

# Cardiac Surgery in New Jersey



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## Executive Summary

**T**his report is for patients and families considering coronary artery bypass graft (CABG) surgery. It summarizes the results of a study of CABG surgery in New Jersey and answers many of the questions you may have about this common procedure.

An important goal of this report is to give you, the patients, and your family information that will help you have more informed discussions with your physicians. Since every patient has different health concerns and risks, we encourage you to discuss the information in this report with your physicians, who can answer your questions and concerns.

Another important goal of this report is to give New Jersey hospitals and surgeons meaningful data they can use in assessing quality of care related to CABG surgery. There is strong evidence, from the handful of states with similar studies, that this kind of information prompts hospitals to examine their process of care in order to improve the overall quality of bypass surgery and ultimately, save lives.

For this study, the Department of Health and Senior Services (Department) collected data on 8,357 patients undergoing open heart surgery at 18 hospitals in 2009. Of these patients, 4,497 had coronary artery bypass graft (CABG) surgery with no other major surgery during the same admission, i.e., *isolated CABG*.

This study was a collaborative effort with a select committee of experts known as the Cardiovascular Health Advisory Panel (CHAP), which includes physicians who specialize in cardiac surgery, cardiologists and other health care professionals.

## How to Use This Report

Hospitals and doctors are not the same in their specialties and expertise. Some are better equipped than others to handle patients with different health conditions. These differences will influence the quality of care you receive and the outcomes of your CABG surgery.

Many consumers want a doctor's recommendation on hospitals and surgeons. Frequently, people collect as much information as possible to make informed decisions. This report will provide some of that information.

However, this report is not intended to be used alone. It is designed to provide important information to help you make informed decisions. There are many factors to consider in determining the best hospital for you. Among these are your own personal health risks as well as the experience certain hospitals have treating patients with those risk factors. Before you make your decisions, you should discuss this report with the physician, usually a cardiologist, who refers you for cardiac surgery. The cardiologist's knowledge and expertise will be a valuable guide in making your decision.

## Key Findings

The Department analyzed the isolated CABG surgery data using a statistical method to assess hospital and surgeon performance, after subjecting the 8,357 CABG surgery patient data to extensive error checks, sampled medical record audits and consulting with the clinical panel of the CHAP. The statistical analysis took into account the patient's health status before surgery as well as demographic factors. This process is commonly known as "risk-adjustment" and allows for fair comparisons among hospitals and surgeons treating diverse patient populations.

Some key findings of the 2009 data analysis are as follows:

### Statewide Summary

- Only 53.8 percent (4,497) of the 8,357 total open heart surgeries performed in New Jersey in 2009 were isolated CABG surgeries.
- Of the 4,497 isolated CABG surgery patients, 59 died while in the hospital or within 30 days after surgery. The

statewide observed operative mortality rate for isolated CABG surgery patients in 2009 was 1.31 percent.

- When comparing 2008 and 2009 on a risk-adjusted basis, mortality rate declined 9.2 percent.
- A review of 16 years of pooled data suggests that the risk-adjusted CABG mortality rate in New Jersey has declined 70.9 percent between 1994 and 2009 (from 4.53 percent to 1.45 percent).

### Mortality Rate by Hospital and by Surgeon

- In 2009, no hospital had statistically significantly different risk-adjusted mortality rate than the statewide rate. Although their rates were not statistically significantly different from the statewide rate, it is nevertheless notable that Englewood Hospital, UMDNJ University Hospital and Valley Hospital had no CABG surgery deaths during 2009.
- In the period 2008-2009, no individual surgeon had a statistically significantly higher or lower risk-adjusted mortality rate than the statewide rate.
- Although their rates were not statistically significantly different from the statewide rate, it is nevertheless notable that a few surgeons, including some who performed less than 100 isolated CABG surgeries, had no CABG surgery deaths during this two-year period. Among surgeons who performed 100 or more isolated CABG surgeries in the period 2008-2009, Dr. James Klein of Englewood Hospital and Medical Center, Dr. Eric Somberg from Hackensack University Medical Center, Dr. Richard Neibart from Jersey Shore Medical Center, Dr. Nilesh Patel from St. Michael's Medical Center and Dr. Alex Zapolanski from The Valley Hospital had no CABG surgery deaths.

### Pre-surgery Patient Risk Factors

- Key factors that are associated with a

patient's chance of surviving the operation include\*:

- ❖ patient's age;
- ❖ whether the patient has various preoperative risk factors, such as lung disease or renal failure that requires dialysis;
- ❖ whether the patient has preoperative cardiac status such as cardiogenic shock, ejection fraction less than 30% or between 30% to 39%, myocardial infarction within 6 hours of the surgery, symptoms of severe cardiac insufficiency.

### Post-surgery Length of Stay

- The average length of hospital stay for a typical CABG surgery patient in 2009 was 6.90 days, lower than that of 7.05 days in 2008.
- The risk-adjusted length of stay by hospital ranged from 4.62 days in St. Joseph's Hospital and Medical Center to 7.06 days in Newark Beth Israel Medical Center.
- There were also important differences in length of stay by surgeon. Risk-adjusted average length of stay by individual eligible surgeon in the period 2008-2009 ranged from 4.42 days to 7.93 days.

### Post-surgery Infections

- In 2009, 6.49 percent of patients had some type of infection, including pneumonia, following isolated CABG surgery. The overall infection rate increased 11.1 percent from 5.84 percent in 2008 to 6.49 percent in 2009 (not risk-adjusted).
- As expected, isolated CABG patients who develop infections after surgery have a much higher mortality rate (5.14 percent vs. 1.05 percent) and a longer hospital stay compared to those who have no infections (15.73 days vs. 6.28 days).

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\* More information on risk factors and methods used in this report is presented in Appendix D.

## Introduction

This report is for patients and families of patients facing the possibility of coronary artery bypass graft (CABG) surgery. It provides mortality rates for the 18 hospitals that performed cardiac surgery in 2009 and the physicians performing this common cardiac surgical procedure in 2008-2009. As part of the Department's continued effort to provide information to consumers, this report includes information on hospital length of stay and infections. The report provides risk-adjusted length of post-surgery hospital stay for CABG surgery patients by hospital and by eligible surgeon (i.e., surgeon who performed at least 100 isolated CABG operations in one hospital in the years 2008 and 2009 combined), while rates of infections are reported for the state as a whole.

An important goal of the report is to give you, the patients, and your family information that will help you have more informed discussions with your physicians. Since every patient has different health concerns and risks, we encourage you to discuss the information in this report with your physicians, who can answer your questions and concerns.

Another important goal of this analysis is to give hospitals data they can use in assessing quality of care related to bypass surgery. There is strong evidence, from other states with similar reports, that this information encourages hospitals to examine their process of care and make changes that can improve quality of care and, ultimately, save lives.

For this report, the Department of Health and Senior Services collected data on 4,497 patients who had bypass surgery with no other major surgery during the same admission (simply referred to as isolated CABG in this report) in 2009. This is the most recent year for which a complete and audited data set is available. The data have been "risk-adjusted,"

which means that they were adjusted to take into account the patient's health conditions before surgery. This risk-adjustment allows for fair comparisons among hospitals and surgeons treating diverse patient populations.

New Jersey's mortality rate for isolated CABG surgery has shown a significant decline since public reporting began with 1994 data. For 2009, the observed mortality rate is 1.31 percent, which is lower than the mortality rate of 1.47 percent for 2008. Risk-adjusted mortality rate declined 9.2 percent between 2008 and 2009, suggesting a continued downward trend (Appendix D). Risk-adjusted mortality rate declined 70.9 percent from 4.53 percent to 1.45 percent between 1994 and 2009, which is statistically significant. A difference is called "**statistically significant**" when it is too large to be due to chance or random variation.

## How to Use this Report

Hospitals and doctors are not the same in their specialties and expertise. Some are better equipped than others to handle patients with different health conditions. These differences will influence the quality of care you receive and the outcomes of your CABG surgery.

Many Consumers want a doctor's recommendation on hospitals and surgeons. Frequently, people collect as much information as possible to make informed decisions. This report will provide some of that information.

However, this report is not intended to be used alone. Volumes, mortality rates and length of stay in this report are just some of the important factors to consider in deciding where to have cardiac surgery. There are many factors to consider in determining the best hospital for you. Among these are your own personal health risks as well as the experience certain hospitals have treating patients with those risk factors. Before you make your decisions, you should

discuss this report with the physician, usually a cardiologist, who refers you for cardiac surgery. You and your physician together can make the best choice after full consideration of your medical needs.

### Cardiovascular Health Advisory Panel

A Cardiovascular Health Advisory Panel (CHAP) was established by the Commissioner of Health and Senior Services by Executive Order (No. 187 (2001) and amended by Executive Directive 207) to provide the Commissioner with expert advice on sound cardiovascular health policy. CHAP provides advice on cardiovascular health promotion, disease prevention, standards of care, emerging technologies and their applications to cardiac services in the State, and review of the State's cardiac data for quality assessment, performance evaluation and research. CHAP's membership includes clinicians in the field such as surgeons, cardiologists, nurses and professional associations and consumer representatives (See Appendix B).

### Heart Disease and Cardiac Surgery in New Jersey

Heart diseases continue to be the leading causes of death of Americans with 616,828 deaths in 2008. Almost every 30 seconds, someone in the United States will suffer a heart attack, and about once every minute, someone will die from one. In New Jersey, heart diseases are the leading causes of death, accounting for 19,056 deaths in 2008 for an age-standardized death rate of 190.6 per 100,000, which is about the same as the national age-standardized rate of 186.5 per 100,000.

([http://www.cdc.gov/nchs/data/nvsr/nvsr59/nvsr59\\_10.pdf](http://www.cdc.gov/nchs/data/nvsr/nvsr59/nvsr59_10.pdf), page 135).

The most common form of heart disease is coronary artery disease. It occurs when the coronary arteries, which carry blood to the heart muscle, become clogged or partially blocked by fatty deposits on the artery walls. This can lead to chest pain, or angina, which is a warning sign

for a heart attack. A heart attack occurs when a coronary artery is totally blocked.

### Treatment Options

Treatment for coronary artery disease will vary for different patients. The choice of treatment depends on the nature and severity of the disease and other factors unique to each patient.

For some patients, lifestyle changes such as quitting smoking, eating a low-fat diet, and getting more exercise may be enough. Some patients require special medications. Others may need medical procedures such as angioplasty or coronary artery bypass graft surgery. Angioplasty reduces obstructions of fatty deposits in coronary arteries and has become an increasingly common treatment method. Bypass surgery uses an artery or vein taken from another part of the body to divert blood around the clogged part of a patient's artery or arteries.

This report is about coronary artery bypass graft surgery outcomes. It describes the performance records of 18 hospitals in New Jersey that offered this type of surgery in 2009 and the surgeons who performed this operation at least 100 times between January 2008 and December 2009 in a hospital. The information in this report can help you in discussions with your doctor about bypass surgery.

### Definition of Operative Mortality

Beginning with the 2000 report<sup>1</sup>, the Department, after consulting with the CHAP, included in its definition of "operative mortality" deaths up to 30 days post-surgery or deaths occurring during the hospital stay in which the surgery was performed, no matter how many days after the procedure. Deaths occurring within 30 days after surgery, but

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<sup>1</sup> Previously, the Department defined patient death for this report as in-hospital death before discharge from the hospital after isolated CABG surgery. As a result, patients who died after being discharged home or to post-acute care facilities were not counted for purposes of calculating CABG surgery mortality rates. This caused concerns about "gaming" of outcomes through discharge practices.

post-discharge, have been identified by matching patient records in the Department's open heart data base against the state's official death records.

Further, in an attempt to continuously improve the quality of data used in assessing CABG surgery mortality, the Department, in consultation with CHAP, reviewed the way operative procedures are coded for the purpose of the cardiac surgery report in New Jersey. The Department issued an operative procedure coding guide to be followed by all hospitals starting with 2005 data. This guideline was designed to avoid differential reporting of operative procedures by hospitals.

Applying the revised definitions of mortality, the Department also recalculated the statewide CABG surgery mortality rates for the prior years, in order to analyze the trend over time. Operative mortality rate estimates by year are presented in Figure 5. Appendix D, Table D3 presents the statewide operative mortality rate estimates for the period 1994-2009.

## Performance Data

In an isolated CABG surgery, no other major heart procedure is performed at the same time. The number of people who died during the hospitalization in which the operation was performed, or after discharge but within 30 days of the surgery, was 59, or 1.31 percent of 4,497 who had the surgery in 2009. This statewide operative CABG surgery mortality rate (1.31 percent) is used as the yard stick in evaluating hospital performance.

## Risk-Adjusted Mortality

In evaluating the performance of hospitals and individual surgeons, it would be unfair to make comparisons only on the basis of how many patients died. The mortality risk for patients undergoing bypass surgery varies significantly with how healthy patients are prior to surgery. For instance, an 85-year-old who has renal failure and severe lung disease would be at

higher risk during this surgery than a 50-year-old who has no history of chronic disease.

In order to produce fair comparisons, the Department applied a method that estimates **risk-adjusted mortality rates**. The risk-adjusted mortality rate assigns "extra credit" to hospitals and surgeons with sicker patient populations, in order not to disadvantage them in the performance comparisons.

Each hospital was required to submit data which contain a risk profile for each patient undergoing bypass surgery.

Key factors that are associated with a patient's chance of surviving the isolated CABG operation include:

- the patient's age;
- whether the patient has various preoperative risk factors, such as:
  - lung disease;
  - renal failure with dialysis;
- whether the patient has preoperative cardiac status such as:
  - cardiogenic shock;
  - ejection fraction less than 30% or between 30% to 39%;
  - myocardial infarction within 6 hours of the surgery;
  - symptoms of severe cardiac insufficiency.

Weights derived from the statistical model were assigned for each key risk factor and calculations were performed for each hospital to produce **risk-adjusted mortality rates** as a fair basis of comparison (see Appendix D for more details).

## Performance Reports Lead to Improvement

This performance report is for use not only by you and your doctors, but also by hospitals to improve the quality of their care and their patients' outcomes. On a risk-adjusted basis, the New Jersey statewide risk-adjusted mortality

rate for isolated CABG surgery declined 9.2 percent between 2008 and 2009, which was not statistically significant. Nevertheless, it is a continuation of the overall decline of 70.9 percent in the statewide risk-adjusted CABG mortality rate since 1994. Evidence both from New Jersey and other states that have published similar performance reports (i.e. California, Massachusetts, New York and Pennsylvania) suggests that these reports contribute to the decline in mortality rates and improve the overall quality of bypass surgery.

### Hospitals

This report provides risk-adjusted mortality rates for each of the 18 hospitals in New Jersey that were licensed to perform coronary artery bypass graft surgery in 2009. You will see that there are substantive variations among the hospitals. Through statistical analysis, the Department is able to determine in which cases the variations reflect real differences in performance after accounting for levels of risk among patients.

Nevertheless, these data should not be used as the sole factor in making choices about hospitals, but should be part of the discussion between you and your doctor.

### Surgeons

A risk-adjusted mortality rate was also calculated for each of the 37 surgeons who performed at least 100 isolated CABG operations in one hospital in the years 2008 and 2009 combined. Even though two years of data were combined, several surgeons still fell short of the 100 cases the Department considers the minimum needed to calculate reliable risk-adjusted mortality rates. The Department recognizes that the volumes of some surgeons may be low because they had left those facilities during the year. Statistics for these low-volume surgeons are grouped under the hospital where the operations took place, in a category called “**All Others.**” These surgeons are listed by name but with no risk-adjusted mortality rates, since their small numbers do not permit an

accurate indication of their performance (Table 2). This report shows the total number of open heart and CABG surgeries these low volume surgeons performed, as well as their number of CABG surgery operative deaths.

### Volume Affects Quality

Many studies nationally and in other states have shown that, in general, hospitals and surgeons that perform bypass surgery more frequently have lower patient mortality rates. New Jersey’s data also confirm this general trend. However, there are exceptions, and a number of hospitals with low volumes have results that are in line with the statewide rate.

### Isolated CABG Surgery Volume at New Jersey Hospitals in 2009

Figure 1 shows the number of isolated CABG operations performed in 2009 in each of the 18 hospitals. You can see that some hospitals do more of these procedures than others, with isolated CABG volume ranging from a low of 44 to a high of 612. Isolated CABG is the most common type of cardiac surgery accounting for 53.8 percent in 2009. Isolated CABG surgery volume in New Jersey has been declining starting in 2000 while angioplasty has stabilized on a higher level. Between 2000 and 2009, the number of isolated CABG surgeries in New Jersey has declined by 45.3 percent.

### Hospital Risk-adjusted Mortality

Figure 2 shows the risk-adjusted mortality rate for each New Jersey hospital performing bypass surgery in 2009<sup>2</sup>. The risk-adjusted mortality rate takes into account the patients’ risk factors going into surgery as well as the actual mortality rate after the surgery, in order to make a fair assessment of hospital performance.

In trying to determine a hospital’s or surgeon’s performance, it is important to

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<sup>2</sup> These data may not reflect current performance of a specific hospital, which may have revamped its program since then.



account for the fact that some differences occur simply due to chance or random variation. Statistical tests are conducted on the data so that we can be as certain as possible that the differences are due to actual differences in performance. A difference is called **“statistically significant”** when it is too large to be due to chance or random variation.

Each hospital's and each surgeon's mortality rate reflects three components: *the quality of their care, the patients' risk factors that affect mortality, and an element of random variation.* Readers of this report should be interested only in the first component, the quality of care delivered by hospitals and surgeons. We use a nationally-accepted risk-adjustment method to control for the second component, risk factors of CABG surgery patients seen by hospitals and surgeons. Because the third component, *random variation*, cannot be observed to be controlled for in the statistical model, we estimate how much higher or lower the risk-adjusted mortality rate could have been given the impact of random variation, using a confidence interval given at the 95% level.

In Figure 2, the dark line in the middle of each hospital's bar represents its estimated risk-adjusted mortality rate. When estimating rates using data, however, we cannot be sure if this number is the actual rate for the facility and not due to chance. We can only be relatively sure that the true rate falls somewhere within the bar. In analyzing data, we use what is called a “95 percent confidence interval,” and the bar represents the lower and upper limits of this confidence interval. We are 95 percent confident that the hospital's actual risk-adjusted

mortality rate falls within the range shown by the bar. Another way of saying it is that the bar represents the statistical margin of error for the estimation of that rate.

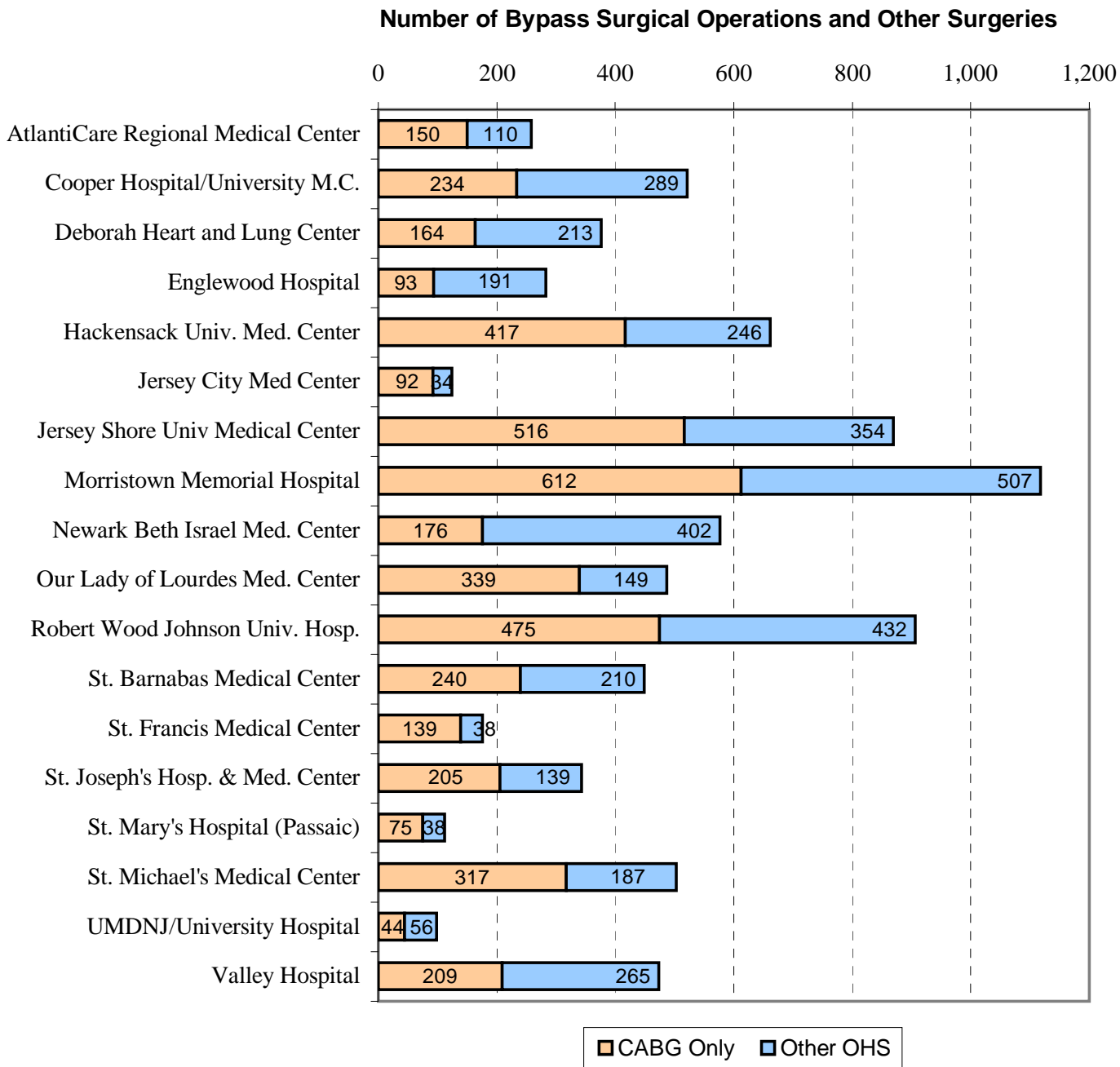
The vertical line on Figure 2 represents New Jersey's statewide isolated CABG surgery operative mortality rate per 100 cases for 2009, i.e. 1.31. Each hospital's performance is displayed graphically in relation to this statewide rate.

Figure 2 indicates that all 18 hospitals have bars that cross the statewide mortality rate line (1.31 percent). That means that their risk-adjusted mortality rates were not statistically different from the statewide rate.

When using this report, it is important to remember that the charts are designed to show whether a hospital's or surgeon's risk-adjusted mortality rate is significantly above or below the statewide rate, or whether a rate is statistically the same as the statewide rate. Thus, it is more important to view the bars in relation to the statewide mortality rate line than it is to examine the individual calculated rates on the bars. The chart should not be used to make hospital-to-hospital or surgeon-to-surgeon comparisons, only to compare hospitals and surgeons to the statewide rate.

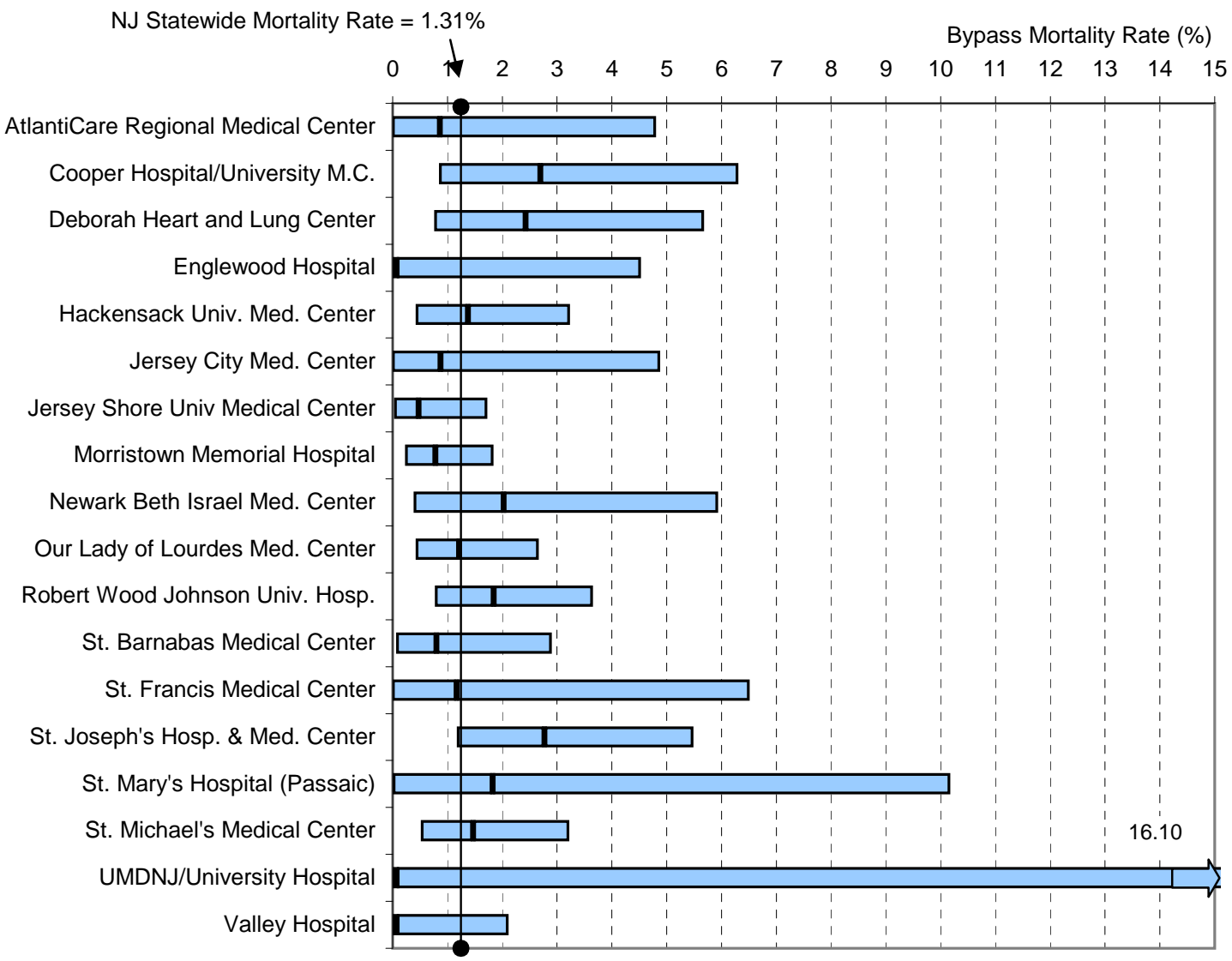
In examining the charts, you will see that some bars are shorter than others. The bar is shorter for hospitals or surgeons performing more surgeries, and longer for those with lower volumes. This reflects the fact that larger numbers -- in this case, more surgeries -- increase the precision of a statistic.

**Figure 1**  
**Number of Isolated Coronary Bypass Graft Surgeries vs. Other Open Heart Surgeries, 2009**



Source: New Jersey Department of Health and Senior Services

**Figure 2**  
**Risk-Adjusted Operative Mortality Rate\* by Hospital (2009)**



SOURCE: New Jersey Department of Health and Senior Services

\* Operative Mortality includes: (1) all deaths occurring during the hospitalization in which the operation was performed, even after 30 days; and (2) those deaths occurring after discharge from the hospital, but within 30 days of the procedures.

## Statewide CABG Surgery Related Infections

The Department has included information on CABG surgery in-hospital infections as an additional tool to monitor hospital performance. The statewide infection rates are provided as one more factor to be considered by policy makers and others involved in quality of care monitoring.

Infections reported in the Open Heart Surgery database included sternal-deep infection (involving muscle, bone and/or mediastinum requiring operative intervention), thoracotomy, leg infections, septicemia (presence of bacteria in the blood stream) and urinary tract infections (UTI). The table also includes post-operative pneumonia. For comparison purposes, statewide infection rates, the corresponding mortality rates and the average length of stay are presented in Table 1 to provide perspective to the statewide rates.

Table 1 indicates that 2.60 percent of patients who underwent isolated CABG surgery had pneumonia. Slightly over three percent (3.18%) had UTI and less than one percent (0.91%) had septicemia. Statewide,

six and half percent (6.49%) of isolated CABG patients had some form of infection (including pneumonia) reported.

As expected, there was a large difference in observed CABG surgery mortality between those who had infections (5.14%) and those who did not (1.05%). Also, patients who developed post-surgery infections stayed in the hospital about two and half times as long (15.73 days) as those who had no infections (6.28 days).

Statewide, overall infection rate after isolated CABG surgery increased 11.1 percent from 5.84 percent in 2008 to 6.49 percent in 2009 (not risk-adjusted). In addition, the increase in infection rate occurred to every type of infection reported except for septicemia. The infection rate for septicemia declined from 1.26 percent to 0.91 percent (see Cardiac Surgery in New Jersey 2008 [www.state.nj.us/health/healthcarequality/documents/cardconsumer08.pdf](http://www.state.nj.us/health/healthcarequality/documents/cardconsumer08.pdf)). Septicemia has the highest mortality rate of 14.63 percent among all the infections reported.

**Table 1**  
**Statewide In-hospital Infection Rate and Operative Mortality Rate by Infection Type, 2009**

	Number of Cases	Infection Rate (%)	Operative Mortality*		Average Length of Stay (in Days)
			Number	Rate (%) (Observed)	
<b>Cases with Infections</b>	<b>292</b>	<b>6.49</b>	<b>15</b>	<b>5.14</b>	<b>15.73</b>
Sternal-Deep	18	0.40	0	0.00	17.94
Thoracotomy	0	0.00	N.A.	N.A.	N.A.
Leg	30	0.67	0	0.00	16.50
Septicemia	41	0.91	6	14.63	25.37
UTI	143	3.18	4	2.80	14.50
Pneumonia	117	2.60	11	9.40	18.44
<b>Cases without Infections</b>	<b>4,205</b>		<b>44</b>	<b>1.05</b>	<b>6.28</b>
<b>Total CABG cases</b>	<b>4,497</b>		<b>59</b>	<b>1.31</b>	<b>6.90</b>

SOURCE: New Jersey Department of Health and Senior Services

\* Operative Mortality includes:

- (1) all deaths occurring during the hospitalization in which the operation was performed, even after 30 days; and
- (2) those deaths occurring after discharge from the hospital, but within 30 days of the procedures.

**Length of Stay by Hospital**

The Department has included information on post-surgery length of stay as an additional tool to monitor hospital and surgeon performance on CABG surgery. The statewide average is 6.90 days.

The risk-adjustment model excluded in-hospital deaths, very low lengths of stay (low outliers) and very long lengths of stay (high outliers) while fitting the regression model to reduce outlier effects on the model.

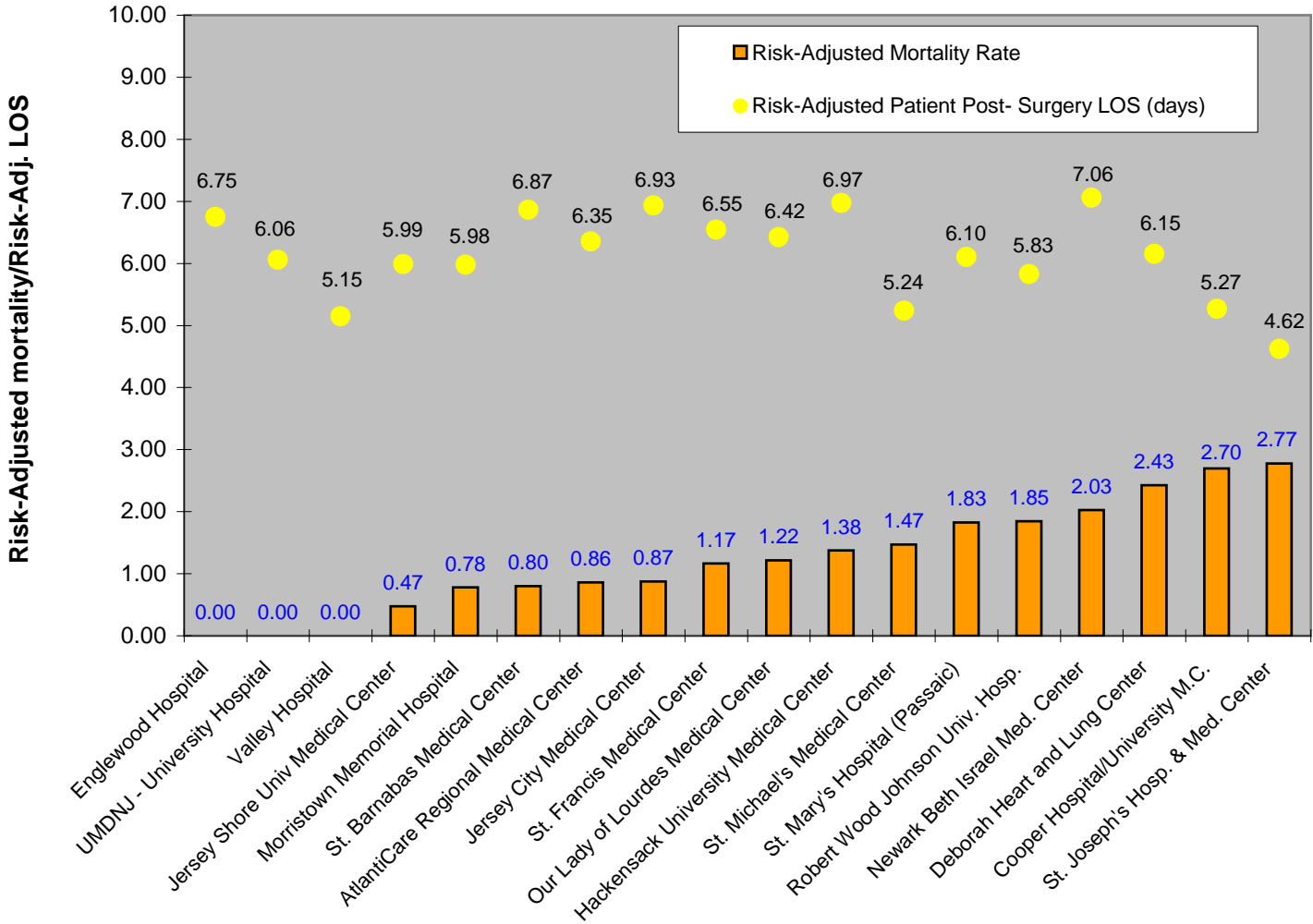
The risk-adjusted lengths of stay by hospital are displayed in Figure 3 and compared against

their respective risk-adjusted mortality rates.

Figure 3 shows that there is a marked variation in risk-adjusted length of stay by hospital. The risk-adjusted length of stay by hospital ranged from 4.62 days in St. Joseph’s Hospital and Medical Center to 7.06 days in Newark Beth Israel Medical Center. Hospitals with high risk-adjusted mortality rates do not necessarily have longer lengths of stay (See Figure 3).

Length of stay data for individual surgeons is presented later in this report.

**Figure 3**  
**Risk-Adjusted Operative Mortality and Length of Stay by Hospital, 2009**



### Individual Surgeon Performance

Figure 4 and Table 2 show the risk-adjusted mortality rate for each of the 37 surgeons who performed at least 100 isolated CABG surgery operations in one hospital in New Jersey in the years 2008 and 2009 combined<sup>3</sup>. In addition, Table 2 shows the risk-adjusted post-operative length of hospitalization for each surgeon.

Figure 4 lists surgeons by name under the hospital at which they practice. At the end of each list of named surgeons, some hospitals have an “All Others” category. “All Others” includes all surgeons who performed too few procedures at that hospital for an individual risk-adjusted mortality rate to be calculated. Figure 4 displays a bar for a surgeon only if 100 or more isolated CABG surgeries were performed by the surgeon in one hospital in the years 2008 and 2009 combined. For a group of surgeons (i.e. All Others) a bar is shown when the group includes at least two or more surgeons and 25 or more total patients. It is important to note that some surgeons may no longer be practicing cardiac surgery in the facilities where they are listed.

Once again, the vertical line on Figure 4 represents the statewide operative mortality rate for 2008-2009 combined. Note that, when two years’ data are combined, the statewide operative mortality rate was 1.39 percent. If a surgeon has a bar completely to the left of the statewide line, i.e. 1.39, it means that the surgeon’s mortality rate was statistically significantly lower than the statewide rate. In 2008-2009, there was no surgeon whose bar was completely to the left of the statewide line. As is the case for some in this report, it is possible for a surgeon to have no patient deaths and still have his/her bar cross the statewide line. Though not intuitive, this happens because the bar is the result of an upper and lower bound which includes standard errors of the estimated

mortality rate. Although their rates were not statistically significantly different from the statewide rate, it is nevertheless notable that a few surgeons, including some who performed less than 100 isolated CABG surgeries, had no CABG surgery deaths during this two-year period. Among surgeons who performed 100 or more isolated CABG surgeries in the period 2008-2009, Dr. James Klein of Englewood Hospital and Medical Center, Dr. Eric Somberg from Hackensack University Medical Center, Dr. Richard Neibart from Jersey Shore Medical Center, Dr. Nilesh Patel from St. Michael’s Medical Center and Dr. Alex Zapolanski from The Valley Hospital had no CABG surgery deaths.

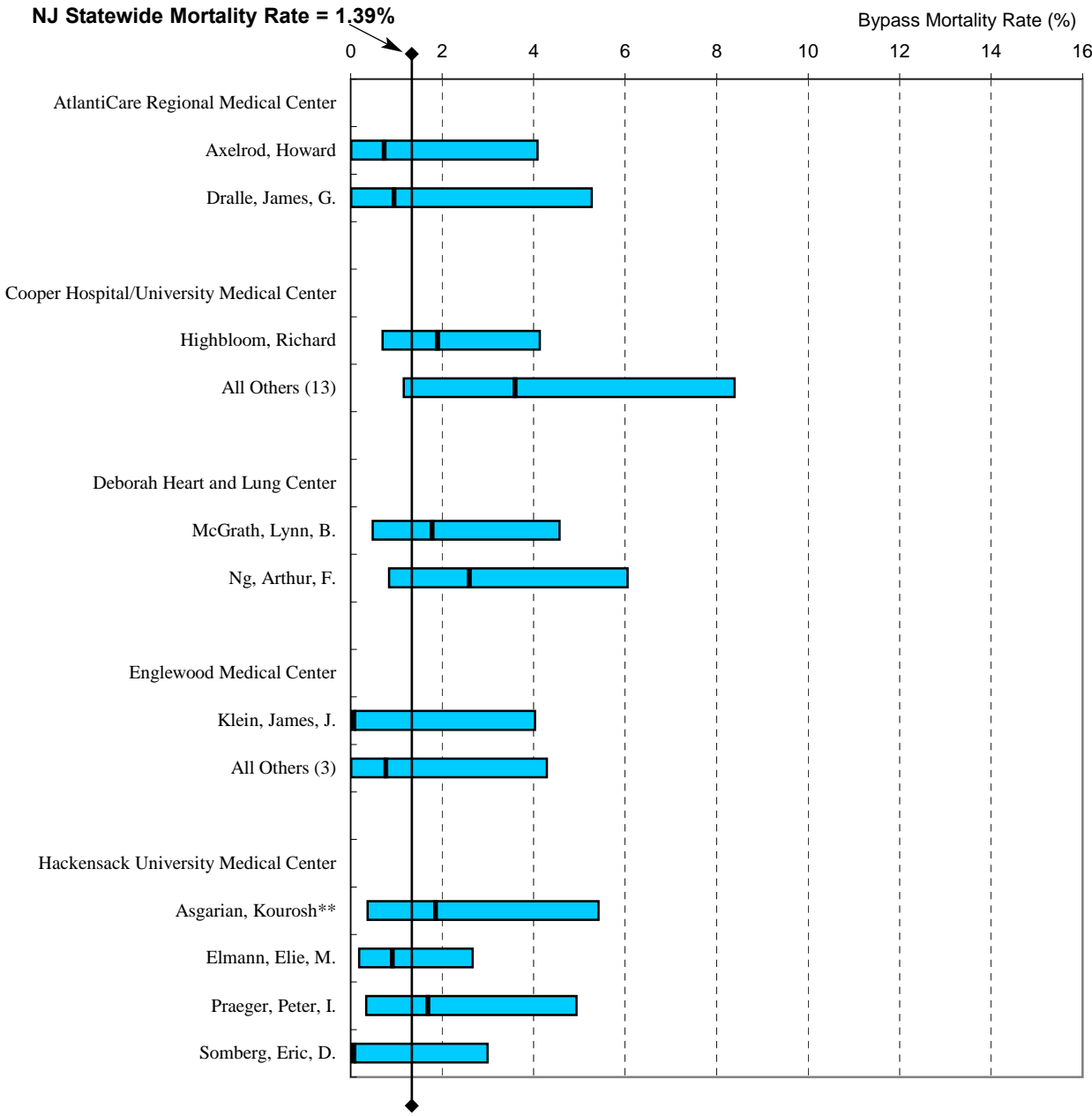
If a surgeon has a bar completely to the right of the statewide mortality rate line, it means that the surgeon’s mortality rate was statistically significantly higher than the statewide rate for this two-year period. In 2008-2009, there was no surgeon whose bar was completely to the right of the line.

In addition to risk-adjusted mortality for surgeons, Table 2 also shows risk-adjusted patient length of stay for each surgeon who performed at least 100 CABG surgeries in the 2008-2009 reporting period. There is an important variation in length of stay among eligible surgeons where the shortest length of stay was 4.42 days while the longest was 7.93 days. The reasons behind the wide variation in mean lengths of stay are not clear and need further study.

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<sup>3</sup> These data may not reflect the current performance of a specific surgeon, which may have improved his performance since then. Also, some surgeons listed in the cardiac surgery centers may have already left the facility since the data were reported.

**Figure 4**  
**Surgeon Risk-Adjusted Operative Mortality\* Rate (2008 - 2009)**

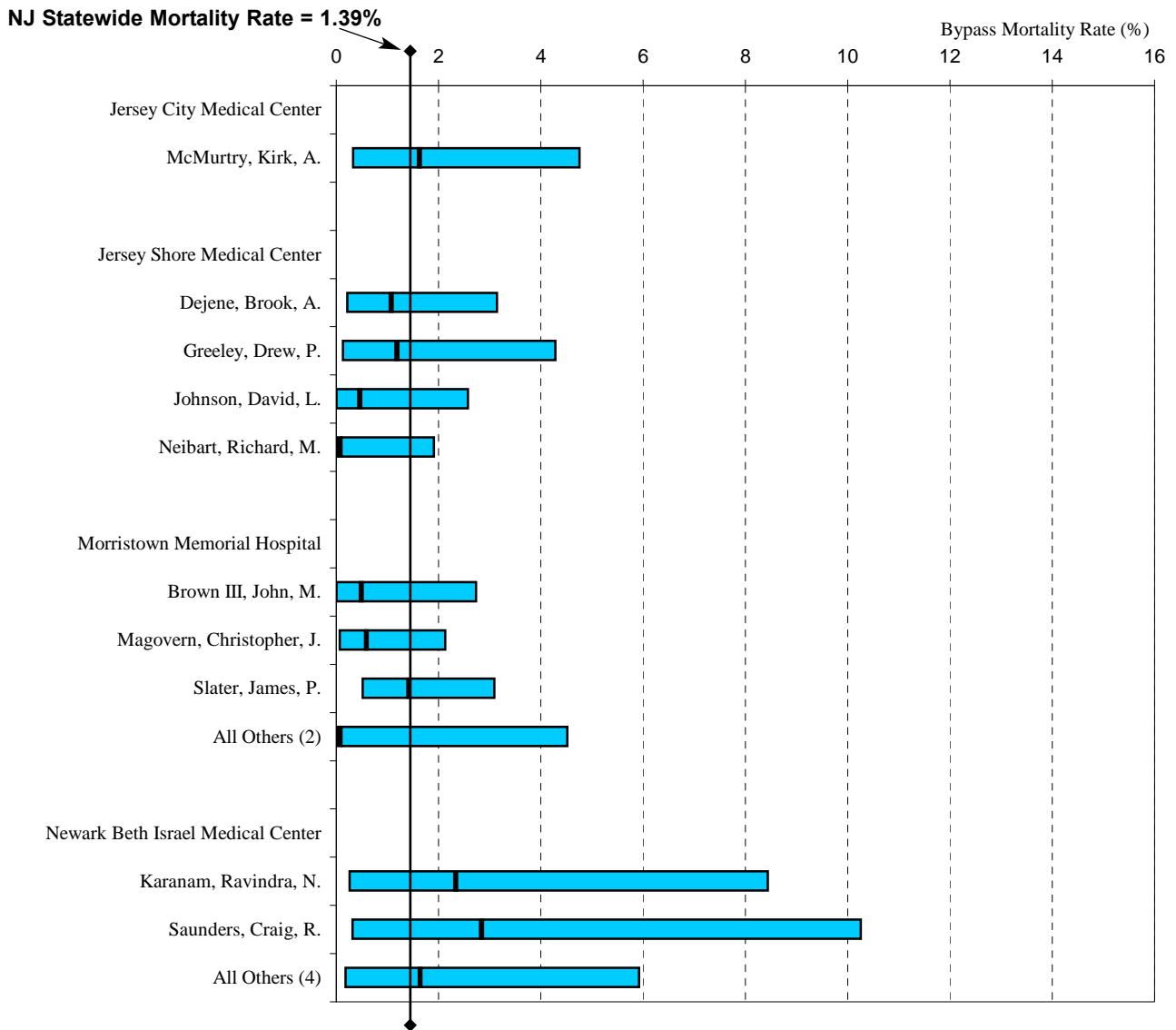


SOURCE: New Jersey Department of Health and Senior Services.

\* = Operative Mortality includes: (1) all deaths occurring during the hospitalization in which the operation was performed, even after 30 days; and (2) those deaths occurring after discharge from the hospital, but within 30 days of the procedures.

\*\* = Surgeon not currently performing CABG surgery in this hospital.

**Figure 4 (continued)**  
**Surgeon Risk-Adjusted Operative Mortality\* Rate (2008 - 2009)**



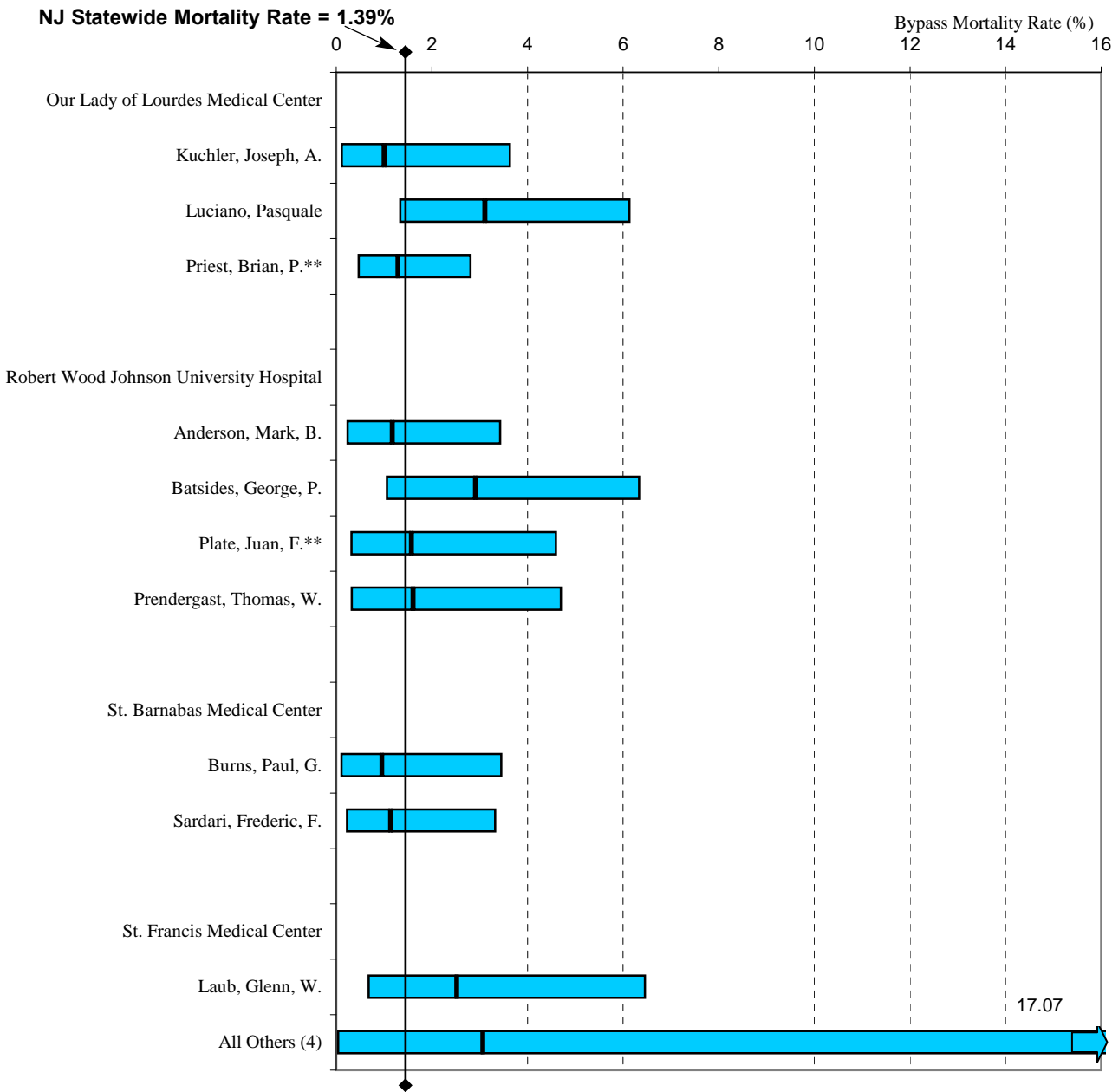
SOURCE: New Jersey Department of Health and Senior Services.

\* = Operative Mortality includes: (1) all deaths occurring during the hospitalization in which the operation was performed, even after 30 days; and (2) those deaths occurring after discharge from the hospital, but within 30 days of the procedures.

\*\* = Surgeon not currently performing CABG surgery in this hospital.



**Figure 4 (continued)**  
**Surgeon Risk-Adjusted Operative Mortality\* Rate (2008 - 2009)**

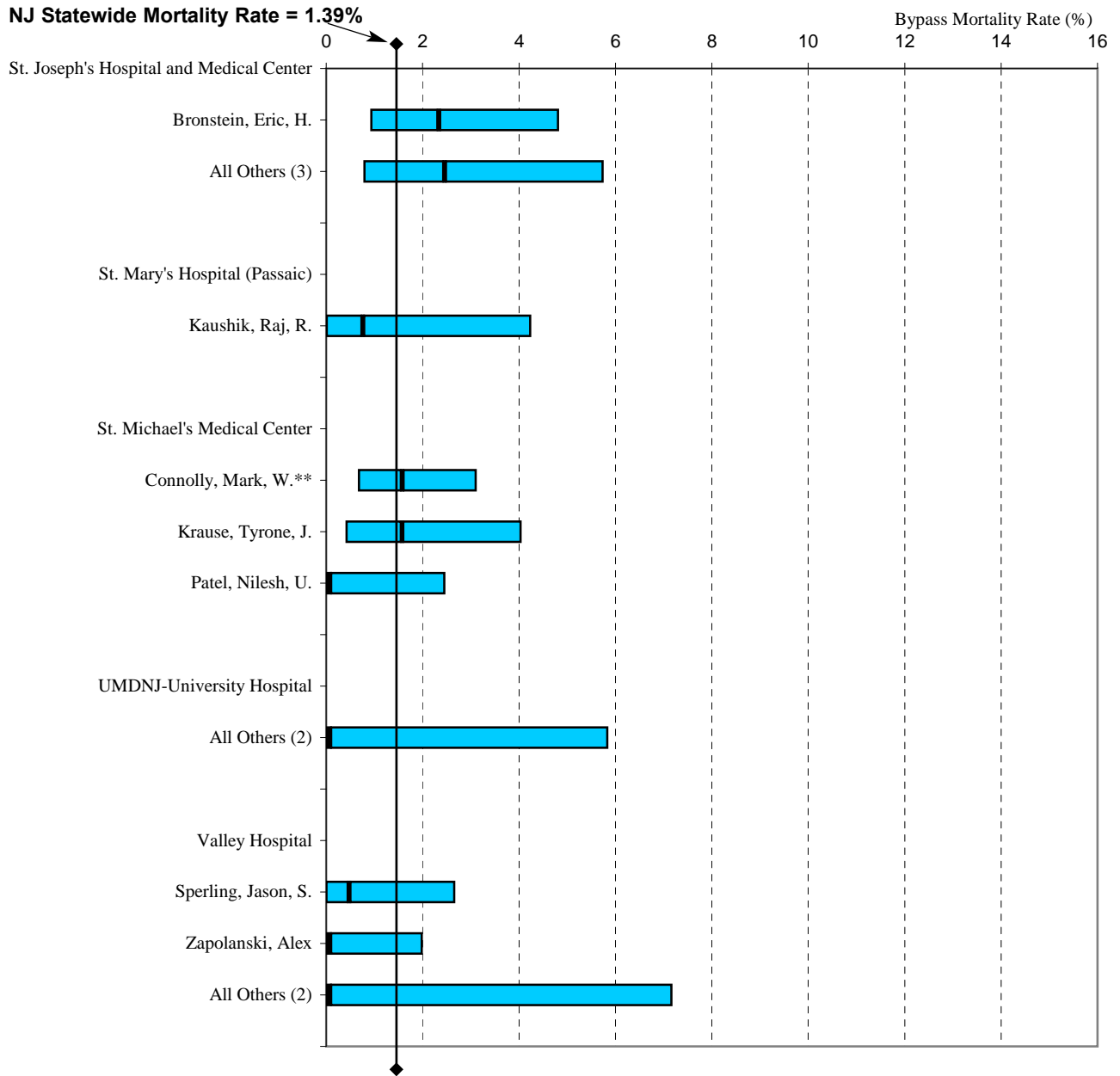


SOURCE: New Jersey Department of Health and Senior Services.

\* = Operative Mortality includes: (1) all deaths occurring during the hospitalization in which the operation was performed, even after 30 days; and (2) those deaths occurring after discharge from the hospital, but within 30 days of the procedures.

\*\* = Surgeon not currently performing CABG surgery in this hospital.

**Figure 4 (continued)**  
**Surgeon Risk-Adjusted Operative Mortality\* Rate (2008 - 2009)**



SOURCE: New Jersey Department of Health and Senior Services.

\* = Operative Mortality includes: (1) all deaths occurring during the hospitalization in which the operation was performed, even after 30 days; and (2) those deaths occurring after discharge from the hospital, but within 30 days of the procedures.

\*\* = Surgeon not currently performing CABG surgery in this hospital.

**Table 2**

**Risk-Adjusted Operative Mortality\* Rate and Post-Surgery Length of Stay by Surgeon (2008 - 2009)**

Hospital and Surgeon	Total Open Heart Procedures	Number of Isolated CABG Operations	Patient Operative Deaths*	Observed Patient Mortality(%)	Expected Patient Mortality(%)	Risk-Adjusted Patient Mortality (%)	95% Confidence Interval	Risk-Adjusted Post-Surgery Length of Stay
<b>AtlantiCare Regional Medical Center</b>								
Axelrod, Howard	241	150	1	0.67	1.26	0.73	(0.01, 4.09)	6.31
Dralle, James, G.	230	135	1	0.74	1.09	0.95	(0.01, 5.28)	6.25
<b>Cooper Hospital/University Medical Center</b>								
Highbloom, Richard	392	340	6	1.76	1.29	1.90	(0.70, 4.14)	5.32
<b>All Others (13)</b>	615	134	5	3.73	1.44	3.60	(1.16, 8.40)	5.79
Axelrad, Alexander**	1	0	0					
Bowen, Frank	236	82	4					
Burns, Richard, K.**	3	0	0					
Deangelo, Frank, J.**	7	0	0					
Eakins, James, S.**	1	0	0					
El-Habre, Wassim**	1	0	0					
Fusco, Cynthia**	2	0	0					
Hagendorf, Benjamin	1	0	0					
Joseph, D'Andrea, K.**	5	0	0					
Rosenbloom, Michael	345	52	1					
Ross, Steven, E.	3	0	0					
Sjoholm, Lars**	2	0	0					
Tsiotsias, George	8	0	0					
<b>Deborah Heart and Lung Center</b>								
McGrath, Lynn, B.	566	232	4	1.72	1.35	1.78	(0.48, 4.57)	6.61
Ng, Arthur, F.	271	128	5	3.91	2.10	2.60	(0.84, 6.06)	5.95
<b>Englewood Hospital &amp; Medical Center</b>								
Klein, James, J.	236	100	0	0.00	1.29	0.00	(0.00, 3.96)	6.86
<b>All Others (3)</b>	345	108	1	0.93	1.67	0.77	(0.01, 4.29)	6.44
Arnofsky, Adam	17	5	0					
Ergin, Arisan, M.**	33	8	0					
McCullough, Jock, N.**	295	95	1					
<b>Hackensack University Medical Center</b>								
Asgarian, Kouros**	302	164	3	1.83	1.37	1.86	(0.37, 5.42)	5.76
Elmann, Elie, M.	476	290	3	1.03	1.58	0.91	(0.18, 2.67)	7.17
Praeger, Peter, I.	246	169	3	1.78	1.46	1.69	(0.34, 4.94)	6.65
Somberg, Eric, D.	278	184	0	0.00	0.95	0.00	(0.00, 2.92)	7.36
<b>All Others (1)</b>	10	2	0					
Masroor, Saqib**	10	2	0					

\* = Operative Mortality includes: (1) all deaths occurring during the hospitalization in which the operation was performed, even after 30 days; and (2) those deaths occurring after discharge from the hospital, but within 30 days of the procedures.

\*\* = Surgeon not currently performing CABG surgery in this hospital.

## Table 2 (continued)

### Risk-Adjusted Operative Mortality\* Rate and Post-Surgery Length of Stay by Surgeon (2008 - 2009)

Hospital and Surgeon	Total Open Heart Procedures	Number of Isolated CABG Operations	Patient Operative Deaths*	Observed Patient Mortality(%)	Expected Patient Mortality(%)	Risk-Adjusted Patient Mortality (%)	95% Confidence Interval	Risk-Adjusted Post-Surgery Length of Stay
<b>Jersey City Medical Center</b>								
McMurtry, Kirk, A.	209	139	3	2.16	1.85	1.63	(0.33, 4.76)	6.72
<b>All Others (1)</b>	35	25	0					
Hanhan, Ziad, G.	35	25	0					
<b>Jersey Shore University Medical Center</b>								
Dejene, Brook, A.	426	279	3	1.08	1.39	1.08	(0.22, 3.15)	5.94
Greeley, Drew, P.	433	252	2	0.79	0.93	1.19	(0.13, 4.29)	6.08
Johnson, David, L.	433	242	1	0.41	1.24	0.46	(0.01, 2.58)	5.90
Neibart, Richard, M.	414	257	0	0.00	1.08	0.00	(0.00, 1.84)	6.02
<b>Morristown Memorial Hospital</b>								
Brown III, John, M.	816	285	1	0.35	0.99	0.49	(0.01, 2.74)	5.84
Magovern, Christopher, J.	629	388	2	0.52	1.21	0.59	(0.07, 2.13)	5.93
Slater, James, P.	620	425	6	1.41	1.38	1.42	(0.52, 3.10)	6.10
<b>All Others (2)</b>	136	96	0	0.00	1.20	0.00	(0.00, 4.45)	6.16
Rodriguez, Alejandro, L.**	4	2	0					
Xydias, Steve	132	94	0					
<b>Newark Beth Israel Medical Center</b>								
Karanam, Ravindra, N.	279	134	2	1.49	0.89	2.34	(0.26, 8.44)	7.40
Saunders, Craig, R.	413	108	2	1.85	0.91	2.84	(0.32, 10.26)	7.07
<b>All Others (4)</b>	432	123	2	1.63	1.38	1.64	(0.18, 5.93)	6.79
Burns, Paul, G.	1	0	0					
Camacho, Margarita	238	45	1					
McBride, Lawrence**	192	78	1					
Starr, Joanne**	1	0	0					
<b>Our Lady of Lourdes Medical Center</b>								
Kuchler, Joseph, A.	285	170	2	1.18	1.63	1.01	(0.11, 3.64)	6.90
Luciano, Pasquale	255	198	8	4.04	1.81	3.11	(1.34, 6.14)	6.86
Priest, Brian, P.**	457	319	6	1.88	2.03	1.29	(0.47, 2.82)	6.43
<b>All Others (1)</b>	33	27	1					
Metcalf, Randy, K.**	33	27	1					
<b>Robert Wood Johnson University Hospital</b>								
Anderson, Mark, B.	632	282	3	1.06	1.26	1.18	(0.24, 3.44)	5.64
Batsides, George, P.	324	193	6	3.11	1.49	2.91	(1.06, 6.34)	6.21
Plate, Juan, F.**	333	221	3	1.36	1.20	1.57	(0.32, 4.60)	5.85
Prendergast, Thomas, W.	325	239	3	1.26	1.09	1.61	(0.32, 4.71)	6.02
<b>All Others (1)</b>	240	86	3					
Scholz, Peter, M.	240	86	3					

\* = Operative Mortality includes: (1) all deaths occurring during the hospitalization in which the operation was performed, even after 30 days; and (2) those deaths occurring after discharge from the hospital, but within 30 days of the procedures.

\*\* = Surgeon not currently performing CABG surgery in this hospital.

**Table 2 (continued)**

**Risk-Adjusted Operative Mortality\* Rate and Post-Surgery Length of Stay by Surgeon (2008 - 2009)**

Hospital and Surgeon	Total Open Heart Procedures	Number of		Observed Patient Mortality(%)	Expected Patient Mortality(%)	Risk-Adjusted Patient Mortality (%)	95% Confidence Interval	Risk-Adjusted Post-Surgery Length of Stay
		Isolated CABG Operations	Patient Operative Deaths*					
<b>St Barnabas Medical Center</b>								
Burns, Paul, G.	422	202	2	0.99	1.44	0.96	(0.11, 3.46)	6.60
Sardari, Frederic, F.	421	258	3	1.16	1.42	1.14	(0.23, 3.33)	6.76
<b>All Others (3)</b>	37	11	0					
Karanam, Ravindra, N.	2	2	0					
McBride, Lawrence**	1	0	0					
Saunders, Craig, R.	34	9	0					
<b>St Francis Medical Center</b>								
Laub, Glenn, W.	270	209	4	1.91	1.06	2.52	(0.68, 6.46)	6.58
<b>All Others (4)</b>	52	43	1	2.33	1.06	3.07	(0.04, 17.07)	5.89
Costic, Joseph	25	22	1					
Deshpande, Anil	18	15	0					
Nixon, Todd	4	3	0					
Shariff, Haji	5	3	0					
<b>St Joseph's Hospital and Medical Center</b>								
Bronstein, Eric, H.	387	233	7	3.00	1.79	2.34	(0.94, 4.82)	4.42
<b>All Others (3)</b>	277	138	5	3.62	2.05	2.46	(0.79, 5.74)	5.96
Cornwell, Lorraine**	139	72	4					
DeFilippi, Vincent, J.**	103	42	0					
Wohler, Alexander	35	24	1					
<b>St. Mary's Hospital (Passaic)</b>								
Kaushik, Raj, R.	220	146	1	0.68	1.25	0.76	(0.01, 4.24)	5.69
<b>All Others (2)</b>	15	11	0					
Goldenberg, Bruce, S.**	8	4	0					
Shakir, Huzaifa, A.	7	7	0					
<b>St Michael's Medical Center</b>								
Connolly, Mark, W.**	610	362	8	2.21	1.95	1.58	(0.68, 3.11)	5.30
Krause, Tyrone, J.	224	144	4	2.78	2.45	1.58	(0.42, 4.04)	5.31
Patel, Nilesh, U.	225	187	0	0.00	1.15	0.00	(0.00, 2.38)	4.76
<b>UMDNJ University Hospital</b>								
<b>All Others (2)</b>	209	102	0	0.00	0.87	0.00	(0.00, 5.76)	6.19
Lovoulos, Constantinos	89	41	0					
Sambol, Justin, T.	120	61	0					
<b>Valley Hospital</b>								
Sperling, Jason, S.	353	193	1	0.52	1.51	0.48	(0.01, 2.66)	5.39
Zapolanski, Alex	506	207	0	0.00	1.29	0.00	(0.00, 1.91)	5.30
<b>All Others (2)</b>	91	47	0	0.00	1.53	0.00	(0.00, 7.09)	5.02
Brizzio, Mariano	22	10	0					
Bronstein, Eric, H.**	69	37	0					
<b>State Total (2008 - 2009)</b>	16,686	9,117	127	1.39	1.39	1.39		6.66

\* = Operative Mortality includes: (1) all deaths occurring during the hospitalization in which the operation was performed, even after 30 days; and (2) those deaths occurring after discharge from the hospital, but within 30 days of the procedures.

\*\* = Surgeon not currently performing CABG surgery in this hospital.

## Statewide Trends in Risk-adjusted CABG Surgery Mortality Rates: Pooled Estimates

Figure 5 presents the statewide risk-adjusted mortality rates for years 1994 to 2009 derived by pooling data from all years.

Figure 5 also presents the trend in statewide observed isolated CABG operative mortality rates for years 1994-2009. The observed operative mortality rate estimates exhibit a declining trend that is similar to the risk-adjusted mortality estimates. (Sources:

Appendix C; Appendix D, Table D3). When compared with 1994, the risk-adjusted patient mortality in 2009 dropped by 70.9 percent.

When a linear regression line is fitted to the pooled annual estimates, CABG mortality rate has been declining, in absolute terms, at the rate of 0.20 percentage points per year (See Appendix D, Figure D1).

**Figure 5**  
Trends in Statewide CABG Surgery Mortality Rates



## Appendix A

### Questions and Answers

**T**hese are answers to some commonly asked questions that may be of interest to you as you read this report.

**Q: Should I go only to the hospitals with below-average risk-adjusted mortality rates?**

**A:** Not necessarily. There are many factors to consider in determining the best hospital for you. Among these are your own personal risk factors and the experience certain hospitals have treating patients with those risk factors. Before making up your mind, you should discuss this report with the physician, usually a cardiologist, who refers you for cardiac surgery. The cardiologist's knowledge and expertise will be a valuable guide in making your decision. You should also keep in mind that the data in this guide is from 2009 and that a hospital's performance may have changed since then.

**Q: Should I avoid any surgeon whose volume is low in this report?**

**A:** No, not necessarily. First, there are lower volume surgeons with good patient outcomes. Second, there may be a good explanation for why a surgeon had a low volume that is unrelated to his/her experience. For example, the surgeon may have recently moved from another state, where he/she performed a high volume of these procedures. It is best to discuss your concerns with your referring doctor.

**Q: Should I refuse to go to a hospital for heart surgery if that hospital has a worse than average mortality record?**

**A:** Important decisions in areas such as cardiac surgery should be made after considering all available information. The statistics in this report are a starting point for discussions with your doctor. But they do not tell the complete story. That is why it is critical to bring your concerns and questions to your doctor.

**Q: Is it better to go to a hospital with a high volume of cases?**

**A:** National studies have demonstrated that, in general, hospitals with higher volumes have better results. However, some hospitals with high volumes have relatively high mortality rates, while others with low volumes have lower mortality rates.

### Notes on Data:

The data used in this study were reported by hospitals according to criteria established by the Department, with assistance from the clinical experts. Additionally, the Department has made a good faith effort to ensure that the data elements and definitions are consistent with those issued by the Society for Thoracic Surgeons (STS). The data were audited by an independent reviewer under contract to the Department.

Throughout the process of developing this report, the Department has taken steps to make sure that all hospitals were informed about data reporting and auditing requirements, as well as the statistical methods being used to risk-adjust the reported mortality data.

The Department considers it a vital function of hospitals to be able to collect and report complete, accurate medical information on patients. This function is critical not only to the success of the cardiac surgery report, but to the hospitals' own ongoing efforts to improve the quality of care for all patients. The Department and hospitals will continue working to improve data collection procedures so that this report contains the best possible information.

## Appendix B

### New Jersey's Cardiovascular Health Advisory Panel (CHAP) Members

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**Appendix C**

**Statewide Observed In-hospital and Operative Mortality Rates:**

<b>Year of Operation</b>	<b>Mortality Rate</b>	
	<b>In-hospital</b>	<b>Operative Mortality *</b>
<b>1994-1995</b>	<b>3.75</b>	<b>4.14</b>
<b>1996-1997</b>	<b>3.37</b>	<b>3.75</b>
<b>1998</b>	<b>2.60</b>	<b>3.01</b>
<b>1999</b>	<b>2.89</b>	<b>3.31</b>
<b>2000</b>	<b>2.22</b>	<b>2.68</b>
<b>2001</b>	<b>2.01</b>	<b>2.51</b>
<b>2002</b>	<b>1.80</b>	<b>2.15</b>
<b>2003</b>	<b>1.91</b>	<b>2.33</b>
<b>2004</b>	<b>1.54</b>	<b>1.98</b>
<b>2005</b>	<b>1.83</b>	<b>2.10</b>
<b>2006</b>	<b>1.73</b>	<b>2.00</b>
<b>2007</b>	<b>1.66</b>	<b>2.00</b>
<b>2008</b>	<b>1.19</b>	<b>1.47</b>
<b>2009</b>	<b>1.00</b>	<b>1.31</b>

\* Operative mortality includes the following:

- all deaths occurring during the hospitalization in which the operation was performed, even after 30 days; and
- deaths occurring after discharge from hospital, but within 30 days of the procedures.

## Appendix D

### Summary of Methods Used in this Report

#### Background

Five states, including New Jersey, have issued reports on isolated CABG surgery outcomes for hospitals, and sometimes surgeons. New York first published a bypass surgery report in 1990 presenting 1989 data, with the latest report released in February 2012 using 2007-2009 data. New York State also publishes a performance report on angioplasty programs and physicians. Starting with its 1990 data, Pennsylvania has published several cardiac surgery reports, with its latest report released in May 2011 using 2008-2009 data. California has also published several cardiac surgery reports, with the most recent released in April 2012 using 2009 data. Massachusetts published its first report on CABG surgery in October 2004 using 2002 data and released its latest report on a fiscal year basis (October 1, 2008 to September 30, 2009) in January 2011. In 1997, New Jersey began reporting on patient mortality for isolated CABG surgery hospitals and surgeons, using 1994 and 1995 data combined.

The experience from these states is that disclosures have contributed to hospital quality improvement initiatives and significant reductions in bypass surgery mortality rate.

#### Factors That Affect a Patient's Risk of CABG Surgery Mortality

The observed patient CABG surgery mortality rate for a hospital or surgeon is estimated as the number of CABG surgery patients who died in the hospital during or after surgery, or patients who died after discharge but within 30 days post-surgery, divided by the total number of patients who underwent the CABG surgery.

Unfortunately, this observed patient mortality rate is not a complete measure of the quality of care provided by a hospital or a

surgeon, because it does not account for how sick the patients were before surgery. If one hospital had considerably sicker patients than another hospital, it would be expected that its observed mortality rate would be somewhat higher. So it would not be fair to evaluate surgeons and hospitals performing bypass surgery solely on the basis of the percentage of their patients that died. For instance, an 80 year-old patient who has renal failure and severe lung disease is at a higher risk of dying, when undergoing this surgery, than a 50 year-old patient with no history of chronic disease.

To perform an even-handed analysis of the quality of surgical care provided by surgeons and hospitals performing bypass surgery, the Department adjusts the patient mortality rates for each surgeon and each hospital by the pre-surgery risk factors of each patient. This method gives hospitals and surgeons who operate on less healthy patients "extra credit." Such hospitals and surgeons are not at a disadvantage when the outcome of the surgical care they provide is presented next to that of other hospitals and surgeons. Additionally, as stated earlier, extremely high risk patients, where the probability of death is very high, may, with the concurrence of the expert clinical panel, be excluded from the calculation.

The risk adjustment method is a statistical approach that uses results of a logistic regression analysis to assess the average risk of an isolated CABG surgery for a patient. Key elements of the health histories of patients who have undergone isolated CABG surgery in the same period, as well as their socio-demographic characteristics, are taken into account to estimate the expected outcome of an isolated CABG surgery.

**Assessing Patient Risk Factors**

A logistic regression model which included all the before-surgery health and demographic factors was fitted to the data for the period covered by this report to identify those risk factors that were important in predicting whether a patient would die after an isolated CABG surgery. The general form of a logistic regression model for estimating the “logit” of the probability of dying (p), denoted by Yi, is presented as follows:

$$Y_i = \sum_k \beta_k X_{ki} + \varepsilon_i, \text{ Where } X_{0i} = 1;$$

$$Y_i = \log_e \left( \frac{p_i}{1 - p_i} \right) = \text{the "logit" of } p_i$$

- i = 1,2,...,n;
- k = 0,1,2,...,K,
- $\beta_k$  = Logistic regression coefficient for risk factor  $X_{ki}$ ,
- K = Number of risk factors in the model,
- n = Number of patients,
- $\varepsilon_i$  = Random error term i.

The statistically significant risk factors for this report ( $X_k$ ) identified by the stepwise logistic regression analysis method are presented in Table D1. Table D1 also includes estimates of coefficients for the statistically significant risk factors, an indication of the level of statistical significance (p-values), and odds ratios. The list of risk factors includes only those that were statistically significant in predicting isolated CABG surgery mortality with p-values of 0.05 or smaller.

The odds ratios are derived from the coefficients, and are used to compare the relative importance of the risk factors in predicting mortality from isolated CABG surgery. For each of the risk factors identified in Table D1, the odds ratio represents how much as likely a patient is to die when compared to a patient who is in the reference group. So, for example, Table D1 shows that a patient who had renal failure with dialysis is four and half times (odds ratio = 4.50) as likely to die during or after isolated CABG surgery compared to a patient who did not have renal disease or dialysis. This is based on the assumption that both patients have the same set of other risk factors presented in the table.

Similarly, the odds of dying during or after isolated CABG surgery for a patient who had a Myocardial Infarction (MI) within 6 hours before surgery is close to four and a quarter times as likely (odds ratio= 4.23) compared with the odds of a patient who did not have a history of MI or had a Myocardial Infarction (MI) more than 6 hours before surgery.

**Estimation of Risk-adjusted Mortality Rates**

The risk factors presented in Table D1 were used in the fitted logistic regression model to predict the probability of death from isolated CABG surgery for each patient. The sum of predicted probabilities of dying for patients operated on in each hospital divided by the number of patients operated on in that hospital provides the predicted (or expected) death rate associated with the hospital. A similar analysis for a surgeon results in the expected death rate associated with that surgeon. Terms such as “expected” and “predicted” are used interchangeably in this report to signify that the estimates are derived from predicted probabilities after accounting for risk factors.

The predicted probability of dying for patient i ( $\hat{p}_i$ ) is given as follows:

$$\hat{p}_i = \frac{e^{\hat{Y}_i}}{1 + e^{\hat{Y}_i}}, \text{ Where } i = 1,2,3,\dots,n ; \text{ and}$$

$$\hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 X_{1i} + \hat{\beta}_2 X_{2i} + \hat{\beta}_3 X_{3i} + \dots + \hat{\beta}_K X_{Ki}$$

To assess the performance of each hospital or surgeon, we compared the observed patient mortality with the expected or predicted patient mortality, based on the risk factors existing for the hospital’s or surgeon’s patients. First, the observed patient mortality is divided by the expected mortality. If the resulting ratio is larger than one, the hospital or surgeon has a higher patient mortality than expected on the basis of their patient mix. If the ratio is smaller than one, the hospital or surgeon has a lower mortality than expected, based on their patient mix. The ratio is then multiplied by the statewide patient mortality rate to produce the risk-adjusted patient mortality rate for the hospital or the surgeon.

## Cardiac Surgery in New Jersey 2009

The risk-adjusted mortality rate represents the best estimate the fitted model provides using the statistically significant health risk factors. The risk-adjusted patient mortality rate represents what the associated hospital's or surgeon's patient mortality would have been if they had a mix of patients identical to the statewide mix. Thus, the risk-adjusted patient mortality has, to the extent possible, ironed out differences among hospitals and surgeons in patient mortality arising from the severity of illness of their patients.

The statistical methods described above are tested to determine if they are sufficiently accurate in predicting the risk of death for all patients – for those who are severely ill prior to undergoing isolated CABG surgery as well as those who are relatively healthy. In the analysis of data for this

report, the tests confirmed that the model is reasonably accurate in predicting how patients of different risk levels will fare when undergoing isolated CABG surgery. The area under the Receiver Operating Characteristic (ROC) curve, denoted by C-statistic in Table D1, was used to evaluate model performance. The C-statistic may be interpreted as the degree to which the risk factors in the model predicted the probability of death for CABG surgery patients. Specifically, the C-statistic measures the tendency of the predicted mortality for patients in the sample that died to be higher than that for patients who were discharged alive and were also alive 30 days after CABG surgery. The 2009 model C-statistic is 77.5 percent and is fairly high, suggesting that the model has strong predictive power.

**Table D1**  
**Risk Factors Identified for Isolated CABG Surgery Operative Mortality\* (2009)**

Patient Risk Factors Identified	Proportion of patients(%)	Logistic Regression Results		
		Coefficient	P-Value	Odds Ratio
<b>Demographic factors</b>				
Age	---	0.0529	<.0001	1.054
<b>Health factors</b>				
Lung Disease	17.37	0.8052	0.0051	2.237
Renal Failure with Dialysis	2.54	1.5043	0.0011	4.501
<b>Factors related to functioning of the heart</b>				
Cardiogenic Shock	1.71	1.3059	0.0057	3.691
Ejection Fraction Less Than 30%	6.27	1.0994	0.0032	3.002
Ejection Fraction 30 - 39%	10.18	0.7811	0.0238	2.184
Myocardial Infarction 1 - 6 Hours	1.00	1.4409	0.0126	4.225
NYHA Classification - IV	16.03	0.6251	0.0479	1.868
Intercept	-8.7802			
C-Statistic	0.775			
Number of CABGs (N)	4,497			

*SOURCE: New Jersey Department of Health and Senior Services*

\* Operative Mortality includes: (1) all deaths occurring during the hospitalization in which the operation was performed, even after 30 days; and (2) those deaths occurring after discharge from the hospital, but within 30 days of the procedures.

## Risk-adjusted Patient Mortality Rate Estimates

This section presents the results of our analysis including:

- (1) comparisons of risk-adjusted patient mortality rates for hospitals to the statewide rate in 2009;
- (2) comparisons of the statewide risk-adjusted patient mortality rate for each year in 1994-2009 to the rate for the whole period.

The risk-adjusted mortality rate estimates are presented in percentage points. The results also include the lowest and the highest risk-adjusted mortality rate estimates one would expect, using a 95 percent confidence level\*.

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\* 95% confidence limits are calculated as follows:

$$LCL = \frac{D \left( 1 - \frac{1}{9D} - \frac{1.96}{3\sqrt{D}} \right)^3}{E} S$$

$$UCL = \frac{(D+1) \left( 1 - \frac{1}{9(D+1)} + \frac{1.96}{3\sqrt{(D+1)}} \right)^3}{E} S$$

Where *D* = Observed mortality, and  
*E* = Predicted or Expected mortality,  
*S* = Statewide rate.

(Source: Liddell, F. D. K., *Simple Exact Analysis of the Standardised Mortality Ratio*. *Journal of Epidemiology and Community Health*, 1984, 38, 85-88.)

## Patient CABG Surgery Mortality Rate by Hospital Compared with the Statewide Rate in 2009

The risk-adjusted patient mortality estimates from isolated CABG surgery for each hospital in 2009 are presented in Table D2. The results compare each hospital's risk-adjusted patient mortality rate with the statewide mortality rate.

After adjusting for how sick the patients were before surgery at each hospital, we present the estimates of risk-adjusted patient mortality rate for each hospital in the sixth column of Table D2.

If a hospital's 95 percent confidence interval contains the statewide rate, it means that the difference between the hospital's risk-adjusted mortality rate and the statewide rate was not statistically significant. If the whole of a hospital's 95 percent confidence interval clearly falls to the left of the statewide rate, it means that the hospital's risk-adjusted patient mortality rate was statistically significantly lower than the statewide rate. If the whole of the 95 percent confidence interval falls to the right of the statewide rate, it means that the hospital's risk-adjusted mortality rate was statistically significantly higher than the statewide rate.

The observed operative mortality rate statewide in 2009 for isolated CABG patients was 1.31 percent, based on 59 deaths out of 4,497 isolated CABG operations performed. Table D2 presents the isolated CABG volume, observed mortality rate, expected mortality rate, risk-adjusted mortality rate and its confidence interval, as well as risk-adjusted length of stay following isolated CABG surgery for each of the 18 hospitals.

## Table D2

### Patient Operative Mortality\* and Length of Stay After Isolated CABG Surgery by Hospital (2009)

Hospital	Number of Isolated CABG Operations	Patient Operative Deaths*	Observed Patient Mortality (%)	Expected Patient Mortality (%)	Risk-Adjusted Patient Mortality (%)	95% Confidence Interval	Risk-Adjusted Patient Post-Surgery LOS (days)
AtlantiCare Regional Medical Center	150	1	0.67	1.02	0.86	(0.01, 4.79)	6.35
Cooper Hospital/University M.C.	234	5	2.14	1.04	2.70	(0.87, 6.29)	5.27
Deborah Heart and Lung Center	164	5	3.05	1.65	2.43	(0.78, 5.67)	6.15
Englewood Hospital	93	0	0.00	1.17	0.00	(0.00, 4.44)	6.75
Hackensack University Medical Center	417	5	1.20	1.14	1.38	(0.44, 3.21)	6.97
Jersey City Medical Center	92	1	1.09	1.63	0.87	(0.01, 4.86)	6.93
Jersey Shore Univ Medical Center	516	2	0.39	1.07	0.47	(0.05, 1.71)	5.99
Morristown Memorial Hospital	612	5	0.82	1.37	0.78	(0.25, 1.82)	5.98
Newark Beth Israel Med. Center	176	3	1.70	1.10	2.03	(0.41, 5.92)	7.06
Our Lady of Lourdes Medical Center	339	6	1.77	1.91	1.22	(0.44, 2.65)	6.42
Robert Wood Johnson Univ. Hosp.	475	8	1.68	1.20	1.85	(0.79, 3.64)	5.83
St. Barnabas Medical Center	240	2	0.83	1.37	0.80	(0.09, 2.88)	6.87
St. Francis Medical Center	139	1	0.72	0.81	1.17	(0.02, 6.49)	6.55
St. Joseph's Hosp. & Med. Center	205	8	3.90	1.85	2.77	(1.19, 5.47)	4.62
St. Mary's Hospital (Passaic)	75	1	1.33	0.96	1.83	(0.02, 10.16)	6.10
St. Michael's Medical Center	317	6	1.89	1.69	1.47	(0.54, 3.21)	5.24
UMDNJ - University Hospital	44	0	0.00	0.68	0.00	(0.00, 16.06)	6.06
Valley Hospital	209	0	0.00	1.14	0.00	(0.00, 2.02)	5.15
Statewide	4,497	59	1.31	1.31	1.31		6.03

SOURCE: New Jersey Department of Health and Senior Services

\* Operative Mortality includes: (1) all deaths occurring during the hospitalization in which the operation was performed, even after 30 days; and (2) those deaths occurring after discharge from the hospital, but within 30 days of the procedures.

### Annual Risk-adjusted Mortality Compared to the Combined 1994-2009 Risk-adjusted Mortality

Table D3 presents the results of an analysis to identify the trend in the statewide mortality rate of patients who underwent isolated CABG surgery using a statistical model based on the pooled data collected over the period 1994-2009. For each of the years, the table presents the observed patient mortality rate, the expected patient mortality rate, and the statewide risk-adjusted patient mortality rate estimate. Note that the numbers differ from those shown in reports produced before, due to the revised definition of mortality and the use of pooled data for the analysis. The table further exhibits whether the risk-adjusted mortality rate for the year is statistically different from the pooled mortality rate for the 1994-2009 period.

Table D3 also shows that between 2008 and 2009, the number of isolated CABG surgeries

performed in New Jersey declined from 4,620 to 4,497 or by 2.7 percent. Over the same time period, the number of deaths declined from 68 to 59 or by 13.2 percent. On risk-adjusted basis, the mortality rate declined 9.2 percent between 2008 and 2009, although the decline was not statistically significant. However, since 1994 risk-adjusted mortality rate has declined 70.9 percent, which was statistically significant.

The trend in operative CABG mortality rate between 1994 and 2009 was estimated by fitting a regression line of pooled annual risk-adjusted CABG mortality rates to procedure year (Figure D1). According to the fitted regression line, operative mortality from CABG surgery has been declining, in absolute terms, at the rate of 0.20 percentage points per year between 1994 and 2009 ( $R^2 = 0.90$ ).

**Table D3**  
**Annual Risk-Adjusted Patient Operative Mortality Rate\* Derived from the**  
**Pooled Data for the Period 1994-2009**

Year	Number of Isolated CABG Operations	Operative Patient Mortality*	Observed Patient Mortality Rate (%)	Predicted Patient Mortality Rate (%)	Risk-Adjusted Patient Mortality Rate (%)		Yearly Change in Risk-Adjusted Mortality Rate (%)	Percent Change from 1994 Risk-Adjusted Mortality Rate (%)
1994	6,957	274	3.94	2.44	4.52	<b>HI</b>	----	----
1995	7,553	327	4.33	2.63	4.61	<b>HI</b>	0.09	2.0
1996	8,262	341	4.13	2.79	4.14	<b>HI</b>	-0.47	-8.4
1997	8,286	280	3.38	2.94	3.21	<b>HI</b>	-0.93	-28.9
1998	8,377	252	3.01	2.85	2.95	<b>SA</b>	-0.26	-34.8
1999	8,108	268	3.31	2.97	3.11	<b>SA</b>	0.16	-31.2
2000	8,220	220	2.68	2.78	2.70	<b>SA</b>	-0.41	-40.4
2001	8,045	202	2.51	2.80	2.50	<b>SA</b>	-0.19	-44.6
2002	7,391	159	2.15	2.82	2.14	<b>LO</b>	-0.37	-52.8
2003	6,817	159	2.33	2.87	2.27	<b>LO</b>	0.14	-49.8
2004	6,177	122	1.98	2.76	2.00	<b>LO</b>	-0.27	-55.8
2005	5,576	117	2.10	2.79	2.10	<b>LO</b>	0.10	-53.5
2006	5,211	104	2.00	2.81	1.99	<b>LO</b>	-0.12	-56.1
2007	4,943	99	2.00	2.86	1.96	<b>LO</b>	-0.03	-56.7
2008	4,620	68	1.47	2.84	1.45	<b>LO</b>	-0.51	-67.9
2009	4,497	59	1.31	2.79	1.32	<b>LO</b>	-0.13	-70.9
<b>1994-2009</b>	<b>109,040</b>	<b>3,051</b>	<b>2.80</b>	<b>2.80</b>	<b>2.80</b>			

*SOURCE: New Jersey Department of Health and Senior Services*

\* Operative Mortality includes: (1) all deaths occurring during the hospitalization in which the operation was performed, even after 30 days; and (2) those deaths occurring after discharge from the hospital, but within 30 days of the procedures.

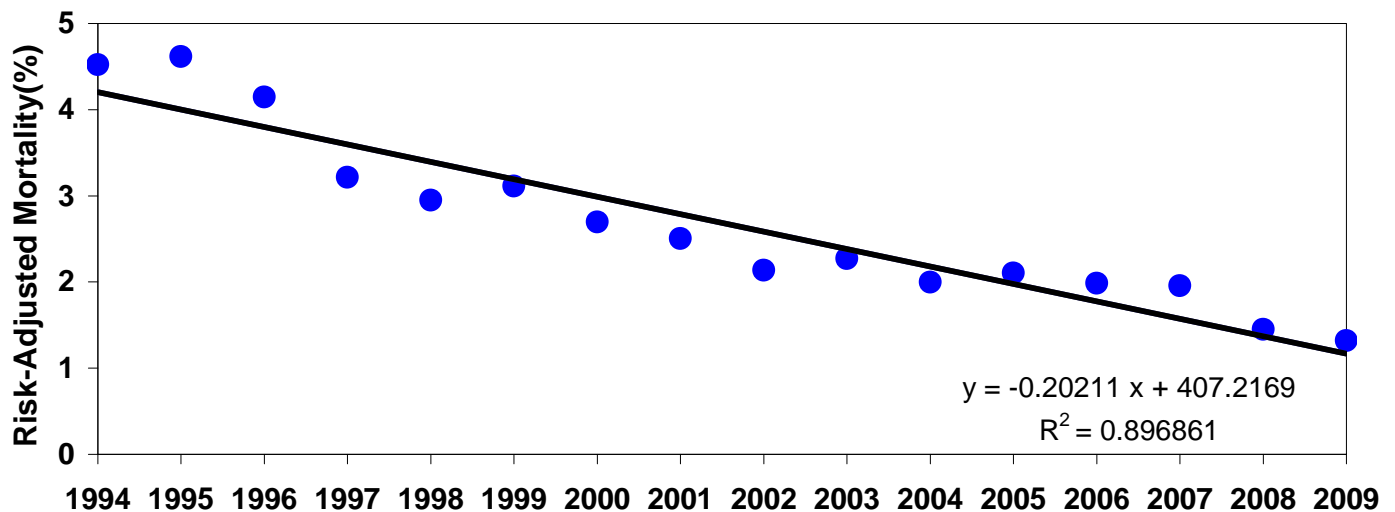
**LO** - The risk-adjusted patient mortality is significantly lower than the mortality for the 1994-2009 combined when evaluated with a 95 percent confidence interval.

**SA** - The risk-adjusted patient mortality is same as the mortality for the 1994-2009 combined when evaluated with a 95 percent confidence interval.

**HI** - The risk-adjusted patient mortality is significantly higher than the mortality for the 1994-2009 combined when evaluated with a 95 percent confidence interval.



**Figure D1**  
**Trend in Risk-Adjusted Operative Mortality\* Rate (1994-2009)**



*SOURCE: New Jersey Department of Health and Senior Services.*

\* Operative Mortality includes: (1) all deaths occurring during the hospitalization in which the operation was performed, even after 30 days; and (2) those deaths occurring after discharge from the hospital, but within 30 days of the procedures.

**Risk Factors for Post-surgery Length of Stay**

In an attempt to predict a patient’s post-operative length of stay, we fitted a generalized linear regression model on the log transformation of length of stay. The model was developed using demographic factors, health factors, factors related to functioning of the heart and prior cardiac intervention as predictors. Patients who died during the CABG surgery hospitalization were excluded from analysis as were patients who stayed fewer than two days in hospital and those who stayed over 30 days.

Table D4 presents the final model used to estimate risk-adjusted length of stay by hospital and includes only those predictors found to be statistically significant at five percent or lower levels. Consistent with findings in Pennsylvania, the predictive power of the model is low (only 18.4 percent). Such low predictive power is usually common when one fits a regression model using individual level data as large as these.

Please note that the coefficients provided in Table D4 are in log form and interpretation of the values should take that into consideration.

**Table D4**  
**Risk Factors Identified for Isolated CABG Surgery Length of Stay (2009)**

Patient Risk Factors Identified	Proportion of Patients(%)	Generalized Linear Regression Results	
		Coefficient	P-Value
<b>Demographic factors</b>			
Ages 60 to 64	16.35	0.0393	0.0213
Ages 65 to 69	16.64	0.0747	<.0001
Ages 70 to 74	14.24	0.1214	<.0001
Ages 75 to 79	13.90	0.1729	<.0001
Ages 80 to 84	8.32	0.2312	<.0001
Ages 85 and over	2.65	0.2548	<.0001
<b>Health factors</b>			
Cerebrovascular Disease - CVA	6.01	0.0760	0.0011
Cerebrovascular Disease - Prior Carotid Surgery	2.61	0.1156	0.0010
Diabetes - Insulin	13.04	0.0847	<.0001
Hypertension	88.05	0.0517	0.0024
Immunosuppressive Therapy	2.18	0.1458	0.0001
Lung Disease	17.12	0.0950	<.0001
Obesity	12.99	0.0897	<.0001
Peripheral Vascular Disease	15.14	0.0434	0.0064
Renal Failure without Dialysis	4.17	0.0938	0.0009
Renal Failure with Dialysis	2.45	0.1796	<.0001
<b>Factors related to functioning of the heart</b>			
Arrhythmia - Afib/Flutter	7.28	0.1607	<.0001
Congestive Heart Failure	14.60	0.0946	<.0001
Ejection Fraction 1 - 29%	6.01	0.0627	0.0108
Emergency Status - AEMI within 24 hours	0.75	0.3390	<.0001
Myocardial Infarction 1 - 7 Days	18.39	0.0330	0.0261
Myocardial Infarction 8 - 21 Days	4.17	0.0944	0.0008
Number of Diseased Vessels - Two	19.20	0.1444	<.0001
Number of Diseased Vessels - Three	76.36	0.1695	<.0001
NYHA Classification - IV	15.60	0.0466	0.0043
Preoperative IABP	6.62	0.1351	<.0001
Resuscitation	0.45	0.2492	0.0024
Intercept	1.3846		
R-Square	18.35		
Number of CABGs (N)*	4,411		

*SOURCE: New Jersey Department of Health and Senior Services.*

\* Excluded are patients who died during hospitalization where CABG was performed; patients with postsurgical LOS > 30 days; and patients with post-surgical LOS < 2 days.

## References

- The Massachusetts Department of Public Health, Adult Coronary Artery Bypass Graft Surgery in the Commonwealth of Massachusetts, Fiscal Year 2009 Report (October 1, 2008 – September 30, 2009). Massachusetts Data Analysis Center, Department of Health Care Policy, Harvard Medical School, January 2011.  
[www.massdac.org/sites/default/files/reports/CABG%20FY2009.pdf](http://www.massdac.org/sites/default/files/reports/CABG%20FY2009.pdf)
- New Jersey Department of Health and Senior Services, Cardiac Surgery in New Jersey 2008, Health Care Quality Assessment, Office of the Commissioner, June 2011.  
[www.state.nj.us/health/healthcarequality/documents/cardconsumer08.pdf](http://www.state.nj.us/health/healthcarequality/documents/cardconsumer08.pdf)
- New York State Department of Health, Adult Cardiac Surgery in New York State: 2007-2009, February 2012.  
[http://www.health.ny.gov/statistics/diseases/cardiovascular/heart\\_disease/docs/2007-2009\\_adult\\_cardiac\\_surgery.pdf](http://www.health.ny.gov/statistics/diseases/cardiovascular/heart_disease/docs/2007-2009_adult_cardiac_surgery.pdf)
- California Office of Statewide Health Planning and Development, the California Report on Coronary Artery Bypass Graft Surgery: 2009 Hospital Data. Sacramento, CA, April 2012.  
[http://www.oshpd.ca.gov/HID/Products/Clinical\\_data/CABG/2009/CABG2009.pdf](http://www.oshpd.ca.gov/HID/Products/Clinical_data/CABG/2009/CABG2009.pdf)
- Pennsylvania Health Care Cost Containment Council, Cardiac Surgery in Pennsylvania 2008-2009: Information about hospitals and cardiothoracic surgeons. May 2011.  
<http://www.phc4.org/reports/cabg/09/docs/cabg2009report.pdf>

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A red ECG line is positioned horizontally across the upper portion of the page. It features several distinct peaks and troughs, characteristic of a heart rate monitor reading. The line is set against a dark blue background with a subtle grid pattern.

# Cardiac Surgery in New Jersey

