimate for the RAMR. The lower and upper confidence limits are calculated using Poisson exact 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 provider is classified as " <b>Better</b> " if the upper 95% confidence limit of its RAMR falls below the California observed mortality rate. A provider is classified as " <b>Worse</b> " if the lower 95% confidence limit of its RAMR is higher than the California observed mortality rate. A provider is classified as " <b>Not Different</b> " (performance rating is blank) if the California mortality rate falls within the confidence interval of the provider's risk-adjusted mortality rate.

## 2009 Hospital Risk-Adjusted Operative Mortality Results

Table 3 presents the risk-adjusted operative mortality results for each hospital for 2009. 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 (excluding salvage patients), the number of observed isolated CABG deaths, observed mortality rate, expected mortality rate predicted by the risk model, RAMR and 95% CI of the RAMR, and the associated hospital performance rating.

Among the 13,260 isolated and non-salvage CABG surgeries performed in 2009, 252 patients died either in-hospital or within 30 days of the surgery date, reflecting an overall operative mortality rate of 1.90%. The *observed* mortality rates among hospitals ranges from 0% to 14.29%. The *expected* mortality rates, which are generated by the risk model and account for patient severity of illness, range between 0.73% and 3.67%. The risk-adjusted mortality rates (RAMR), which measure hospital performance, range from 0% to 13.01%.

Based on the 95% confidence intervals for risk-adjusted mortality rates, 116 of 119 hospitals (97%) performed within the expected range when compared to the state's overall mortality rate (denoted by a blank space in the performance rating column of Table 3), one hospital performed significantly "**Better**" than the state average, and two hospitals performed significantly "**Worse**" than the state average. Hospitals marked with † in Table 3 submitted statements regarding this report (presented in Appendix B).

**Table 3: Hospital Risk-Adjusted Operative Mortality Results by Region, 2009**

<i>Region</i>	<i>Hospital</i>	<i>All CABG Cases</i>	<i>Isolated CABG Cases</i>	<i>Isolated CABG Mortality</i>	<i>Observed Mortality Rate (%)</i>	<i>Expected Mortality Rate (%)</i>	<i>Risk-Adjusted Mortality Rate (% , RAMR)</i>	<i>95% CI for RAMR</i>	<i>Performance Rating*</i>
<b>State</b>		<b>17,211</b>	<b>13,260</b>	<b>252</b>	<b>1.90</b>				
Sacramento Valley & Northern California Region	Enloe Medical Center	173	155	1	0.65	1.91	0.64	(0.02, 3.57)	
	Mercy General Hospital	770	516	4	0.78	1.52	0.97	(0.26, 2.48)	
	Mercy Medical Center - Redding	173	129	3	2.33	1.98	2.23	(0.46, 6.52)	
	Mercy San Juan Hospital	143	105	0	0.00	1.49	0.00	(0.00, 4.48)	
	North Bay Medical Center	19	19	0	0.00	1.35	0.00	(0.00, 27.24)	
	Rideout Memorial Hospital	157	125	4	3.20	1.33	4.57	(1.24, 11.69)	
	Shasta Regional Medical Center	55	50	1	2.00	3.67	1.04	(0.03, 5.77)	
	St. Joseph Hospital - Eureka	66	48	0	0.00	2.18	0.00	(0.00, 6.68)	
	Sutter Memorial Hospital	468	328	4	1.22	2.04	1.14	(0.31, 2.91)	
	UC Davis Medical Center	210	141	4	2.84	1.34	4.02	(1.09, 10.29)	
San Francisco Bay Area & San Jose	Alta Bates Summit Medical Center - Summit Campus	550	421	3	0.71	1.43	0.95	(0.20, 2.76)	
	California Pacific Medical Center - Pacific Campus	82	60	0	0.00	2.37	0.00	(0.00, 4.92)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RAMR falls below the California observed mortality rate (1.90%). 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 left blank) if the California mortality rate falls within the 95% CI of a hospital’s RAMR.

† Hospitals submitted statements regarding this report. See Appendix B for their statements.

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<i>Region</i>	<i>Hospital</i>	<i>All CABG Cases</i>	<i>Isolated CABG Cases</i>	<i>Isolated CABG Mortality</i>	<i>Observed Mortality Rate (%)</i>	<i>Expected Mortality Rate (%)</i>	<i>Risk-Adjusted Mortality Rate (%), RAMR</i>	<i>95% CI for RAMR</i>	<i>Performance Rating*</i>
<b>State</b>		<b>17,211</b>	<b>13,260</b>	<b>252</b>	<b>1.90</b>				
San Francisco Bay Area & San Jose (continued)	Community Hospital Monterey Peninsula	81	58	0	0.00	2.08	0.00	(0.00, 5.81)	
	Dominican Hospital	72	60	3	5.00	1.90	5.00	(1.03, 14.62)	
	El Camino Hospital	80	58	2	3.45	2.93	2.24	(0.27, 8.08)	
	Good Samaritan Hospital - San Jose†	113	83	1	1.20	2.90	0.79	(0.02, 4.40)	
	John Muir Medical Center - Concord Campus	291	229	5	2.18	1.54	2.69	(0.87, 6.27)	
	Kaiser Foundation Hospital (Geary San Francisco)	241	189	1	0.53	1.37	0.74	(0.02, 4.10)	
	Kaiser Foundation Hospital (Santa Clara)	234	137	2	1.46	1.85	1.50	(0.18, 5.42)	
	Marin General Hospital	52	41	0	0.00	1.05	0.00	(0.00, 16.32)	
	O'Connor Hospital	62	55	1	1.82	2.68	1.29	(0.03, 7.18)	
	Peninsula Medical Center	55	39	1	2.56	1.35	3.62	(0.09, 20.14)	
	Queen of the Valley Hospital	148	109	1	0.92	2.62	0.67	(0.02, 3.71)	
	Regional Medical of San Jose	38	36	0	0.00	1.52	0.00	(0.00, 12.84)	
	Salinas Valley Memorial Hospital	118	92	0	0.00	1.66	0.00	(0.00, 4.58)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RAMR falls below the California observed mortality rate (1.90%). 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 left blank) if the California mortality rate falls within the 95% CI of a hospital’s RAMR.

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<b>State</b>		<b>17,211</b>	<b>13,260</b>	<b>252</b>	<b>1.90</b>				
San Francisco Bay Area & San Jose (continued)	San Ramon Regional Medical Center	44	32	0	0.00	1.39	0.00	(0.00, 15.80)	
	Santa Clara Valley Medical Center	43	38	1	2.63	1.22	4.11	(0.10, 22.88)	
	Santa Rosa Memorial Hospital	77	65	0	0.00	2.74	0.00	(0.00, 3.94)	
	Sequoia Hospital	99	54	1	1.85	2.17	1.62	(0.04, 9.03)	
	Seton Medical Center	134	117	2	1.71	2.64	1.23	(0.15, 4.44)	
	St. Helena Hospital	66	54	0	0.00	2.37	0.00	(0.00, 5.47)	
	St. Mary's Medical Center, San Francisco	39	31	0	0.00	1.79	0.00	(0.00, 12.65)	
	Stanford University Hospital	156	101	3	2.97	2.53	2.24	(0.46, 6.53)	
	Sutter Medical Center of Santa Rosa	97	68	0	0.00	1.30	0.00	(0.00, 7.94)	
	UCSF Medical Center	97	69	1	1.45	1.18	2.33	(0.06, 13.00)	
	Valleycare Medical Center	38	34	2	5.88	3.50	3.19	(0.39, 11.52)	
	Washington Hospital - Fremont	135	119	2	1.68	1.78	1.80	(0.22, 6.49)	
	Central California	Bakersfield Heart Hospital	168	144	4	2.78	2.12	2.49	(0.68, 6.36)
Bakersfield Memorial Hospital		148	125	3	2.40	1.15	3.98	(0.82, 11.63)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RAMR falls below the California observed mortality rate (1.90%). 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 left blank) if the California mortality rate falls within the 95% CI of a hospital’s RAMR.

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<b>State</b>		<b>17,211</b>	<b>13,260</b>	<b>252</b>	<b>1.90</b>				
Central California (continued)	Community Medical Center - Fresno	238	206	6	2.91	2.15	2.57	(0.94, 5.60)	
	Dameron Hospital	66	63	1	1.59	1.74	1.73	(0.04, 9.65)	
	Doctors Medical Center - Modesto Campus	341	267	6	2.25	2.34	1.82	(0.67, 3.96)	
	Fresno Heart Hospital	225	173	4	2.31	1.59	2.77	(0.75, 7.09)	
	Kaweah Delta Hospital	304	240	5	2.08	2.14	1.85	(0.60, 4.32)	
	Marian Medical Center	59	47	1	2.13	2.04	1.98	(0.05, 11.02)	
	Memorial Medical Center of Modesto	260	217	2	0.92	2.05	0.85	(0.10, 3.09)	
	San Joaquin Community Hospital	104	96	4	4.17	2.19	3.62	(0.98, 9.25)	
	St. Agnes Medical Center	316	273	10	3.66	2.36	2.95	(1.41, 5.42)	
	St. Joseph's Medical Center of Stockton	331	258	9	3.49	1.90	3.49	(1.60, 6.63)	
San Fernando Valley, Antelope Valley, Ventura & Santa Barbara	Antelope Valley Hospital Medical Center	26	22	2	9.09	1.59	10.85	(1.31, 39.20)	
	Community Memorial Hospital of San Buenaventura	83	66	0	0.00	1.59	0.00	(0.00, 6.69)	
	French Hospital Medical Center	139	105	3	2.86	1.61	3.37	(0.70, 9.85)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RAMR falls below the California observed mortality rate (1.90%). 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 left blank) if the California mortality rate falls within the 95% CI of a hospital’s RAMR.

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<b>State</b>		<b>17,211</b>	<b>13,260</b>	<b>252</b>	<b>1.90</b>				
San Fernando Valley, Antelope Valley, Ventura & Santa Barbara (continued)	Glendale Adventist Medical Center - Wilson Terrace	128	115	4	3.48	1.64	4.04	(1.10, 10.35)	
	Glendale Memorial Hospital and Health Center	195	126	3	2.38	2.17	2.09	(0.43, 6.10)	
	Lancaster Community Hospital	8	7	1	14.29	2.09	13.01	(0.33, 72.48)	
	Los Robles Regional Medical Center	92	73	2	2.74	2.19	2.38	(0.29, 8.59)	
	Northridge Hospital Medical Center	72	58	1	1.72	1.59	2.06	(0.05, 11.47)	
	Providence Holy Cross Medical Center	95	71	1	1.41	2.05	1.31	(0.03, 7.28)	
	Providence St. Joseph Medical Center	65	52	0	0.00	1.60	0.00	(0.00, 8.43)	
	Providence Tarzana Medical Center	88	62	5	8.06	3.05	5.03	(1.63, 11.74)	
	Santa Barbara Cottage Hospital	153	114	2	1.75	2.00	1.67	(0.20, 6.02)	
	St. John's Regional Medical Center	97	75	4	5.33	2.37	4.27	(1.16, 10.93)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RAMR falls below the California observed mortality rate (1.90%). 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 left blank) if the California mortality rate falls within the 95% CI of a hospital’s RAMR.

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<i>Region</i>	<i>Hospital</i>	<i>All CABG Cases</i>	<i>Isolated CABG Cases</i>	<i>Isolated CABG Mortality</i>	<i>Observed Mortality Rate (%)</i>	<i>Expected Mortality Rate (%)</i>	<i>Risk-Adjusted Mortality Rate (% , RAMR)</i>	<i>95% CI for RAMR</i>	<i>Performance Rating*</i>
<b>State</b>		<b>17,211</b>	<b>13,260</b>	<b>252</b>	<b>1.90</b>				
San Fernando Valley, Antelope Valley, Ventura & Santa Barbara (continued)	Valley Presbyterian Hospital	40	36	0	0.00	1.92	0.00	(0.00, 10.16)	
	West Hills Regional Medical Center	58	49	5	10.20	3.25	5.97	(1.94, 13.92)	Worse
Greater Los Angeles	Beverly Hospital	21	19	1	5.26	1.63	6.12	(0.15, 34.10)	
	Cedars Sinai Medical Center	174	105	4	3.81	2.10	3.44	(0.94, 8.82)	
	Centinela Hospital Medical Center	44	39	2	5.13	3.38	2.89	(0.35, 10.42)	
	Citrus Valley Medical Center – IC Campus	104	87	2	2.30	1.99	2.20	(0.27, 7.94)	
	Downey Regional Medical Center	55	48	0	0.00	1.22	0.00	(0.00, 11.93)	
	Garfield Medical Center	122	97	3	3.09	1.67	3.53	(0.73, 10.31)	
	Good Samaritan Hospital - Los Angeles	124	103	3	2.91	2.58	2.14	(0.44, 6.26)	
	Huntington Memorial Hospital	70	51	0	0.00	1.97	0.00	(0.00, 6.97)	
	Kaiser Foundation Hospital (Sunset)	632	487	9	1.85	1.88	1.87	(0.85, 3.55)	
	Lakewood Regional Medical Center	128	106	3	2.83	2.60	2.07	(0.43, 6.04)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RAMR falls below the California observed mortality rate (1.90%). 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 left blank) if the California mortality rate falls within the 95% CI of a hospital’s RAMR.

† Hospitals submitted statements regarding this report. See Appendix B for their statements.

**Table 3: Hospital Risk-Adjusted Operative Mortality Results by Region, 2009**

<i>Region</i>	<i>Hospital</i>	<i>All CABG Cases</i>	<i>Isolated CABG Cases</i>	<i>Isolated CABG Mortality</i>	<i>Observed Mortality Rate (%)</i>	<i>Expected Mortality Rate (%)</i>	<i>Risk-Adjusted Mortality Rate (%), RAMR</i>	<i>95% CI for RAMR</i>	<i>Performance Rating*</i>
<b>State</b>		<b>17,211</b>	<b>13,260</b>	<b>252</b>	<b>1.90</b>				
Greater Los Angeles (continued)	Little Company of Mary Hospital	60	50	0	0.00	1.89	0.00	(0.00, 7.42)	
	Long Beach Memorial Medical Center	286	248	5	2.02	1.71	2.24	(0.73, 5.23)	
	Los Angeles Co. Harbor - UCLA Medical Center	86	62	3	4.84	1.82	5.05	(1.04, 14.75)	
	Los Angeles Co. USC Medical Center	116	101	2	1.98	0.73	5.13	(0.62, 18.54)	
	Methodist Hospital of Southern California	45	37	1	2.70	2.98	1.72	(0.04, 9.60)	
	Presbyterian Intercommunity Hospital	97	72	2	2.78	2.02	2.62	(0.32, 9.46)	
	Ronald Reagan UCLA Medical Center	207	114	2	1.75	2.22	1.50	(0.18, 5.42)	
	Santa Monica - UCLA Medical Center	20	18	0	0.00	2.95	0.00	(0.00, 13.18)	
	St. Francis Medical Center	49	48	0	0.00	1.11	0.00	(0.00, 13.11)	
	St. John's Hospital and Health Center	86	50	1	2.00	2.10	1.81	(0.05, 10.11)	
	St. Mary Medical Center	50	44	3	6.82	3.61	3.58	(0.74, 10.47)	
	St. Vincent Medical Center	108	89	2	2.25	1.96	2.18	(0.26, 7.86)	
	Torrance Memorial Medical Center	90	58	0	0.00	2.12	0.00	(0.00, 5.70)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RAMR falls below the California observed mortality rate (1.90%). 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 left blank) if the California mortality rate falls within the 95% CI of a hospital’s RAMR.

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**Table 3: Hospital Risk-Adjusted Operative Mortality Results by Region, 2009**

<i>Region</i>	<i>Hospital</i>	<i>All CABG Cases</i>	<i>Isolated CABG Cases</i>	<i>Isolated CABG Mortality</i>	<i>Observed Mortality Rate (%)</i>	<i>Expected Mortality Rate (%)</i>	<i>Risk-Adjusted Mortality Rate (%), RAMR</i>	<i>95% CI for RAMR</i>	<i>Performance Rating*</i>
<b>State</b>		<b>17,211</b>	<b>13,260</b>	<b>252</b>	<b>1.90</b>				
Greater Los Angeles (continued)	USC University Hospital	178	97	1	1.03	1.70	1.15	(0.03, 6.42)	
	White Memorial Medical Center	50	44	3	6.82	1.58	8.21	(1.69, 24.00)	
Inland Empire, Riverside & San Bernardino	Desert Regional Medical Center	170	138	4	2.90	1.31	4.21	(1.15, 10.78)	
	Eisenhower Memorial Hospital	203	162	3	1.85	2.41	1.46	(0.30, 4.27)	
	Loma Linda University Medical Center	280	212	0	0.00	1.58	0.00	(0.00, 2.09)	
	Pomona Valley Hospital Medical Center	144	121	1	0.83	3.10	0.51	(0.01, 2.82)	
	Riverside Community Hospital	193	151	2	1.32	2.05	1.23	(0.15, 4.43)	
	San Antonio Community Hospital	158	121	1	0.83	2.19	0.72	(0.02, 4.00)	
	St. Bernardine Medical Center	575	488	6	1.23	1.30	1.79	(0.66, 3.90)	
	St. Mary Regional Medical Center	197	182	1	0.55	1.77	0.59	(0.01, 3.29)	
Orange County	Anaheim Memorial Medical Center	143	113	0	0.00	1.56	0.00	(0.00, 3.98)	
	Fountain Valley Regional Hospital	115	105	2	1.90	2.08	1.74	(0.21, 6.28)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RAMR falls below the California observed mortality rate (1.90%). 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 left blank) if the California mortality rate falls within the 95% CI of a hospital’s RAMR.

† Hospitals submitted statements regarding this report. See Appendix B for their statements.

**Table 3: Hospital Risk-Adjusted Operative Mortality Results by Region, 2009**

<i>Region</i>	<i>Hospital</i>	<i>All CABG Cases</i>	<i>Isolated CABG Cases</i>	<i>Isolated CABG Mortality</i>	<i>Observed Mortality Rate (%)</i>	<i>Expected Mortality Rate (%)</i>	<i>Risk-Adjusted Mortality Rate (%), RAMR</i>	<i>95% CI for RAMR</i>	<i>Performance Rating*</i>
<b>State</b>		<b>17,211</b>	<b>13,260</b>	<b>252</b>	<b>1.90</b>				
Orange County (continued)	Hoag Memorial Hospital Presbyterian	217	147	2	1.36	1.42	1.83	(0.22, 6.60)	
	Mission Hospital Regional Medical Center	144	108	1	0.93	1.45	1.22	(0.03, 6.78)	
	Saddleback Memorial Medical Center	147	124	2	1.61	1.48	2.07	(0.25, 7.48)	
	St. Joseph Hospital - Orange	143	118	2	1.69	1.75	1.84	(0.22, 6.65)	
	St. Jude Medical Center	128	109	1	0.92	1.48	1.17	(0.03, 6.54)	
	UC Irvine Medical Center	55	46	0	0.00	1.52	0.00	(0.00, 10.04)	
	West Anaheim Medical Center	11	9	0	0.00	0.74	0.00	(0.00, 100.0)	
	Western Medical Center - Santa Ana	51	45	1	2.22	1.76	2.40	(0.06, 13.36)	
	Western Medical Center Hospital - Anaheim	116	104	1	0.96	2.08	0.88	(0.02, 4.90)	
Greater San Diego	Alvarado Hospital Medical Center	76	65	2	3.08	2.36	2.48	(0.30, 8.96)	
	Palomar Medical Center	126	95	5	5.26	1.74	5.76	(1.87, 13.44)	
	Scripps Green Hospital	83	47	0	0.00	1.31	0.00	(0.00, 11.35)	
	Scripps Memorial Hospital - La Jolla†	413	277	1	0.36	2.37	0.29	(0.01, 1.61)	Better
	Scripps Mercy Hospital†	159	122	8	6.56	1.53	8.14	(3.51, 16.04)	Worse

\*A hospital is classified as “**Better**” if the upper 95% CI of the RAMR falls below the California observed mortality rate (1.90%). 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 left blank) if the California mortality rate falls within the 95% CI of a hospital’s RAMR.

† Hospitals submitted statements regarding this report. See Appendix B for their statements.

**Table 3: Hospital Risk-Adjusted Operative Mortality Results by Region, 2009**

<i>Region</i>	<i>Hospital</i>	<i>All CABG Cases</i>	<i>Isolated CABG Cases</i>	<i>Isolated CABG Mortality</i>	<i>Observed Mortality Rate (%)</i>	<i>Expected Mortality Rate (%)</i>	<i>Risk-Adjusted Mortality Rate (%), RAMR</i>	<i>95% CI for RAMR</i>	<i>Performance Rating*</i>
<b>State</b>		<b>17,211</b>	<b>13,260</b>	<b>252</b>	<b>1.90</b>				
Greater San Diego (continued)	Sharp Chula Vista Medical Center	185	141	3	2.13	2.73	1.48	(0.30, 4.32)	
	Sharp Grossmont Hospital	217	173	8	4.62	2.28	3.86	(1.67, 7.61)	
	Sharp Memorial Hospital	162	95	0	0.00	1.28	0.00	(0.00, 5.74)	
	Tri-City Medical Center	85	69	2	2.90	2.14	2.57	(0.31, 9.29)	
	UCSD Medical Center	28	25	0	0.00	2.53	0.00	(0.00, 11.09)	
	UCSD Medical Center - La Jolla, John M. & Sally B. Thornton Hospital	110	69	0	0.00	1.32	0.00	(0.00, 7.68)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RAMR falls below the California observed mortality rate (1.90%). 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 left blank) if the California mortality rate falls within the 95% CI of a hospital’s RAMR.

† Hospitals submitted statements regarding this report. See Appendix B for their statements.

## VI. RISK MODEL FOR ADJUSTING HOSPITAL POST-OPERATIVE STROKE RATES, 2008-2009

Post-operative stroke is a fairly rare complication that can occur after CABG surgery. To assess hospital performance on this outcome, CCORP combined 2008 and 2009 data to increase the number of cases and reliability of hospital results. Similar to the methodology used to assess the operative mortality rate, CCORP used a multivariable logistic regression model to estimate the relationship between each of the demographic and pre-operative risk factors and the probability of post-operative stroke.

To develop the risk model, the 27,217 isolated (non-salvage) CABG surgery cases (2008 and 2009) were evaluated for missing data (26,449 cases had no missing data in any field and were used for the risk model parameter estimation). The 768 (approximately 3%) 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 768 records were imputed (after risk model parameter estimation) by replacing them with the lowest risk category of the same variable (e.g., *mitral insufficiency = none/trivial/mild*). CCORP assigned the lowest risk value based on the following rationale: 1) some hospitals leave data fields blank by design when the risk factor is absent or the value is normal; 2) to maintain consistency with other major cardiac reporting programs that 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 post-operative stroke. CCORP summed these probabilities to estimate the expected outcome for each hospital. The risk model, based on the 2008-2009 data, is presented in Table 4 with statistically significant risk factors identified in bolded text.

<b>GUIDE TO INTERPRETING TABLE 4: LOGISTIC REGRESSION RISK MODEL FOR POST-OPERATIVE STROKE, 2008-2009</b>	
Coefficient	The coefficient for each explanatory factor represents the effect that factor has on a patient's likelihood of having post-operative stroke unresolved within 24 hours following bypass surgery. If the value is positive, it means that the characteristic is associated with an increased risk of post-operative stroke compared to not having the characteristic, while controlling for the effect of all of the other factors. If the coefficient is negative, having that characteristic is associated with a lower risk of post-operative stroke compared to not having the characteristic. The larger the value (whether positive or negative), the greater the effect or weight this characteristic has on the risk of post-operative stroke. For example, note that the coefficient for "cerebrovascular disease" is 0.525 and is statistically significant. This value is positive, so it indicates that CABG patients with cerebrovascular disease are at an increased risk of post-operative stroke 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.
Odds Ratio	An odds ratio is another way of characterizing the impact of each factor on post-operative stroke. Mathematically, the odds ratio is the antilogarithm of the coefficient value. The larger the odds ratio, the greater the impact that characteristic has on the risk of post-operative stroke. An odds ratio close to 1.0 means the effect of the factor is close to neutral. For example, the odds ratio for cerebrovascular disease is 1.691. This means that for patients with "cerebrovascular disease", the odds of post-operative stroke is about 69% higher compared to patients without "cerebrovascular disease", assuming all other risk factors are the same.

**Table 4: Logistic Regression Risk Model for Post-Operative Stroke, 2008-2009**

<b>Risk Factors</b>		<b>Coefficient</b>	<b>Standard Error</b>	<b>p-value</b>	<b>Odds Ratio</b>
Intercept		-7.908	0.578	<.0001	.
Age		<b>0.0251</b>	<b>0.006</b>	<b>&lt;0.001</b>	<b>1.025</b>
Gender	<b>Female vs. Male</b>	<b>0.335</b>	<b>0.122</b>	<b>0.006</b>	<b>1.398</b>
Race	<b>Non-White vs. White</b>	<b>0.302</b>	<b>0.119</b>	<b>0.011</b>	<b>1.352</b>
Status of the Procedure	<b>Elective</b>	Reference			
	<b>Urgent</b>	<b>0.602</b>	<b>0.155</b>	<b>0.0001</b>	<b>1.826</b>
	Emergent	<b>1.114</b>	<b>0.299</b>	<b>0.0002</b>	<b>3.047</b>
Last Creatinine Level PreOp (mg/dl)		<b>0.5719</b>	<b>0.189</b>	<b>0.003</b>	<b>1.772</b>
Hypertension		0.078	0.194	0.689	1.081
Peripheral Vascular Disease		0.245	0.143	0.087	1.277
Cerebrovascular Disease		<b>0.525</b>	<b>0.187</b>	<b>0.005</b>	<b>1.691</b>
Cerebrovascular Accident Timing	No CVA	Reference			
	> 2 weeks	0.112	0.218	0.606	1.119
	<b>&lt;= 2 weeks</b>	<b>1.337</b>	<b>0.577</b>	<b>0.021</b>	<b>3.806</b>
Diabetes		0.091	0.122	0.456	1.096
Chronic Lung Disease (CLD)	None/Mild	Reference			
	Moderate	0.150	0.228	0.511	1.161
	Severe	0.102	0.259	0.695	1.107
Immunosuppressive Treatment		0.0582	0.330	0.860	1.060
Arrhythmia: Third Degree Heart Block		0.5516	0.399	0.167	1.736
Timing of Myocardial Infarction	No MI	Reference			
	21+ days ago	-0.142	0.179	0.425	0.867
	8-21 days ago	0.238	0.227	0.294	1.268
	1-7 days ago	0.018	0.150	0.907	1.018
	Within 24 hours	0.116	0.275	0.673	1.123
Cardiogenic Shock		0.562	0.322	0.081	1.754
Heart Failure		0.064	0.143	0.653	1.066
Ejection Fraction (%)		-0.004	0.004	0.341	0.996
Number of Diseased Vessels	0, 1, or 2	Reference			
	<b>3 or more</b>	<b>0.491</b>	<b>0.163</b>	<b>0.003</b>	<b>1.634</b>
Year	2009 vs. 2008	-0.067	0.115	0.560	0.935

**Bolded text** indicates statistical significance.

Note: "Last Creatinine PreOp" and "Ejection Fraction" were modeled using piecewise linear transformations.

## Discrimination

Risk models that distinguish well between patients who have an adverse event and those who do not 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 has post-operative stroke and the other does not, the C-statistic describes the proportion of pairs where the patient with a post-operative stroke had a higher predicted risk of post-operative stroke than the patient with no stroke. C-statistics range from 0.5 to 1, with higher values indicating better discrimination. For the 2008-2009 risk model, the C-statistic was 0.714. The CCORP 2008-2009 risk model compares favorably with the Society of Thoracic Surgeons' recently published post-operative stroke model (C-statistic = 0.716 for isolated CABG surgery).<sup>8</sup>

## Calibration

Calibration refers to the ability of a risk model to match predicted and observed post-operative stroke cases. A model in which the number of observed stroke cases matches closely with the number of stroke cases predicted by the model demonstrates good calibration. Good calibration is essential for accurate risk adjustment. A common measure of calibration is the Hosmer-Lemeshow  $\chi^2$  test, which compares observed and predicted outcomes over deciles of risk. The p-value of the Hosmer-Lemeshow test statistic for this post-operative stroke risk model is 0.518, indicating adequate calibration. That is, predicted post-operative stroke was consistent with actual post-operative stroke in the data.

Another way to test model calibration is to partition the data and compare observed stroke cases with predicted stroke cases in each of 10 risk groups. The 10 risk groups are created by sorting all observations by the predicted risk of post-operative stroke and then dividing the sorted observations into deciles of approximately equal size. As presented in Table 5, Risk Group 1 shows the patients in the lowest risk group. Among the 2,251 patients in this group, 9 patients had post-operative strokes, but the model predicted 8.0 cases. Assuming a Poisson distribution for a binary outcome, the predicted range of strokes for this group is 2.5 to 13.5. The observed number of 9 strokes falls within the range of predicted strokes. In fact, none of the 10 risk groups has either significantly fewer or significantly more post-operative strokes than were predicted by the model. Overall the risk model shows no systematic underestimation or overestimation of stroke cases at the extremes.

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<sup>8</sup> Shahian DM, O'Brien SM, Filardo G, et al. The Society of Thoracic Surgeons 2008 cardiac surgery risk models: part 1—coronary artery bypass grafting surgery. *Ann Thorac Surg* 2009; 88:S2-22.

**Table 5: Calibration of Risk Model for Post-Operative Stroke, 2008-2009**

<b>Risk Group</b>	<b>Isolated CABG Cases</b>	<b>Observed Post-op Strokes</b>	<b>Predicted Post-op Strokes</b>	<b>Difference</b>	<b>95%CI of Predicted Post-op Strokes</b>
1	2,251	9	8.0	-1.0	(2.5, 13.5)
2	2,253	9	12.1	3.1	(5.3, 18.9)
3	2,250	11	15.4	4.4	(7.7, 23.1)
4	2,250	14	18.5	4.5	(10.1, 27.0)
5	2,250	25	22.0	-3.0	(12.8, 31.2)
6	2,250	25	26.0	1.0	(16.0, 36.0)
7	2,250	38	31.3	-6.8	(20.3, 42.2)
8	2,250	33	38.7	5.7	(26.5, 50.9)
9	2,250	59	51.6	-7.4	(37.5, 65.7)
10	2,243	98	97.4	-0.6	(78.1, 116.8)
Total	22,497	321	321.0	0	

## VII. RISK-ADJUSTED POST-OPERATIVE STROKE RESULTS AND HOSPITAL PERFORMANCE RATINGS, 2008-2009

### Process for Calculating RASR and Performance Ratings

The risk-adjusted post-operative stroke rate (RASR) represents the best estimate of what a healthcare provider's post-operative stroke rate would have been if the provider had a patient case mix identical to the statewide average. Thus, this rate is comparable among providers because it accounts for the differences in patient severity-of-illness.

The RASR is computed first by dividing the provider's number of patient strokes by the provider's expected number of patient strokes (based on the risk model) to obtain the observed/expected (O/E) ratio. If the O/E ratio is greater than one, the provider has a higher stroke rate than expected based on patient mix. If the O/E ratio is less than one, the provider has a lower stroke rate than expected. The O/E ratio is then multiplied by the average state post-operative stroke rate (1.41% for 2008-2009) to obtain the provider's risk-adjusted stroke rate.

The performance rating is based on a comparison of the 95% confidence interval (CI) of each provider's RASR to the California average post-operative stroke rate. Thus, CCORP treated 2008-2009 data as a sample, and inferred the range in which each provider's true performance was likely to fall. As shown in Table 6, if the upper 95% CI of a provider's risk-adjusted stroke rate is below the state average stroke rate, indicating the provider's RASR is significantly lower than the state average, the performance rating is "**Better.**" If the lower 95% CI of a provider's RASR is above the state average stroke rate, indicating the provider's risk-adjusted stroke rate is significantly higher than the state average, the performance rating is "**Worse.**" If the state average stroke rate is within the 95% CI of a provider's RASR, the performance rating is "**Not Different**" and left blank.

<b>GUIDE TO INTERPRETING TABLE 6: HOSPITAL RISK-ADJUSTED POST-OPERATIVE STROKE RESULTS BY REGION, 2008-2009</b>	
All CABG Cases	The total number of isolated and non-isolated CABG cases submitted to CCORP for 2008 and 2009 combined. 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. All patients in salvage operative status are excluded from the isolated CABG cases, thus only isolated CABG cases without salvage operative status are used in calculating performance ratings.
Isolated CABG Post-op strokes	The actual number of post-operative strokes that were unresolved (> 24 hours) for isolated CABG cases for the time period indicated.
Observed Post-op Stroke Rate	The ratio of the number of isolated CABG with post-operative stroke and the isolated CABG cases multiplied by 100: Observed Post-operative Stroke Rate = Number of Isolated CABG Post-op Strokes/Isolated CABG Cases X 100.
Expected Post-op Stroke Rate	The ratio of the expected number of post-operative strokes predicted for a provider (after risk adjusting for their patient population) and the isolated CABG cases multiplied by 100: Expected Post-operative Stroke Rate = Number of Expected Post-operative Strokes/Number of Isolated CABG Cases X 100.
Risk-Adjusted Post-operative Stroke Rate (95% CI)	The Risk-Adjusted Post-operative Stroke Rate (RASR) is obtained by multiplying the observed state post-operative stroke rate by a provider's O/E ratio. The 95% confidence interval represents the confidence we have in the estimate for the RASR. The lower and upper confidence limits are calculated using Poisson exact confidence interval calculations.
Performance Rating	The performance rating is based on a comparison of each provider's risk-adjusted post-operative stroke rate and the state observed post-operative stroke rate. This is a test of statistical significance. A provider is classified as " <b>Better</b> " if the upper 95% confidence limit of its RASR falls below the California observed post-operative stroke rate. A provider is classified as " <b>Worse</b> " if the lower 95% confidence limit of its RASR is higher than the California observed post-operative stroke rate. A provider is classified as " <b>Not Different</b> " (performance rating is blank) if the California post-operative stroke rate falls within the confidence interval of the provider's risk-adjusted post-operative stroke rate.

## 2008-2009 Hospital Risk-Adjusted Post-Operative Stroke Results

Table 6 presents the risk-adjusted results for each hospital for 2008-2009. The table is sorted by geographic region and contains, for each hospital, total number of CABG surgeries performed (isolated and non-isolated combined), number of isolated CABG surgeries (excluding salvage cases), number of observed isolated CABG post-operative stroke cases, observed post-operative stroke rate, expected post-operative stroke rate predicted by the risk model, RASR and 95% CI of the RASR, and the associated hospital performance rating.

Among the 27,217 isolated CABG surgeries performed in 2008-2009, 384 patients had a post-operative stroke in-hospital, reflecting an overall rate of 1.41%. Among 384 patients with post-operative stroke, 69 (18.0%) died either in hospital or after discharge but within 30 days of CABG surgery. The observed stroke rate among hospitals ranged from 0% to 10.53%. The expected stroke rates, which are generated by the model and measure patient severity of illness, were between 0.97% and 2.13%. The risk-adjusted stroke rates, which measure hospital performance, ranged from 0% to 8.87%.

Based on the 95% confidence intervals for risk-adjusted stroke rates, 114 of 121 hospitals (94%) performed within the expected range compared to the state's average stroke rate (denoted by a blank space in the performance rating column of Table 6), three hospitals performed significantly "**Better**" than the state average, and four hospitals performed significantly "**Worse**" than the state average. Hospitals marked with † in Table 6 submitted statements regarding this report and are presented in Appendix B.

**Table 6: Hospital Risk-Adjusted Post-Operative Stroke Results by Region, 2008-2009**

<i>Region</i>	<i>Hospital</i>	<i>All CABG Cases</i>	<i>Isolated CABG Cases</i>	<i>Isolated CABG Post-Operative Stroke</i>	<i>Observed Post-Operative Stroke Rate (%)</i>	<i>Expected Post-Operative Stroke Rate (%)</i>	<i>Risk-Adjusted Post-Operative Stroke Rate (% RASR)</i>	<i>95% CI for RASR</i>	<i>Performance Rating*</i>
<b>State</b>		<b>35,251</b>	<b>27,217</b>	<b>384</b>	<b>1.41</b>				
Sacramento Valley & Northern California Region	Enloe Medical Center	326	289	1	0.35	1.39	0.35	(0.01, 1.95)	
	Mercy General Hospital	1,636	1,095	21	1.92	1.21	2.24	(1.38, 3.42)	
	Mercy Medical Center - Redding	351	268	2	0.75	1.26	0.84	(0.10, 3.01)	
	Mercy San Juan Hospital	279	211	3	1.42	1.30	1.54	(0.32, 4.50)	
	North Bay Medical Center	19	19	0	0.00	1.04	0.00	(0.00, 26.45)	
	Rideout Memorial Hospital	332	271	5	1.85	1.35	1.93	(0.62, 4.49)	
	Shasta Regional Medical Center	111	103	1	0.97	1.30	1.06	(0.03, 5.87)	
	St. Joseph Hospital - Eureka	129	96	0	0.00	1.37	0.00	(0.00, 3.95)	
	Sutter Memorial Hospital	908	642	8	1.25	1.29	1.37	(0.59, 2.69)	
	UC Davis Medical Center	410	273	4	1.47	1.50	1.39	(0.38, 3.54)	
San Francisco Bay Area & San Jose	Alta Bates Summit Medical Center - Summit Campus	1,187	937	5	0.53	1.32	0.57	(0.19, 1.33)	Better
	California Pacific Medical Center - Pacific Campus	174	122	2	1.64	1.30	1.78	(0.21, 6.40)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RASR falls below the California observed post-operative stroke rate (1.41%). A hospital is classified as “**Worse**” if the lower 95% CI of the RASR is higher than the California observed post-operative stroke rate. A hospital’s performance is considered “**Not Different**” from the state average (rating is left blank) if the California post-operative stroke rate falls within the 95% CI of a hospital’s RASR.

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<b>State</b>		<b>35,251</b>	<b>27,217</b>	<b>384</b>	<b>1.41</b>				
San Francisco Bay Area & San Jose (continued)	Community Hospital Monterey Peninsula	182	132	1	0.76	1.02	1.05	(0.03, 5.83)	
	Dominican Hospital	162	129	4	3.10	1.44	3.04	(0.83, 7.76)	
	El Camino Hospital	162	122	2	1.64	1.34	1.73	(0.21, 6.24)	
	Good Samaritan Hospital - San Jose†	227	169	7	4.14	1.43	4.11	(1.65, 8.44)	Worse
	John Muir Medical Center - Concord Campus	608	481	9	1.87	1.39	1.90	(0.87, 3.60)	
	Kaiser Foundation Hospital (Geary San Francisco)	660	490	6	1.22	1.21	1.44	(0.53, 3.12)	
	Kaiser Foundation Hospital (Santa Clara)	384	238	3	1.26	1.34	1.33	(0.27, 3.87)	
	Marin General Hospital	96	76	0	0.00	0.97	0.00	(0.00, 7.03)	
	O'Connor Hospital	139	117	3	2.56	2.13	1.70	(0.35, 4.95)	
	Peninsula Medical Center	91	66	2	3.03	1.20	3.59	(0.43, 12.91)	
Queen of the Valley Hospital	299	239	4	1.67	1.61	1.47	(0.40, 3.76)		
Regional Medical of San Jose	75	66	3	4.55	1.72	3.75	(0.77, 10.91)		

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<b>State</b>		<b>35,251</b>	<b>27,217</b>	<b>384</b>	<b>1.41</b>				
San Francisco Bay Area & San Jose (continued)	Salinas Valley Memorial Hospital	256	205	1	0.49	1.39	0.50	(0.01, 2.77)	
	San Ramon Regional Medical Center	90	70	1	1.43	1.06	1.91	(0.05, 10.61)	
	Santa Clara Valley Medical Center	93	82	0	0.00	1.02	0.00	(0.00, 6.20)	
	Santa Rosa Memorial Hospital	153	125	0	0.00	1.49	0.00	(0.00, 2.79)	
	Sequoia Hospital	242	136	0	0.00	1.14	0.00	(0.00, 3.36)	
	Seton Medical Center	337	298	7	2.35	1.73	1.92	(0.77, 3.94)	
	St. Helena Hospital	145	124	4	3.23	1.81	2.53	(0.69, 6.45)	
	St. Mary's Medical Center, San Francisco	66	54	3	5.56	1.52	5.18	(1.07, 15.10)	
	Stanford University Hospital	305	194	1	0.52	1.21	0.60	(0.02, 3.34)	
	Sutter Medical Center of Santa Rosa	180	131	1	0.76	1.17	0.92	(0.02, 5.14)	
	UCSF Medical Center	200	143	1	0.70	0.98	1.01	(0.03, 5.63)	
	Valleycare Medical Center	88	70	0	0.00	1.86	0.00	(0.00, 4.00)	
	Washington Hospital - Fremont	249	226	3	1.33	1.50	1.25	(0.26, 3.65)	

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<b>State</b>		<b>35,251</b>	<b>27,217</b>	<b>384</b>	<b>1.41</b>				
Central California	Bakersfield Heart Hospital	377	319	5	1.57	1.20	1.85	(0.60, 4.30)	
	Bakersfield Memorial Hospital	322	273	9	3.30	1.07	4.38	(2.00, 8.28)	Worse
	Community Medical Center - Fresno	473	399	7	1.75	1.62	1.53	(0.61, 3.15)	
	Dameron Hospital	98	92	3	3.26	1.47	3.14	(0.65, 9.14)	
	Doctors Medical Center - Modesto Campus	649	509	7	1.38	1.57	1.24	(0.50, 2.55)	
	Fresno Heart Hospital	493	402	2	0.50	1.13	0.63	(0.08, 2.25)	
	Kaweah Delta Hospital	593	460	6	1.30	1.53	1.21	(0.44, 2.62)	
	Marian Medical Center	157	125	1	0.80	1.57	0.72	(0.02, 4.01)	
	Memorial Medical Center of Modesto	550	445	9	2.02	1.47	1.94	(0.88, 3.67)	
	San Joaquin Community Hospital	168	149	2	1.34	1.45	1.31	(0.16, 4.71)	
	St. Agnes Medical Center	551	460	7	1.52	1.47	1.46	(0.59, 3.00)	
	St. Joseph's Medical Center of Stockton	617	487	1	0.21	1.30	0.22	(0.01, 1.24)	Better

\*A hospital is classified as “**Better**” if the upper 95% CI of the RASR falls below the California observed post-operative stroke rate (1.41%). A hospital is classified as “**Worse**” if the lower 95% CI of the RASR is higher than the California observed post-operative stroke rate. A hospital’s performance is considered “**Not Different**” from the state average (rating is left blank) if the California post-operative stroke rate falls within the 95% CI of a hospital’s RASR.

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<b>State</b>		<b>35,251</b>	<b>27,217</b>	<b>384</b>	<b>1.41</b>				
San Fernando Valley, Antelope Valley, Ventura & Santa Barbara	Antelope Valley Hospital Medical Center	49	45	0	0.00	1.44	0.00	(0.00, 8.03)	
	Community Memorial Hospital of San Buenaventura	200	167	2	1.20	1.54	1.10	(0.13, 3.96)	
	French Hospital Medical Center	259	194	1	0.52	1.20	0.61	(0.02, 3.38)	
	Glendale Adventist Medical Center - Wilson Terrace	248	223	4	1.79	1.26	2.01	(0.55, 5.13)	
	Glendale Memorial Hospital and Health Center	427	283	3	1.06	1.49	1.01	(0.21, 2.93)	
	Lancaster Community Hospital	14	13	1	7.69	1.23	8.87	(0.22, 49.26)	
	Los Robles Regional Medical Center	183	136	2	1.47	1.55	1.34	(0.16, 4.84)	
	Northridge Hospital Medical Center	178	151	3	1.99	1.45	1.93	(0.40, 5.63)	
	Providence Holy Cross Medical Center	177	128	1	0.78	1.59	0.70	(0.02, 3.87)	

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<b>State</b>		<b>35,251</b>	<b>27,217</b>	<b>384</b>	<b>1.41</b>				
San Fernando Valley, Antelope Valley, Ventura & Santa Barbara (continued)	Providence St. Joseph Medical Center	144	111	3	2.70	1.29	2.96	(0.61, 8.63)	
	Providence Tarzana Medical Center	178	137	7	5.11	1.35	5.35	(2.14, 10.99)	Worse
	Santa Barbara Cottage Hospital	309	239	4	1.67	1.30	1.83	(0.50, 4.66)	
	Sierra Vista Regional Medical Center	20	19	2	10.53	2.05	7.25	(0.88, 26.12)	
	St. John's Regional Medical Center	213	164	5	3.05	1.61	2.68	(0.87, 6.24)	
	Valley Presbyterian Hospital	77	71	1	1.41	1.33	1.49	(0.04, 8.29)	
	West Hills Regional Medical Center	112	96	4	4.17	1.25	4.70	(1.28, 12.00)	
	Greater Los Angeles	Beverly Hospital	31	27	0	0.00	1.17	0.00	(0.00, 16.47)
	Cedars Sinai Medical Center	407	239	2	0.84	1.05	1.13	(0.14, 4.05)	
	Centinela Hospital Medical Center	97	88	4	4.55	1.92	3.35	(0.91, 8.56)	
	Citrus Valley Medical Center – IC Campus	181	147	2	1.36	1.52	1.27	(0.15, 4.56)	

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<b>State</b>		<b>35,251</b>	<b>27,217</b>	<b>384</b>	<b>1.41</b>				
Greater Los Angeles (continued)	Downey Regional Medical Center	121	104	0	0.00	1.14	0.00	(0.00, 4.37)	
	Garfield Medical Center	254	217	2	0.92	1.83	0.71	(0.09, 2.56)	
	Good Samaritan Hospital - Los Angeles	266	219	1	0.46	1.78	0.36	(0.01, 2.01)	
	Huntington Memorial Hospital	148	106	1	0.94	1.42	0.94	(0.02, 5.22)	
	Kaiser Foundation Hospital (Sunset)	1,293	986	12	1.22	1.51	1.14	(0.59, 1.99)	
	Lakewood Regional Medical Center	224	190	2	1.05	1.77	0.84	(0.10, 3.03)	
	Little Company of Mary Hospital	138	103	3	2.91	1.75	2.36	(0.48, 6.86)	
	Long Beach Memorial Medical Center	552	474	3	0.63	1.33	0.67	(0.14, 1.96)	
	Los Angeles Co. Harbor - UCLA Medical Center	172	141	1	0.71	1.42	0.71	(0.02, 3.92)	
	Los Angeles Co. USC Medical Center	215	186	1	0.54	1.22	0.63	(0.02, 3.47)	
	Methodist Hospital of Southern California	113	95	3	3.16	1.65	2.71	(0.56, 7.89)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RASR falls below the California observed post-operative stroke rate (1.41%). A hospital is classified as “**Worse**” if the lower 95% CI of the RASR is higher than the California observed post-operative stroke rate. A hospital’s performance is considered “**Not Different**” from the state average (rating is left blank) if the California post-operative stroke rate falls within the 95% CI of a hospital’s RASR.

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Greater Los Angeles (continued)	Presbyterian Intercommunity Hospital	210	145	1	0.69	1.54	0.63	(0.02, 3.53)	
	Ronald Reagan UCLA Medical Center	403	226	3	1.33	1.31	1.43	(0.29, 4.18)	
	Santa Monica - UCLA Medical Center	44	39	0	0.00	1.95	0.00	(0.00, 6.83)	
	St. Francis Medical Center	89	85	0	0.00	1.14	0.00	(0.00, 5.36)	
	St. John's Hospital and Health Center	175	112	2	1.79	1.11	2.27	(0.27, 8.19)	
	St. Mary Medical Center	103	90	0	0.00	2.10	0.00	(0.00, 2.75)	
	St. Vincent Medical Center	239	201	3	1.49	1.56	1.36	(0.28, 3.95)	
	Torrance Memorial Medical Center	193	120	2	1.67	1.35	1.74	(0.21, 6.27)	
	USC University Hospital	343	180	3	1.67	1.31	1.80	(0.37, 5.24)	
	White Memorial Medical Center	111	100	4	4.00	1.49	3.80	(1.03, 9.69)	
Inland Empire, Riverside & San Bernardino	Desert Regional Medical Center	369	293	4	1.37	1.29	1.50	(0.41, 3.82)	

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<b>State</b>		<b>35,251</b>	<b>27,217</b>	<b>384</b>	<b>1.41</b>				
Inland Empire, Riverside & San Bernardino (continued)	Eisenhower Memorial Hospital	471	369	7	1.90	1.43	1.87	(0.75, 3.85)	
	Loma Linda University Medical Center	604	462	6	1.30	1.44	1.27	(0.47, 2.76)	
	Pomona Valley Hospital Medical Center	320	270	5	1.85	1.75	1.50	(0.48, 3.48)	
	Riverside Community Hospital	449	369	3	0.81	1.33	0.87	(0.18, 2.52)	
	San Antonio Community Hospital	301	225	6	2.67	1.58	2.38	(0.87, 5.16)	
	St. Bernardine Medical Center	1,164	999	5	0.50	1.26	0.56	(0.18, 1.31)	Better
	St. Mary Regional Medical Center	409	368	2	0.54	1.46	0.52	(0.06, 1.89)	
Orange County	Anaheim Memorial Medical Center	310	254	2	0.79	1.37	0.81	(0.10, 2.93)	
	Fountain Valley Regional Hospital	244	229	2	0.87	1.48	0.84	(0.10, 3.01)	
	Hoag Memorial Hospital Presbyterian	454	292	6	2.05	1.05	2.78	(1.02, 6.03)	
	Irvine Regional Hospital and Medical Center	40	32	0	0.00	1.76	0.00	(0.00, 9.21)	

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Orange County (continued)	Mission Hospital Regional Medical Center	268	206	0	0.00	1.11	0.00	(0.00, 2.28)	
	Saddleback Memorial Medical Center	263	224	0	0.00	1.06	0.00	(0.00, 2.18)	
	St. Joseph Hospital - Orange	272	222	4	1.80	1.20	2.12	(0.58, 5.42)	
	St. Jude Medical Center	232	196	4	2.04	1.16	2.50	(0.68, 6.37)	
	UC Irvine Medical Center	115	88	0	0.00	1.33	0.00	(0.00, 4.45)	
	West Anaheim Medical Center	28	26	0	0.00	1.43	0.00	(0.00, 14.01)	
	Western Medical Center - Santa Ana	91	81	2	2.47	1.45	2.41	(0.29, 8.69)	
	Western Medical Center Hospital - Anaheim	224	200	2	1.00	1.43	0.99	(0.12, 3.55)	
Greater San Diego	Alvarado Hospital Medical Center	160	134	1	0.75	1.49	0.71	(0.02, 3.93)	
	Palomar Medical Center	213	157	0	0.00	1.20	0.00	(0.00, 2.77)	
	Scripps Green Hospital	209	131	1	0.76	1.12	0.96	(0.02, 5.34)	
	Scripps Memorial Hospital - La Jolla†	788	531	17	3.20	1.46	3.10	(1.80, 4.94)	Worse

\*A hospital is classified as “**Better**” if the upper 95% CI of the RASR falls below the California observed post-operative stroke rate (1.41%). A hospital is classified as “**Worse**” if the lower 95% CI of the RASR is higher than the California observed post-operative stroke rate. A hospital’s performance is considered “**Not Different**” from the state average (rating is left blank) if the California post-operative stroke rate falls within the 95% CI of a hospital’s RASR.

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**Table 6: Hospital Risk-Adjusted Post-Operative Stroke Results by Region, 2008-2009**

<i>Region</i>	<i>Hospital</i>	<i>All CABG Cases</i>	<i>Isolated CABG Cases</i>	<i>Isolated CABG Post-Operative Stroke</i>	<i>Observed Post-Operative Stroke Rate (%)</i>	<i>Expected Post-Operative Stroke Rate (%)</i>	<i>Risk-Adjusted Post-Operative Stroke Rate (% RASR)</i>	<i>95% CI for RASR</i>	<i>Performance Rating*</i>
<b>State</b>		<b>35,251</b>	<b>27,217</b>	<b>384</b>	<b>1.41</b>				
Greater San Diego (continued)	Scripps Mercy Hospital†	301	232	6	2.59	1.34	2.73	(1.00, 5.93)	
	Sharp Chula Vista Medical Center	365	279	6	2.15	1.80	1.69	(0.62, 3.67)	
	Sharp Grossmont Hospital	416	322	8	2.48	1.60	2.20	(0.95, 4.31)	
	Sharp Memorial Hospital	366	227	3	1.32	1.10	1.69	(0.35, 4.93)	
	Tri-City Medical Center	202	159	5	3.14	1.20	3.71	(1.20, 8.62)	
	UCSD Medical Center	70	59	1	1.69	1.58	1.52	(0.04, 8.45)	
	UCSD Medical Center - La Jolla, John M. & Sally B. Thornton Hospital	224	155	1	0.65	1.18	0.77	(0.02, 4.28)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RASR falls below the California observed post-operative stroke rate (1.41%). A hospital is classified as “**Worse**” if the lower 95% CI of the RASR is higher than the California observed post-operative stroke rate. A hospital’s performance is considered “**Not Different**” from the state average (rating is left blank) if the California post-operative stroke rate falls within the 95% CI of a hospital’s RASR.

† Hospitals submitted statements regarding this report. See Appendix B for their statements.

## VIII. RISK MODEL FOR ADJUSTING 30-DAY HOSPITAL READMISSION RATES, 2009

Readmissions account for a significant percentage of hospital healthcare costs. To assess hospital performance on this outcome, CCORP limited the analysis to isolated CABG surgery patients readmitted to an acute care hospital within 30 days of being discharged to home or a non-acute care setting. A readmission was counted only if the patient was readmitted with a principal diagnosis (i.e., principal reason for the readmission) that indicated a heart-related condition, or an infection or a complication that was likely related to the CABG surgery (see Appendix A for a list of principal diagnosis categories and their associated ICD-9-CM codes that were included in the readmissions analysis).

Similar to the methodology used to assess the operative mortality and post-operative stroke rate, CCORP used a multivariable logistic regression model to estimate relationship between each of the demographic and pre-operative risk factors and the probability of 30-day readmission. Multivariable logistic regression models relate the probability of readmission to the risk factor (e.g., *patient age*) while controlling for all other risk factors in the model.

To develop the risk model, the 11,823 isolated (non-salvage) CABG surgery cases discharged alive in 2009 were evaluated for missing data (11,811 cases had no missing data in any field and were used for the risk model parameter estimation). The 12 (0.1%) 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 results, missing values for these 12 records were imputed (after risk model parameter estimation) by replacing them with the lowest risk category of the same variable (e.g., *chronic lung disease = none*). CCORP assigned the lowest risk value based on the following rationales: 1) some hospitals leave data fields blank by design when the risk factor is absent or the value is normal; 2) to maintain consistency with other major cardiac reporting programs that 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 readmission. CCORP summed these probabilities to estimate the expected readmission for each hospital. The risk model, based on the 2009 data, is presented in Table 7 with statistically significant risk factors identified in bolded text.

<b>GUIDE TO INTERPRETING TABLE 7: LOGISTIC REGRESSION RISK MODEL FOR 30-DAY READMISSION, 2009</b>	
Coefficient	The coefficient for each explanatory factor represents the effect that factor has on a patient's likelihood of hospital readmission within 30 days following bypass surgery. If the value is positive, it means that the characteristic is associated with an increased risk of readmission 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 readmission compared to not having the characteristic. The larger the value (whether positive or negative), the greater the effect or weight this characteristic has on the risk of readmission. For example, note that the coefficient for "female gender" is 0.320 and is statistically significant. This value is positive, so it indicates that female patients undergoing CABG are at an increased risk of being readmitted to hospital after surgery compared to male patients.
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.
Odds Ratio	An odds ratio is another way of characterizing the impact of each factor on readmission. Mathematically, the odds ratio is the antilogarithm of the coefficient value. The larger the odds ratio, the greater the impact that characteristic has on the risk of readmission. An odds ratio close to 1.0 means the effect of the factor is close to neutral. For example, the odds ratio for "female gender" is 1.378. This means that for females undergoing CABG surgery, the odds of readmission is about 38% higher compared to male patients, assuming all other risk factors are the same.

**Table 7: Logistic Regression Risk Model for 30-Day Readmissions, 2009**

Risk Factor		Coefficient	Standard Error	p-value	Odds Ratio
Intercept		-4.114	0.269	<.0001	
Patient Age (Years)		<b>0.014</b>	<b>0.003</b>	<b>&lt;.0001</b>	<b>1.014</b>
Gender	<b>Female vs. Male</b>	<b>0.320</b>	<b>0.062</b>	<b>&lt;.0001</b>	<b>1.378</b>
Race	Non-White vs. White	<b>0.215</b>	<b>0.059</b>	<b>0.0003</b>	<b>1.239</b>
Body Mass Index	18.5-39.9	Reference			
	< 18.5	-0.052	0.311	0.867	0.949
	<b>≥ 40</b>	<b>0.381</b>	<b>0.125</b>	<b>0.002</b>	<b>1.463</b>
Status of the Procedure	Elective	Reference			
	<b>Urgent</b>	<b>0.150</b>	<b>0.061</b>	<b>0.014</b>	<b>1.162</b>
	Emergent	0.180	0.171	0.292	1.197
Last Creatinine PreOp (mg/dl)		<b>0.565</b>	<b>0.099</b>	<b>&lt;.0001</b>	<b>1.759</b>
Hypertension		0.148	0.095	0.120	1.160
Peripheral Arterial Disease		<b>0.207</b>	<b>0.075</b>	<b>0.006</b>	<b>1.230</b>
Cerebrovascular Disease		0.187	0.107	0.080	1.206
Cerebrovascular Accident Timing	No CVA	Reference			
	> 2 weeks	0.138	0.132	0.296	1.147
	≤ 2 weeks	0.428	0.532	0.421	1.533
Diabetes		<b>0.180</b>	<b>0.059</b>	<b>0.002</b>	<b>1.198</b>
Chronic Lung Disease	None/Mild	Reference			
	Moderate	0.186	0.110	0.091	1.205
	Severe	0.132	0.129	0.307	1.141
Immunosuppressive Treatment		0.234	0.156	0.133	1.263
Arrhythmia Type	<b>Afib/Flutter</b>	<b>0.485</b>	<b>0.094</b>	<b>&lt;.0001</b>	<b>1.625</b>
Cardiogenic Shock		0.355	0.276	0.197	1.427
Heart Failure		<b>0.241</b>	<b>0.072</b>	<b>0.001</b>	<b>1.272</b>
Prior Cardiac Surgery	None	Reference			
	One or more	0.117	0.145	0.420	1.124
Interval from Prior PCI to Surgery	No prior PCIs	Reference			
	<b>Prior PCI &gt; 6 HRS</b>	<b>0.142</b>	<b>0.065</b>	<b>0.029</b>	<b>1.152</b>
	Prior PCI ≤ 6 HRS	0.287	0.270	0.287	1.333
Ejection Fraction		-0.004	0.002	0.084	0.996
Resuscitation		0.154	0.671	0.818	1.166

**Bolded text** indicates statistical significance.

*Note:* "Last Creatinine PreOp", "Ejection Fraction", and "Left Main Stenosis" were modeled using piecewise linear transformations.

## Discrimination

Risk models that distinguish well between patients who were readmitted to a hospital and those who were not 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 patient is readmitted and the other is not readmitted, the C-statistic describes the proportion of pairs where the patient who was readmitted had a higher predicted risk of readmission than the patient who was not. C-statistics range from 0.5 to 1, with higher values indicating better discrimination. For the 2009 risk model, the C-statistic was 0.642. In recently published CABG surgery readmission reports by Pennsylvania (2007-2008 data), the C-statistic was 0.637, which is similar to the 2009 CCORP model.

## Calibration

Calibration refers to the ability of a risk model to match predicted readmission with observed readmission. A model in which the number of observed readmissions matches closely with the number of readmissions predicted by the model demonstrates good calibration. Good calibration is essential for accurate risk adjustment. A common measure of calibration is the Hosmer-Lemeshow  $\chi^2$  test, which compares observed and predicted outcomes over deciles of risk. The p-value of the Hosmer-Lemeshow test statistic for this 2009 risk model is 0.257, indicating adequate calibration. That is, the predicted readmission was consistent with actual readmission in the data.

Another way to test model calibration is to partition the data and compare observed readmissions with predicted readmissions in each of 10 risk groups. The 10 risk groups are created by sorting all observations by the predicted risk of readmission and then dividing the sorted observations into deciles of approximately equal size. As presented in Table 8, Risk Group 1 shows the patients in the lowest risk group. Among the 1,181 patients in this group, 64 patients were readmitted to hospital, but the model predicted 77.8 readmissions. Assuming a Poisson distribution for a binary outcome, the predicted range of deaths for Risk Group 1 is 60.5 to 95.0. The observed number of 64 readmissions falls within the range of predicted readmissions. In fact, none of the 10 risk groups has either significantly fewer or significantly more readmissions than were predicted by the model. Overall, the risk model shows no systematic underestimation or overestimation of readmission at the extremes.

**Table 8: Calibration of Risk Model for 30-Day Readmission, 2009**

<b>Risk Group</b>	<b>Isolated CABG cases</b>	<b>Observed Readmission</b>	<b>Predicted Readmission</b>	<b>Difference</b>	<b>95%CI of predicted readmission</b>
1	1,181	64	77.76	13.8	(60.5, 95.0)
2	1,181	84	93.72	9.7	(74.7, 112.7)
3	1,182	111	106.24	-4.8	(86.0, 126.4)
4	1,181	113	117.93	4.9	(96.6, 139.2)
5	1,181	139	130.29	-8.7	(107.9, 152.7)
6	1,181	141	145.07	4.1	(121.5, 168.7)
7	1,181	186	162.78	-23.2	(137.8, 187.8)
8	1,181	196	187.09	-8.9	(160.3, 213.9)
9	1,181	226	225.31	-0.7	(195.9, 254.7)
10	1,181	303	316.82	13.8	(281.9, 351.7)
Total	11,811	1,563	1563.0	0	

## IX. RISK-ADJUSTED 30-DAY READMISSION RESULTS AND HOSPITAL PERFORMANCE RATINGS

### Process for Calculating RARR and Performance Ratings

The risk-adjusted readmission rate (RARR) represents the best estimate of what a healthcare provider's readmission rate would have been if the provider had a patient case mix identical to the statewide average. Thus, this rate is comparable among providers because it accounts for the differences in patient severity-of-illness.

The RARR is computed, first by dividing the provider's observed readmission by the provider's expected readmission (obtained from the risk model calculation) to get the observed/expected (O/E) ratio. If the O/E ratio is greater than one, the provider has a higher readmission than expected based on patient mix. If the O/E ratio is less than one, the provider has a lower readmission rate than expected. The O/E ratio is then multiplied by the overall state readmission rate (13.24% for 2009) to obtain the provider's risk-adjusted readmission rate.

However, because a provider's point estimate of the RARR can be attributed to chance, this report determines the performance rating not based on a point estimate of the RARR, but based on a comparison of the 95% confidence interval (CI) of each provider's RARR to the California average readmission rate.<sup>9</sup> CCORP treated the 2009 data as samples, and inferred a range within which each provider's true performance was likely to fall. As shown in Table 9, if the upper 95% CI of a provider's risk-adjusted readmission is below the state average readmission rate, indicating the provider's RARR is significantly lower than the state average, the performance rating is "**Better.**" If the lower 95% CI of a provider's RARR is above the state average readmission rate, indicating the provider's risk-adjusted readmission is significantly higher than the state average, the performance rating is "**Worse.**" If the state average readmission rate is within the 95% CI of a provider's RARR, the performance rating is "**Not Different**" and left blank.

<sup>9</sup> The Poisson Exact Probability method is used for computing the 95% confidence interval for the risk-adjusted readmission rate. (Buchan Iain, *Calculating Poisson Confidence Interval in Excel*, January 2004)

<b>GUIDE TO INTERPRETING TABLE 9: HOSPITAL RISK-ADJUSTED READMISSION RESULTS, 2009</b>	
All CABG Cases	The total number of isolated and non-isolated CABG cases submitted to CCORP for 2009. Non-isolated CABG cases are not used in calculating performance ratings.
Isolated CABG Cases Discharged-alive	The number of isolated CABGs submitted to CCORP for 2009, where the patient was discharged alive from a CABG hospital and could be followed-up via hospital patient discharge data (PDD) in 2009-2010. Patients in salvage operative status, patients who were transferred to acute care or patients who left against medical advice were excluded.
Isolated CABG Readmissions	The number of hospital readmissions within 30 days of being discharged from the hospital where an isolated CABG operation was performed, irrespective of the hospital to which they were readmitted. A readmission was included only if the patient was readmitted with a principal diagnosis that indicated a heart-related condition, an infection or a complication that was likely related to the CABG surgery. Readmission was attributed to the hospital performing the initial CABG surgery.
Observed Readmission Rate	The ratio of the number of isolated CABG readmissions within 30 days of discharge and the discharged-alive isolated CABG cases multiplied by 100: Observed Readmission Rate = Number of Isolated CABG Readmissions within 30 Days of Discharge/Discharged-alive Isolated CABG Cases X 100.
Expected Readmission Rate	The ratio of the expected number of readmissions predicted for a provider (after adjusting for their patient population) and the discharged-alive isolated CABG cases multiplied by 100: Expected Readmission Rate = Number of Expected Readmissions/Number of Discharged-alive Isolated CABG Cases X 100.
Risk-Adjusted Readmission Rate (95% CI)	The Risk-Adjusted Readmission Rate (RARR) is obtained by multiplying the observed state readmission rate by a provider's O/E ratio. The 95% confidence interval represents the confidence in the estimate for the RARR. The lower and upper confidence limits are calculated using Poisson exact confidence interval calculations.
Performance Rating	The performance rating is based on a comparison of each provider's risk-adjusted readmission rate and the state observed readmission rate. This is a test of statistical significance. A provider is classified as " <b>Better</b> " if the upper 95% confidence limit of its RARR falls below the California observed readmission rate. A provider is classified as " <b>Worse</b> " if the lower 95% confidence limit of its RARR is higher than the California observed readmission rate. A provider is classified as " <b>Not Different</b> " (performance rating is blank) if the California readmission rate falls within the confidence interval of the provider's risk-adjusted readmission rate.

## 2009 Hospital Risk-Adjusted 30-Day Readmission Results

Table 9 presents the risk-adjusted readmission results for each hospital for 2009. 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 patients discharged alive isolated CABG surgeries (excluding salvage patients), the number of observed isolated CABG readmissions, observed readmission rate, expected readmission rate predicted by the risk model, RARR and 95% CI of the RARR, and the associated hospital performance rating.

Among the 11,823 isolated (non-salvage) CABG surgeries performed in 2009 who were discharged alive, 1,565 patients were readmitted to the same or another acute care hospital within 30 days of the surgery date, reflecting an overall readmission rate of 13.24%. The observed readmission rates among hospitals ranges from 0% to 26.92%. The expected readmission rates, which are generated by the risk model and account for patient severity of illness, range between 10.21% and 19.36%. The risk-adjusted readmission rates (RARR), which measure hospital performance, range from 0% to 29.77%.

Based on the 95% confidence intervals for risk-adjusted readmission rates, 117 of 119 hospitals (98%) performed within the expected range compared to the state's overall readmission rate (denoted by a blank space in the performance rating column of Table 9), one hospital performed significantly "**Better**" than the state average, and one hospital performed significantly "**Worse**" than the state average. Hospitals marked with † in Table 9 submitted statements regarding this report (presented in Appendix B).

**Table 9: Hospital Risk-Adjusted Readmission Results by Region, 2009**

<i>Region</i>	<i>Hospital</i>	<i>All CABG Cases</i>	<i>Isolated CABG Cases Discharged-alive</i>	<i>Isolated CABG Readmissions</i>	<i>Observed Readmission Rate (%)</i>	<i>Expected Readmission Rate (%)</i>	<i>Risk-Adjusted Readmission Rate (% RARR)</i>	<i>95% CI for RARR</i>	<i>Performance Rating*</i>
<b>State</b>		<b>17,211</b>	<b>11,823</b>	<b>1,565</b>	<b>13.24</b>				
Sacramento Valley & Northern California Region	Enloe Medical Center	173	153	17	11.11	12.83	11.46	(6.68, 18.36)	
	Mercy General Hospital	770	414	41	9.90	11.93	10.99	(7.89, 14.91)	
	Mercy Medical Center - Redding	173	119	14	11.76	12.11	12.86	(7.03, 21.59)	
	Mercy San Juan Hospital	143	100	7	7.00	11.50	8.06	(3.24, 16.60)	
	North Bay Medical Center	19	18	2	11.11	14.03	10.48	(1.27, 37.88)	
	Rideout Memorial Hospital	157	120	16	13.33	12.65	13.95	(7.98, 22.67)	
	Shasta Regional Medical Center	55	26	4	15.38	12.97	15.70	(4.28, 40.21)	
	St. Joseph Hospital - Eureka	66	48	2	4.17	14.07	3.92	(0.47, 14.16)	
	Sutter Memorial Hospital	468	303	30	9.90	12.89	10.17	(6.86, 14.52)	
	UC Davis Medical Center	210	119	17	14.29	12.70	14.89	(8.68, 23.85)	
San Francisco Bay Area & San Jose	Alta Bates Summit Medical Center - Summit Campus	550	243	41	16.87	13.13	17.01	(12.21, 23.08)	
	California Pacific Medical Center - Pacific Campus	82	59	5	8.47	12.54	8.94	(2.90, 20.88)	
	Community Hospital Monterey Peninsula	81	55	6	10.91	11.21	12.88	(4.73, 28.04)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RARR falls below the California observed readmission rate (13.24%). A hospital is classified as “**Worse**” if the lower 95% CI of the RARR is higher than the California observed readmission rate. A hospital’s performance is considered “**Not Different**” from the state average (rating is left blank) if the California readmission rate falls within the 95% CI of a hospital’s RARR.

† Hospitals submitted statements regarding this report. See Appendix B for their statements.

**Table 9: Hospital Risk-Adjusted Readmission Results by Region, 2009**

<i>Region</i>	<i>Hospital</i>	<i>All CABG Cases</i>	<i>Isolated CABG Cases Discharged-alive</i>	<i>Isolated CABG Readmissions</i>	<i>Observed Readmission Rate (%)</i>	<i>Expected Readmission Rate (%)</i>	<i>Risk-Adjusted Readmission Rate (% RARR)</i>	<i>95% CI for RARR</i>	<i>Performance Rating*</i>
<b>State</b>		<b>17,211</b>	<b>11,823</b>	<b>1,565</b>	<b>13.24</b>				
San Francisco Bay Area & San Jose (continued)	Dominican Hospital	72	47	7	14.89	11.31	17.44	(7.01, 35.93)	
	El Camino Hospital	80	54	6	11.11	12.43	11.83	(4.34, 25.76)	
	Good Samaritan Hospital - San Jose†	113	80	14	17.50	12.88	17.99	(9.84, 30.19)	
	John Muir Medical Center - Concord Campus	291	210	20	9.52	12.65	9.97	(6.09, 15.40)	
	Kaiser Foundation Hospital (Geary San Francisco)	241	181	16	8.84	11.93	9.81	(5.61, 15.93)	
	Kaiser Foundation Hospital (Santa Clara)	234	132	20	15.15	13.23	15.16	(9.26, 23.42)	
	Marin General Hospital	52	40	1	2.50	10.82	3.06	(0.08, 17.05)	
	O'Connor Hospital	62	53	8	15.09	19.36	10.32	(4.46, 20.35)	
	Peninsula Medical Center	55	35	3	8.57	11.97	9.48	(1.95, 27.70)	
	Queen of the Valley Hospital	148	70	4	5.71	15.57	4.86	(1.32, 12.44)	Better
	Regional Medical of San Jose	38	31	7	22.58	16.64	17.96	(7.22, 37.01)	
	Salinas Valley Memorial Hospital	118	88	10	11.36	13.23	11.37	(5.45, 20.91)	
	San Ramon Regional Medical Center	44	29	3	10.34	11.74	11.67	(2.41, 34.10)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RARR falls below the California observed readmission rate (13.24%). A hospital is classified as “**Worse**” if the lower 95% CI of the RARR is higher than the California observed readmission rate. A hospital’s performance is considered “**Not Different**” from the state average (rating is left blank) if the California readmission rate falls within the 95% CI of a hospital’s RARR.

† Hospitals submitted statements regarding this report. See Appendix B for their statements.

**Table 9: Hospital Risk-Adjusted Readmission Results by Region, 2009**

<i>Region</i>	<i>Hospital</i>	<i>All CABG Cases</i>	<i>Isolated CABG Cases Discharged-alive</i>	<i>Isolated CABG Readmissions</i>	<i>Observed Readmission Rate (%)</i>	<i>Expected Readmission Rate (%)</i>	<i>Risk-Adjusted Readmission Rate (% RARR)</i>	<i>95% CI for RARR</i>	<i>Performance Rating*</i>
<b>State</b>		<b>17,211</b>	<b>11,823</b>	<b>1,565</b>	<b>13.24</b>				
San Francisco Bay Area & San Jose (continued)	Santa Clara Valley Medical Center	43	32	4	12.50	11.90	13.90	(3.79, 35.60)	
	Santa Rosa Memorial Hospital	77	61	6	9.84	13.92	9.35	(3.43, 20.36)	
	Sequoia Hospital	99	50	4	8.00	12.24	8.65	(2.36, 22.15)	
	Seton Medical Center	134	110	20	18.18	15.71	15.31	(9.36, 23.66)	
	St. Helena Hospital	66	51	12	23.53	14.84	20.98	(10.85, 36.66)	
	St. Mary's Medical Center, San Francisco	39	30	3	10.00	13.26	9.98	(2.06, 29.18)	
	Stanford University Hospital	156	91	9	9.89	12.53	10.45	(4.78, 19.84)	
	Sutter Medical Center of Santa Rosa	97	61	6	9.84	12.08	10.78	(3.96, 23.46)	
	UCSF Medical Center	97	51	8	15.69	11.81	17.58	(7.59, 34.65)	
	Valleycare Medical Center	38	28	4	14.29	14.40	13.13	(3.58, 33.62)	
	Washington Hospital - Fremont	135	108	19	17.59	14.45	16.11	(9.70, 25.17)	
Central California	Bakersfield Heart Hospital	168	132	24	18.18	12.53	19.21	(12.31, 28.59)	
	Bakersfield Memorial Hospital	148	104	15	14.42	11.90	16.04	(8.98, 26.47)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RARR falls below the California observed readmission rate (13.24%). A hospital is classified as “**Worse**” if the lower 95% CI of the RARR is higher than the California observed readmission rate. A hospital’s performance is considered “**Not Different**” from the state average (rating is left blank) if the California readmission rate falls within the 95% CI of a hospital’s RARR.

† Hospitals submitted statements regarding this report. See Appendix B for their statements.

**Table 9: Hospital Risk-Adjusted Readmission Results by Region, 2009**

<i>Region</i>	<i>Hospital</i>	<i>All CABG Cases</i>	<i>Isolated CABG Cases Discharged-alive</i>	<i>Isolated CABG Readmissions</i>	<i>Observed Readmission Rate (%)</i>	<i>Expected Readmission Rate (%)</i>	<i>Risk-Adjusted Readmission Rate (% RARR)</i>	<i>95% CI for RARR</i>	<i>Performance Rating*</i>
<b>State</b>		<b>17,211</b>	<b>11,823</b>	<b>1,565</b>	<b>13.24</b>				
Central California (continued)	Community Medical Center - Fresno	238	192	37	19.27	14.78	17.26	(12.15, 23.79)	
	Dameron Hospital	66	62	10	16.13	14.40	14.82	(7.11, 27.27)	
	Doctors Medical Center - Modesto Campus	341	251	31	12.35	14.06	11.63	(7.90, 16.51)	
	Fresno Heart Hospital	225	168	22	13.10	12.68	13.67	(8.57, 20.69)	
	Kaweah Delta Hospital	304	230	28	12.17	14.74	10.93	(7.27, 15.80)	
	Marian Medical Center	59	45	2	4.44	13.99	4.21	(0.51, 15.20)	
	Memorial Medical Center Modesto	260	206	34	16.50	13.94	15.68	(10.86, 21.91)	
	San Joaquin Community Hospital	104	80	20	25.00	13.52	24.48	(14.96, 37.82)	Worse
	St. Agnes Medical Center	316	244	30	12.30	12.91	12.60	(8.51, 18.00)	
	St. Joseph's Medical Center of Stockton	331	249	28	11.24	13.21	11.27	(7.49, 16.29)	
San Fernando Valley, Antelope Valley, Ventura & Santa Barbara	Antelope Valley Hospital Medical Center	26	19	3	15.79	10.21	20.47	(4.22, 59.82)	
	Community Memorial Hospital of San Buenaventura	83	64	8	12.50	12.62	13.11	(5.66, 25.84)	
	French Hospital Medical Center	139	95	10	10.53	11.78	11.83	(5.67, 21.75)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RARR falls below the California observed readmission rate (13.24%). A hospital is classified as “**Worse**” if the lower 95% CI of the RARR is higher than the California observed readmission rate. A hospital’s performance is considered “**Not Different**” from the state average (rating is left blank) if the California readmission rate falls within the 95% CI of a hospital’s RARR.

† Hospitals submitted statements regarding this report. See Appendix B for their statements.

**Table 9: Hospital Risk-Adjusted Readmission Results by Region, 2009**

<i>Region</i>	<i>Hospital</i>	<i>All CABG Cases</i>	<i>Isolated CABG Cases Discharged-alive</i>	<i>Isolated CABG Readmissions</i>	<i>Observed Readmission Rate (%)</i>	<i>Expected Readmission Rate (%)</i>	<i>Risk-Adjusted Readmission Rate (% RARR)</i>	<i>95% CI for RARR</i>	<i>Performance Rating*</i>
<b>State</b>		<b>17,211</b>	<b>11,823</b>	<b>1,565</b>	<b>13.24</b>				
San Fernando Valley, Antelope Valley, Ventura & Santa Barbara (continued)	Glendale Adventist Medical Center - Wilson Terrace	128	102	12	11.76	12.69	12.28	(6.34, 21.45)	
	Glendale Memorial Hospital and Health Center	195	120	25	20.83	13.53	20.39	(13.20, 30.10)	
	Lancaster Community Hospital	8	5	0	0.00	12.68	0.00	(0.00, 77.02)	
	Los Robles Regional Medical Center	92	68	8	11.76	12.94	12.03	(5.20, 23.72)	
	Northridge Hospital Medical Center	72	50	8	16.00	13.20	16.05	(6.93, 31.62)	
	Providence Holy Cross Medical Center	95	66	10	15.15	13.42	14.94	(7.17, 27.48)	
	Providence St. Joseph Medical Center	65	50	2	4.00	11.84	4.47	(0.54, 16.16)	
	Providence Tarzana Medical Center	88	57	7	12.28	13.53	12.02	(4.83, 24.77)	
	Santa Barbara Cottage Hospital	153	110	13	11.82	13.00	12.04	(6.41, 20.59)	
	St. John's Regional Medical Center	97	64	10	15.63	15.40	13.43	(6.44, 24.71)	
	Valley Presbyterian Hospital	40	26	7	26.92	11.97	29.77	(11.97, 61.35)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RARR falls below the California observed readmission rate (13.24%). A hospital is classified as “**Worse**” if the lower 95% CI of the RARR is higher than the California observed readmission rate. A hospital’s performance is considered “**Not Different**” from the state average (rating is left blank) if the California readmission rate falls within the 95% CI of a hospital’s RARR.

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<b>State</b>		<b>17,211</b>	<b>11,823</b>	<b>1,565</b>	<b>13.24</b>				
San Fernando Valley, Antelope Valley, Ventura & Santa Barbara (continued)	West Hills Regional Medical Center	58	42	6	14.29	11.99	15.77	(5.79, 34.33)	
Greater Los Angeles	Beverly Hospital	21	17	2	11.76	15.51	10.04	(1.22, 36.29)	
	Cedars Sinai Medical Center	174	95	15	15.79	12.23	17.09	(9.57, 28.19)	
	Centinela Hospital Medical Center	44	36	6	16.67	16.23	13.59	(4.99, 29.59)	
	Citrus Valley Medical Center – IC Campus	104	81	10	12.35	13.27	12.31	(5.90, 22.64)	
	Downey Regional Medical Center	55	46	3	6.52	12.41	6.96	(1.44, 20.34)	
	Garfield Medical Center	122	78	15	19.23	15.46	16.47	(9.22, 27.17)	
	Good Samaritan Hospital - Los Angeles	124	86	17	19.77	16.25	16.10	(9.38, 25.78)	
	Huntington Memorial Hospital	70	48	7	14.58	15.28	12.63	(5.08, 26.04)	
	Kaiser Foundation Hospital (Sunset)	632	466	61	13.09	13.30	13.03	(9.97, 16.74)	
	Lakewood Regional Medical Center	128	100	15	15.00	14.86	13.36	(7.48, 22.04)	
	Little Company of Mary Hospital	60	50	4	8.00	14.41	7.35	(2.00, 18.82)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RARR falls below the California observed readmission rate (13.24%). A hospital is classified as “**Worse**” if the lower 95% CI of the RARR is higher than the California observed readmission rate. A hospital’s performance is considered “**Not Different**” from the state average (rating is left blank) if the California readmission rate falls within the 95% CI of a hospital’s RARR.

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<b>State</b>		<b>17,211</b>	<b>11,823</b>	<b>1,565</b>	<b>13.24</b>				
Greater Los Angeles (continued)	Long Beach Memorial Medical Center	286	232	39	16.81	13.37	16.65	(11.84, 22.76)	
	Los Angeles Co. Harbor - UCLA Medical Center	86	43	9	20.93	13.01	21.30	(9.74, 40.44)	
	Los Angeles Co. USC Medical Center	116	49	9	18.37	11.40	21.33	(9.76, 40.50)	
	Methodist Hospital of Southern California	45	34	7	20.59	15.25	17.87	(7.19, 36.83)	
	Presbyterian Intercommunity Hospital	97	69	8	11.59	15.23	10.07	(4.35, 19.85)	
	Ronald Reagan UCLA Medical Center	207	99	9	9.09	13.77	8.74	(4.00, 16.59)	
	Santa Monica - UCLA Medical Center	20	16	3	18.75	16.20	15.32	(3.16, 44.78)	
	St. Francis Medical Center	49	43	2	4.65	12.20	5.05	(0.61, 18.23)	
	St. John's Hospital and Health Center	86	48	7	14.58	11.79	16.38	(6.59, 33.75)	
	St. Mary Medical Center	50	41	7	17.07	13.93	16.23	(6.53, 33.44)	
	St. Vincent Medical Center	108	80	15	18.75	15.70	15.81	(8.85, 26.08)	
	Torrance Memorial Medical Center	90	55	8	14.55	13.77	13.99	(6.04, 27.57)	
	USC University Hospital	178	85	18	21.18	13.23	21.19	(12.56, 33.50)	

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<b>State</b>		<b>17,211</b>	<b>11,823</b>	<b>1,565</b>	<b>13.24</b>				
Greater Los Angeles (continued)	White Memorial Medical Center	50	37	7	18.92	13.94	17.97	(7.23, 37.03)	
Inland Empire, Riverside & San Bernardino	Desert Regional Medical Center	170	130	19	14.62	12.03	16.09	(9.69, 25.12)	
	Eisenhower Memorial Hospital	203	144	19	13.19	13.66	12.79	(7.70, 19.98)	
	Loma Linda University Medical Center	280	188	26	13.83	13.83	13.24	(8.65, 19.40)	
	Pomona Valley Hospital Medical Center	144	111	9	8.11	14.38	7.46	(3.41, 14.17)	
	Riverside Community Hospital	193	143	17	11.89	13.17	11.95	(6.96, 19.14)	
	San Antonio Community Hospital	158	114	13	11.40	14.23	10.60	(5.65, 18.14)	
	St. Bernardine Medical Center	575	386	44	11.40	12.74	11.85	(8.61, 15.91)	
	St. Mary Regional Medical Center	197	168	28	16.67	13.23	16.68	(11.09, 24.11)	
Orange County	Anaheim Memorial Medical Center	143	96	19	19.79	13.80	18.98	(11.43, 29.65)	
	Fountain Valley Regional Hospital	115	100	16	16.00	13.93	15.20	(8.69, 24.70)	

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<i>Region</i>	<i>Hospital</i>	<i>All CABG Cases</i>	<i>Isolated CABG Cases Discharged-alive</i>	<i>Isolated CABG Readmissions</i>	<i>Observed Readmission Rate (%)</i>	<i>Expected Readmission Rate (%)</i>	<i>Risk-Adjusted Readmission Rate (% RARR)</i>	<i>95% CI for RARR</i>	<i>Performance Rating*</i>
<b>State</b>		<b>17,211</b>	<b>11,823</b>	<b>1,565</b>	<b>13.24</b>				
Orange County (continued)	Hoag Memorial Hospital Presbyterian	217	143	10	6.99	11.73	7.89	(3.79, 14.52)	
	Mission Hospital Regional Medical Center	144	98	11	11.22	11.46	12.96	(6.47, 23.19)	
	Saddleback Memorial Medical Center	147	118	11	9.32	11.63	10.61	(5.30, 18.99)	
	St. Joseph Hospital - Orange	143	110	11	10.00	13.32	9.94	(4.96, 17.79)	
	St. Jude Medical Center	128	104	8	7.69	12.49	8.15	(3.52, 16.07)	
	UC Irvine Medical Center	55	40	10	25.00	12.63	26.20	(12.57, 48.20)	
	West Anaheim Medical Center	11	8	0	0.00	11.05	0.00	(0.00, 55.25)	
	Western Medical Center - Santa Ana	51	34	4	11.76	12.79	12.17	(3.32, 31.17)	
	Western Medical Center Hospital - Anaheim	116	98	17	17.35	13.19	17.41	(10.14, 27.88)	
Greater San Diego	Alvarado Hospital Medical Center	76	56	8	14.29	13.51	14.00	(6.04, 27.58)	
	Palomar Medical Center	126	88	11	12.50	11.42	14.49	(7.23, 25.93)	
	Scripps Green Hospital	83	45	5	11.11	12.58	11.69	(3.80, 27.29)	
	Scripps Memorial Hospital - La Jolla†	413	234	36	15.38	14.42	14.12	(9.89, 19.56)	
	Scripps Mercy Hospital†	159	108	16	14.81	13.35	14.69	(8.40, 23.87)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RARR falls below the California observed readmission rate (13.24%). A hospital is classified as “**Worse**” if the lower 95% CI of the RARR is higher than the California observed readmission rate. A hospital’s performance is considered “**Not Different**” from the state average (rating is left blank) if the California readmission rate falls within the 95% CI of a hospital’s RARR.

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<b>State</b>		<b>17,211</b>	<b>11,823</b>	<b>1,565</b>	<b>13.24</b>				
Greater San Diego (continued)	Sharp Chula Vista Medical Center	185	128	17	13.28	15.24	11.54	(6.72, 18.48)	
	Sharp Grossmont Hospital	217	151	23	15.23	13.29	15.17	(9.62, 22.76)	
	Sharp Memorial Hospital	162	90	10	11.11	11.03	13.34	(6.40, 24.53)	
	Tri-City Medical Center	85	66	7	10.61	12.33	11.39	(4.58, 23.47)	
	UCSD Medical Center	28	23	2	8.70	11.60	9.92	(1.20, 35.86)	
	UCSD Medical Center - La Jolla, John M. & Sally B. Thornton Hospital	110	66	9	13.64	11.86	15.22	(6.96, 28.91)	

\*A hospital is classified as “**Better**” if the upper 95% CI of the RARR falls below the California observed readmission rate (13.24%). A hospital is classified as “**Worse**” if the lower 95% CI of the RARR is higher than the California observed readmission rate. A hospital’s performance is considered “**Not Different**” from the state average (rating is left blank) if the California readmission rate falls within the 95% CI of a hospital’s RARR.

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## X. INTERNAL MAMMARY ARTERY USAGE BY HOSPITAL, 2009: A PROCESS MEASURE OF QUALITY

A widely accepted definition of healthcare quality contains three dimensions: process, structure, and outcomes.<sup>10</sup> In addition to publishing hospital outcomes (risk-adjusted operative mortality rates, risk-adjusted post-operative stroke rates, and risk-adjusted readmission rates), this report also assesses a process of care measure by reporting hospital use of the Internal Mammary Artery (IMA) in surgery. Although outcomes measurement permits comparison of provider performance and can be used for investigating internal processes and structures, assessing the process 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 outcomes are monitored, some healthcare quality problems can be detected long before demonstrable health 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 IMA (also known as the internal thoracic artery). Clinical literature strongly supports use of the IMA to promote long-term graft patency (durability) and patient survival. Recent research also suggests a reduction in immediate, operative mortality associated with use of the internal mammary artery rather than saphenous (leg) vein revascularization.<sup>11</sup> The IMA, and especially the left IMA, is considered the preferred conduit for CABG surgery of the left anterior descending (LAD) coronary artery.

Many nationally respected organizations encourage the use of IMA when appropriate. Currently, the Leapfrog Evidence-Based Hospital Referral program endorses the goal of 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. The Society of Thoracic Surgeons (STS) states that IMA use should be given primary consideration in every CABG surgery patient. Furthermore, a number of healthcare quality advocates recommend public reporting of IMA usage rates for CABG surgery.

Table 10 presents hospital results for usage of the IMA by region for 2009. Only first-time isolated CABG surgeries where the operative status is elective or urgent and the LAD was bypassed are included in calculating IMA-usage rates. The statewide IMA usage rate increased from 95.8% in 2008 to 96.2% in 2009. Five hospitals received a “**Low**” rating for 2009. Hospital IMA usage rates above the statewide average rate were not evaluated because there is no consensus on what constitutes an optimal IMA usage rate. Hospitals marked with † in Table 10 submitted statements regarding this report. Their statements are presented in Appendix B.

<sup>10</sup> Donabedian A. Evaluating the Quality of Medical Care. *The Milbank Quarterly*, 2005; 83(4):691-729.

<sup>11</sup> Ferguson TB Jr., Coombs LP, Peterson ED. Internal thoracic artery grafting in the elderly patient undergoing coronary artery bypass grafting: room for process improvement? *Journal of Thoracic and Cardiovascular Surgery*, 2002; 123(5):869-80.

<b>GUIDE TO INTERPRETING TABLE 10: INTERNAL MAMMARY ARTERY USAGE RESULTS, 2009</b>	
Isolated CABG Surgeries	Includes only first-time non-cardiogenic shock isolated CABG surgeries for 2009 where the operative status was elective or urgent and the Left Anterior Descending (LAD) artery was bypassed. 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.
Performance Rating	A blank rating indicates that the IMA Usage Rate is acceptable. A <b>“Low”</b> rating indicates that the IMA Usage Rate for a hospital is less than 85.54%, i.e., two standard deviations (0.0544 X 1.96) below the hospital statewide average IMA usage rate (96.20%). IMA usage rates above the hospital statewide average IMA usage rate was not evaluated because there is no consensus on what constitutes an optimal rate of usage.

**Table 10: Hospital Internal Mammary Artery Usage Results by Region, 2009**

<i>Region</i>	<i>Hospital</i>	<i>Isolated CABGs*</i>	<i>Percent IMA Use</i>	<i>Rate**</i>
<b>State</b>		<b>11,859</b>	<b>96.20%</b>	
Sacramento Valley & Northern California Region	Enloe Medical Center	138	86.96%	
	Mercy General Hospital	482	98.34%	
	Mercy Medical Center - Redding	102	100.00%	
	Mercy San Juan Hospital	95	96.84%	
	North Bay Medical Center	17	100.00%	
	Rideout Memorial Hospital	114	97.37%	
	Shasta Regional Medical Center	39	74.36%	Low
	St. Joseph Hospital - Eureka	40	95.00%	
	Sutter Memorial Hospital	298	96.98%	
	UC Davis Medical Center	133	97.74%	
	San Francisco Bay Area & San Jose	Alta Bates Summit Medical Center - Summit Campus	394	99.49%
California Pacific Medical Center - Pacific Campus		54	98.15%	
Community Hospital Monterey Peninsula		51	98.04%	
Dominican Hospital		55	94.55%	
El Camino Hospital		52	96.15%	
Good Samaritan Hospital - San Jose†		66	98.48%	
John Muir Medical Center - Concord Campus		207	98.55%	
Kaiser Foundation Hospital (Geary San Francisco)		181	97.24%	
Kaiser Foundation Hospital (Santa Clara)		126	99.21%	
Marin General Hospital		40	97.50%	
O'Connor Hospital		46	97.83%	
Peninsula Medical Center		37	94.59%	
Queen of the Valley Hospital		87	100.00%	
Regional Medical of San Jose		34	100.00%	
Salinas Valley Memorial Hospital		74	95.95%	
San Ramon Regional Medical Center	29	93.10%		
Santa Clara Valley Medical Center	37	100.00%		

\* Only includes first-time, non-cardiogenic shock, isolated CABGs where the operative status was elective or urgent and LAD was bypassed.

\*\* "Low" rating: IMA usage rate for a hospital is less than 85.54%, i.e., two standard deviations (0.0544 x 1.96) below the hospital statewide average IMA usage rate (96.20%).

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<b>State</b>		<b>11,859</b>	<b>96.20%</b>	
San Francisco Bay Area & San Jose (continued)	Santa Rosa Memorial Hospital	56	87.50%	
	Sequoia Hospital	46	100.00%	
	Seton Medical Center	106	89.62%	
	St. Helena Hospital	45	93.33%	
	St. Mary's Medical Center, San Francisco	30	100.00%	
	Stanford University Hospital	89	95.51%	
	Sutter Medical Center of Santa Rosa	61	73.77%	Low
	UCSF Medical Center	65	98.46%	
	Valleycare Medical Center	30	100.00%	
	Washington Hospital - Fremont	108	99.07%	
Central California	Bakersfield Heart Hospital	127	92.91%	
	Bakersfield Memorial Hospital	110	98.18%	
	Community Medical Center - Fresno	169	95.86%	
	Dameron Hospital	56	96.43%	
	Doctors Medical Center - Modesto Campus	238	93.28%	
	Fresno Heart Hospital	156	98.08%	
	Kaweah Delta Hospital	228	99.12%	
	Marian Medical Center	44	100.00%	
	Memorial Medical Center of Modesto	193	91.71%	
	San Joaquin Community Hospital	81	98.77%	
San Fernando Valley, Antelope Valley, Ventura & Santa Barbara	St. Agnes Medical Center	222	98.20%	
	St. Joseph's Medical Center of Stockton	226	98.23%	
	Antelope Valley Hospital Medical Center	20	75.00%	Low
	Community Memorial Hospital of San Buenaventura	59	98.31%	
	French Hospital Medical Center	92	97.83%	
	Glendale Adventist Medical Center - Wilson Terrace	110	95.45%	
	Glendale Memorial Hospital and Health Center	103	99.03%	

\* Only includes first-time, non-cardiogenic shock, isolated CABGs where the operative status was elective or urgent and LAD was bypassed.

\*\* "Low" rating: IMA usage rate for a hospital is less than 85.54%, i.e., two standard deviations (0.0544 x 1.96) below the hospital statewide average IMA usage rate (96.20%).

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<b>State</b>		<b>11,859</b>	<b>96.20%</b>	
San Fernando Valley, Antelope Valley, Ventura & Santa Barbara (continued)	Lancaster Community Hospital	6	66.67%	Low
	Los Robles Regional Medical Center	55	100.00%	
	Northridge Hospital Medical Center	55	94.55%	
	Providence Holy Cross Medical Center	62	100.00%	
	Providence St. Joseph Medical Center	49	95.92%	
	Providence Tarzana Medical Center	51	98.04%	
	Santa Barbara Cottage Hospital	108	95.37%	
	St. John's Regional Medical Center	70	94.29%	
	Valley Presbyterian Hospital	31	96.77%	
	West Hills Regional Medical Center	37	100.00%	
Greater Los Angeles	Beverly Hospital	18	100.00%	
	Cedars Sinai Medical Center	96	100.00%	
	Centinela Hospital Medical Center	33	96.97%	
	Citrus Valley Medical Center – IC Campus	76	96.05%	
	Downey Regional Medical Center	44	100.00%	
	Garfield Medical Center	91	95.60%	
	Good Samaritan Hospital - Los Angeles	79	100.00%	
	Huntington Memorial Hospital	49	97.96%	
	Kaiser Foundation Hospital (Sunset)	452	94.91%	
	Lakewood Regional Medical Center	99	92.93%	
	Little Company of Mary Hospital	48	100.00%	
	Long Beach Memorial Medical Center	230	96.52%	
	Los Angeles Co. Harbor - UCLA Medical Center	56	100.00%	
	Los Angeles Co. USC Medical Center	96	90.63%	
	Methodist Hospital of Southern California	33	100.00%	
	Presbyterian Intercommunity Hospital	65	100.00%	
	Ronald Reagan UCLA Medical Center	82	97.56%	
	Santa Monica - UCLA Medical Center	14	100.00%	
	St. Francis Medical Center	47	97.87%	
	St. John's Hospital and Health Center	47	91.49%	

\* Only includes first-time, non-cardiogenic shock, isolated CABGs where the operative status was elective or urgent and LAD was bypassed.

\*\* "Low" rating: IMA usage rate for a hospital is less than 85.54%, i.e., two standard deviations (0.0544 x 1.96) below the hospital statewide average IMA usage rate (96.20%).

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<b>State</b>		<b>11,859</b>	<b>96.20%</b>	
Greater Los Angeles (continued)	St. Mary Medical Center	37	91.89%	
	St. Vincent Medical Center	83	97.59%	
	Torrance Memorial Medical Center	50	100.00%	
	USC University Hospital	80	93.75%	
	White Memorial Medical Center	40	97.50%	
Inland Empire, Riverside & San Bernardino	Desert Regional Medical Center	127	96.85%	
	Eisenhower Memorial Hospital	146	85.62%	
	Loma Linda University Medical Center	189	96.30%	
	Pomona Valley Hospital Medical Center	97	97.94%	
	Riverside Community Hospital	135	97.04%	
	San Antonio Community Hospital	94	96.81%	
	St. Bernardine Medical Center	470	96.81%	
	St. Mary Regional Medical Center	153	98.69%	
	Orange County	Anaheim Memorial Medical Center	108	98.15%
Fountain Valley Regional Hospital		96	96.88%	
Hoag Memorial Hospital Presbyterian		135	94.81%	
Mission Hospital Regional Medical Center		102	96.08%	
Saddleback Memorial Medical Center		113	98.23%	
St. Joseph Hospital - Orange		107	100.00%	
St. Jude Medical Center		103	97.09%	
UC Irvine Medical Center		44	95.45%	
West Anaheim Medical Center		8	100.00%	
Western Medical Center - Santa Ana		40	100.00%	
Greater San Diego	Western Medical Center Hospital - Anaheim	91	96.70%	
	Alvarado Hospital Medical Center	59	98.31%	
	Palomar Medical Center	90	96.67%	
	Scripps Green Hospital	43	100.00%	
	Scripps Memorial Hospital - La Jolla†	250	96.80%	
	Scripps Mercy Hospital†	115	99.13%	
	Sharp Chula Vista Medical Center	126	98.41%	
Sharp Grossmont Hospital	149	100.00%		

\* Only includes first-time, non-cardiogenic shock, isolated CABGs where the operative status was elective or urgent and LAD was bypassed.

\*\* "Low" rating: IMA usage rate for a hospital is less than 85.54%, i.e., two standard deviations (0.0544 x 1.96) below the hospital statewide average IMA usage rate (96.20%).

† Hospitals submitted statements regarding this report. See Appendix B for their statements.

**Table 10: Hospital Internal Mammary Artery Usage Results by Region, 2009**

<i>Region</i>	<i>Hospital</i>	<i>Isolated CABGs*</i>	<i>Percent IMA Use</i>	<i>Rate**</i>
<b>State</b>		<b>11,859</b>	<b>96.20%</b>	
Greater San Diego (continued)	Sharp Memorial Hospital	58	96.55%	
	Tri-City Medical Center	60	85.00%	Low
	UCSD Medical Center	21	100.00%	
	UCSD Medical Center - La Jolla, John M. & Sally B. Thornton Hospital	63	100.00%	

\* Only includes first-time, non-cardiogenic shock, isolated CABGs where the operative status was elective or urgent and LAD was bypassed.

\*\* "Low" rating: IMA usage rate for a hospital is less than 85.54%, i.e., two standard deviations (0.0544 x 1.96) below the hospital statewide average IMA usage rate (96.20%).

† Hospitals submitted statements regarding this report. See Appendix B for their statements.

## XI. USE OF CABG AND ANGIOPLASTY PROCEDURES AND OBSERVED IN-HOSPITAL MORTALITY

There are two types of cardiac revascularization procedures: CABG surgery and percutaneous coronary interventions (PCI), also known as angioplasty or intra-coronary stenting. These procedures, which have been 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 has largely replaced angioplasty without stents because of its lower rate of re-narrowing the arteries (restenosis). New technologies and improved adjunctive medical therapy (e.g., medication) 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. However, CABG surgery is associated with lower rates of repeat revascularization, less overall angina (chest pain), 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.

### Cardiac Revascularization Volume

Figure 1 shows change in the use of the two revascularization procedures, CABG and PCI, over time using data from OSHPD's Patient Discharge Data. Despite a dip in recent years (2007-2010), PCI volume increased by 13% between 1997 and 2010 in California. Increased use of drug-eluting stents and related Centers for Medicare and Medicaid Services (CMS) reimbursement policy changes may be partly responsible for this overall growth.<sup>12</sup> During the same timeframe, the number of isolated CABG surgeries decreased 55% between 1997 and 2010.<sup>13</sup> Non-isolated CABG surgery volume remained relatively constant, with a slight decline each year since 2001.

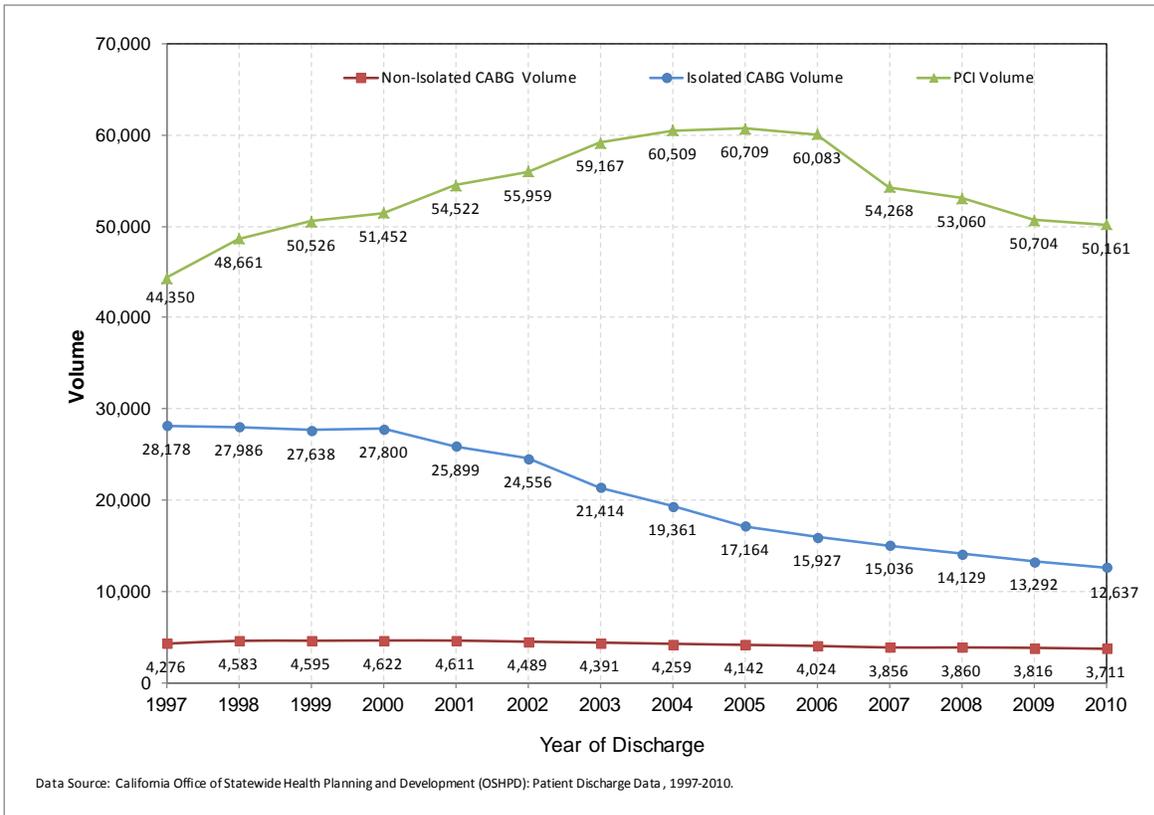
### Cardiac Revascularization Mortality

Figure 2 presents the trends in observed in-hospital mortality rates for isolated CABG surgeries, non-isolated CABG surgeries and PCIs in California between 1997 and 2010. During the 14 years between 1997 and 2010, the in-hospital mortality rate for isolated CABG surgeries declined from 3.08%, when the voluntary California CABG Mortality Reporting Program (CCMRP) was launched in 1997 to 1.74% in 2010, the eighth year of the mandatory reporting program. Meanwhile, the observed in-hospital mortality rates for non-isolated CABG surgeries also declined from 9.66% in 1997 to 5.60% in 2009. However, the observed in-hospital mortality rate for PCIs increased from 1.70% in 1997 to 1.96% in 2009, for the first time surpassing in-hospital mortality for isolated CABG surgery in California.

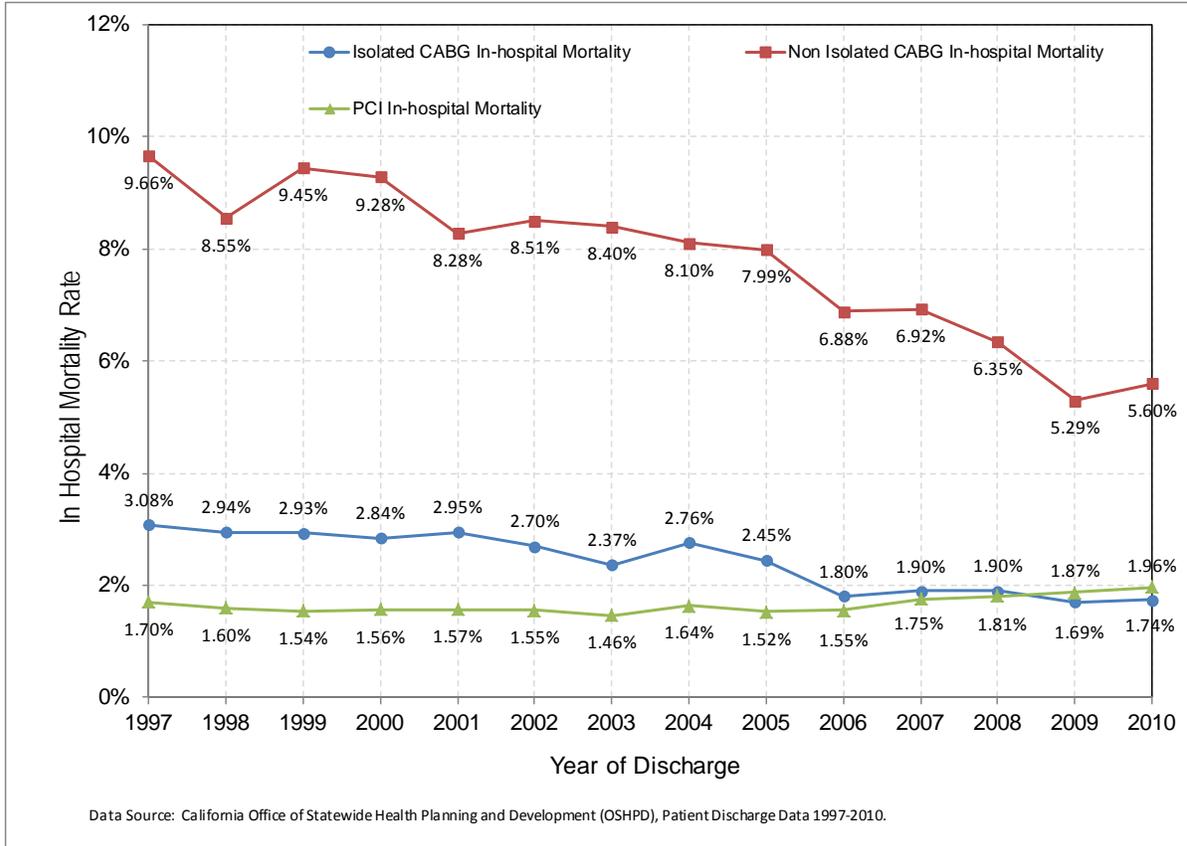
<sup>12</sup> Ryan, J and Cohen, DJ. Are drug-eluting stents cost-effective?: It depends on whom you ask. *Circulation* 2006; 114:1736-1744.

<sup>13</sup> 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 from 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 1: Volume of Isolated CABG, Non-Isolated CABG, and PCI Procedures in California, 1997-2010**



**Figure 2: In-Hospital Mortality Rates for Isolated CABG, Non-Isolated CABG, and PCI Procedures in California, 1997-2010**



## APPENDIX A: DEFINITION OF READMISSION

A readmission was counted only if the patient was readmitted with a principal diagnosis (i.e., the reason for the readmission) that indicated a heart-related condition, or an infection or a complication that was likely related to the CABG surgery hospitalization. California adopted the diagnosis categories and associated ICD-9-CM codes used by the Pennsylvania Healthcare Cost Containment Council for readmissions. The following list of categories shows the ICD-9-CM codes that were counted as readmissions if the code was located in the principal diagnosis position.

### CIRCULATORY SYSTEM

#### Cardiac Dysrhythmias

Heart Block: 426.0, 426.10, 426.11, 426.12, 426.13, 426.2, 426.3, 426.4, 426.50, 426.51, 426.52, 426.53, 426.54, 426.6, 426.7, 426.81, 426.82, 426.89, 426.9  
 Paroxysmal Tachycardia: 427.0, 427.1, 427.2  
 Atrial Fibrillation and Atrial Flutter: 427.31, 427.32  
 Ventricular Fibrillation and Ventricular Flutter: 427.41, 427.42, 427.5  
 Premature Heart Beats: 427.60, 427.61, 427.69  
 Other Cardiac Dysrhythmias: 427.81, 427.89, 427.9

Heart Failure: 398.91, 428.0, 428.1, 428.20, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, 428.9

Functional Disturbances Follow Cardiac Surgery (Postcardiotomy Syndrome): 429.4

#### Hypertension and Hypotension:

Essential Hypertension: 401.0, 401.1, 401.9  
 Hypertensive Heart Disease: 402.00, 402.01, 402.10, 402.11, 402.90, 402.91  
 Hypertensive Chronic Kidney Disease: 403.00, 403.01, 403.10, 403.11, 403.90, 403.91  
 Hypertensive Heart and Chronic Kidney Disease: 404.00, 404.01, 404.02, 404.03, 404.10, 404.11, 404.12, 404.13, 404.90, 404.91, 404.92, 404.93  
 Secondary Hypertension: 405.01, 405.09, 405.11, 405.19, 405.91, 405.99  
 Hypotension: 458.0, 458.1, 458.21, 458.29, 458.8, 458.9, 796.3

#### Myocardial Infarction and Ischemia

Acute Myocardial Infarction, Initial Episode: 410.01, 410.11, 410.21, 410.31, 410.41, 410.51, 410.61, 410.71, 410.81, 410.91  
 Acute Myocardial Infarction, Unspecified or Subsequent Episode: 410.00, 410.02, 410.10, 410.12, 410.20, 410.22, 410.30, 410.32, 410.40, 410.42, 410.50, 410.52, 410.60, 410.62, 410.70, 410.72, 410.80, 410.82, 410.90, 410.92  
 Other Forms of Myocardial Ischemia: 411.0, 411.81, 411.89, 429.79

Angina Pectoris and Chest Pain: 411.1, 413.0, 413.1, 413.9, 786.50, 786.51, 786.59

#### Atherosclerosis

Coronary Atherosclerosis: 414.00, 414.01, 414.02, 414.03, 414.04, 414.05, 414.06, 414.07, 414.2, 414.3  
 Other Atherosclerosis: 429.2, 440.0, 440.1, 440.20, 440.21, 440.22, 440.23, 440.24, 440.29, 440.30, 440.31, 440.32, 440.8, 440.9

Heart Aneurysm and Dissection: 414.10, 414.11, 414.12, 414.19

Pericarditis, Endocarditis and Myocarditis: 397.9, 398.0, 420.90, 420.91, 420.99, 421.0, 421.9, 422.90, 422.91, 422.92, 422.93, 422.99, 423.1, 423.2, 423.3, 423.8, 423.9, 424.90, 424.99, 429.0, 429.1

#### Heart Valve Disease:

Mitral Valve Disease: 394.0, 394.1, 394.2, 394.9, 424.0  
 Aortic Valve Disease: 395.0, 395.1, 395.2, 395.9, 424.1  
 Tricuspid Valve Disease: 397.0, 424.2  
 Pulmonary Valve Disease: 397.1, 424.3  
 Multiple Valve Disease: 396.0, 396.1, 396.2, 396.3, 396.8, 396.9  
 Other Endocardial Structure Disease: 429.5, 429.6, 429.71, 429.81

Cardiomyopathies: 425.0, 425.1, 425.3, 425.4, 425.9

#### Other Aneurysm and Dissection

Aortic Aneurysm and Dissection: 441.00, 441.01, 441.02, 441.03, 441.1, 441.2, 441.3, 441.4, 441.5, 441.6, 441.7, 441.9  
 Other Arterial Aneurysm: 442.0, 442.1, 442.2, 442.3, 442.81, 442.82, 442.83, 442.84, 442.89, 442.9

Other Arterial Dissection: 443.21, 443.22, 443.23, 443.24, 443.29

#### Arterial Embolism and Thrombosis

Abdominal and Thoracic Aorta: 444.0, 444.1

Arteries of the Extremities: 444.21, 444.22, 445.01, 445.02

Other Arteries Excluding Precerebral and Cerebral Arteries: 444.81, 444.89, 444.9, 445.81, 445.89, 449, 593.81

#### Venous Embolism and Thrombosis

Lower Extremity Venous Embolism and Thrombosis: 453.40, 453.41, 453.42

Renal Vein Embolism and Thrombosis: 453.3

Other Venous Embolism and Thrombosis: 453.8, 453.9

#### Phlebitis and Thrombophlebitis

Lower Extremity Phlebitis and Thrombophlebitis: 451.0, 451.11, 451.19, 451.2

Upper Extremity Phlebitis and Thrombophlebitis: 451.82, 451.83, 451.84

Other Vessel Phlebitis and Thrombophlebitis: 451.81, 451.89, 451.9

#### Occlusion and Stenosis

Precerebral Artery Occlusion and Stenosis: 433.00, 433.20, 433.30, 433.80, 433.90

Cerebral Artery Occlusion and Stenosis: 433.10, 434.00, 434.10, 434.90

Retinal Artery Occlusion and Visual Loss: 362.30, 362.31, 362.32, 362.33, 362.34, 362.35, 362.36, 362.37, 368.11, 368.12, 368.40

Other Diseases and Symptoms of the Circulatory System: 398.90, 398.99, 414.8, 414.9, 423.0, 429.3, 429.82, 429.89, 429.9, V533.1, V533.2, V533.9

### RESPIRATORY SYSTEM

#### Pulmonary Embolism and Infarction

Pulmonary Embolism and Infarction: 415.0, 415.12, 415.19

Postoperative Pulmonary Embolism and Infarction: 415.11

Pleural Effusion and Atelectasis: 511.0, 511.8, 511.89, 511.9, 518.0

#### Pneumothorax

Pneumothorax: 512.0, 512.8

Postoperative Pneumothorax: 512.1

Pulmonary Edema: 514, 518.4, 518.5

Acute Respiratory Failure: 518.81, 518.82, 518.84, 799.1

Other Diseases and Symptoms of the Respiratory System: 518.1, 519.19, 519.2, 733.6, 786.00, 786.02, 786.04, 786.05, 786.06, 786.09, 786.3, 786.52, 786.6, 786.7, 786.8, 786.9, 998.81

### NERVOUS SYSTEM

#### Stroke

Ischemic Stroke: 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91

Hemorrhagic Stroke: 430, 431, 432.0, 432.1, 432.9

Transient Cerebral Ischemia: 435.0, 435.1, 435.2, 435.3, 435.8, 435.9

Postoperative Stroke: 997.02

Encephalopathies: 348.30, 348.31, 348.39, 349.82, 437.2

Cerebral Edema and Brain Compression: 348.4, 348.5

Anoxic Brain Damage: 348.1

Coma and Stupor: 780.01, 780.03, 780.09

Postoperative Pain: 338.12, 338.18

Other Diseases and Symptoms of the Nervous System: 336.1, 436, 780.2, 780.4, 780.97

## **DIGESTIVE SYSTEM**

Ischemic Bowel and Vascular Insufficiency of the Intestine: 557.0, 557.9

Intestinal Obstruction and Ileus: 560.1, 560.81, 560.89, 560.9

Ulceration, Bleeding and Perforation of the Digestive System: 528.00, 528.02, 528.09, 530.10, 530.12, 530.20, 530.21, 530.82, 531.00, 531.01, 531.10, 531.11, 531.20, 531.21, 531.30, 531.31, 531.40, 531.41, 531.50, 531.51, 531.60, 531.61, 531.70, 531.71, 531.90, 531.91, 532.00, 532.01, 532.10, 532.11, 532.20, 532.21, 532.30, 532.31, 532.40, 532.41, 532.50, 532.51, 532.60, 532.61, 532.70, 532.71, 532.90, 532.91, 533.00, 533.01, 533.10, 533.11, 533.20, 533.21, 533.30, 533.31, 533.40, 533.41, 533.50, 533.51, 533.60, 533.61, 533.70, 533.71, 533.90, 533.91, 534.00, 534.01, 534.10, 534.11, 534.20, 534.21, 534.30, 534.31, 534.40, 534.41, 534.50, 534.51, 534.60, 534.61, 534.70, 534.71, 534.90, 534.91, 535.00, 535.01, 535.40, 535.41, 535.50, 535.51, 535.60, 535.61, 569.3, 569.82, 569.83, 578.9

Acute Liver Failure: 570, 572.2

Other Diseases and Symptoms of the Digestive System: 560.30, 560.39, 568.81, 577.0, 578.0, 578.1

## **URINARY SYSTEM**

Acute Glomerulonephritis and Pyelonephritis: 580.0, 580.4, 580.89, 580.9, 590.10, 590.11, 590.80

Nephrotic Syndrome: 581.0, 581.1, 581.2, 581.3, 581.89, 581.9

Acute Renal Failure: 584.5, 584.6, 584.7, 584.8, 584.9

Other Diseases and Symptoms of the Urinary System: 593.9, 599.7, 599.70, 599.71, 599.72, 788.20, 788.29

## **COMPLICATIONS OF SURGICAL AND MEDICAL CARE**

Mechanical Complication of Cardiac Device, Implant and Graft

Mechanical Complication of Cardiac Pacemaker and AICD: 996.00, 996.01, 996.04

Mechanical Complication of Heart Valve Prosthesis: 996.02

Mechanical Complication of Coronary Artery Bypass Graft: 996.03

Other and Unspecified Mechanical Complication: 996.09, 996.1, 996.59

Other Complication of Internal Prosthetic Device, Implant and Graft

Other Complication of Heart Valve Prosthesis: 996.71

Other Complication of Other Cardiac Device, Implant and Graft: 996.72

Other Complication of Vascular Device, Implant and Graft: 996.74

Shock

Postoperative Shock: 998.0

Cardiogenic Shock: 785.51

Other Shock: 785.50, 785.59

Hemorrhage and Hematoma Complicating a Procedure: 459.0, 998.11, 998.12, 998.13

Foreign Body Accidentally Left or Accidental Laceration During a Procedure: 998.2, 998.4, 998.7

Dehiscence and Rupture of Operation Wound: 998.31, 998.32, 998.6, 998.83

Other Complications of Surgical and Medical Care

Nervous System Complication: 997.00, 997.01, 997.09

Circulatory System Complication: 997.1, 997.2, 997.71, 997.72, 997.79, 999.1, 999.2

Respiratory System Complication: 519.00, 519.02, 519.09, 997.3, 997.39

Digestive System Complication: 536.40, 536.42, 536.49, 997.4

Urinary System Complication: 997.5

Other Complications: 998.89, 998.9, 999.8, 999.89

## **INFECTIONS**

Postoperative Infections: 997.31, 998.51, 998.59, 99.3, 999.31, 999.39

Sepsis and Bacteremia: 038.0, 038.10, 038.11, 038.12, 038.19, 038.2, 038.3, 038.40, 038.41, 038.42, 038.43, 038.44, 038.49, 038.8, 038.9, 785.52, 790.7, 995.90, 995.91, 995.92

**Pneumonia**

Pneumonia: 481, 482.0, 482.1, 482.2, 482.30, 482.31, 482.32, 482.39, 482.40, 482.41, 482.42, 482.49, 482.81, 482.82, 482.83, 482.84, 482.89, 482.9, 485, 486, 511.1

Aspiration Pneumonia: 507.0

Empyema and Abscess of Lung: 510.0, 510.9, 513.0, 513.1

**Infection due to Device, Implant and Graft**

Cardiac Device, Implant and Graft: 996.61

Vascular Device, Implant and Graft: 996.62

Other and Unspecified Infections due to Device, Implant and Graft: 519.01, 536.41

Urinary Tract Infection: 590.3, 590.9, 595.0, 599.0, 996.64

Cellulitis: 681.00, 681.01, 681.02, 681.10, 681.11, 681.9, 682.0, 682.1, 682.2, 682.3, 682.4, 682.5, 682.6, 682.7, 682.8, 682.9

Osteomyelitis: 730.03, 730.06, 730.07, 730.08, 730.09

Intestinal Infection due to Clostridium difficile: 008.45

Other Infection Related Conditions and Symptoms: 567.21, 567.29, 567.9, 590.2, 780.6, 780.60, 780.61, 780.62

**FLUID AND ELECTROLYTE IMBALANCE**

Hyperosmolality and Hyposmolality: 276.0, 276.1

Acidosis and Alkalosis: 276.2, 276.3, 276.4

Dehydration and Hypovolemia: 276.50, 276.51, 276.52

Fluid Overload: 276.6

Hyperpotassemia and Hypopotassemia: 276.7, 276.8

Other Electrolyte and Fluid Disorders: 276.9

**ANEMIA AND COAGULATION DEFECTS**

**Anemia**

Acute Posthemorrhagic Anemia: 285.1

Anemia: 280.0, 285.8, 285.9

**Coagulation Defects**

Hemorrhagic Disorders due to Anticoagulants: 286.5

Thrombocytopenia: 287.4, 287.5, 289.84, 446.6

Other Coagulation Defects: 286.6, 286.7, 286.9, 289.82, 790.92

## **APPENDIX B: HOSPITAL STATEMENTS**

CCORP provided each hospital with a preliminary report containing the risk-adjusted models, explanatory materials, and results for all hospitals. Hospitals were given a 60-day review period to submit statements to OSHPD for inclusion in this report. Three hospitals submitted statements, which are included here.



October 20, 2011

Via Federal Express

Holly Hoegh, Ph.D.  
Manager, Clinical Data Programs  
Office of Statewide Health Planning and Development  
400 R Street, Room 250  
Sacramento, CA 95811

Dear Dr. Hoegh:

As consumers review comparisons of California hospital performance on Coronary Artery Bypass Grafts (CABG), we encourage them to consider this report as a single thread in a complex fabric of quality reporting.

Consumers can gain additional perspective by reviewing a series of these reports. We believe that careful review will demonstrate continued improvement in our patient outcomes regarding stroke following CABG. Our rigorous patient by patient review of outcomes and application of evidence-based medicine has made a positive difference in our results and will continue to do so in the future.

This study is one of the many tools patients may use in making a choice about their healthcare. We recommend consumers also review information available through HospitalCompare, the Leapfrog Group and The Joint Commission. Above all else, patients should talk with their physicians about the experience, patient outcomes and clinical quality improvement programs at any hospital they are considering for their care.

Sincerely,

Arthur W. Douville, MD  
Chief Medical Officer

cc: Christie Plesche, Director, Cardiac Cath Lab



Scripps Memorial Hospital La Jolla  
Administration  
9888 Genesee Avenue  
La Jolla, CA 92037-1276  
Tel 858-457-4123

October 21, 2011

Holly Hoegh, PhD  
Manager, Clinical Data Programs  
Office of Statewide Health Planning and Development  
400 R Street, Room 250  
Sacramento, CA 95811



Dear Dr. Hoegh:

Scripps Memorial Hospital La Jolla is the principle provider of cardiovascular surgical procedures within the Scripps Health system, which performs more cardiovascular procedures than any other heart care program in California.

In response to the 2008-2009 CCORP data on stroke complications following coronary artery bypass graft (CABG), we welcome the opportunity to provide information to patients and our community with regard to the quality of cardiovascular surgery delivered by Scripps Memorial, and our vigilance in maintaining that quality.

We implement a multidisciplinary clinical quality review process for any outcome of major complication or death. This process involves both focused review including specialists in cardiology, cardiac surgery, neurology, radiology and intensive medicine, as well as closely monitoring trends.

The 2008 Stroke complication data has been reviewed and has contributed to a revised and enhanced review process. Our cardiologists now perform a secondary review of information prior to submission of data to CCORP in order to ensure accurate capture of stroke pathology.

The increase in stroke complications in this report was isolated to 2008. A significantly lower number of strokes (50% less) were reported in 2009 and this improvement has been sustained.

We would also like to note that as part of our quality program, we voluntarily participate in the Society of Thoracic Surgeons (STS) data registry. STS composite data for all complications, including stroke, for the years 2007, 2008, 2009 and 2010 reflects rates well within national standards in this gold standard nationally benchmarked database.

Sincerely,

A handwritten signature in black ink, appearing to read "Gary G. Fybel".

Gary G. Fybel, FACHE  
Chief Executive



Scripps Mercy Hospital

4077 Fifth Avenue  
San Diego, CA 92103-2180

Tel 619-294-8111

October 21, 2011

Dr. Holly Hoegh, Ph.D  
Manager, Clinical Data Programs  
Office of Statewide Health Planning and Development  
400 R Street, Room 250  
Sacramento, CA 95811

Dear Doctor Hoegh:

Scripps Mercy Hospital San Diego has been providing excellence in compassionate healthcare to the community of San Diego for over 120 years. As a tertiary referral center, we provide a high level of complex specialty care in many areas including major trauma and cardiovascular services.

In response to the 2009 CCORP data on operative mortality (death while hospitalized) following coronary artery bypass graft (CABG), we welcome the opportunity to provide information to patients and our community with regard to the quality of cardiovascular surgery delivered by Scripps Mercy, and our vigilance in maintaining that quality.

We initiate a multidisciplinary clinical quality review process for every cardiac surgical major complication or death. A focused review involving specialists in cardiology, cardiac surgery, radiology and critical care medicine is undertaken to identify opportunities for improvement, implement changes, and to monitor our results.

In 2009 we reported 8 deaths of CABG patients, which was an isolated increase in mortality rate, not seen in 2007, 2008 or 2010. Our clinical quality review process at that time demonstrated that this isolated increase was primarily the result of 5 critically ill patients, with many high surgical risk factors, who were transferred to Scripps Mercy San Diego from community providers. Processes have been implemented that corrected the identified problems with patients transferred in for cardiovascular surgery.

As part of our quality program, we voluntarily participate in the Society of Thoracic Surgeons (STS) data registry. Our STS data for CABG surgery for the years 2007, 2008, 2009 and 2010 reflects that mortality rates are well within national standards as measured by this gold standard nationally benchmarked database.

Sincerely,



Davis Cracroft, MD  
Senior Director, Medical Affairs  
Scripps Mercy Hospital



**APRIL 2012**

Additional copies of The California Report on Coronary Artery Bypass Graft Surgery  
can be obtained by visiting [www.oshpd.ca.gov](http://www.oshpd.ca.gov)