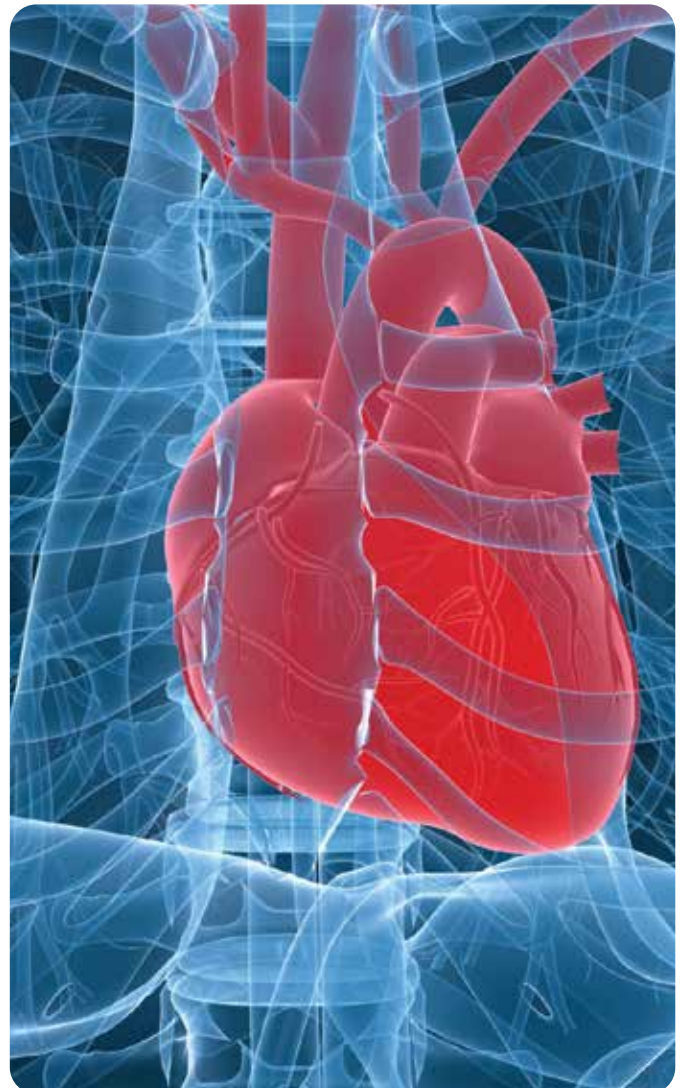


# The California Report on Coronary Artery Bypass Graft Surgery

## 2011 Hospital Data

California CABG  
Outcomes Reporting  
Program

February 2014



# **The California Report on Coronary Artery**

## **Bypass Graft Surgery**

**2011 Hospital Data**

**February 2014**

Edmund G. Brown Jr., Governor  
State of California

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## ***PREFACE***

February 2014

The Office of Statewide Health Planning and Development (OSHPD) is pleased to share with you the ninth public release of data from the state's mandatory heart bypass surgery reporting program, the California Coronary Artery Bypass Graft (CABG) Outcomes Reporting Program (CCORP). This report provides quality ratings for 122 state-licensed hospitals performing isolated CABG surgery during 2011. The hospital performance ratings are based on three risk-adjusted health outcomes: operative mortality, post-operative stroke, and hospital readmission. This is our third report that rates hospitals on their unplanned readmissions, a problem that has received considerable national attention because it contributes to increased costs to the healthcare system. This report also includes 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 2011, the statewide operative mortality rate for isolated CABG surgery was 2.01%. This is a slight increase from the 2.00% rate in 2010, but a 31% reduction from the 2.91% rate in 2003, the first year of mandatory reporting.

This information is intended for cardiac patients and their families who are considering treatment plans with their doctors. It is also intended for hospitals and surgeons who are developing quality improvement activities and for organizations that purchase healthcare coverage for their members. The 2011 report provides accurate and valid findings; however, cardiac surgeon or hospital practices may have changed since the 2011 data were collected by OSHPD.

OSHPD commends the hospitals and cardiac surgeons in California and the CCORP Clinical Advisory Panel, which oversees this program, for their hard work and support of this public reporting program. OSHPD continues to work with hospitals, physicians, and professional surgical societies to ensure that these reports are accurate and fair, and that they contribute to improved cardiac surgical care for all residents of the Golden State.

Robert P. David  
Director  
California Office of Statewide Health Planning and Development



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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 provide ongoing feedback on the design of the program, which is vital to its success, and members of the CCORP Clinical Advisory Panel provide oversight and policy guidance for data collection and analysis. 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 for improved data quality.

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# Executive Summary

The California Coronary Artery Bypass Graft (CABG) Outcomes Reporting Program (CCORP), established in 2001, is the largest public reporting program on CABG surgery outcomes in the United States.

The *California Report on Coronary Artery Bypass Graft Surgery, 2011 Hospital Data* presents findings from analyses of data collected from 122 California-licensed hospitals that performed adult isolated CABG<sup>1</sup> surgery during 2011. The hospital results for risk-adjusted mortality, risk-adjusted readmissions and internal mammary artery utilization are based on 2011 data. The hospital results for risk-adjusted post-operative stroke are based on combined 2010 and 2011 data.

The three outcome measures (operative mortality, post-operative stroke, and hospital readmission) help patients, hospitals, physicians, and payers evaluate hospital performance. These measures are risk-adjusted, which is a statistical technique that enables fair comparison of hospital outcomes even though some hospitals treat sicker patients. In this report, operative mortality includes all deaths that occurred 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 the deaths occurred). Post-operative stroke is defined as a post-operative, central neurologic deficit that did not resolve within 24 hours. 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.

Additionally, this report provides 2011 hospital-level data on internal mammary artery (IMA)<sup>2</sup> usage, which is an important process measure of surgical quality. This report also compares statewide volume and mortality outcomes for two types of cardiac revascularization procedures: percutaneous coronary interventions (PCI) and CABG surgery. PCI is also known as angioplasty or balloon catheterization.

## Key Findings

### ***2011 Hospital Operative Mortality Findings:***

- ❖ There were 249 operative deaths among 12,399 isolated CABG surgeries performed in 2011.
- ❖ The operative mortality rate for isolated CABG surgery in California was 2.01% in 2011 (compared to 2.00% in 2010). This represents a 31% reduction in the operative mortality rate since 2003 (2.91%), the first year of mandated public reporting.

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<sup>1</sup> Isolated CABG surgery refers to heart bypass surgery without other major surgery, such as heart or lung transplantation, valve repair, etc., that was performed concurrently with the bypass procedure.

<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.

- ❖ There was significant<sup>3</sup> variation, from 0% to 8.18%, in hospital operative mortality rates after adjusting for patient pre-operative health. Despite such variation, 121 of 122 hospitals (99%) performed at a rate that did not differ significantly from the statewide average.
- ❖ No hospital performed significantly **“Better”** than the state average in terms of risk-adjusted operative mortality (Table 1), and one hospital performed **“Worse”** than the state average (Table 2).

### ***2010-2011 Hospital Post-Operative Stroke Findings:***

- ❖ 329 of the 24,947 patients (1.32%) who underwent isolated CABG surgery in 2010-2011 experienced a post-operative stroke; this is a slight increase since 2009-2010 (1.31%), and just below the national rate of 1.4% reported by the Society of Thoracic Surgeons.<sup>4</sup>
- ❖ There was wide variation in post-operative stroke rates among hospitals after adjusting for patient pre-operative health. Hospital risk-adjusted post-operative stroke rates ranged from 0% to 5.10% and 118 of 123 hospitals (96%) performed at a rate that did not differ significantly from the statewide average.
- ❖ One hospital performed **“Better”** than the state average (Table 1), and four hospitals performed **“Worse”** than the state average (Table 2).

### ***2011 Hospital Readmission Findings:***

- ❖ 1,438 of the 11,085 patients (12.97%) who underwent isolated CABG surgery in 2011 and were discharged alive experienced a hospital readmission within 30 days of the surgery. This represents a 1.4% reduction from the 2010 rate of 13.15%.
- ❖ There was wide variation in the readmission rates among hospitals performing CABG surgery after adjusting for patient pre-operative conditions. Hospital risk-adjusted readmission rates ranged from 0% to 33.05% and 116 of 122 hospitals (95%) performed at a rate that did not differ significantly from the statewide average.
- ❖ Two hospitals performed **“Better”** than the state average on hospital readmissions (Table 1), and four hospitals performed **“Worse”** than the state average (Table 2).

### ***2011 Hospital 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 hospitals had a 96.65% IMA usage rate in 2011 compared to 89.6% in 2003.<sup>5</sup>

<sup>3</sup> Significant refers to statistically significant with a less than 5% probability that the result is due to chance alone ( $p < 0.05$ ).

<sup>4</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.

<sup>5</sup> The increase in the statewide IMA usage rate from 93.7% in 2007 to 95.9% in 2008, 96.2% in 2009, 96.0% in 2010, and 96.7% in 2011 is partly due to a change in the IMA measure. Beginning in 2008, patients who did not have the LAD bypassed were excluded from the denominator. If this exclusion were not used, the statewide IMA usage rate would be 94.4% for 2008, 94.8% for 2009, 94.7% for 2010, and 95.2% for 2011.

Five California hospitals had IMA usage rates that were significantly lower than the state average and were given **“Low”** performance ratings (Table 2). There is no consensus on what an optimal usage rate should be, so **“Better”** performance ratings were not given for very high rates of IMA usage. Those hospitals with **“Low”** performance ratings are listed in Table 2.

**Table 1:** Hospitals with **“Better”** Performance Ratings

HOSPITAL	REGION
<b>Hospitals with “Better” Risk-Adjusted Post-Operative Stroke Rates, 2010-2011</b>	
Sutter Memorial Hospital	Sacramento Valley & Northern California Region
<b>Hospitals with “Better” Risk-Adjusted 30-Day Readmission Rates, 2011</b>	
Regional Medical of San Jose	San Francisco Bay Area & San Jose
Santa Rosa Memorial Hospital	San Francisco Bay Area & San Jose

**Table 2:** Hospitals with **“Worse”** or **“Low”** Performance Ratings

HOSPITAL	REGION
<b>Hospitals with “Worse” Risk-Adjusted Operative Mortality Rates, 2011</b>	
AHMC Anaheim Regional Medical Center	Orange County
<b>Hospitals with “Worse” Risk-Adjusted Post-Operative Stroke Rates, 2010-2011</b>	
Seton Medical Center	San Francisco Bay Area & San Jose
Providence Tarzana Medical Center	San Fernando Valley, Antelope Valley, Ventura & Santa Barbara
Hoag Memorial Hospital Presbyterian	Orange County
Sharp Memorial Hospital	Greater San Diego
<b>Hospitals with “Worse” Risk-Adjusted 30-Day Readmission Rates, 2011</b>	
West Hills Hospital and Medical Center	San Fernando Valley, Antelope Valley, Ventura & Santa Barbara
Ronald Reagan UCLA Medical Center	Greater Los Angeles
White Memorial Medical Center	Greater Los Angeles
Saddleback Memorial Medical Center	Orange County
<b>Hospitals with “Low” Internal Mammary Artery (IMA) Use Rates, 2011</b>	
Marin General Hospital	San Francisco Bay Area & San Jose
Santa Rosa Memorial Hospital - Montgomery	San Francisco Bay Area & San Jose
Sutter Medical Center of Santa Rosa	San Francisco Bay Area & San Jose
Memorial Hospital Medical Center - Modesto	Central California
Palmdale Regional Medical Center	San Fernando Valley, Antelope Valley, Ventura & Santa Barbara

***Percutaneous Coronary Intervention (PCI) vs. CABG Utilization and Outcomes Findings:***

- ❖ **Volume:** Between 1997 and 2012, PCI (angioplasty/balloon catheterization) volume *decreased* by 3% (from 44,350 to 42,941) while isolated CABG surgeries decreased by 58% (from 28,178 to 11,725) and non-isolated CABG surgeries decreased by 20% (from 4,276 to 3,400). For the same time period, valve-only procedures increased by 68% (from 4,473 to 7,519).
  
- ❖ **Mortality:** Between 1997 and 2012, observed in-hospital mortality rates for isolated and non-isolated CABG surgeries decreased from 3.08% to 1.63% and from 9.66% to 6.06%, respectively. The observed in-hospital mortality for valve-only procedures decreased from 5.28% to 3.11%. However, the observed in-hospital mortality rate for PCIs increased from 1.70% to 2.41%, surpassing the in-hospital mortality rate for isolated CABG surgeries.

# 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 2011. It is the ninth 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 122 California state-licensed hospitals that performed this procedure in 2011.

## What is CABG surgery?

The two most common cardiac revascularization procedures for treating 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/or 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 evidence shows it maintains better blood flow over time and is associated with better long-term patient survival.

### What is Coronary Artery Disease?

**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 myocardial infarction (heart attack).

In 2011, 103,208 Californians were admitted to hospitals for treatment of coronary artery disease.<sup>6</sup> This represents approximately 4.1% of all adult non-maternal admissions.

## What does this report measure?

This report provides hospital performance data on four key measures of CABG surgery for the 122 hospitals in California that performed this procedure: risk-adjusted CABG surgery **operative mortality**, **post-operative stroke**, and **30-day hospital readmission** (outcome measures) and **use of internal mammary artery** (process measure). The outcome measures are adjusted statistically (risk-adjusted) to account for variation in the health status of patients prior to CABG surgery.

## Measure Definitions:

**Operative mortality** is defined as a 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

<sup>6</sup> OSHPD, Patient Discharge Data, 2011. Patients were identified with coronary artery disease if the principal diagnosis was coded as ICD-9-CM 410.0-414.9.

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>7</sup> CCORP uses the STS definition of operative mortality, and also verifies deaths following patient discharge using death records from the California Department of Public Health.

**Post-operative stroke** is defined as a post-operative, central neurologic deficit that did not resolve within 24 hours after surgery.

**Hospital readmission** includes only those patients readmitted to any hospital within 30 days of being discharged after CABG surgery, who had a principal diagnosis indicating a heart-related condition or an infection or a complication that was likely related to the CABG surgery. Readmissions for other reasons are excluded in this analysis. California adopted the diagnosis categories and associated ICD-9-CM codes used by the Pennsylvania Healthcare Cost Containment Council to identify readmissions. OSHPD extends its thanks to the Council for making these available (Appendix F).

**Use of the internal mammary artery (IMA)** is the preferred method for CABG surgery of the left anterior descending artery. Research shows that high rates of IMA use result in long-term graft patency and improved patient survival.

Additionally, this report describes the longitudinal change in statewide volume of CABG surgeries and PCI (angioplasty) procedures and their related in-hospital mortality rates. These data provide an important context when considering California's overall performance of cardiac revascularization procedures.

### **Why are these outcomes important to measure?**

CABG surgery is one of the most common major cardiac surgeries and one of the most expensive surgeries performed in California. It has a declining mortality rate, but major complications (e.g., stroke, surgical site infections) can occur. Reporting surgical outcomes makes the healthcare system more accountable to consumers, payers, and employers, and assists providers with improving their quality of care.

### **Who is the intended audience for this report?**

This report may help patients and their families make more informed decisions about their health care. Healthcare purchasers may use this information to allocate their dollars more effectively. Finally, these data provide benchmarks against which hospitals and surgeons may measure their own performance, review patient care practices, and improve their outcomes related to CABG surgery.

OSHPD provided all hospitals listed in this report an opportunity to review their results prior to publication. Two hospitals submitted comment letters, which are included in Appendix G. These

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<sup>7</sup> National Quality Forum (NQF). National voluntary consensus standards for cardiac surgery, Washington, DC: National Quality Forum, January 2005. NQF recently updated the endorsed measure as part of the QPS tracking system (see [www.qualityforum.org](http://www.qualityforum.org)).



statements may help readers understand the concerns of some hospitals regarding the information released about them.

### **Who is included in this report (study population)?**

Under state law, California-licensed hospitals are required to report all isolated and non-isolated CABG surgeries to OSHPD. 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 on page 39 of the training manual: <http://www.oshpd.ca.gov/HID/CORC/>.

In 2011, there were 16,284 adult CABG surgeries performed in California. Of these, 12,399 (76%) were isolated CABG surgeries and 3,885 (24%) were non-isolated CABG surgeries. Isolated CABG surgery cases are used as the study population because uniformity of the surgical process allows adequate pre-operative risk adjustment for patient conditions. Non-isolated CABG cases are not used to determine hospital performance ratings in this report. The study population for this report consists of all adult patients who underwent isolated CABG surgery and were discharged in 2011. However, for post-operative stroke by hospital, the study population included those patients who were discharged in 2010 and 2011 to ensure the risk-adjusted stroke rates were based on a large sample size.

### **What data are used in this report?**

The primary data source for this report is the 2011 clinical data registry collected by CCORP from 122 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, and were readmitted to a hospital within 30 days of CABG surgery.

The CCORP clinical data registry primarily relies on a subset of data elements that are also collected by the Society of Thoracic Surgeons (STS) for their Adult Cardiac Surgery Database. 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 2011 and their definitions can be found at <http://www.oshpd.ca.gov/HID/CORC/>. For more details regarding the data collection, quality review, and verification methods, see Appendix A.



# Risk-Adjusted Isolated CABG Surgery Outcomes: Hospital Performance Ratings

Table 3 presents the performance ratings for each hospital's risk-adjusted outcomes and one process of care measure:

- Operative mortality (2011)
- Post-operative stroke (2010-2011)
- 30-day readmission (2011)
- Use of the internal mammary artery (2011)

The table is sorted by geographic region. Detailed statistical results for the four measures are located in Appendices B, C, D, and E.

## 2011 Hospital Risk-Adjusted Operative Mortality Results

The risk-adjusted operative mortality results represent the best estimate of what a hospital's mortality rate would have been if the hospital had a patient case mix identical to the statewide average. OSHPD defines operative mortality as a patient death occurring in the hospital after CABG surgery regardless of length of stay, or death occurring anywhere after hospital discharge but within 30 days after the CABG surgery. Hospital ratings are risk-adjusted, which allows for fair comparison of hospital outcomes even though some hospitals have sicker patients than average.

Of the 122 reporting hospitals, 121 hospitals (99%) performed within the expected range (**"Average"**) when compared to the state's overall mortality rate of 2.01%. No hospital performed significantly **"Better"** than the state average, and one hospital performed significantly **"Worse"** than the state average. Hospitals marked with † in Table 3 submitted statements regarding this report (Appendix G).

## 2010-2011 Hospital Risk-Adjusted Post-Operative Stroke Results

Table 3 also presents the risk-adjusted post-operative stroke results for each hospital for 2010-2011. OSHPD defines this measure as a post-operative central neurologic deficit persisting for more than 24 hours after CABG surgery (while in the operating hospital).

Of the 123 reporting hospitals, 118 hospitals (96%) performed within the expected range (**"Average"**) compared to the state's average stroke rate of 1.32%. One hospital performed significantly **"Better"** than the state average and four hospitals performed significantly **"Worse"** than the state average. Hospitals marked with † in Table 3 submitted statements regarding this report (Appendix G).

## 2011 Hospital Risk-Adjusted 30-Day Readmission Results

Table 3 presents the risk-adjusted 30-day readmission results for each hospital for 2011. Readmission is defined as a CABG surgery patient being readmitted to an acute care hospital within 30 days of being discharged to home or a non-acute care setting with a principal diagnosis indicating a heart-related condition, or an infection or a complication that was likely related to the CABG surgery.

Of the 122 reporting hospitals, 116 hospitals (95%) performed within the expected range compared to the state's overall readmission rate (denoted as "**Average**"). Two hospitals performed significantly "**Better**" than the state average, and four hospitals performed significantly "**Worse**" than the state average. Hospitals marked with † in Table 3 submitted statements regarding this report (Appendix G).

### **2011 Internal Mammary Artery Usage by Hospital: A Process Measure of Quality**

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 provides a process of care<sup>8</sup> measure: use of the internal mammary artery (IMA) in surgery. Both outcome and process of care measures are valuable to assessing quality of care. Outcome measurement permits a more comprehensive comparison of hospital performance over the long term and can be used for investigating internal processes and structures. Measuring the process of care provides a more immediate path to improving a particular aspect of patient care. If particular processes with clear links to health 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). The IMA, and especially the left IMA, is considered the preferred conduit for CABG surgery of the left anterior descending (LAD) coronary artery. Clinical research shows that IMA grafts used in CABG surgery stay open longer and increase patient survival. Research also suggests that a reduction in immediate operative mortality is associated with use of the IMA rather than saphenous (leg) vein revascularization.<sup>9</sup> Very low hospital utilization rates of IMA may be associated with poorer care.

Table 3 presents hospital results for usage of the IMA by hospitals in 2011. 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 remained nearly the same between 2010 and 2011 (96.0% and 96.7% respectively). Five hospitals received a "**Low**" rating for 2011. 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 3 submitted statements regarding this report. Their statements are presented in Appendix G.

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<sup>8</sup> Donabedian A. Evaluating the Quality of Medical Care. *The Milbank Quarterly*, 2005; 83(4):691-729.

<sup>9</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.

**Table 3:** California Hospital Performance Ratings for Coronary Artery Bypass Graft (CABG) Surgery by Region as Compared to the Statewide Average, 2011

Region	Hospital Name	Operative Mortality 2011 <sup>1</sup>	Post-Operative Stroke 2010-2011 <sup>2</sup>	30-Day Readmission 2011 <sup>3</sup>	Internal Mammary Artery Use 2011 <sup>4</sup>
<b>Sacramento Valley &amp; Northern California Region</b>	Enloe Medical Center – Esplanade Campus	Average	Average	Average	
	Mercy General Hospital	Average	Average	Average	
	Mercy Medical Center – Redding	Average	Average	Average	
	Mercy San Juan Hospital	Average	Average	Average	
	Rideout Memorial Hospital	Average	Average	Average	
	Shasta Regional Medical Center	Average	Average	Average	
	St. Joseph Hospital – Eureka	Average	Average	Average	
	Sutter Memorial Hospital	Average	<b>Better</b>	Average	
	UC Davis Medical Center	Average	Average	Average	
<b>San Francisco Bay Area &amp; San Jose</b>	Alta Bates Summit Medical Center – Summit Campus – Hawthorne	Average	Average	Average	
	California Pacific Medical Center – Pacific Campus	Average	Average	Average	
	Community Hospital Monterey Peninsula	Average	Average	Average	
	Dominican Hospital - Santa Cruz/Soquel	Average	Average	Average	
	El Camino Hospital	Average	Average	Average	
	Good Samaritan Hospital – San Jose	Average	Average	Average	
	John Muir Medical Center – Concord Campus	Average	Average	Average	
	Kaiser Foundation Hospital – San Francisco	Average	Average	Average	
	Kaiser Foundation Hospital – Santa Clara	Average	Average	Average	
	Marin General Hospital	Average	Average	Average	<b>Low</b>
	North Bay Medical Center†	Average	Average	Average	
	O'Connor Hospital – San Jose	Average	Average	Average	
	Peninsula Medical Center	Average	Average	Average	

**Table 3:** California Hospital Performance Ratings for Coronary Artery Bypass Graft (CABG) Surgery by Region as Compared to the Statewide Average, 2011

Region	Hospital Name	Operative Mortality 2011 <sup>1</sup>	Post-Operative Stroke 2010-2011 <sup>2</sup>	30-Day Readmission 2011 <sup>3</sup>	Internal Mammary Artery Use 2011 <sup>4</sup>
<b>San Francisco Bay Area &amp; San Jose (continued)</b>	Queen of the Valley Hospital – Napa	Average	Average	Average	
	Regional Medical of San Jose	Average	Average	<b>Better</b>	
	Salinas Valley Memorial Hospital	Average	Average	Average	
	San Ramon Regional Medical Center	Average	Average	Average	
	Santa Clara Valley Medical Center	Average	Average	Average	
	Santa Rosa Memorial Hospital – Montgomery	Average	Average	<b>Better</b>	<b>Low</b>
	Sequoia Hospital	Average	Average	Average	
	Seton Medical Center	Average	<b>Worse</b>	Average	
	St. Helena Hospital	Average	Average	Average	
	St. Mary's Medical Center – San Francisco	Average	Average	Average	
	Stanford Hospital	Average	Average	Average	
	Sutter Medical Center of Santa Rosa	Average	Average	Average	<b>Low</b>
	UCSF Medical Center	Average	Average	Average	
	Valleycare Medical Center	Average	Average	Average	
	Washington Hospital – Fremont	Average	Average	Average	
<b>Central California</b>	Bakersfield Heart Hospital	Average	Average	Average	
	Bakersfield Memorial Hospital	Average	Average	Average	
	Community Regional Medical Center – Fresno	Average	Average	Average	
	Dameron Hospital	Average	Average	Average	
	Doctors Medical Center	Average	Average	Average	
	Emanuel Medical Center	Average	Average	Average	
	Fresno Heart and Surgical Center	Average	Average	Average	
	Kaweah Delta Medical Center	Average	Average	Average	

**Table 3:** California Hospital Performance Ratings for Coronary Artery Bypass Graft (CABG) Surgery by Region as Compared to the Statewide Average, 2011

Region	Hospital Name	Operative Mortality 2011 <sup>1</sup>	Post-Operative Stroke 2010-2011 <sup>2</sup>	30-Day Readmission 2011 <sup>3</sup>	Internal Mammary Artery Use 2011 <sup>4</sup>
<b>Central California (continued)</b>	Marian Medical Center	Average	Average	Average	
	Memorial Medical Center of Modesto	Average	Average	Average	<b>Low</b>
	San Joaquin Community Hospital	Average	Average	Average	
	St. Agnes Medical Center	Average	Average	Average	
	St. Joseph's Medical Center of Stockton	Average	Average	Average	
<b>San Fernando Valley, Antelope Valley, Ventura &amp; Santa Barbara</b>	Antelope Valley Hospital	Average	Average	Average	
	Community Memorial Hospital of San Buenaventura	Average	Average	Average	
	French Hospital Medical Center	Average	Average	Average	
	Glendale Adventist Medical Center - Wilson Terrace	Average	Average	Average	
	Glendale Memorial Hospital and Health Center	Average	Average	Average	
	Lancaster Community Hospital	No CABG	Average	No CABG	No CABG
	Los Robles Hospital and Medical Center	Average	Average	Average	
	Northridge Hospital Medical Center	Average	Average	Average	
	Palmdale Regional Medical Center	Average	Average	Average	<b>Low</b>
	Providence Holy Cross Medical Center	Average	Average	Average	
	Providence St. Joseph Medical Center	Average	Average	Average	
	Providence Tarzana Medical Center	Average	<b>Worse</b>	Average	
	Santa Barbara Cottage Hospital	Average	Average	Average	
	St. John's Regional Medical Center	Average	Average	Average	
	Valley Presbyterian Hospital	Average	Average	Average	
	West Hills Hospital and Medical Center	Average	Average	<b>Worse</b>	

**Table 3:** California Hospital Performance Ratings for Coronary Artery Bypass Graft (CABG) Surgery by Region as Compared to the Statewide Average, 2011

Region	Hospital Name	Operative Mortality 2011 <sup>1</sup>	Post-Operative Stroke 2010-2011 <sup>2</sup>	30-Day Readmission 2011 <sup>3</sup>	Internal Mammary Artery Use 2011 <sup>4</sup>
Greater Los Angeles	Beverly Hospital	Average	Average	Average	
	Cedars Sinai Medical Center	Average	Average	Average	
	Centinela Hospital Medical Center	Average	Average	Average	
	Citrus Valley Medical Center – IC Campus	Average	Average	Average	
	Downey Regional Medical Center	Average	Average	Average	
	Garfield Medical Center	Average	Average	Average	
	Good Samaritan Hospital – Los Angeles	Average	Average	Average	
	Hollywood Presbyterian Medical Center	Average	Average	Average	
	Huntington Memorial Hospital	Average	Average	Average	
	Kaiser Foundation Hospital – Sunset	Average	Average	Average	
	Keck Hospital of USC	Average	Average	Average	
	Lakewood Regional Medical Center	Average	Average	Average	
	Long Beach Memorial Medical Center	Average	Average	Average	
	Los Angeles Co. Harbor – UCLA Medical Center	Average	Average	Average	
	Los Angeles Co. USC Medical Center	Average	Average	Average	
	Methodist Hospital of Southern California	Average	Average	Average	
	Presbyterian Intercommunity Hospital	Average	Average	Average	
	Providence Little Company of Mary Medical Center - Torrance	Average	Average	Average	
	Ronald Reagan UCLA Medical Center	Average	Average	Worse	
	Santa Monica – UCLA Medical Center and Orthopaedic Hospital	Average	Average	Average	

**Table 3:** California Hospital Performance Ratings for Coronary Artery Bypass Graft (CABG) Surgery by Region as Compared to the Statewide Average, 2011

Region	Hospital Name	Operative Mortality 2011 <sup>1</sup>	Post-Operative Stroke 2010-2011 <sup>2</sup>	30-Day Readmission 2011 <sup>3</sup>	Internal Mammary Artery Use 2011 <sup>4</sup>
<b>Greater Los Angeles (continued)</b>	St. Francis Medical Center	Average	Average	Average	
	St. John's Health Center	Average	Average	Average	
	St. Mary Medical Center	Average	Average	Average	
	St. Vincent Medical Center	Average	Average	Average	
	Torrance Memorial Medical Center	Average	Average	Average	
	White Memorial Medical Center	Average	Average	<b>Worse</b>	
<b>Inland Empire, Riverside &amp; San Bernardino</b>	Desert Regional Medical Center	Average	Average	Average	
	Eisenhower Memorial Hospital	Average	Average	Average	
	Loma Linda University Medical Center	Average	Average	Average	
	Pomona Valley Hospital Medical Center	Average	Average	Average	
	Riverside Community Hospital	Average	Average	Average	
	San Antonio Community Hospital	Average	Average	Average	
	St. Bernardine Medical Center	Average	Average	Average	
	St. Mary Regional Medical Center	Average	Average	Average	
<b>Orange County</b>	AHMC Anaheim Regional Medical Center	<b>Worse</b>	Average	Average	
	Fountain Valley Regional Hospital and Medical Center - Euclid	Average	Average	Average	
	Hoag Memorial Hospital Presbyterian	Average	<b>Worse</b>	Average	
	Mission Hospital Regional Medical Center	Average	Average	Average	
	Orange Coast Memorial Medical Center	Average	Average	Average	
	Saddleback Memorial Medical Center	Average	Average	<b>Worse</b>	
	St. Joseph Hospital - Orange	Average	Average	Average	
	St. Jude Medical Center	Average	Average	Average	
	UC Irvine Medical Center	Average	Average	Average	

**Table 3:** California Hospital Performance Ratings for Coronary Artery Bypass Graft (CABG) Surgery by Region as Compared to the Statewide Average, 2011

Region	Hospital Name	Operative Mortality 2011 <sup>1</sup>	Post-Operative Stroke 2010-2011 <sup>2</sup>	30-Day Readmission 2011 <sup>3</sup>	Internal Mammary Artery Use 2011 <sup>4</sup>
<b>Orange County (continued)</b>	West Anaheim Medical Center	Average	Average	Average	
	Western Medical Center - Santa Ana	Average	Average	Average	
	Western Medical Center Hospital – Anaheim	Average	Average	Average	
<b>Greater San Diego</b>	Alvarado Hospital Medical Center	Average	Average	Average	
	Palomar Medical Center	Average	Average	Average	
	Scripps Green Hospital	Average	Average	Average	
	Scripps Memorial Hospital – La Jolla	Average	Average	Average	
	Scripps Mercy Hospital	Average	Average	Average	
	Sharp Chula Vista Medical Center	Average	Average	Average	
	Grossmont Hospital	Average	Average	Average	
	Sharp Memorial Hospital†	Average	<b>Worse</b>	Average	
	Tri-City Medical Center	Average	Average	Average	
	UCSD Medical Center	Average	Average	Average	
	UCSD Medical Center – La Jolla, John M. & Sally B. Thornton Hospital	Average	Average	Average	

Note: “No CABG” indicates there was no coronary artery bypass operation performed in the hospital for the specified year.

Note: †=See Appendix G for statements submitted by hospitals regarding this report.

<sup>1</sup> **Operative Mortality** is defined as patient death occurring in the hospital after CABG surgery, regardless of length of stay, or death occurring anywhere after hospital discharge but within 30 days after the CABG surgery. Hospital ratings are risk-adjusted using a statistical technique that allows for fair comparison of hospital outcomes even though some hospitals have sicker patients than average.

<sup>2</sup> **Post-Operative Stroke** is defined as a post-operative, central neurologic deficit persisting for more than 24 hours after CABG surgery while in the operating hospital. Hospital ratings are risk-adjusted using a statistical technique that allows for fair comparison of hospital outcomes even though some hospitals have sicker patients than average.

<sup>3</sup> **Readmission** is defined as a CABG surgery patient being re-admitted to an acute care hospital within 30 days of being discharged to home or a non-acute care setting with a principal diagnosis indicating a heart-related condition, or an infection or a complication that was likely related to the CABG surgery. Hospital ratings are risk-adjusted using a statistical technique that allows for fair comparison of hospital outcomes even though some hospitals have sicker patients than average.

<sup>4</sup> **Internal Mammary Artery (IMA)** usage in CABG surgery is an evidence-based indicator of surgery quality. Clinical research shows that IMA grafts used in CABG surgery stay open longer and increase patients’ survival. Very low hospital utilization rates may be associated with poorer care. Hospitals are not assessed for very high IMA-usage rates because there is no consensus on what constitutes an optimal rate. Most first-time CABG surgery patients are eligible to receive an IMA bypass.



# Cardiac Revascularization Procedures: Statewide Volume and Observed In-Hospital Mortality of CABG Surgeries and PCI Procedures

There are two types of cardiac revascularization procedures: CABG surgery and percutaneous coronary interventions (PCI), also known as angioplasty, balloon catheterization, or intra-coronary stenting. These procedures, which have been refined during the past 30 years, have contributed to improved survival for heart attack patients. Since its introduction, the intra-coronary stent insertion procedure (using small wire cylinders to hold a narrow or clogged artery open) has largely replaced angioplasty without stents because of its lower rate of restenosis (re-narrowing of the arteries). 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, can be repeated, and is performed by a cardiologist without anesthesia. 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 measuring PCI outcomes.

## Cardiac Revascularization Volume

Figure 1 shows changes in the use of the two revascularization procedures, CABG and PCI, over time using data from OSHPD's Patient Discharge Data. Despite a sharp increase between 1997 and 2005, PCI volume decreased 3.2% between 1997 and 2012 in California. During the same timeframe, the number of isolated CABG surgeries decreased 58%.<sup>10</sup> Non-isolated CABG surgery volume remained relatively constant, with a slight decline each year since 2001. Meanwhile, the valve-only procedures increased by 68% from 4,473 in 1997 to 7,519 in 2012.

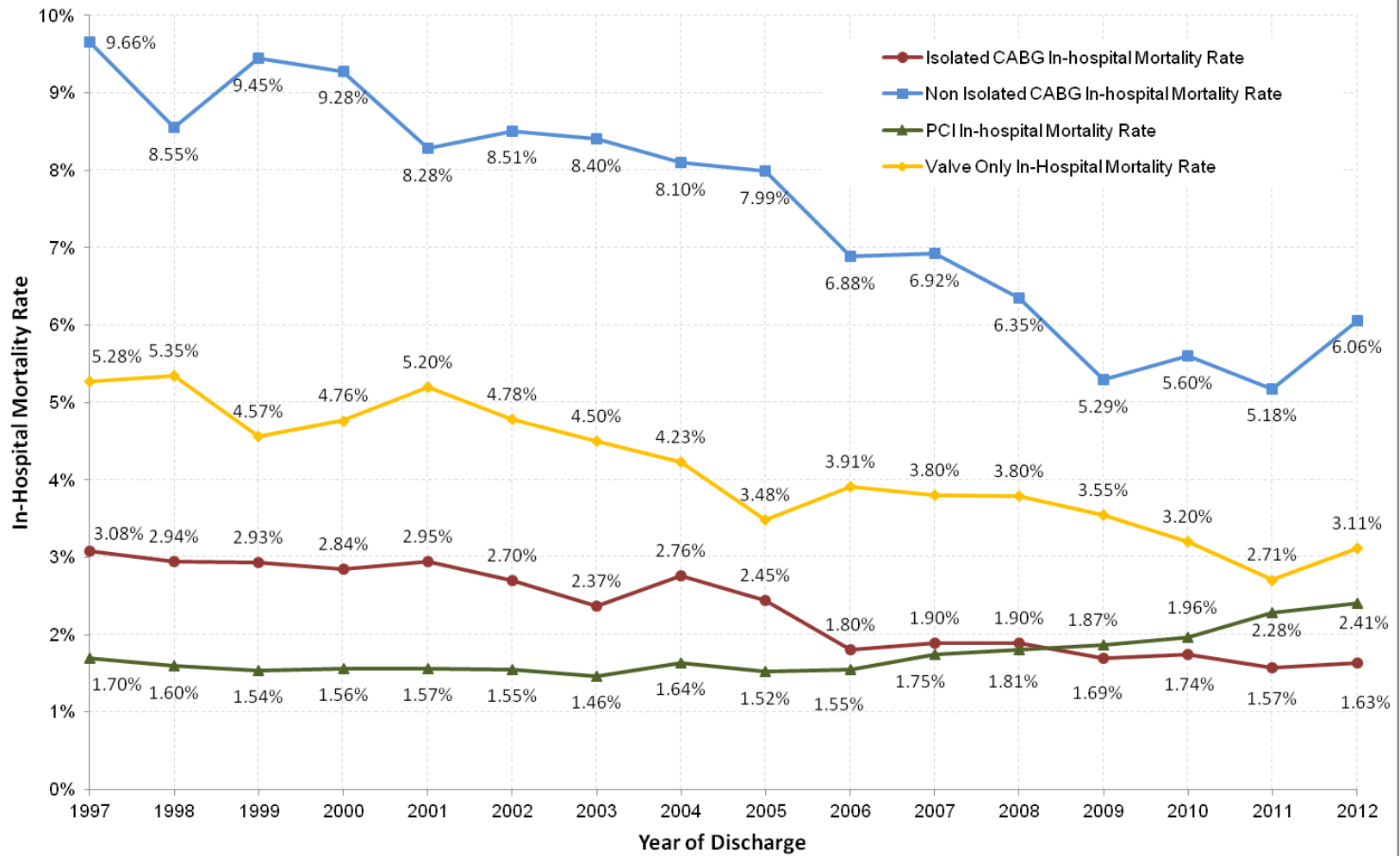
## Cardiac Revascularization Mortality

Figure 2 presents the trends in observed in-hospital mortality rates for isolated CABG surgeries, non-isolated CABG surgeries, valve-only procedures, and PCIs in California between 1997 and 2012. During the 16 years between 1997 and 2012, 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 1.63% in 2012, the tenth year of the mandatory reporting program. Meanwhile, the observed in-hospital mortality rates for non-isolated CABG surgeries and valve-only procedures also declined from 9.66% to 6.06% and from 5.28% to 3.11%, respectively. However, the observed in-hospital mortality rate for PCIs increased from 1.70% in 1997 to 2.41% in 2012. The increase in the PCI mortality rate may be due, in part, to changes in selection criteria for certain high-risk patients getting PCIs.

<sup>10</sup> This report uses two data sources to report isolated CABG volume. The numbers used in this section to compare isolated CABG and PCI volume were obtained from the OSHPD Patient Discharge Data (PDD). Note that the number of isolated CABGs reported in this section differs somewhat from the volume reported earlier in this report, which are based on the CCORP registry data. Because OSHPD does not maintain a PCI data registry, only the PDD provides a consistent source of numbers to compare both procedures.

**Figure 1:** Volume of Isolated CABG, Non-Isolated CABG, Valve-Only, and PCI Procedures in California, 1997-2012

Data source: California Patient Discharge Data (OSHPD)

**Figure 2: In-Hospital Mortality Rates for Isolated CABG, Non-Isolated CABG, Valve-Only, and PCI Procedures in California, 1997-2012**

Data source: California Patient Discharge Data (OSHPD)

# **Appendices:**

## **Technical Notes on Statistical Methods and Hospital Statements**

## Appendix A: 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 Collection and Acceptance***

Hospitals report their data using CCORP's online clinical data collection system, Cardiac Online Reporting for California (CORC). Data acceptance reports are generated electronically which notify hospitals of invalid, missing and abnormally high or low data values. Data quality reports are also generated each time a hospital submits data. Hospitals review these summary reports before they adjust, finalize and certify their data submission.

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

Data discrepancy reports compare the CCORP clinical 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 2011 were reported; 2) each CABG was accurately coded as isolated or non-isolated CABG surgery; 3) coding of *Discharge Status* was consistent; 4) *Resuscitation* occurred prior to CABG surgery; and 5) coding of *Post-Operative Complications* (including strokes) was consistent.

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

Risk-factor coding reports identify values that may be extreme by comparing the hospital reported prevalence rates in the current year compared to prior years and to administrative data from the PDD. CCORP requests hospitals to review and, when necessary, correct miscoded data elements.

## **Hospital Medical Chart Audit**

After completing the three-step data quality review and verification process, CCORP develops a preliminary risk model for in-hospital mortality and post-operative stroke to help identify candidate hospitals for an on-site medical chart audit. Candidate selection for the 2011 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 of patient risk prevalence. Additionally, a small number of hospitals were randomly selected for audit.

The 2011 audit included 18 hospitals and a total of 1,291 patient records (15% of all hospitals and approximately 9% of all CABG surgery cases in 2011). On-site medical chart reviews were conducted by trained, independent auditors under contract with OSHPD. All isolated CABG deaths and 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 fewer than 40 isolated CABG surgeries per year, all surgeries were audited. Individual audit summary reports were sent to audited hospitals for review and comment.

Key findings from the 2011 hospital medical chart audit include:

- *Discharge Status* was coded correctly for all isolated and non-isolated CABG records audited.
- Auditors found eight CABG cases reported by hospitals to CCORP as non-isolated CABG cases were not CABG procedures.
- Auditors found ten CABG cases reported to CCORP as isolated were non-isolated cases.
- Kappa statistics<sup>11</sup> show that most surgical data elements were well coded. The most poorly coded elements were *Mitral Insufficiency, Chronic Lung Disease, Immunocompromise, NYHA Class IV, Peripheral Arterial Disease and Warfarin (use within 5 days of surgery)*.
- Kappa statistics for all post-operative complications ranged from moderate to excellent (0.50-0.90). *Post-Operative Stroke*, which is publically reported, showed excellent agreement (0.80).

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<sup>11</sup> The Kappa statistic measures the degree to which CCORP data abstractors and auditors concurred in coding each data element. It measures agreement beyond that expected by chance, can range from 0 (no agreement) to 1.0 (perfect agreement), and is used to identify potential coding problems.

## Appendix B: Technical Notes on Hospital Operative Mortality Rate Calculations (2011)

### Risk Model for Adjusting Hospital Operative Mortality Rates, 2011

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 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 for hospital operative mortality.

To make fair comparisons of care delivered by different hospitals, CCORP "levels the playing field" by considering the pre-operative condition of each patient. Hospitals handling more complex cases receive a larger risk-adjustment weight in the risk model, and hospitals that handle less complex cases receive a smaller weight. Thus, hospitals treating sicker patients are not at a disadvantage when their performance is compared with other hospitals.

CCORP used a multivariable logistic regression model to 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 12,399 isolated (non-salvage) CABG surgery cases in 2011 were evaluated for missing data; 11,382 cases had no missing data in any field and were used for the risk model parameter estimation. The 1,017 (8.2%) 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 1,017 records were imputed (after risk model parameter estimation) by replacing most with the lowest risk category of the same variable (e.g., *Chronic Lung Disease = none*). CCORP assigned the lowest risk value for the following reasons: 1) some hospitals leave data fields blank by design when the risk factor is absent or the value is normal; 2) this maintains consistency with other major cardiac reporting programs that replace missing data with the lowest-risk or normal value; and 3) this imputing method 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 2011 data, is presented in Table B-1 with statistically significant risk factors identified in bolded text.

**Table B-1:** Logistic Regression Risk Model for Operative Mortality, 2011

Risk Factor		Coefficient	Standard Error	p-value	Odds Ratio
Intercept		-7.997	0.704	<.0001	
<b>Age (Years)</b>		<b>0.039</b>	<b>0.007</b>	<b>&lt;.0001</b>	<b>1.039</b>
<b>Gender</b>	Male	Reference			
	<b>Female</b>	<b>0.418</b>	<b>0.151</b>	<b>0.006</b>	<b>1.519</b>
Race	White	Reference			
	Non-White	-0.237	0.152	0.119	0.789
Body Mass Index	18.5-39.9	Reference			
	< 18.5	0.670	0.490	0.171	1.954
	<b>≥ 40</b>	<b>0.801</b>	<b>0.273</b>	<b>0.003</b>	<b>2.228</b>
Status of the Procedure	Elective	Reference			
	Urgent	-0.015	0.190	0.936	0.985
	Emergent	0.301	0.361	0.405	1.351
<b>Last Creatinine Level</b>		<b>1.134</b>	<b>0.200</b>	<b>&lt;.0001</b>	<b>3.107</b>
Hypertension		0.026	0.243	0.916	1.026
<b>Peripheral Arterial Disease</b>		<b>0.629</b>	<b>0.164</b>	<b>0.001</b>	<b>1.876</b>
Cerebrovascular Disease		0.397	0.237	0.093	1.487
Cerebrovascular Accident (CVA) Timing	No CVA	Reference			
	> 2 or ≤ 2 weeks	0.284	0.277	0.306	1.328
Chronic Lung Disease	None/Mild	Reference			
	Moderate	0.096	0.283	0.734	1.101
	Severe	0.372	0.251	0.139	1.450
Arrhythmia Type	Afib/Flutter	0.348	0.198	0.078	1.416
	Sust VT/VF	0.458	0.275	0.096	1.581
Timing of Myocardial Infarction (MI)	No MI	Reference			
	21 or more days	0.002	0.228	0.993	1.002
	8-20 days ago	0.265	0.302	0.380	1.304
	<b>1-7 days ago</b>	<b>0.583</b>	<b>0.194</b>	<b>0.003</b>	<b>1.792</b>
	<b>Within 24 Hours</b>	<b>1.196</b>	<b>0.311</b>	<b>0.001</b>	<b>3.308</b>
<b>Cardiogenic Shock</b>		<b>0.971</b>	<b>0.352</b>	<b>0.006</b>	<b>2.640</b>
Heart Failure		0.025	0.170	0.884	1.025
Prior Cardiac Surgery	None	Reference			
	<b>One or more</b>	<b>0.852</b>	<b>0.271</b>	<b>0.002</b>	<b>2.345</b>
Interval from Prior PCI to Surgery	No prior PCIs	Reference			
	<b>Prior PCI &gt; 6 HRS</b>	<b>0.352</b>	<b>0.159</b>	<b>0.026</b>	<b>1.422</b>
	<b>Prior PCI ≤ 6 HRS</b>	<b>0.899</b>	<b>0.428</b>	<b>0.036</b>	<b>2.457</b>
<b>Ejection Fraction (%)</b>		<b>-0.023</b>	<b>0.005</b>	<b>&lt;.0001</b>	<b>0.978</b>
Left Main Disease (% Stenosis)		0.233	0.146	0.110	1.262
Number of Diseased Vessels	None, One, or Two	Reference			
	Three or more	-0.024	0.173	0.892	0.977
Mitral Insufficiency	None/Trivial/Mild	Reference			
	Moderate/Severe	0.308	0.208	0.139	1.360

**Bolded text** indicates statistically significant.

*Note:* Last Creatinine level Pre-Op, Ejection Fraction, and Left Main Stenosis were modeled using piecewise linear transformations.



## **Discrimination of the Risk Model for Operative Mortality**

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 2011 operative mortality risk model, the C-statistic was 0.806. 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 2011 CCORP model.<sup>12</sup>

## **Calibration of the Risk Model for Operative Mortality**

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 2011 risk model is 0.500, 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 B-2, Risk Group 10 shows the patients in the highest risk group. Among the 1,136 patients in Group 10, 107 patients died, and the model predicted 107.2 patient deaths. Assuming a Poisson distribution for a binary outcome, the predicted range of deaths for Risk Group 10 is 86.9 to 127.5. The observed number of 107 deaths falls within the range of predicted deaths. In fact, none of the 10 risk groups had 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.

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<sup>12</sup> <http://www.state.nj.us/health/healthcarequality/cardiacsurgery.shtml>  
<http://www.health.state.ny.us/statistics/diseases/cardiovascular/>  
<http://www.phc4.org/reports/cabg>

**Table B-2:** Calibration of Risk Model for Operative Mortality, 2011

Risk Group	Isolated CABG Cases	Observed Deaths	Predicted Deaths	Difference	95%CI of Predicted Deaths
1	1,139	2	3.0	1.0	(-0.4, 6.4)
2	1,138	3	4.7	1.7	(0.5, 9.0)
3	1,140	9	6.3	-2.7	(1.4, 11.2)
4	1,138	7	7.9	0.9	(2.4, 13.5)
5	1,138	7	10.0	3.0	(3.8, 16.2)
6	1,139	9	12.9	3.9	(5.9, 19.9)
7	1,138	14	17.0	3.0	(8.9, 25.1)
8	1,138	30	23.5	-6.5	(14.0, 33.0)
9	1,138	41	36.4	-4.6	(24.6, 48.3)
10	1,136	107	107.2	0.2	(86.9, 127.5)
<b>Total</b>	<b>11,382</b>	<b>229</b>	<b>229.0</b>	<b>0</b>	

Note: Risk Group 1 is at lowest risk and Risk Group 10 is at highest risk.

### Process for Calculating Hospital Risk-Adjusted Mortality Rates and Performance Rating

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

The RAMR is computed by dividing the hospital's observed mortality by its 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 hospital has a higher mortality than expected based on patient mix. If the O/E ratio is less than one, the hospital has a lower mortality rate than expected. The O/E ratio is then multiplied by the state average mortality to obtain the hospital's RAMR.

However, because a hospital'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 hospital's RAMR to the California average mortality rate.<sup>13</sup> CCORP treated the 2011 data as a sample, and inferred a range within which each hospital's true performance was likely to fall. As shown in Table B-3, if the upper 95% CI of a hospital's risk-adjusted mortality is below the state average mortality rate, indicating the hospital's RAMR is significantly lower than the state average, then the hospital's performance rating is **"Better."** If the lower 95% CI of a hospital's RAMR is above the state average mortality rate, indicating the hospital'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 hospital's RAMR, then the performance rating is **"Average."** See the following section for detailed discussion of results.

<sup>13</sup> CCORP uses the Poisson Exact Probability method to compute the 95% confidence interval for the risk-adjusted mortality rate. (Iain Buchan, *Calculating Poisson Confidence Interval in Excel*, January 2004. <http://www.nwpho.org.uk/sadb/Poisson%20CI%20in%20spreadsheets.pdf>).

## Statistical Details of Hospital Risk-Adjusted Operative Mortality Rate Results (2011)

Table B-3 presents the risk-adjusted mortality rate (RAMR) results for each hospital for 2011. 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 deaths, observed mortality rate, expected mortality rate predicted by the risk model, RAMR and 95% confidence intervals (CI) of the RAMR, and the associated hospital performance rating.

Among the 12,399 isolated and non-salvage CABG surgeries performed at 122 hospitals in 2011, 249 patients died either in-hospital or within 30 days of the surgery date, reflecting an overall operative mortality rate of 2.01%. The *observed* mortality rates among hospitals ranged from 0% to 8.06%. The *expected* mortality rates, which are generated by the risk model and account for patient severity-of-illness, ranged between 0.63% and 7.26%. The RAMR, which measures hospital performance, ranged from 0% to 8.18%.

Based on the 95% CI for risk-adjusted mortality rates, 121 of 122 hospitals (99%) performed within the expected range when compared to the state's overall mortality rate (denoted by "**Average**" in the performance rating column of Table B-3), and one hospital performed significantly "**Worse**" than the state average. Hospitals marked with † in Table B-3 submitted statements regarding this report (Appendix G).

### Definitions of Table B-3 Terms

**All CABG Cases:** The total number of isolated and non-isolated CABG cases submitted to CCORP for 2011. Non-isolated CABG cases are not used in calculating performance ratings.

**Isolated CABG Cases:** The number of isolated CABG cases submitted to CCORP in 2011. 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 number of deaths includes 1) all deaths that occur during the hospitalization in which the isolated 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:  $\text{Observed Mortality Rate} = \text{Isolated CABG Deaths} / \text{Isolated CABG Cases} \times 100$ .

**Expected Mortality Rate:** The ratio of the expected number of operative deaths predicted for a hospital (after risk adjusting for their patient population) and the isolated CABG cases multiplied by 100:  $\text{Expected Mortality Rate} = \text{Expected Deaths} / \text{Isolated CABG Cases} \times 100$ .

**Risk-Adjusted Mortality Rate (95% CI):** The Risk-Adjusted Mortality Rate (RAMR) is obtained by multiplying the statewide average mortality rate by a hospital's O/E ratio. The 95% CI 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 hospital's risk-adjusted mortality rate to the California observed mortality rate. A hospital is classified as **"Better"** if the upper 95% confidence limit of its RAMR falls below the California observed mortality rate. A hospital is classified as **"Worse"** if the lower 95% confidence limit of its RAMR is higher than the California observed mortality rate. A hospital is classified as **"Average"** if the California mortality rate falls within the confidence interval of the hospital's risk-adjusted mortality rate.

**Table B-3:** Hospital Risk-Adjusted Operative Mortality Results by Region, 2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (% RAMR)	95% CI for RAMR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>16,284</b>	<b>12,399</b>	<b>249</b>	<b>2.01</b>				
<b>Sacramento Valley &amp; Northern California Region</b>	Enloe Medical Center – Esplanade Campus	175	149	3	2.01	2.45	1.65	(0.34, 4.83)	Average
	Mercy General Hospital	803	539	5	0.93	1.62	1.15	(0.37, 2.69)	Average
	Mercy Medical Center – Redding	145	102	2	1.96	3.00	1.31	(0.16, 4.75)	Average
	Mercy San Juan Hospital	185	128	0	0.00	1.56	0.00	(0.00, 3.72)	Average
	Rideout Memorial Hospital	123	90	4	4.44	1.71	5.23	(1.43, 13.41)	Average
	Shasta Regional Medical Center	66	59	1	1.69	1.99	1.71	(0.04, 9.51)	Average
	St. Joseph Hospital – Eureka	37	33	1	3.03	5.56	1.09	(0.03, 6.10)	Average
	Sutter Memorial Hospital	454	314	6	1.91	2.04	1.88	(0.69, 4.09)	Average
	UC Davis Medical Center	141	97	0	0.00	1.40	0.00	(0.00, 5.45)	Average
<b>San Francisco Bay Area &amp; San Jose</b>	Alta Bates Summit Medical Center – Summit Campus – Hawthorne	169	130	2	1.54	2.17	1.42	(0.17, 5.14)	Average
	California Pacific Medical Center – Pacific Campus	72	38	1	2.63	1.88	2.81	(0.07, 15.68)	Average
	Community Hospital Monterey Peninsula	82	61	2	3.28	1.88	3.51	(0.43, 12.68)	Average
	Dominican Hospital – Santa Cruz/Soquel	59	47	1	2.13	1.45	2.95	(0.07, 16.48)	Average
	El Camino Hospital	115	66	1	1.52	1.61	1.89	(0.05, 10.55)	Average
	Good Samaritan Hospital – San Jose	87	62	1	1.61	2.47	1.31	(0.03, 7.31)	Average

**Table B-3:** Hospital Risk-Adjusted Operative Mortality Results by Region, 2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (% RAMR)	95% CI for RAMR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>16,284</b>	<b>12,399</b>	<b>249</b>	<b>2.01</b>				
<b>San Francisco Bay Area &amp; San Jose (continued)</b>	John Muir Medical Center – Concord Campus	264	207	2	0.97	1.76	1.10	(0.13, 3.99)	Average
	Kaiser Foundation Hospital – San Francisco	436	315	1	0.32	1.26	0.51	(0.01, 2.83)	Average
	Kaiser Foundation Hospital – Santa Clara	282	179	3	1.68	1.83	1.84	(0.38, 5.38)	Average
	Marin General Hospital	54	44	0	0.00	1.56	0.00	(0.00, 10.79)	Average
	North Bay Medical Center†	35	32	1	3.13	1.38	4.54	(0.12, 25.31)	Average
	O'Connor Hospital – San Jose	62	57	0	0.00	1.52	0.00	(0.00, 8.54)	Average
	Peninsula Medical Center	53	36	1	2.78	1.53	3.65	(0.09, 20.38)	Average
	Queen of the Valley Hospital – Napa	68	52	0	0.00	3.04	0.00	(0.00, 4.69)	Average
	Regional Medical of San Jose	81	68	0	0.00	1.62	0.00	(0.00, 6.72)	Average
	Salinas Valley Memorial Hospital	111	95	3	3.16	2.38	2.66	(0.55, 7.79)	Average
	San Ramon Regional Medical Center	39	31	0	0.00	1.32	0.00	(0.00, 18.07)	Average
	Santa Clara Valley Medical Center	83	72	1	1.39	1.00	2.78	(0.07, 15.49)	Average
	Santa Rosa Memorial Hospital – Montgomery	98	87	3	3.45	1.74	3.98	(0.82, 11.64)	Average
	Sequoia Hospital	111	57	1	1.75	2.49	1.41	(0.04, 7.89)	Average
	Seton Medical Center	85	76	2	2.63	3.09	1.71	(0.21, 6.18)	Average

**Table B-3:** Hospital Risk-Adjusted Operative Mortality Results by Region, 2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (% RAMR)	95% CI for RAMR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>16,284</b>	<b>12,399</b>	<b>249</b>	<b>2.01</b>				
<b>San Francisco Bay Area &amp; San Jose (continued)</b>	St. Helena Hospital	54	46	1	2.17	5.21	0.84	(0.02, 4.67)	Average
	St. Mary's Medical Center – San Francisco	43	35	2	5.71	2.34	4.91	(0.60, 17.75)	Average
	Stanford Hospital	102	62	2	3.23	2.73	2.38	(0.29, 8.60)	Average
	Sutter Medical Center of Santa Rosa	97	65	1	1.54	1.30	2.38	(0.06, 13.29)	Average
	UCSF Medical Center	82	66	1	1.52	1.84	1.65	(0.04, 9.21)	Average
	Valleycare Medical Center	48	34	1	2.94	2.44	2.42	(0.06, 13.49)	Average
	Washington Hospital – Fremont	95	89	4	4.49	2.50	3.62	(0.99, 9.27)	Average
<b>Central California</b>	Bakersfield Heart Hospital	111	94	5	5.32	2.36	4.53	(1.47, 10.59)	Average
	Bakersfield Memorial Hospital	154	125	4	3.20	1.81	3.56	(0.97, 9.11)	Average
	Community Regional Medical Center – Fresno	288	243	8	3.29	2.23	2.96	(1.28, 5.84)	Average
	Dameron Hospital	64	62	5	8.06	2.75	5.90	(1.92, 13.78)	Average
	Doctors Medical Center	309	242	8	3.31	2.15	3.09	(1.33, 6.09)	Average
	Emanuel Medical Center	19	16	1	6.25	3.08	4.08	(0.10, 22.74)	Average
	Fresno Heart and Surgical Center	210	172	3	1.74	1.65	2.13	(0.44, 6.22)	Average
	Kaweah Delta Medical Center	231	201	3	1.49	1.83	1.64	(0.34, 4.79)	Average
	Marian Medical Center	68	60	3	5.00	1.55	6.49	(1.34, 19.00)	Average
	Memorial Hospital Medical Center – Modesto	236	186	6	3.23	2.05	3.16	(1.16, 6.88)	Average

**Table B-3:** Hospital Risk-Adjusted Operative Mortality Results by Region, 2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (% , RAMR)	95% CI for RAMR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>16,284</b>	<b>12,399</b>	<b>249</b>	<b>2.01</b>				
<b>Central California (continued)</b>	San Joaquin Community Hospital	83	77	1	1.30	2.74	0.95	(0.02, 5.31)	Average
	St. Agnes Medical Center	331	289	11	3.81	2.51	3.05	(1.52, 5.46)	Average
	St. Joseph's Medical Center of Stockton	313	249	7	2.81	2.60	2.17	(0.87, 4.47)	Average
<b>San Fernando Valley, Antelope Valley, Ventura &amp; Santa Barbara</b>	Antelope Valley Hospital	30	28	2	7.14	1.75	8.18	(0.99, 29.57)	Average
	Community Memorial Hospital of San Buenaventura	56	48	3	6.25	3.52	3.57	(0.74, 10.44)	Average
	French Hospital Medical Center	107	76	0	0.00	1.91	0.00	(0.00, 5.11)	Average
	Glendale Adventist Medical Center – Wilson Terrace	134	110	1	0.91	1.72	1.06	(0.03, 5.92)	Average
	Glendale Memorial Hospital and Health Center	117	105	0	0.00	1.59	0.00	(0.00, 4.43)	Average
	Los Robles Hospital and Medical Center	78	51	4	7.84	2.34	6.73	(1.84, 17.25)	Average
	Northridge Hospital Medical Center	87	71	3	4.23	2.16	3.92	(0.81, 11.47)	Average
	Palmdale Regional Medical Center	9	8	0	0.00	1.48	0.00	(0.00, 62.65)	Average
	Providence Holy Cross Medical Center	67	52	1	1.92	1.89	2.04	(0.05, 11.40)	Average
	Providence St. Joseph Medical Center	70	47	0	0.00	1.47	0.00	(0.00, 10.76)	Average



**Table B-3:** Hospital Risk-Adjusted Operative Mortality Results by Region, 2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (% , RAMR)	95% CI for RAMR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>16,284</b>	<b>12,399</b>	<b>249</b>	<b>2.01</b>				
<b>San Fernando Valley, Antelope Valley, Ventura &amp; Santa Barbara (continued)</b>	Providence Tarzana Medical Center	68	54	1	1.85	1.98	1.88	(0.05, 10.49)	Average
	Santa Barbara Cottage Hospital	111	84	1	1.19	1.80	1.33	(0.03, 7.41)	Average
	St. John's Regional Medical Center	80	66	0	0.00	2.65	0.00	(0.00, 4.24)	Average
	Valley Presbyterian Hospital	61	53	2	3.77	2.67	2.83	(0.34, 10.25)	Average
	West Hills Hospital and Medical Center	64	56	1	1.79	1.67	2.14	(0.05, 11.96)	Average
<b>Greater Los Angeles</b>	Beverly Hospital	23	20	0	0.00	1.64	0.00	(0.00, 22.66)	Average
	Cedars Sinai Medical Center	184	112	1	0.89	1.49	1.21	(0.03, 6.73)	Average
	Centinela Hospital Medical Center	17	14	1	7.14	2.32	6.20	(0.16, 34.55)	Average
	Citrus Valley Medical Center – IC Campus	124	102	2	1.96	1.86	2.12	(0.26, 7.66)	Average
	Downey Regional Medical Center	35	34	2	5.88	1.84	6.43	(0.78, 23.24)	Average
	Garfield Medical Center	132	116	2	1.72	1.06	3.27	(0.40, 11.81)	Average
	Good Samaritan Hospital – Los Angeles	117	94	3	3.19	2.17	2.96	(0.61, 8.65)	Average
	Hollywood Presbyterian Medical Center	22	12	0	0.00	7.26	0.00	(0.00, 8.51)	Average

**Table B-3:** Hospital Risk-Adjusted Operative Mortality Results by Region, 2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (% RAMR)	95% CI for RAMR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>16,284</b>	<b>12,399</b>	<b>249</b>	<b>2.01</b>				
<b>Greater Los Angeles (continued)</b>	Huntington Memorial Hospital	97	78	0	0.00	1.59	0.00	(0.00, 5.98)	Average
	Kaiser Foundation Hospital – Sunset	665	498	6	1.20	1.60	1.51	(0.56, 3.30)	Average
	Keck Hospital of USC	245	54	1	1.85	1.61	2.31	(0.06, 12.90)	Average
	Lakewood Regional Medical Center	122	103	3	2.91	2.77	2.11	(0.44, 6.17)	Average
	Long Beach Memorial Medical Center	194	159	5	3.14	2.37	2.66	(0.86, 6.22)	Average
	Los Angeles Co. Harbor – UCLA Medical Center	93	77	0	0.00	1.43	0.00	(0.00, 6.71)	Average
	Los Angeles Co. USC Medical Center	146	117	2	1.71	0.63	5.47	(0.66, 19.76)	Average
	Methodist Hospital of Southern California	48	38	0	0.00	2.71	0.00	(0.00, 7.19)	Average
	Presbyterian Intercommunity Hospital	114	69	0	0.00	3.32	0.00	(0.00, 3.23)	Average
	Providence Little Company of Mary Medical Center – Torrance	73	58	3	5.17	2.38	4.37	(0.90, 12.77)	Average
	Ronald Reagan UCLA Medical Center	213	92	1	1.09	1.78	1.23	(0.03, 6.84)	Average
	Santa Monica – UCLA Medical Center and Orthopaedic Hospital	1	1	0	0.00	1.37	0.00	(0.00, 100.0)	Average
	St. Francis Medical Center	45	40	1	2.50	1.31	3.82	(0.10, 21.30)	Average

**Table B-3:** Hospital Risk-Adjusted Operative Mortality Results by Region, 2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (% RAMR)	95% CI for RAMR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>16,284</b>	<b>12,399</b>	<b>249</b>	<b>2.01</b>				
<b>Greater Los Angeles (continued)</b>	St. John's Health Center	63	47	1	2.13	2.54	1.68	(0.04, 9.38)	Average
	St. Mary Medical Center	64	53	2	3.77	2.98	2.54	(0.31, 9.19)	Average
	St. Vincent Medical Center	76	65	2	3.08	1.82	3.40	(0.41, 12.31)	Average
	Torrance Memorial Medical Center	93	65	3	4.62	1.67	5.56	(1.15, 16.25)	Average
	White Memorial Medical Center	50	41	1	2.44	1.31	3.74	(0.09, 20.85)	Average
<b>Inland Empire, Riverside &amp; San Bernardino</b>	Desert Regional Medical Center	152	129	6	4.65	2.20	4.25	(1.56, 9.26)	Average
	Eisenhower Memorial Hospital	200	160	3	1.88	1.71	2.20	(0.45, 6.44)	Average
	Loma Linda University Medical Center	246	197	2	1.02	2.23	0.92	(0.11, 3.31)	Average
	Pomona Valley Hospital Medical Center	139	118	2	1.69	3.45	0.99	(0.12, 3.57)	Average
	Riverside Community Hospital	204	158	2	1.27	2.11	1.20	(0.15, 4.35)	Average
	San Antonio Community Hospital	184	139	2	1.44	2.16	1.34	(0.16, 4.84)	Average
	St. Bernardine Medical Center	567	486	6	1.23	1.54	1.61	(0.59, 3.52)	Average
	St. Mary Regional Medical Center	153	124	0	0.00	1.64	0.00	(0.00, 3.66)	Average

**Table B-3:** Hospital Risk-Adjusted Operative Mortality Results by Region, 2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (% RAMR)	95% CI for RAMR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>16,284</b>	<b>12,399</b>	<b>249</b>	<b>2.01</b>				
<b>Orange County</b>	AHMC Anaheim Regional Medical Center	164	135	7	5.19	2.05	5.07	(2.04, 10.46)	<b>Worse</b>
	Fountain Valley Regional Hospital and Medical Center – Euclid	132	116	3	2.59	1.95	2.66	(0.55, 7.78)	Average
	Hoag Memorial Hospital Presbyterian	197	128	3	2.34	2.82	1.67	(0.34, 4.88)	Average
	Mission Hospital Regional Medical Center	149	121	4	3.31	1.68	3.95	(1.08, 10.13)	Average
	Orange Coast Memorial Medical Center	49	43	1	2.33	1.53	3.05	(0.08, 17.03)	Average
	Saddleback Memorial Medical Center	104	88	1	1.14	1.99	1.15	(0.03, 6.39)	Average
	St. Joseph Hospital – Orange	142	100	2	2.00	2.03	1.98	(0.24, 7.16)	Average
	St. Jude Medical Center	105	85	2	2.35	1.37	3.45	(0.42, 12.47)	Average
	UC Irvine Medical Center	63	54	0	0.00	1.43	0.00	(0.00, 9.61)	Average
	West Anaheim Medical Center	25	20	0	0.00	2.44	0.00	(0.00, 15.16)	Average
	Western Medical Center – Santa Ana	59	51	0	0.00	2.13	0.00	(0.00, 6.81)	Average
	Western Medical Center Hospital – Anaheim	81	64	3	4.69	2.44	3.86	(0.80, 11.30)	Average
<b>Greater San Diego</b>	Alvarado Hospital Medical Center	61	48	1	2.08	2.23	1.87	(0.05, 10.45)	Average
	Palomar Medical Center	66	53	2	3.77	2.65	2.86	(0.35, 10.33)	Average

**Table B-3:** Hospital Risk-Adjusted Operative Mortality Results by Region, 2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Deaths	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (% , RAMR)	95% CI for RAMR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>16,284</b>	<b>12,399</b>	<b>249</b>	<b>2.01</b>				
<b>Greater San Diego (continued)</b>	Scripps Green Hospital	84	45	0	0.00	1.71	0.00	(0.00, 9.65)	Average
	Scripps Memorial Hospital – La Jolla	331	245	2	0.82	1.94	0.85	(0.10, 3.06)	Average
	Scripps Mercy Hospital	169	140	1	0.71	2.10	0.68	(0.02, 3.81)	Average
	Sharp Chula Vista Medical Center	189	150	3	2.00	2.12	1.89	(0.39, 5.54)	Average
	Grossmont Hospital	183	143	0	0.00	2.39	0.00	(0.00, 2.17)	Average
	Sharp Memorial Hospital†	150	84	2	2.38	1.20	3.99	(0.48, 14.44)	Average
	Tri-City Medical Center	84	67	2	2.99	2.57	2.33	(0.28, 8.44)	Average
	UCSD Medical Center	8	8	0	0.00	1.54	0.00	(0.00, 60.32)	Average
	UCSD Medical Center – La Jolla, John M. & Sally B. Thornton Hospital	136	96	1	1.04	1.68	1.24	(0.03, 6.94)	Average

\*A hospital is **“Better”** if the upper 95% CI of the RAMR falls below the California observed mortality rate (2.01%). A hospital is **“Worse”** if the lower 95% CI of the RAMR is higher than the California observed mortality rate. A hospital’s performance is considered **“Average”** if the California mortality rate falls within the 95% CI of a hospital’s RAMR.

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

## **Appendix C: Technical Notes on Risk-Adjusted Hospital Post-Operative Stroke Calculations**

### **Risk Model for Adjusting Hospital Post-Operative Stroke Rates, 2010-2011**

To assess hospital performance on this outcome, CCORP combined 2010 and 2011 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 24,947 isolated (non-salvage) CABG surgery cases (2010 and 2011) were evaluated for missing data (23,795 cases had no missing data in any field and were used for the risk model parameter estimation). The 1,152 (approximately 4.6%) 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 1,152 records were imputed (after risk model parameter estimation) by replacing most with the lowest risk category of the same variable (e.g., *Timing of Myocardial Infarction = No MI*). 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 2010-2011 data, is presented in Table C-1 with statistically significant risk factors identified in bolded text.

**Table C-1:** Logistic Regression Risk Model for Post-Operative Stroke, 2010-2011

Risk Factors			Coefficient	Standard Error	p-value	Odds Ratio
Intercept			-7.181	0.594	<.0001	
Age (Years)			0.025	0.006	<.0001	1.025
Gender	Male		Reference			
	Female		0.081	0.128	0.527	1.085
Race	White		Reference			
	Non-White		0.396	0.119	0.001	1.486
Status of the Procedure	Elective		Reference			
	Urgent		0.314	0.149	0.035	1.369
	Emergent		0.541	0.328	0.099	1.717
Last Creatinine Level Pre-Op (mg/dl)			0.017	0.208	0.935	1.017
Hypertension			0.386	0.228	0.090	1.472
Peripheral Arterial Disease			0.379	0.147	0.010	1.461
Cerebrovascular Disease			0.538	0.201	0.008	1.713
Cerebrovascular Accident (CVA) Timing	NO CVA		Reference			
	> 2 weeks		0.275	0.232	0.236	1.317
	<= 2 weeks		0.500	0.756	0.508	1.649
Diabetes			0.231	0.123	0.061	1.260
Chronic Lung Disease (CLD)	None/Mild		Reference			
	Moderate		0.109	0.243	0.654	1.115
	Severe		0.555	0.215	0.010	1.741
Arrhythmia: Third Degree Heart Block			0.351	0.517	0.497	1.421
Timing of Myocardial Infarction (MI)	No MI		Reference			
	21 or more days ago		-0.021	0.177	0.907	0.980
	8 - 20 days ago		-0.140	0.266	0.598	0.869
	1-7 days ago		0.230	0.150	0.127	1.258
	Within 24 Hours		0.625	0.280	0.026	1.869
Cardiogenic Shock			0.201	0.412	0.625	1.223
Heart Failure			0.263	0.144	0.068	1.301
Ejection Fraction (%)			-0.006	0.005	0.188	0.994
Number of Diseased Vessels	None, One or Two		Reference			
	3 or More		0.211	0.153	0.167	1.235
Year	2011 vs. 2010		0.064	0.115	0.576	1.066

**Bolded text** indicates statistical significance.

Note: "Last Creatinine level Pre-Op" and "Ejection Fraction" were modeled using piecewise linear transformations.

## Discrimination of the Risk Model for Post-Operative Stroke

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 2010-2011 post-operative risk model, the C-statistic was 0.706, which compares favorably with the Society of Thoracic Surgeons' recently published post-operative stroke model (C-statistic = 0.716 for isolated CABG surgery).<sup>14</sup>

## Calibration of the Risk Model for Post-Operative Stroke

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 the 2010-2011 post-operative stroke risk model is 0.098, indicating adequate calibration. That is, the number of predicted post-operative stroke cases was consistent with actual post-operative stroke cases 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 C-2, Risk Group 1 shows the patients in the lowest risk group. Among the 2,381 patients in this group, 7 patients had post-operative strokes, but the model predicted 9.1 cases. Assuming a Poisson distribution for a binary outcome, the predicted range of strokes for this group is 3.2 to 15.0. The observed number of 7 strokes falls within the range of predicted strokes. In fact, none of the 10 risk groups had 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>14</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 C-2:** Calibration of Risk Model for Post-Operative Stroke, 2010-2011

Risk Group	Isolated CABG Cases	Observed Post-Op Strokes	Predicted Post-Op Strokes	Difference	95% CI of Predicted Post-Op Strokes
1	2,381	7	9.1	2.1	(3.2, 15.0)
2	2,380	10	12.9	2.9	(5.9, 19.9)
3	2,380	9	15.8	6.8	(8.0, 23.6)
4	2,381	25	18.7	-6.3	(10.2, 27.2)
5	2,380	22	21.9	-0.1	(12.7, 31.0)
6	2,381	16	25.6	9.6	(15.7, 35.5)
7	2,380	38	30.4	-7.6	(19.6, 41.2)
8	2,380	34	37.4	3.4	(25.4, 49.3)
9	2,380	57	49.5	-7.5	(35.7, 63.3)
10	2,372	95	91.8	-3.2	(73.0, 110.6)
<b>Total</b>	<b>23,795</b>	<b>313</b>	<b>313.0</b>	<b>0</b>	

Note: Risk Group 1 is at lowest risk and Risk Group 10 is at highest risk.

### Process for Calculating Risk-Adjusted Post-Operative Stroke Rate and Performance Ratings

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

The RASR is computed by dividing the hospital's number of patient post-operative strokes by its expected number of post-operative strokes (obtained from the risk model) to obtain the observed/expected (O/E) ratio. If the O/E ratio is greater than one, the hospital has a higher stroke rate than expected based on patient mix. If the O/E ratio is less than one, the hospital has a lower stroke rate than expected. The O/E ratio is then multiplied by the state average post-operative stroke rate (1.32% for 2010-2011) to obtain the hospital's RASR.

The performance rating is based on a comparison of the 95% confidence interval (CI) of each hospital's RASR to the California average post-operative stroke rate. Thus, CCORP treated 2010-2011 data as a sample, and inferred the range in which each hospital's true performance was likely to fall. As shown in Table C-3, if the upper 95% CI of a hospital's risk-adjusted stroke rate is below the state average stroke rate, indicating the hospital's RASR is significantly lower than the state average, the performance rating is **"Better."** If the lower 95% CI of a hospital's RASR is above the state average stroke rate, indicating the hospital'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 hospital's RASR, the performance rating is **"Average."** See the following section for a detailed discussion of results.

## Statistical Details of Hospital Risk-Adjusted Post-Operative Stroke Results, 2010-2011

Table C-3 presents the risk-adjusted results for each hospital for 2010-2011. 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% confidence interval (CI) of the RASR, and the associated hospital performance rating.

Among the 24,947 isolated CABG surgeries performed in 2010-2011, 329 patients had a post-operative stroke in-hospital, reflecting an overall rate of 1.32%. Among 329 patients with post-operative stroke, 55 (16.7%) died either in-hospital or after discharge but within 30 days of CABG surgery. The observed stroke rate among hospitals ranged from 0% to 5.14%. The expected stroke rates, which are generated by the model and measure patient severity of illness, were between 0.87% and 2.03%. The risk-adjusted stroke rates, which measure hospital performance, ranged from 0% to 5.10%.

Based on the 95% CI for risk-adjusted stroke rates, 118 of 123 hospitals (96%) performed within the expected range compared to the state's average stroke rate (denoted by "**Average**" in the performance rating column of Table C-3), one hospital performed significantly "**Better**" than the state average, and four hospitals performed significantly "**Worse**" than the state average. Hospitals marked with † in Table C-3 submitted statements regarding this report and are presented in Appendix G.

### Definitions of Table C-3 Terms

**All CABG Cases:** The total number of isolated and non-isolated CABG cases submitted to CCORP for 2010 and 2011 combined. Non-isolated CABG cases are not used to calculate performance ratings.

**Isolated CABG Cases:** The number of isolated CABG cases submitted to CCORP in 2010-2011. 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 after 24 hours for isolated CABG cases for 2010-2011.

**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:  $\text{Observed Post-Operative Stroke Rate} = \text{Isolated CABG Post-Operative Strokes} / \text{Isolated CABG Cases} \times 100$ .

**Expected Post-Op Stroke Rate:** The ratio of the expected number of post-operative strokes predicted for a hospital (after risk adjusting for their patient population) and the isolated CABG cases multiplied by 100:  $\text{Expected Post-Operative Stroke Rate} = \text{Expected Post-Operative Strokes} / \text{Isolated CABG Cases} \times 100$ .

**Risk-Adjusted Post-Operative Stroke Rate (95% CI):** The Risk-Adjusted Post-Operative Stroke Rate (RASR) is obtained by multiplying the state average post-operative stroke rate by a hospital'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 hospital's RASR to the state observed post-operative stroke rate. A hospital is classified as "**Better**" if the upper 95% confidence limit of its RASR falls below the California observed post-operative stroke rate. A hospital is classified as "**Worse**" if the lower 95% confidence limit of its RASR is higher than the California observed post-operative stroke rate. A hospital is classified as "**Average**" if the California post-operative stroke rate falls within the confidence interval of the hospital's RASR.

**Table C-3:** Hospital Risk-Adjusted Post-Operative Stroke Results by Region, 2010-2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Post-Op Strokes	Observed Post-Op Stroke Rate (%)	Expected Post-Op Stroke Rate (%)	Risk-Adjusted Post-Op Stroke Rate (% , RASR)	95% CI for RASR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>32,630</b>	<b>24,947</b>	<b>329</b>	<b>1.32</b>				
<b>Sacramento Valley &amp; Northern California Region</b>	Enloe Medical Center – Esplanade Campus	345	297	2	0.67	1.28	0.69	(0.08, 2.51)	Average
	Mercy General Hospital	1,596	1,031	16	1.55	1.18	1.73	(0.99, 2.81)	Average
	Mercy Medical Center – Redding	275	197	0	0.00	1.25	0.00	(0.00, 1.98)	Average
	Mercy San Juan Hospital	338	244	2	0.82	1.08	1.00	(0.12, 3.60)	Average
	Rideout Memorial Hospital	272	213	3	1.41	1.15	1.62	(0.33, 4.73)	Average
	Shasta Regional Medical Center	133	119	0	0.00	1.12	0.00	(0.00, 3.64)	Average
	St. Joseph Hospital – Eureka	79	66	0	0.00	1.46	0.00	(0.00, 5.04)	Average
	Sutter Memorial Hospital	959	656	2	0.30	1.12	0.36	(0.04, 1.30)	<b>Better</b>
	UC Davis Medical Center	304	216	3	1.39	1.12	1.64	(0.34, 4.79)	Average
<b>San Francisco Bay Area &amp; San Jose</b>	Alta Bates Summit Medical Center – Summit Campus – Hawthorne	458	364	2	0.55	1.49	0.48	(0.06, 1.75)	Average
	California Pacific Medical Center – Pacific Campus	150	91	0	0.00	1.01	0.00	(0.00, 5.32)	Average
	Community Hospital Monterey Peninsula	162	118	0	0.00	1.13	0.00	(0.00, 3.66)	Average
	Dominican Hospital – Santa Cruz/Soquel	141	111	2	1.80	1.01	2.35	(0.28, 8.49)	Average
	El Camino Hospital	197	117	4	3.42	1.08	4.16	(1.13, 10.66)	Average

**Table C-3:** Hospital Risk-Adjusted Post-Operative Stroke Results by Region, 2010-2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Post-Op Strokes	Observed Post-Op Stroke Rate (%)	Expected Post-Op Stroke Rate (%)	Risk-Adjusted Post-Op Stroke Rate (% , RASR)	95% CI for RASR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>32,630</b>	<b>24,947</b>	<b>329</b>	<b>1.32</b>				
<b>San Francisco Bay Area &amp; San Jose (continued)</b>	Good Samaritan Hospital – San Jose	172	123	2	1.63	1.19	1.80	(0.22, 6.49)	Average
	John Muir Medical Center – Concord Campus	512	414	6	1.45	1.29	1.48	(0.54, 3.23)	Average
	Kaiser Foundation Hospital – San Francisco	823	613	11	1.79	1.05	2.25	(1.12, 4.03)	Average
	Kaiser Foundation Hospital – Santa Clara	593	371	4	1.08	1.32	1.08	(0.29, 2.76)	Average
	Marin General Hospital	113	90	1	1.11	1.03	1.42	(0.04, 7.91)	Average
	North Bay Medical Center†	68	64	1	1.56	1.08	1.91	(0.05, 10.67)	Average
	O'Connor Hospital – San Jose	136	121	1	0.83	1.54	0.71	(0.02, 3.96)	Average
	Peninsula Medical Center	102	79	2	2.53	0.95	3.51	(0.43, 12.68)	Average
	Queen of the Valley Hospital – Napa	138	101	2	1.98	1.45	1.80	(0.22, 6.51)	Average
	Regional Medical of San Jose	133	118	1	0.85	2.03	0.55	(0.01, 3.07)	Average
	Salinas Valley Memorial Hospital	218	179	4	2.23	1.38	2.13	(0.58, 5.46)	Average
	San Ramon Regional Medical Center	75	58	0	0.00	1.07	0.00	(0.00, 7.83)	Average
	Santa Clara Valley Medical Center	131	118	2	1.69	1.00	2.23	(0.27, 8.07)	Average
	Santa Rosa Memorial Hospital – Montgomery	182	151	1	0.66	1.13	0.77	(0.02, 4.30)	Average

**Table C-3:** Hospital Risk-Adjusted Post-Operative Stroke Results by Region, 2010-2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Post-Op Strokes	Observed Post-Op Stroke Rate (%)	Expected Post-Op Stroke Rate (%)	Risk-Adjusted Post-Op Stroke Rate (%, RASR)	95% CI for RASR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>32,630</b>	<b>24,947</b>	<b>329</b>	<b>1.32</b>				
<b>San Francisco Bay Area &amp; San Jose (continued)</b>	Sequoia Hospital	211	109	0	0.00	1.18	0.00	(0.00, 3.77)	Average
	Seton Medical Center	198	175	9	5.14	1.50	4.52	(2.07, 8.58)	<b>Worse</b>
	St. Helena Hospital	127	109	1	0.92	1.62	0.75	(0.02, 4.16)	Average
	St. Mary's Medical Center – San Francisco	78	66	2	3.03	1.39	2.87	(0.35, 10.37)	Average
	Stanford Hospital	233	135	1	0.74	1.29	0.76	(0.02, 4.22)	Average
	Sutter Medical Center of Santa Rosa	193	135	0	0.00	0.89	0.00	(0.00, 4.06)	Average
	UCSF Medical Center	162	128	2	1.56	1.19	1.73	(0.21, 6.25)	Average
	Valleycare Medical Center	84	60	0	0.00	1.34	0.00	(0.00, 6.06)	Average
	Washington Hospital – Fremont	194	184	2	1.09	1.51	0.95	(0.12, 3.44)	Average
<b>Central California</b>	Bakersfield Heart Hospital	233	199	4	2.01	1.26	2.10	(0.57, 5.39)	Average
	Bakersfield Memorial Hospital	283	235	1	0.43	1.12	0.50	(0.01, 2.79)	Average
	Community Regional Medical Center – Fresno	554	462	3	0.65	1.46	0.59	(0.12, 1.71)	Average
	Dameron Hospital	120	116	4	3.45	1.47	3.10	(0.84, 7.94)	Average
	Doctors Medical Center	613	482	3	0.62	1.63	0.50	(0.10, 1.47)	Average
	Emanuel Medical Center	19	16	0	0.00	1.59	0.00	(0.00, 19.14)	Average
	Fresno Heart and Surgical Center	406	327	2	0.61	1.09	0.74	(0.09, 2.68)	Average
	Kaweah Delta Medical Center	539	462	10	2.16	1.57	1.81	(0.87, 3.34)	Average

**Table C-3:** Hospital Risk-Adjusted Post-Operative Stroke Results by Region, 2010-2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Post-Op Strokes	Observed Post-Op Stroke Rate (%)	Expected Post-Op Stroke Rate (%)	Risk-Adjusted Post-Op Stroke Rate (% , RASR)	95% CI for RASR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>32,630</b>	<b>24,947</b>	<b>329</b>	<b>1.32</b>				
<b>Central California (continued)</b>	Marian Medical Center	161	147	5	3.40	1.23	3.65	(1.18, 8.52)	Average
	Memorial Hospital Medical Center – Modesto	470	377	6	1.59	1.38	1.52	(0.56, 3.31)	Average
	San Joaquin Community Hospital	161	149	0	0.00	1.31	0.00	(0.00, 2.50)	Average
	St. Agnes Medical Center	645	553	4	0.72	1.29	0.74	(0.20, 1.89)	Average
	St. Joseph's Medical Center of Stockton	594	465	7	1.51	1.49	1.33	(0.54, 2.75)	Average
<b>San Fernando Valley, Antelope Valley, Ventura &amp; Santa Barbara</b>	Antelope Valley Hospital	63	58	1	1.72	1.14	2.00	(0.05, 11.17)	Average
	Community Memorial Hospital of San Buenaventura	156	133	1	0.75	1.42	0.70	(0.02, 3.90)	Average
	French Hospital Medical Center	230	169	4	2.37	1.15	2.71	(0.74, 6.96)	Average
	Glendale Adventist Medical Center – Wilson Terrace	241	207	0	0.00	1.18	0.00	(0.00, 1.99)	Average
	Glendale Memorial Hospital and Health Center	309	244	2	0.82	1.38	0.78	(0.09, 2.83)	Average
	Lancaster Community Hospital	8	8	0	0.00	1.33	0.00	(0.00, 45.89)	Average
	Los Robles Hospital and Medical Center	167	117	2	1.71	1.13	2.00	(0.24, 7.24)	Average
	Northridge Hospital Medical Center	174	148	2	1.35	1.22	1.46	(0.18, 5.29)	Average
	Palmdale Regional Medical Center	9	8	0	0.00	1.29	0.00	(0.00, 47.06)	Average

**Table C-3:** Hospital Risk-Adjusted Post-Operative Stroke Results by Region, 2010-2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Post-Op Strokes	Observed Post-Op Stroke Rate (%)	Expected Post-Op Stroke Rate (%)	Risk-Adjusted Post-Op Stroke Rate (% RASR)	95% CI for RASR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>32,630</b>	<b>24,947</b>	<b>329</b>	<b>1.32</b>				
<b>San Fernando Valley, Antelope Valley, Ventura &amp; Santa Barbara (continued)</b>	Providence Holy Cross Medical Center	144	107	2	1.87	1.48	1.67	(0.20, 6.04)	Average
	Providence St. Joseph Medical Center	142	102	1	0.98	0.98	1.32	(0.03, 7.34)	Average
	Providence Tarzana Medical Center	156	122	5	4.10	1.18	4.57	(1.49, 10.67)	<b>Worse</b>
	Santa Barbara Cottage Hospital	243	184	2	1.09	1.16	1.23	(0.15, 4.46)	Average
	St. John's Regional Medical Center	167	132	2	1.52	1.70	1.17	(0.14, 4.24)	Average
	Valley Presbyterian Hospital	119	106	1	0.94	1.23	1.01	(0.03, 5.62)	Average
	West Hills Hospital and Medical Center	129	111	1	0.90	1.19	1.00	(0.03, 5.59)	Average
<b>Greater Los Angeles</b>	Beverly Hospital	42	36	0	0.00	1.37	0.00	(0.00, 9.87)	Average
	Cedars Sinai Medical Center	350	211	2	0.95	0.99	1.27	(0.15, 4.58)	Average
	Centinela Hospital Medical Center	61	54	2	3.70	1.96	2.50	(0.30, 9.03)	Average
	Citrus Valley Medical Center – IC Campus	238	199	2	1.01	1.41	0.94	(0.11, 3.41)	Average
	Downey Regional Medical Center	83	77	0	0.00	1.32	0.00	(0.00, 4.80)	Average
	Garfield Medical Center	234	200	3	1.50	1.46	1.35	(0.28, 3.96)	Average
	Good Samaritan Hospital – Los Angeles	224	176	3	1.70	1.52	1.47	(0.30, 4.31)	Average



**Table C-3:** Hospital Risk-Adjusted Post-Operative Stroke Results by Region, 2010-2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Post-Op Strokes	Observed Post-Op Stroke Rate (%)	Expected Post-Op Stroke Rate (%)	Risk-Adjusted Post-Op Stroke Rate (% RASR)	95% CI for RASR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>32,630</b>	<b>24,947</b>	<b>329</b>	<b>1.32</b>				
<b>Greater Los Angeles (continued)</b>	Hollywood Presbyterian Medical Center	22	12	0	0.00	1.36	0.00	(0.00, 29.93)	Average
	Huntington Memorial Hospital	195	161	1	0.62	1.21	0.68	(0.02, 3.78)	Average
	Kaiser Foundation Hospital – Sunset	1,291	939	11	1.17	1.35	1.14	(0.57, 2.04)	Average
	Keck Hospital of USC	410	131	2	1.53	1.09	1.84	(0.22, 6.65)	Average
	Lakewood Regional Medical Center	263	229	4	1.75	1.74	1.32	(0.36, 3.39)	Average
	Long Beach Memorial Medical Center	414	341	5	1.47	1.45	1.33	(0.43, 3.11)	Average
	Los Angeles Co. Harbor – UCLA Medical Center	207	162	1	0.62	1.42	0.57	(0.01, 3.19)	Average
	Los Angeles Co. USC Medical Center	251	193	3	1.55	1.04	1.97	(0.41, 5.75)	Average
	Methodist Hospital of Southern California	88	72	2	2.78	1.70	2.16	(0.26, 7.80)	Average
	Presbyterian Intercommunity Hospital	212	144	0	0.00	1.77	0.00	(0.00, 1.92)	Average
	Providence Little Company of Mary Medical Center – Torrance	146	118	2	1.69	1.97	1.13	(0.14, 4.10)	Average
	Ronald Reagan UCLA Medical Center	424	193	3	1.55	1.10	1.87	(0.39, 5.46)	Average
	Santa Monica – UCLA Medical Center and Orthopaedic Hospital	5	5	0	0.00	1.00	0.00	(0.00, 97.10)	Average

**Table C-3:** Hospital Risk-Adjusted Post-Operative Stroke Results by Region, 2010-2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Post-Op Strokes	Observed Post-Op Stroke Rate (%)	Expected Post-Op Stroke Rate (%)	Risk-Adjusted Post-Op Stroke Rate (% , RASR)	95% CI for RASR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>32,630</b>	<b>24,947</b>	<b>329</b>	<b>1.32</b>				
<b>Greater Los Angeles (continued)</b>	St. Francis Medical Center	80	72	0	0.00	1.20	0.00	(0.00, 5.63)	Average
	St. John's Health Center	130	95	1	1.05	1.23	1.12	(0.03, 6.27)	Average
	St. Mary Medical Center	125	111	1	0.90	1.84	0.65	(0.02, 3.60)	Average
	St. Vincent Medical Center	157	137	2	1.46	1.56	1.23	(0.15, 4.46)	Average
	Torrance Memorial Medical Center	174	117	4	3.42	1.50	3.00	(0.82, 7.68)	Average
	White Memorial Medical Center	104	92	3	3.26	1.48	2.90	(0.60, 8.48)	Average
<b>Inland Empire, Riverside &amp; San Bernardino</b>	Desert Regional Medical Center	284	233	1	0.43	1.40	0.41	(0.01, 2.26)	Average
	Eisenhower Memorial Hospital	402	318	4	1.26	1.24	1.34	(0.37, 3.44)	Average
	Loma Linda University Medical Center	531	427	4	0.94	1.27	0.97	(0.26, 2.48)	Average
	Pomona Valley Hospital Medical Center	272	232	4	1.72	1.65	1.38	(0.38, 3.53)	Average
	Riverside Community Hospital	395	310	3	0.97	1.31	0.97	(0.20, 2.84)	Average
	San Antonio Community Hospital	351	263	4	1.52	1.37	1.46	(0.40, 3.75)	Average
	St. Bernardine Medical Center	1,106	948	8	0.84	1.16	0.96	(0.42, 1.90)	Average
	St. Mary Regional Medical Center	339	289	2	0.69	1.29	0.71	(0.09, 2.56)	Average
<b>Orange County</b>	AHMC Anaheim Regional Medical Center	328	265	5	1.89	1.63	1.53	(0.50, 3.56)	Average

**Table C-3:** Hospital Risk-Adjusted Post-Operative Stroke Results by Region, 2010-2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Post-Op Strokes	Observed Post-Op Stroke Rate (%)	Expected Post-Op Stroke Rate (%)	Risk-Adjusted Post-Op Stroke Rate (% , RASR)	95% CI for RASR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>32,630</b>	<b>24,947</b>	<b>329</b>	<b>1.32</b>				
<b>Orange County (continued)</b>	Fountain Valley Regional Hospital and Medical Center – Euclid	276	248	5	2.02	1.76	1.51	(0.49, 3.53)	Average
	Hoag Memorial Hospital Presbyterian	405	271	8	2.95	1.14	3.42	(1.48, 6.74)	<b>Worse</b>
	Mission Hospital Regional Medical Center	293	244	2	0.82	0.87	1.24	(0.15, 4.49)	Average
	Orange Coast Memorial Medical Center	67	61	1	1.64	1.15	1.89	(0.05, 10.53)	Average
	Saddleback Memorial Medical Center	216	181	1	0.55	1.01	0.72	(0.02, 4.04)	Average
	St. Joseph Hospital – Orange	273	207	1	0.48	1.18	0.54	(0.01, 3.01)	Average
	St. Jude Medical Center	245	195	2	1.03	1.20	1.13	(0.14, 4.09)	Average
	UC Irvine Medical Center	99	80	2	2.50	1.54	2.13	(0.26, 7.72)	Average
	West Anaheim Medical Center	35	29	0	0.00	1.80	0.00	(0.00, 9.30)	Average
	Western Medical Center – Santa Ana	101	87	2	2.30	1.67	1.81	(0.22, 6.55)	Average
	Western Medical Center Hospital – Anaheim	155	129	2	1.55	1.72	1.19	(0.14, 4.30)	Average
<b>Greater San Diego</b>	Alvarado Hospital Medical Center	133	104	2	1.92	1.39	1.82	(0.22, 6.59)	Average
	Palomar Medical Center	154	118	2	1.69	1.24	1.80	(0.22, 6.52)	Average
	Scripps Green Hospital	149	79	1	1.27	1.03	1.62	(0.04, 9.05)	Average

**Table C-3:** Hospital Risk-Adjusted Post-Operative Stroke Results by Region, 2010-2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Post-Op Strokes	Observed Post-Op Stroke Rate (%)	Expected Post-Op Stroke Rate (%)	Risk-Adjusted Post-Op Stroke Rate (% RASR)	95% CI for RASR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>32,630</b>	<b>24,947</b>	<b>329</b>	<b>1.32</b>				
<b>Greater San Diego (continued)</b>	Scripps Memorial Hospital – La Jolla	672	454	9	1.98	1.30	2.01	(0.92, 3.82)	Average
	Scripps Mercy Hospital	337	278	5	1.80	1.32	1.79	(0.58, 4.19)	Average
	Sharp Chula Vista Medical Center	385	305	8	2.62	1.71	2.02	(0.87, 3.99)	Average
	Grossmont Hospital	377	298	8	2.68	1.59	2.23	(0.96, 4.40)	Average
	Sharp Memorial Hospital†	345	193	8	4.15	1.07	5.10	(2.21, 10.06)	<b>Worse</b>
	Tri-City Medical Center	176	146	1	0.68	1.21	0.74	(0.02, 4.15)	Average
	UCSD Medical Center	35	33	0	0.00	1.60	0.00	(0.00, 9.22)	Average
	UCSD Medical Center – La Jolla, John M. & Sally B. Thornton Hospital	224	158	1	0.63	1.18	0.71	(0.02, 3.93)	Average

\*A hospital is classified as **“Better”** if the upper 95% CI of the RASR falls below the California observed stroke rate (1.32%). A hospital is classified as **“Worse”** if the lower 95% CI of the RASR is higher than the California observed stroke rate. A hospital’s performance is considered **“Average”** if the California stroke rate falls within the 95% CI of a hospital’s RASR.

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

## Appendix D: Technical Notes for 30-Day Risk-Adjusted Hospital Readmission Results

### Risk Model for Adjusting 30-Day Hospital Readmission Rates, 2011

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 F 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 the 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 11,085 isolated (non-salvage) CABG surgery cases discharged alive in 2011 were evaluated for missing data (10,171 cases had no missing data in any field and were used for the risk model parameter estimation). The 914 (8.2%) 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 914 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*). 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 2011 data, is presented in Table D-1 with statistically significant risk factors identified in bolded text.

**Table D-1:** Logistic Regression Risk Model for 30-Day Readmission, 2011

Risk Factor		Coefficient	Standard Error	p-value	Odds Ratio
Intercept		-4.189	0.290	<.0001	
<b>Age (Years)</b>		<b>0.012</b>	<b>0.003</b>	<b>0.001</b>	<b>1.012</b>
<b>Gender</b>	Male	Reference			
	<b>Female</b>	<b>0.346</b>	<b>0.067</b>	<b>&lt;.0001</b>	<b>1.413</b>
Race	White	Reference			
	Non-White	0.102	0.064	0.108	1.108
Body Mass Index	18.5-39.9	Reference			
	< 18.5	0.196	0.302	0.516	1.216
	<b>≥ 40</b>	<b>0.446</b>	<b>0.128</b>	<b>0.001</b>	<b>1.563</b>
Status of the Procedure	Elective	Reference			
	<b>Urgent</b>	<b>0.273</b>	<b>0.067</b>	<b>&lt;.0001</b>	<b>1.314</b>
	<b>Emergent</b>	<b>0.470</b>	<b>0.155</b>	<b>0.002</b>	<b>1.600</b>
<b>Last Creatinine Level Pre-Op (mg/dl)</b>		<b>0.786</b>	<b>0.099</b>	<b>&lt;.0001</b>	<b>2.194</b>
<b>Hypertension</b>		<b>0.228</b>	<b>0.110</b>	<b>0.038</b>	<b>1.256</b>
<b>Peripheral Arterial Disease</b>		<b>0.195</b>	<b>0.086</b>	<b>0.024</b>	<b>1.215</b>
<b>Cerebrovascular Disease</b>		<b>0.189</b>	<b>0.083</b>	<b>0.022</b>	<b>1.208</b>
<b>Diabetes</b>		<b>0.176</b>	<b>0.065</b>	<b>0.007</b>	<b>1.193</b>
Chronic Lung Disease	None/Mild	Reference			
	<b>Moderate</b>	<b>0.322</b>	<b>0.122</b>	<b>0.008</b>	<b>1.380</b>
	Severe	0.265	0.136	0.052	1.303
<b>Immunosuppressive Treatment</b>		<b>0.441</b>	<b>0.167</b>	<b>0.008</b>	<b>1.554</b>
<b>Arrhythmia Type</b>	<b>Afib/Flutter</b>	<b>0.416</b>	<b>0.100</b>	<b>&lt;.0001</b>	<b>1.515</b>
<b>Heart Failure</b>		<b>0.185</b>	<b>0.077</b>	<b>0.017</b>	<b>1.203</b>
Prior Cardiac Surgery	None	Reference			
	One or more	0.005	0.165	0.977	1.005
<b>Ejection Fraction</b>		<b>-0.007</b>	<b>0.002</b>	<b>0.004</b>	<b>0.993</b>

**Bolded text** indicates statistical significance.

Note: "Last Creatinine Level Pre-Op" and "Ejection Fraction" were modeled using piecewise linear transformations.

### **Discrimination of the Risk Model for 30-Day Readmission**

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 2011 risk model, the C-statistic was 0.649. In recently published CABG surgery readmission reports by Pennsylvania (2008-2009 data), the C-statistic was 0.641, which is similar to the 2011 CCORP model.<sup>15</sup>

### **Calibration of the Risk Model for 30-Day Readmission**

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 2011 risk model is 0.836, 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 D-2, Risk Group 1 shows the patients in the lowest risk group. Among the 1,017 patients in this group, 56 patients were readmitted to hospital, but the model predicted 62.7 readmissions. Assuming a Poisson distribution for a binary outcome, the predicted range of deaths for Risk Group 1 is 47.2 to 78.3. The observed number of 56 readmissions falls within the range of predicted readmissions. In fact, none of the 10 risk groups had 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.

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<sup>15</sup> <http://www.phc4.org/reports/cabg>

**Table D-2:** Calibration of Risk Model for 30-Day Readmission, 2011

Risk Group	Isolated CABG cases	Observed Readmissions	Predicted Readmissions	Difference	95% CI of Predicted Readmissions
1	1,017	56	62.7	6.7	(47.2, 78.3)
2	1,017	85	76.7	-8.3	(59.6, 93.9)
3	1,019	83	86.9	3.9	(68.6, 105.2)
4	1,019	90	97.0	7.0	(77.7, 116.3)
5	1,017	100	107.7	7.7	(87.3, 128.0)
6	1,018	129	120.3	-8.7	(98.8, 141.8)
7	1,017	139	136.5	-2.5	(113.6, 159.4)
8	1,017	163	157.9	-5.1	(133.3, 182.6)
9	1,017	197	192.7	-4.3	(165.5, 219.9)
10	1,013	280	283.5	3.5	(250.5, 316.5)
<b>Total</b>	<b>10,171</b>	<b>1,322</b>	<b>1322.0</b>	<b>0</b>	

Note: Risk Group 1 is at lowest risk and Risk Group 10 is at highest risk.

### Process for Calculating Risk-Adjusted Readmission Rate and Performance Ratings: 30-Day Readmission

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

The RARR is computed first by dividing the hospital's number of observed readmissions by its expected number of readmissions (obtained from the risk model calculation) to get the observed/expected (O/E) ratio. If the O/E ratio is greater than one, the hospital has a higher readmission rate than expected based on patient mix. If the O/E ratio is less than one, the hospital has a lower readmission rate than expected. The O/E ratio is then multiplied by the state average readmission rate (12.97% for 2011) to obtain the hospital's RARR.

However, because a hospital'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 hospital's RARR to the California average readmission rate.<sup>16</sup> CCORP treated the 2011 data as samples, and inferred a range within which each hospital's true performance was likely to fall. As shown in Table D-3, if the upper 95% CI of a hospital's risk-adjusted readmission is below the state average readmission rate, indicating its RARR is significantly lower than the state average, the performance rating is **"Better."** If the lower 95% CI of a hospital's RARR is above the state average readmission rate, indicating its risk-adjusted readmission is significantly higher than the state average, the performance rating is **"Worse."** If the

<sup>16</sup> CCORP uses Poisson Exact Probability method to compute the 95% confidence interval for the risk-adjusted readmission rate. (Buchan Iain, *Calculating Poisson Confidence Interval in Excel*, January 2004)



state average readmission rate is within the 95% CI of a hospital's RARR, the performance rating is **"Average."** See the following section for a detailed discussion of results.

### Statistical Details of 30-Day Risk-Adjusted Readmission Results, 2011

Table D-3 presents the risk-adjusted readmission rate (RARR) results for each hospital for 2011. 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 after 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 11,085 isolated (non-salvage) CABG surgeries performed in 2010 who were discharged alive, 1,438 patients were readmitted to the same or another acute care hospital within 30 days of the surgery date, reflecting an overall readmission rate of 12.97%. The observed readmission rates among hospitals ranged from 0% to 32.43%. The expected readmission rates, which are generated by the risk model and account for patient severity of illness, range between 9.55% and 17.06%. The RARR, which measures hospital performance, ranged from 0% to 33.05%.

Based on the 95% confidence intervals for risk-adjusted readmission rates, 116 of 122 hospitals (95%) performed within the expected range compared to the state's overall readmission rate (denoted by **"Average"** in the performance rating column of Table D-3), two hospitals performed significantly **"Better"** than the state average, and four hospitals performed significantly **"Worse"** than the state average. Hospitals marked with † in Table D-3 submitted statements regarding this report (presented in Appendix G).

### Definitions of Table D-3 Terms

**All CABG Cases:** The total number of isolated and non-isolated CABG cases submitted to CCORP for 2011. 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 2011, where the patient was discharged alive from a CABG hospital and could be followed up via hospital patient discharge data (PDD) in 2011-2012. The following patients were excluded: patients in salvage operative status, patients who were transferred to acute care, and patients who left against medical advice.

**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 = Isolated CABG Readmissions within 30 Days of Discharge/Isolated CABG Cases (Discharged Alive) × 100.

**Expected Readmission Rate:** The ratio of the expected number of readmissions predicted for a hospital (after adjusting for their patient population) and the discharged-alive isolated CABG cases multiplied by 100:  $\text{Expected Readmission Rate} = \text{Expected Readmissions} / \text{Isolated CABG Cases (Discharged Alive)} \times 100$ .

**Risk-Adjusted Readmission Rate (95% CI):** The Risk-Adjusted Readmission Rate (RARR) is obtained by multiplying the state average readmission rate by a hospital's O/E ratio. The 95% confidence interval represents the confidence in the estimate of 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 hospital's risk-adjusted readmission rate and the state observed readmission rate. This is a test of statistical significance. A hospital is classified as **"Better"** if the upper 95% confidence limit of its RARR falls below the California observed readmission rate. A hospital is classified as **"Worse"** if the lower 95% confidence limit of its RARR is higher than the California observed readmission rate. A hospital is classified as **"Average"** if the California readmission rate falls within the confidence interval of the hospital's risk-adjusted readmission rate.

Table D-3: Hospital Risk-Adjusted Readmission Results by Region, 2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Readmission	Observed Readmission Rate (%)	Expected Readmission Rate (%)	Risk-Adjusted Readmission Rate (% RARR)	95% CI for RARR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>16,284</b>	<b>11,085</b>	<b>1,438</b>	<b>12.97</b>				
<b>Sacramento Valley &amp; Northern California Region</b>	Enloe Medical Center – Esplanade Campus	175	145	24	16.55	12.42	17.28	(11.07, 25.71)	Average
	Mercy General Hospital	803	444	41	9.23	11.94	10.03	(7.20, 13.61)	Average
	Mercy Medical Center – Redding	145	97	8	8.25	12.39	8.63	(3.73, 17.01)	Average
	Mercy San Juan Hospital	185	118	12	10.17	11.57	11.40	(5.89, 19.91)	Average
	Rideout Memorial Hospital	123	83	11	13.25	11.96	14.38	(7.18, 25.72)	Average
	Shasta Regional Medical Center	66	54	8	14.81	12.86	14.95	(6.45, 29.45)	Average
	St. Joseph Hospital – Eureka	37	32	2	6.25	14.59	5.56	(0.67, 20.07)	Average
	Sutter Memorial Hospital	454	291	34	11.68	12.09	12.54	(8.68, 17.51)	Average
	UC Davis Medical Center	141	86	6	6.98	11.62	7.79	(2.86, 16.95)	Average
<b>San Francisco Bay Area &amp; San Jose</b>	Alta Bates Summit Medical Center – Summit Campus – Hawthorne	169	109	18	16.51	14.04	15.26	(9.04, 24.11)	Average
	California Pacific Medical Center – Pacific Campus	72	31	1	3.23	11.53	3.63	(0.09, 20.22)	Average
	Community Hospital Monterey Peninsula	82	57	6	10.53	11.45	11.92	(4.37, 25.94)	Average
	Dominican Hospital – Santa Cruz/Soquel	59	40	6	15.00	10.58	18.40	(6.75, 40.04)	Average
	El Camino Hospital	115	61	7	11.48	11.29	13.18	(5.30, 27.16)	Average
	Good Samaritan Hospital – San Jose	87	59	10	16.95	12.45	17.66	(8.47, 32.48)	Average

Table D-3: Hospital Risk-Adjusted Readmission Results by Region, 2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Readmission	Observed Readmission Rate (%)	Expected Readmission Rate (%)	Risk-Adjusted Readmission Rate (% RARR)	95% CI for RARR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>16,284</b>	<b>11,085</b>	<b>1,438</b>	<b>12.97</b>				
<b>San Francisco Bay Area &amp; San Jose (continued)</b>	John Muir Medical Center – Concord Campus	264	197	19	9.64	11.90	10.52	(6.33, 16.42)	Average
	Kaiser Foundation Hospital – San Francisco	436	306	34	11.11	11.44	12.60	(8.73, 17.61)	Average
	Kaiser Foundation Hospital – Santa Clara	282	173	14	8.09	12.71	8.26	(4.52, 13.86)	Average
	Marin General Hospital	54	39	5	12.82	9.72	17.11	(5.55, 39.92)	Average
	North Bay Medical Center†	35	29	3	10.34	13.87	9.68	(1.99, 28.27)	Average
	O'Connor Hospital – San Jose	62	52	5	9.62	13.22	9.43	(3.06, 22.01)	Average
	Peninsula Medical Center	53	28	2	7.14	9.87	9.39	(1.14, 33.90)	Average
	Queen of the Valley Hospital – Napa	68	41	9	21.95	14.91	19.09	(8.73, 36.24)	Average
	Regional Medical of San Jose	81	62	3	4.84	14.53	4.32	(0.89, 12.62)	<b>Better</b>
	Salinas Valley Memorial Hospital	111	90	14	15.56	13.58	14.86	(8.12, 24.92)	Average
	San Ramon Regional Medical Center	39	30	3	10.00	11.51	11.27	(2.32, 32.94)	Average
	Santa Clara Valley Medical Center	83	66	11	16.67	11.14	19.40	(9.68, 34.71)	Average
	Santa Rosa Memorial Hospital – Montgomery	98	83	3	3.61	12.16	3.86	(0.79, 11.26)	<b>Better</b>

Table D-3: Hospital Risk-Adjusted Readmission Results by Region, 2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Readmission	Observed Readmission Rate (%)	Expected Readmission Rate (%)	Risk-Adjusted Readmission Rate (% RARR)	95% CI for RARR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>16,284</b>	<b>11,085</b>	<b>1,438</b>	<b>12.97</b>				
<b>San Francisco Bay Area &amp; San Jose (continued)</b>	Sequoia Hospital	111	53	7	13.21	12.50	13.71	(5.51, 28.23)	Average
	Seton Medical Center	85	70	10	14.29	15.26	12.14	(5.82, 22.33)	Average
	St. Helena Hospital	54	45	6	13.33	17.06	10.14	(3.72, 22.07)	Average
	St. Mary's Medical Center – San Francisco	43	30	5	16.67	14.16	15.27	(4.96, 35.63)	Average
	Stanford Hospital	102	52	6	11.54	13.26	11.29	(4.14, 24.56)	Average
	Sutter Medical Center of Santa Rosa	97	58	5	8.62	11.78	9.49	(3.08, 22.15)	Average
	UCSF Medical Center	82	56	12	21.43	12.59	22.08	(11.41, 38.56)	Average
	Valleycare Medical Center	48	30	2	6.67	13.33	6.49	(0.79, 23.43)	Average
	Washington Hospital – Fremont	95	80	12	15.00	12.56	15.49	(8.00, 27.05)	Average
<b>Central California</b>	Bakersfield Heart Hospital	111	83	15	18.07	13.25	17.70	(9.90, 29.19)	Average
	Bakersfield Memorial Hospital	154	109	17	15.60	12.74	15.89	(9.25, 25.43)	Average
	Community Regional Medical Center – Fresno	288	226	37	16.37	13.90	15.28	(10.75, 21.05)	Average
	Dameron Hospital	64	56	9	16.07	13.60	15.33	(7.01, 29.09)	Average
	Doctors Medical Center	309	218	32	14.68	14.56	13.08	(8.95, 18.46)	Average
	Emanuel Medical Center	19	12	1	8.33	15.07	7.17	(0.18, 39.96)	Average
	Fresno Heart and Surgical Center	210	164	14	8.54	12.37	8.95	(4.89, 15.02)	Average
	Kaweah Delta Medical Center	231	187	26	13.90	13.67	13.20	(8.62, 19.33)	Average

Table D-3: Hospital Risk-Adjusted Readmission Results by Region, 2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Readmission	Observed Readmission Rate (%)	Expected Readmission Rate (%)	Risk-Adjusted Readmission Rate (% RARR)	95% CI for RARR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>16,284</b>	<b>11,085</b>	<b>1,438</b>	<b>12.97</b>				
<b>Central California (continued)</b>	Marian Medical Center	68	50	5	10.00	11.86	10.94	(3.55, 25.52)	Average
	Memorial Hospital Medical Center – Modesto	236	173	16	9.25	13.52	8.87	(5.07, 14.41)	Average
	San Joaquin Community Hospital	83	70	15	21.43	15.47	17.97	(10.05, 29.63)	Average
	St. Agnes Medical Center	331	240	25	10.42	13.30	10.16	(6.58, 15.00)	Average
	St. Joseph's Medical Center of Stockton	313	233	32	13.73	14.44	12.34	(8.44, 17.42)	Average
<b>San Fernando Valley, Antelope Valley, Ventura &amp; Santa Barbara</b>	Antelope Valley Hospital	30	22	3	13.64	10.99	16.09	(3.32, 47.01)	Average
	Community Memorial Hospital of San Buenaventura	56	41	8	19.51	13.83	18.31	(7.90, 36.06)	Average
	French Hospital Medical Center	107	68	12	17.65	13.10	17.48	(9.03, 30.53)	Average
	Glendale Adventist Medical Center – Wilson Terrace	134	95	15	15.79	11.28	18.15	(10.16, 29.93)	Average
	Glendale Memorial Hospital and Health Center	117	98	11	11.22	12.82	11.36	(5.67, 20.32)	Average
	Los Robles Hospital and Medical Center	78	45	7	15.56	13.43	15.03	(6.04, 30.96)	Average
	Northridge Hospital Medical Center	87	62	12	19.35	14.47	17.35	(8.96, 30.30)	Average
	Palmdale Regional Medical Center	9	7	2	28.57	11.96	30.99	(3.75, 100.0)	Average
	Providence Holy Cross Medical Center	67	50	9	18.00	14.79	15.79	(7.22, 29.96)	Average

Table D-3: Hospital Risk-Adjusted Readmission Results by Region, 2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Readmission	Observed Readmission Rate (%)	Expected Readmission Rate (%)	Risk-Adjusted Readmission Rate (% RARR)	95% CI for RARR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>16,284</b>	<b>11,085</b>	<b>1,438</b>	<b>12.97</b>				
<b>San Fernando Valley, Antelope Valley, Ventura &amp; Santa Barbara (continued)</b>	Providence St. Joseph Medical Center	70	43	3	6.98	11.47	7.89	(1.63, 23.05)	Average
	Providence Tarzana Medical Center	68	50	6	12.00	11.59	13.43	(4.93, 29.22)	Average
	Santa Barbara Cottage Hospital	111	79	9	11.39	12.22	12.09	(5.53, 22.95)	Average
	St. John's Regional Medical Center	80	59	9	15.25	14.32	13.82	(6.32, 26.23)	Average
	Valley Presbyterian Hospital	61	51	7	13.73	13.55	13.14	(5.28, 27.07)	Average
	West Hills Hospital and Medical Center	64	52	13	25.00	13.30	24.38	(12.98, 41.68)	<b>Worse</b>
<b>Greater Los Angeles</b>	Beverly Hospital	23	16	2	12.50	14.07	11.52	(1.40, 41.61)	Average
	Cedars Sinai Medical Center	184	94	11	11.70	10.09	15.04	(7.51, 26.90)	Average
	Centinela Hospital Medical Center	17	11	3	27.27	15.23	23.23	(4.79, 67.87)	Average
	Citrus Valley Medical Center – IC Campus	124	92	10	10.87	13.31	10.60	(5.08, 19.48)	Average
	Downey Regional Medical Center	35	32	6	18.75	11.86	20.52	(7.53, 44.65)	Average
	Garfield Medical Center	132	92	15	16.30	13.23	15.98	(8.94, 26.36)	Average
	Good Samaritan Hospital – Los Angeles	117	68	13	19.12	14.38	17.25	(9.18, 29.49)	Average
	Hollywood Presbyterian Medical Center	22	10	3	30.00	11.96	32.54	(6.71, 95.07)	Average

Table D-3: Hospital Risk-Adjusted Readmission Results by Region, 2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Readmission	Observed Readmission Rate (%)	Expected Readmission Rate (%)	Risk-Adjusted Readmission Rate (% RARR)	95% CI for RARR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>16,284</b>	<b>11,085</b>	<b>1,438</b>	<b>12.97</b>				
<b>Greater Los Angeles (continued)</b>	Huntington Memorial Hospital	97	71	5	7.04	12.27	7.45	(2.42, 17.37)	Average
	Kaiser Foundation Hospital – Sunset	665	487	57	11.70	13.49	11.25	(8.52, 14.58)	Average
	Keck Hospital of USC	245	51	6	11.76	13.55	11.26	(4.13, 24.51)	Average
	Lakewood Regional Medical Center	122	90	18	20.00	16.82	15.42	(9.14, 24.37)	Average
	Long Beach Memorial Medical Center	194	138	21	15.22	13.66	14.45	(8.94, 22.09)	Average
	Los Angeles Co. Harbor – UCLA Medical Center	93	60	12	20.00	13.97	18.58	(9.60, 32.45)	Average
	Los Angeles Co. USC Medical Center	146	91	15	16.48	11.14	19.19	(10.74, 31.64)	Average
	Methodist Hospital of Southern California	48	33	4	12.12	14.31	10.99	(2.99, 28.13)	Average
	Presbyterian Intercommunity Hospital	114	67	10	14.93	14.89	13.01	(6.24, 23.92)	Average
	Providence Little Company of Mary Medical Center – Torrance	73	55	10	18.18	15.66	15.06	(7.22, 27.70)	Average
	Ronald Reagan UCLA Medical Center	213	83	17	20.48	11.82	22.47	(13.09, 35.97)	<b>Worse</b>
	Santa Monica – UCLA Medical Center and Orthopaedic Hospital	1	1	0	0.00	11.58	0.00	(0.00, 100.0)	Average
	St. Francis Medical Center	45	35	4	11.43	14.22	10.43	(2.84, 26.69)	Average



Table D-3: Hospital Risk-Adjusted Readmission Results by Region, 2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Readmission	Observed Readmission Rate (%)	Expected Readmission Rate (%)	Risk-Adjusted Readmission Rate (% , RARR)	95% CI for RARR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>16,284</b>	<b>11,085</b>	<b>1,438</b>	<b>12.97</b>				
<b>Greater Los Angeles (continued)</b>	St. John's Health Center	63	42	4	9.52	9.55	12.94	(3.53, 33.13)	Average
	St. Mary Medical Center	64	48	3	6.25	14.19	5.71	(1.18, 16.69)	Average
	St. Vincent Medical Center	76	57	7	12.28	15.55	10.24	(4.12, 21.10)	Average
	Torrance Memorial Medical Center	93	56	8	14.29	12.31	15.06	(6.50, 29.66)	Average
	White Memorial Medical Center	50	37	12	32.43	12.73	33.05	(17.07, 57.71)	<b>Worse</b>
<b>Inland Empire, Riverside &amp; San Bernardino</b>	Desert Regional Medical Center	152	121	17	14.05	13.28	13.73	(7.99, 21.97)	Average
	Eisenhower Memorial Hospital	200	144	13	9.03	12.76	9.18	(4.88, 15.69)	Average
	Loma Linda University Medical Center	246	173	24	13.87	13.65	13.18	(8.44, 19.61)	Average
	Pomona Valley Hospital Medical Center	139	109	16	14.68	14.12	13.49	(7.71, 21.90)	Average
	Riverside Community Hospital	204	146	16	10.96	12.43	11.43	(6.53, 18.57)	Average
	San Antonio Community Hospital	184	132	15	11.36	14.04	10.50	(5.88, 17.32)	Average
	St. Bernardine Medical Center	567	346	44	12.72	11.27	14.64	(10.63, 19.64)	Average
	St. Mary Regional Medical Center	153	117	17	14.53	12.31	15.32	(8.92, 24.52)	Average

Table D-3: Hospital Risk-Adjusted Readmission Results by Region, 2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Readmission	Observed Readmission Rate (%)	Expected Readmission Rate (%)	Risk-Adjusted Readmission Rate (% RARR)	95% CI for RARR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>16,284</b>	<b>11,085</b>	<b>1,438</b>	<b>12.97</b>				
<b>Orange County</b>	AHMC Anaheim Regional Medical Center	164	104	15	14.42	15.16	12.34	(6.91, 20.35)	Average
	Fountain Valley Regional Hospital and Medical Center – Euclid	132	112	20	17.86	14.79	15.66	(9.57, 24.18)	Average
	Hoag Memorial Hospital Presbyterian	197	118	8	6.78	11.38	7.73	(3.34, 15.22)	Average
	Mission Hospital Regional Medical Center	149	108	10	9.26	9.84	12.20	(5.85, 22.43)	Average
	Orange Coast Memorial Medical Center	49	39	5	12.82	11.95	13.91	(4.52, 32.47)	Average
	Saddleback Memorial Medical Center	104	83	17	20.48	11.80	22.51	(13.11, 36.04)	<b>Worse</b>
	St. Joseph Hospital – Orange	142	93	10	10.75	12.75	10.94	(5.25, 20.12)	Average
	St. Jude Medical Center	105	81	4	4.94	10.86	5.90	(1.61, 15.11)	Average
	UC Irvine Medical Center	63	42	5	11.90	13.42	11.51	(3.74, 26.85)	Average
	West Anaheim Medical Center	25	15	2	13.33	15.00	11.53	(1.40, 41.65)	Average
	Western Medical Center – Santa Ana	59	44	7	15.91	12.30	16.78	(6.75, 34.57)	Average
	Western Medical Center Hospital – Anaheim	81	61	7	11.48	15.79	9.43	(3.79, 19.42)	Average
<b>Greater San Diego</b>	Alvarado Hospital Medical Center	61	40	5	12.50	13.77	11.78	(3.82, 27.48)	Average
	Palomar Medical Center	66	45	6	13.33	13.18	13.13	(4.82, 28.57)	Average

Table D-3: Hospital Risk-Adjusted Readmission Results by Region, 2011

Region	Hospital	All CABG Cases	Isolated CABG Cases	Isolated CABG Readmission	Observed Readmission Rate (%)	Expected Readmission Rate (%)	Risk-Adjusted Readmission Rate (% RARR)	95% CI for RARR	Performance Rating*
<b>State</b>	<b>All Hospitals</b>	<b>16,284</b>	<b>11,085</b>	<b>1,438</b>	<b>12.97</b>				
<b>Greater San Diego (continued)</b>	Scripps Green Hospital	84	42	6	14.29	12.47	14.86	(5.45, 32.33)	Average
	Scripps Memorial Hospital – La Jolla	331	219	26	11.87	12.57	12.25	(8.00, 17.95)	Average
	Scripps Mercy Hospital	169	119	18	15.13	14.10	13.92	(8.25, 22.00)	Average
	Sharp Chula Vista Medical Center	189	136	20	14.71	14.50	13.15	(8.03, 20.31)	Average
	Grossmont Hospital	183	131	25	19.08	13.79	17.95	(11.61, 26.49)	Average
	Sharp Memorial Hospital†	150	75	7	9.33	10.54	11.48	(4.62, 23.66)	Average
	Tri-City Medical Center	84	59	7	11.86	12.70	12.12	(4.87, 24.97)	Average
	UCSD Medical Center	8	8	2	25.00	15.65	20.72	(2.51, 74.84)	Average
	UCSD Medical Center – La Jolla, John M. & Sally B. Thornton Hospital	136	86	14	16.28	11.65	18.13	(9.91, 30.40)	Average

\*A hospital is classified as **“Better”** if the upper 95% CI of the RARR falls below the California observed readmission rate (12.97%). 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 **“Average”** if the California readmission rate falls within the 95% CI of a hospital’s RARR.

† Hospital submitted a statement regarding this report. See Appendix G for their statements.

## Appendix E: Statistical Details of Internal Mammary Artery Usage by Hospital, 2011: A Process Measure of Quality

A widely accepted definition of healthcare quality measurement contains three dimensions: process, structure, and outcomes.<sup>17</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 hospital 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>18</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 national organizations encourage use of the 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 E-1 presents hospital results for usage of the IMA by region for 2011. 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 was slightly higher (96.65% in 2011 vs. 95.99%). Five hospitals received a “**Low**” rating for 2011. Hospital IMA usage rates above the statewide average rate are not rated because there is no consensus on what constitutes an optimal IMA usage rate. Hospitals marked with † in Table E-1 submitted statements regarding this report. Their statements are presented in Appendix G.

### Definitions of Table E-1 Terms

**Isolated CABG Cases (eligible for IMA grafts):** This is a subset of total isolated CABG surgeries and includes only first-time non-cardiogenic shock isolated CABG surgeries for 2011 where the operative status was elective or urgent and the left anterior descending (LAD) artery was bypassed. Therefore, this number will be smaller than the total isolated CABG cases performed by the hospital.

<sup>17</sup> Donabedian A. Evaluating the Quality of Medical Care. *The Milbank Quarterly*, 2005; 83(4):691-729.

<sup>18</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.

**IMA Usage Rate:** The ratio of the number of eligible isolated CABG surgeries with IMA grafts (including left IMA, right IMA and bilateral IMA) and isolated CABG cases eligible for IMA grafts multiplied by 100: Percent IMA use = Isolated CABG Surgeries with IMA Grafts/Isolated CABG Cases eligible for IMA Grafts  $\times$  100.

**Performance Rating:** A blank rating indicates that the IMA usage rate is acceptable. A “**Low**” rating indicates that the IMA usage rate for a hospital is less than 86.53%, i.e., two standard deviations ( $0.0516 \times 1.96$ ) below the state average IMA usage rate (96.65%). IMA usage rates above the state average IMA usage rate was not evaluated because there is no consensus on what constitutes an optimal rate of usage.

**Table E-1:** Hospital Internal Mammary Artery Usage Results by Region, 2011

Region	Hospital	Isolated CABGs*	Percent IMA Use	Rank <sup>†</sup>
<b>State</b>	<b>All Hospitals</b>	<b>10,978</b>	<b>96.65%</b>	
<b>Sacramento Valley &amp; Northern California Region</b>	Enloe Medical Center – Esplanade Campus	121	95.04%	
	Mercy General Hospital	487	98.97%	
	Mercy Medical Center – Redding	60	100.00%	
	Mercy San Juan Hospital	118	98.31%	
	Rideout Memorial Hospital	80	97.50%	
	Shasta Regional Medical Center	52	92.31%	
	St. Joseph Hospital – Eureka	28	96.43%	
	Sutter Memorial Hospital	285	97.54%	
	UC Davis Medical Center	92	97.83%	
<b>San Francisco Bay Area &amp; San Jose</b>	Alta Bates Summit Medical Center – Summit Campus – Hawthorne	118	100.00%	
	California Pacific Medical Center – Pacific Campus	36	97.22%	
	Community Hospital Monterey Peninsula	57	98.25%	
	Dominican Hospital – Santa Cruz/Soquel	43	95.35%	
	El Camino Hospital	59	100.00%	
	Good Samaritan Hospital – San Jose	54	98.15%	
	John Muir Medical Center – Concord Campus	186	97.85%	
	Kaiser Foundation Hospital – San Francisco	301	98.34%	
	Kaiser Foundation Hospital – Santa Clara	170	97.65%	
	Marin General Hospital	41	75.61%	<b>Low</b>
	North Bay Medical Center†	32	100.00%	

**Table E-1: Hospital Internal Mammary Artery Usage Results by Region, 2011**

Region	Hospital	Isolated CABGs*	Percent IMA Use	Rank <sup>†</sup>
State	All Hospitals	10,978	96.65%	
<b>San Francisco Bay Area &amp; San Jose (continued)</b>	O'Connor Hospital – San Jose	55	100.00%	
	Peninsula Medical Center	33	96.97%	
	Queen of The Valley Hospital – Napa	48	100.00%	
	Regional Medical of San Jose	62	98.39%	
	Salinas Valley Memorial Hospital	85	97.65%	
	San Ramon Regional Medical Center	27	100.00%	
	Santa Clara Valley Medical Center	69	98.55%	
	Santa Rosa Memorial Hospital – Montgomery	75	85.33%	<b>Low</b>
	Sequoia Hospital	46	97.83%	
	Seton Medical Center	63	87.30%	
	St. Helena Hospital	36	94.44%	
	St. Mary's Medical Center, San Francisco	31	90.32%	
	Stanford Hospital	55	98.18%	
	Sutter Medical Center of Santa Rosa	59	61.02%	<b>Low</b>
	UCSF Medical Center	61	100.00%	
	Valleycare Medical Center	30	100.00%	
	Washington Hospital – Fremont	84	100.00%	
<b>Central California</b>	Bakersfield Heart Hospital	81	92.59%	
	Bakersfield Memorial Hospital	96	93.75%	
	Community Regional Medical Center – Fresno	206	100.00%	
	Dameron Hospital	50	98.00%	
	Doctors Medical Center	216	93.52%	
	Emanuel Medical Center, Inc	14	100.00%	
	Fresno Heart and Surgical Center	152	98.03%	
	Kaweah Delta Medical Center	182	99.45%	
	Marian Medical Center	54	100.00%	
	Memorial Hospital Medical Center – Modesto	167	85.63%	<b>Low</b>
	San Joaquin Community Hospital	68	94.12%	
	St. Agnes Medical Center	240	98.75%	
	St. Joseph's Medical Center of Stockton	207	98.07%	
<b>San Fernando Valley, Antelope Valley, Ventura &amp; Santa Barbara</b>	Antelope Valley Hospital	24	100.00%	
	Community Memorial Hospital of San Buenaventura	39	97.44%	
	French Hospital Medical Center	67	100.00%	

**Table E-1: Hospital Internal Mammary Artery Usage Results by Region, 2011**

Region	Hospital	Isolated CABGs*	Percent IMA Use	Rank <sup>†</sup>
State	All Hospitals	10,978	96.65%	
San Fernando Valley, Antelope Valley, Ventura & Santa Barbara (continued)	Glendale Adventist Medical Center – Wilson Terrace	103	99.03%	
	Glendale Memorial Hospital And Health Center	93	89.25%	
	Los Robles Hospital and Medical Center	43	95.35%	
	Northridge Hospital Medical Center	65	95.38%	
	Palmdale Regional Medical Center	6	83.33%	Low
	Providence Holy Cross Medical Center	47	100.00%	
	Providence St. Joseph Medical Center	43	100.00%	
	Providence Tarzana Medical Center – Tarzana	50	100.00%	
	Santa Barbara Cottage Hospital	81	93.83%	
	St. John's Regional Medical Center	58	94.83%	
	Valley Presbyterian Hospital	51	94.12%	
	West Hills Hospital and Medical Center	46	100.00%	
Greater Los Angeles	Beverly Hospital	17	100.00%	
	Cedars Sinai Medical Center	93	97.85%	
	Centinela Hospital Medical Center	11	100.00%	
	Citrus Valley Medical Center – IC Campus	90	93.33%	
	Downey Regional Medical Center	32	100.00%	
	Garfield Medical Center	91	92.31%	
	Good Samaritan Hospital – Los Angeles	82	97.56%	
	Hollywood Presbyterian Medical Center	8	100.00%	
	Huntington Memorial Hospital	76	97.37%	
	Kaiser Foundation Hospital – Sunset	464	95.91%	
	Keck Hospital of USC	50	100.00%	
	Lakewood Regional Medical Center	97	87.63%	
	Long Beach Memorial Medical Center	140	91.43%	
	Los Angeles Co. Harbor – UCLA Medical Center	68	97.06%	
	Los Angeles Co. USC Medical Center	116	98.28%	
	Methodist Hospital of Southern California	33	100.00%	
	Presbyterian Intercommunity Hospital	64	95.31%	
	Providence Little Company of Mary Medical Center – Torrance	53	94.34%	
	Ronald Reagan UCLA Medical Center	74	97.30%	

**Table E-1: Hospital Internal Mammary Artery Usage Results by Region, 2011**

Region	Hospital	Isolated CABGs*	Percent IMA Use	Rank <sup>†</sup>
<b>State</b>	<b>All Hospitals</b>	<b>10,978</b>	<b>96.65%</b>	
<b>Inland Empire, Riverside &amp; San Bernardino</b>	Santa Monica – UCLA Medical Center and Orthopaedic Hospital	1	100.00%	
	St. Francis Medical Center	38	94.74%	
	St. John's Health Center	44	95.45%	
	St. Mary Medical Center	44	100.00%	
	St. Vincent Medical Center	62	100.00%	
	Torrance Memorial Medical Center	60	100.00%	
	White Memorial Medical Center	39	94.87%	
	Desert Regional Medical Center	115	94.78%	
	Eisenhower Memorial Hospital	150	93.33%	
	Loma Linda University Medical Center	168	98.21%	
	Pomona Valley Hospital Medical Center	55	98.18%	
	Riverside Community Hospital	138	97.83%	
	San Antonio Community Hospital	110	99.09%	
	St. Bernardine Medical Center	453	97.35%	
	St. Mary Regional Medical Center	112	96.43%	
<b>Orange County</b>	AHMC Anaheim Regional Medical Center	122	98.36%	
	Fountain Valley Regional Hospital and Medical Center – Euclid	105	91.43%	
	Hoag Memorial Hospital Presbyterian	109	97.25%	
	Mission Hospital Regional Medical Center	105	99.05%	
	Orange Coast Memorial Medical Center	38	100.00%	
	Saddleback Memorial Medical Center	75	89.33%	
	St. Joseph Hospital – Orange	97	100.00%	
	St. Jude Medical Center	72	100.00%	
	UC Irvine Medical Center	51	98.04%	
	West Anaheim Medical Center	12	100.00%	
	Western Medical Center – Santa Ana	37	97.30%	
	Western Medical Center Hospital – Anaheim	57	96.49%	
<b>Greater San Diego</b>	Alvarado Hospital Medical Center	44	100.00%	
	Palomar Medical Center	47	100.00%	
	Scripps Green Hospital	43	100.00%	
	Scripps Memorial Hospital – La Jolla	224	98.66%	
	Scripps Mercy Hospital	132	100.00%	
	Sharp Chula Vista Medical Center	130	99.23%	



**Table E-1: Hospital Internal Mammary Artery Usage Results by Region, 2011**

Region	Hospital	Isolated CABGs*	Percent IMA Use	Rank <sup>†</sup>
State	All Hospitals	10,978	96.65%	
Greater San Diego (continued)	Grossmont Hospital	131	100.00%	
	Sharp Memorial Hospital <sup>‡</sup>	58	98.28%	
	Tri-City Medical Center	57	100.00%	
	UCSD Medical Center	8	100.00%	
	UCSD Medical Center – La Jolla, John M. & Sally B. Thornton Hospital	88	100.00%	

\* CABG limited to first-time non-cardiogenic shock isolated CABGs where the operative status was elective or urgent and LAD was bypassed.

‡ Low Rank: IMA usage rate for a hospital is less than 86.53%, i.e., two standard deviations ( $0.0516 \times 1.96$ ) below the hospital statewide average IMA usage rate (96.65%)

† Hospital submitted a statement regarding this report. See Appendix G for the statements.

## Appendix F: 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, 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 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 Following 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 G: Hospital Statements**

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



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,

This letter is in response to our receipt of the 2010-2011 California Outcomes Reporting Program (CCORP) report. Sharp Memorial Hospital scored worse than expected on Post-Operative Stroke and we would like to respond to this rating. In 2010 we noted an unusual cluster of 7 strokes. Each case was individually reviewed and no trends or common causes could be identified. This unusual cluster strongly influenced our results for the 2 year period. Rates of stroke occurrence improved significantly in the two years following the data reported from 2010 (one in 2011 and two in 2012). In view of this, we feel that the rating, while accurate in number, does not reflect our current performance in this area.

Sharp Memorial Hospital has participated in the California CABG Outcomes Reporting Program since 1998, when it was a voluntary program. The CCORP staff does an excellent job of ensuring accuracy of this data and we wholeheartedly support the program.

Thanks for this opportunity to comment on our results.

A handwritten signature in blue ink, appearing to read "Robert Adamson", with a long horizontal flourish extending to the right.

Robert Adamson MD  
Cardiothoracic Surgeon  
Medical Director Cardiac Transplant Program  
Sharp Memorial Hospital



July 1, 2013

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

Dear Dr. Hoegh:

We appreciate the opportunity to comment on the 2011 CCORP results. NorthBay Healthcare is committed to providing compassionate care, advanced medicine, close to home. To that end, since 2009, we became the first and only hospital in Solano County to be certified as a Chest Pain Center and offer an open heart surgery program as well. Our commitment was once again reaffirmed in 2011 when we were certified as the only STEMI Receiving Center in the county.

As a health care organization, being successful in these high risk programs does not mean we have become complacent. Upon reviewing the preliminary 2011 CCORP report, we have identified an erroneous submission of a post operative stroke, which in fact, did not occur. In light of this information, our observed rate should be zero (0%), not 1.56%.

Our goal continues to be the achievement of the highest standards in our organization. To that end, we will be utilizing our Lean Excellence Program to improve all processes, including ensuring data quality and integrity.

Sincerely,

A handwritten signature in black ink that reads "Deborah Sugiyama".

Deborah Sugiyama  
President  
NorthBay Healthcare Group

*Compassionate Care,  
Advanced Medicine,  
Close to Home*

1200 B. Gale Wilson Blvd.  
Fairfield, CA 94533-3587  
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February 2014

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