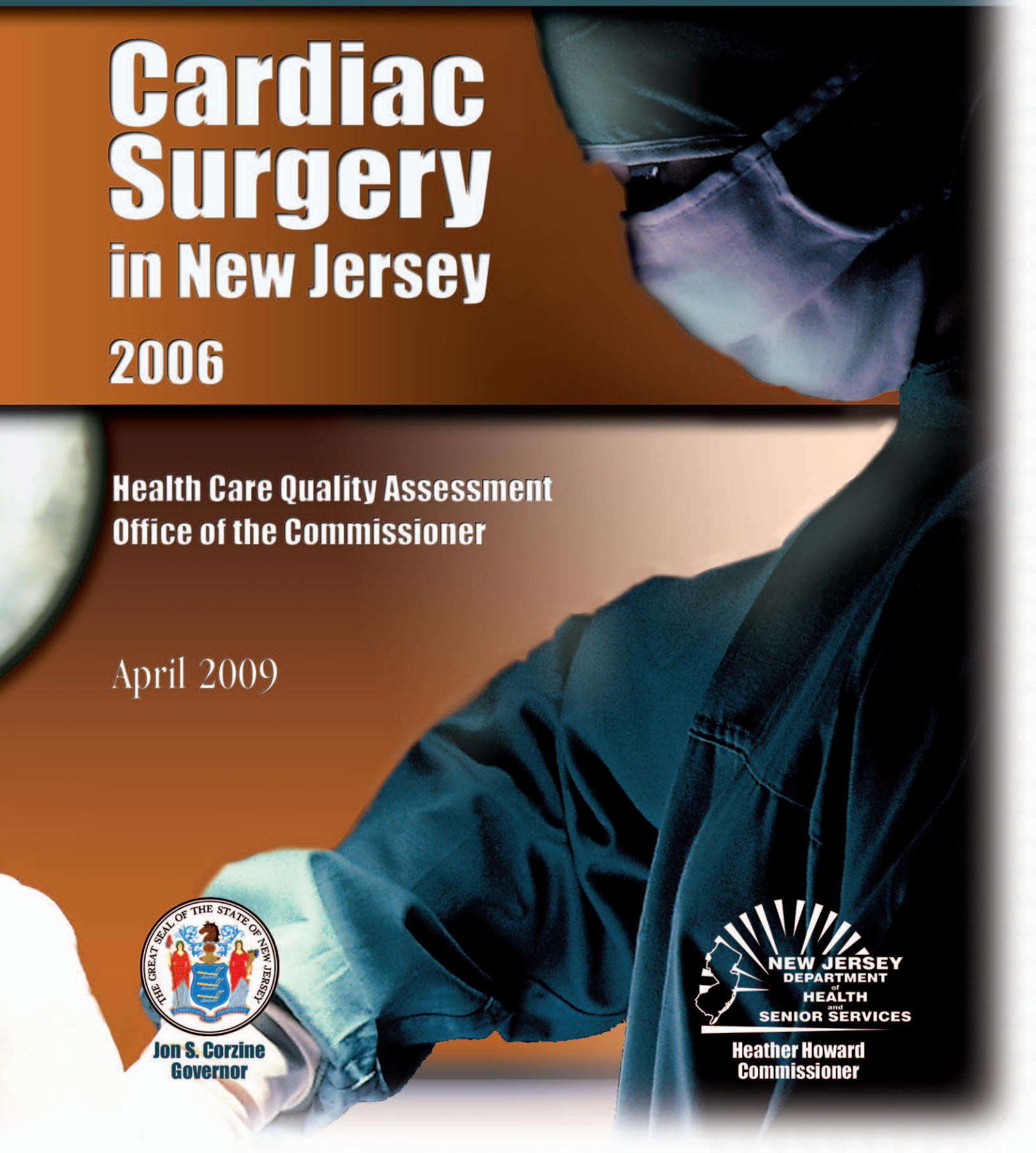
HCQA Health Care Quality Assessment

Cardiac Surgery in New Jersey 2006



Health Care Quality Assessment
Office of the Commissioner

April 2009

Jon S. Corzine
Governor

NEW JERSEY DEPARTMENT of HEALTH and SENIOR SERVICES

Heather Howard
Commissioner

Message From The Commissioner

I am pleased to present the tenth Cardiac Surgery report in New Jersey, the state's consumer report on coronary artery bypass graft surgery. This report summarizes mortality, length of stay and infections among patients who underwent bypass surgery in New Jersey hospitals in 2006.

New Jersey's cardiac bypass surgery mortality rate has continued to decline, according to this latest report. Overall, the state's heart centers have achieved a 53.7 percent reduction in operative mortality between 1994 and 2006. This is a remarkable tribute to the continued commitment of New Jersey hospitals and surgeons to making cardiac surgery safer.

The Department of Health and Senior Services has worked closely with the Cardiovascular Health Advisory Panel (CHAP) to bring consumers and providers the best possible data on cardiac bypass surgery outcomes. For the first time, the report includes statewide information on cardiac bypass surgery-related infections. The report also provides information on the total number of cardiac surgeries physicians performed, including but not limited to bypass surgeries. I would like to thank the CHAP members for their important efforts to support quality improvement in cardiac services in New Jersey.

In facing cardiac bypass surgery, patients and their families have questions and concerns. We hope this report answers some of those questions and helps patients discuss concerns and treatment options with their physicians.

Heather Howard
Commissioner

NEW JERSEY DEPARTMENT of HEALTH and SENIOR SERVICES

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Executive Summary

The Department of Health and Senior Services (Department) collected data on 8,706 patients undergoing open heart surgery at 18 hospitals in 2006. Of these patients, 5,211 had coronary artery bypass graft (CABG) surgery with no other major surgery during the same admission, i.e., isolated CABG.

One important goal of this report is to provide New Jersey hospitals and surgeons with data they can use in assessing quality of care related to bypass surgery. More importantly, this report presents patients and families of patients with important information they can use in discussing questions and issues related to bypass surgery with their physicians.

After subjecting the CABG surgery data to extensive error checks and consulting with the clinical panel of the CHAP, the Department analyzed the isolated CABG surgery data using a statistical procedure to assess hospital and surgeon performance. 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 2006 data analysis are as follows:

- In 2006, only 59.9% (5,211) of the 8,706 total open heart surgeries performed in New Jersey were isolated CABG surgeries.
- Of the 5,211 isolated CABG surgery patients, 104 died while in the hospital or within 30 days after surgery.
- The statewide observed operative mortality rate for isolated CABG surgery patients in 2006 was 2.0 percent and represents a 4.8 percent decline over 2005. When comparing 2005 and 2006 mortality rates on a risk-adjusted basis, the decline was 5.1 percent but was not statistically significant.
- A review of 13 years of pooled data suggests that the risk-adjusted CABG patient mortality in New Jersey has declined by 53.7 percent between 1994 and 2006.
- In 2006, there was one hospital (Cooper Hospital/University Medical Center) among the eighteen which had a statistically significantly higher risk-adjusted mortality rate than the statewide average.
- In the period 2005-2006, no individual surgeon had a statistically significantly lower or statistically significantly higher risk-adjusted mortality than the statewide average. However, low volume surgeons as a group in Cooper Hospital/University Medical Center had statistically significantly higher risk-adjusted mortality rates than the statewide average. Although their rates were not statistically significantly different from the statewide average, it is nevertheless notable that Dr. Kirk McMurthry of Engelwood Hospital and Medical Center and Dr. Raj Kaushik of St. Mary's Hospital (Passaic) had no CABG surgery deaths during this two-year period.
- As expected, the risk of death from isolated CABG surgery increases with age, with the rate increasing at a faster rate as the patient's age increases.
- Not surprisingly, sicker patients were at greater risk:
  - An isolated CABG surgery patient who had peripheral vascular disease (PVD) prior to the surgery was 2.99 times as likely to die after the surgery compared with a patient who had no PVD.
  - The odds of dying from isolated CABG surgery patients who had renal failure were 2.24 times compared with patients who had no renal failure.
  - The odds of dying for congestive heart disease and arrhythmia patients, respectively, were 1.65 and 1.64.

- Recent myocardial infarction was a statistically significant predictor of CABG surgery mortality among New Jersey patients*.

- The average length of hospital stay for a typical CABG surgery patient in 2006 was 6.32 days compared with 6.41 days in 2005.

- The average length of stay by hospital ranged from 5.41 days in St. Michael's Medical Center to 8.01days in Jersey City Medical Center.

- There was a general tendency for high mortality hospitals to be associated with increased length of stay but this tendency was not statistically significant at 95% confidence level.

- There were also important differences in length of stay by surgeon. Individual eligible surgeon length of stay averages in the period 2005-2006 ranged from 5.28 days to 7.99 days.

* *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 -- isolated CABG. It provides mortality rates for the 18 hospitals that performed cardiac surgery in 2006 and the physicians performing this common cardiac surgical procedure in 2005-2006. 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 initial post-surgery hospital stay for CABG surgery patients, by hospital and by eligible surgeon (those who performed at least 100 bypass operations in one hospital in the years 2005 and 2006 combined) while rates of infections are reported for the state.

For this study, the Department of Health and Senior Services collected data on 5,211 patients who had bypass surgery with no other major surgery during the same admission (simply referred to as bypass surgery in this report) in 2006. This is the most recent year for which a complete, 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 condition before surgery. This risk-adjustment allows for fair comparisons among hospitals and surgeons treating diverse patient populations.

An 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 the handful of states with similar reports, that this information encourages hospitals to examine their procedures and make changes that can improve quality of care and, ultimately, save lives.

New Jersey's mortality rate for bypass surgery has shown a significant decline since public reporting began with 1994 data. For 2006, the observed mortality rate of 2.00 percent is lower than the 2.10 percent mortality rate for 2005, suggesting a continued downward trend (Appendix D). When data from all years are pooled and analyzed, the resulting 5.1 percent decrease in the risk-adjusted mortality rate from 2005 to 2006, though not statistically significant, is notable. A difference is called **"statistically significant"** when it is too large to be due to chance or random variation.

Another goal of the report is to give patients and physicians important information to use in discussing questions and issues related to bypass surgery. Please remember that volumes, mortality rates and length of stay in this report are just additional factors to consider in deciding where to have cardiac surgery. You and your physician together can make the best choice after full consideration of your medical needs. Also note that hospital data in this report are from 2006, while surgeon data refer to 2005 and 2006 combined. These data may not reflect the current performance of specific hospitals, which may have revamped their programs since then. Also, some surgeons listed in the cardiac surgery centers may have already left the facility and/or the state since the data were reported.

Readers who have followed the Department's CABG surgery reports for years prior to 2000 will observe that the mortality rates presented in this report may appear to be higher than previously released. This is not really the case. Instead, starting with the 2000 CABG surgery report, the Department, in consultation with the Cardiovascular Health Advisory Panel (CHAP), changed its definition of mortality to reduce the possibility that hospital discharge policies could artificially lower CABG surgery mortality rates. The definition is discussed in greater detail later in this report along with recent improvements to CABG surgery classification.

Cardiovascular Health Advisory Panel

A Cardiovascular Health Advisory Panel (CHAP) was established by the Commissioner of Health 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, 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 cause of death of Americans with 652,091 deaths in 2005. 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 20,655 deaths in 2005 for an age-standardized death rate of 208.9 per 100,000. This compares favorably against the national age-standardized rate of 211.1 per 100,000 in 2005 (www.cdc.gov/nchs/data/nvsr/nvsr56/nvsr56_10.pdf).

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 2006 and the surgeons who performed this operation at least 100 times between January 2005 and December 2006. 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, the Department, after consulting with the CHAP, changed the way mortality is defined for the purposes of the Department's cardiac surgery performance report. 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.

Therefore, beginning with the 2000 report, the Department 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 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 has issued an operative procedure coding guide to be followed by all hospitals and has been implemented starting with 2005 data. This guideline was designed to avoid differential reporting of operative procedures by hospitals.

Applying the revised definitions of mortality and operative procedure, 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 1994-2006.

Performance Data

In an isolated bypass 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 104, or 2.0 percent of 5,211 who had the surgery. This statewide operative CABG surgery mortality rate (2.0 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 peripheral vascular disease would be at higher risk during this surgery than a 50-year-old who had 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 operation include:

- the patient's age;
- whether the patient has various preoperative risk factors, such as renal failure, peripheral vascular disease;
- whether the patient has preoperative cardiac status, like:
  - arrhythmia;
  - recent myocardial infarction;
  - congestive heart failure;
  - symptoms of severe cardiac insufficiency as indicated by NYHA.

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 bypass surgery decreased by 5.1 percent from 2005 to 2006. However, this decline was not statistically significant. This one-year drop in mortality is a continuation of the decline 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 2006. 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 46 surgeons who performed at least 100 bypass operations in one hospital in the years 2005 and 2006 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). Please note that 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 average.

Bypass Surgery Volume at New Jersey Hospitals in 2006

Figure 1 shows the number of bypass operations performed in 2006 in each of the 18 hospitals. You can see that some hospitals do more of these procedures than others, with totals ranging from a low of 66 to a high of 690. Bypass surgery volume in New Jersey has been declining starting in 2000 while angioplasty was increasing. Bypass is the most common type of cardiac surgery accounting for about 60 percent (59.9%) in 2006. Between 2000 and 2006, the number of cardiac surgeries in New Jersey has declined by 25.5 percent.

Hospital Risk-adjusted Mortality

Figure 2 shows the risk-adjusted mortality rate for each New Jersey hospital performing bypass surgery in 2006. 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 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 95% level.

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 2006, i.e. 2.0. Each hospital's performance is displayed graphically in relation to this statewide average.

Figure 2 indicates that 17 of the 18 hospitals have bars that cross the statewide average line (2.0 percent). That means that their risk-adjusted mortality rates were not statistically different from the statewide average. Cooper Hospital/University Medical Center has its bars completely to the right of

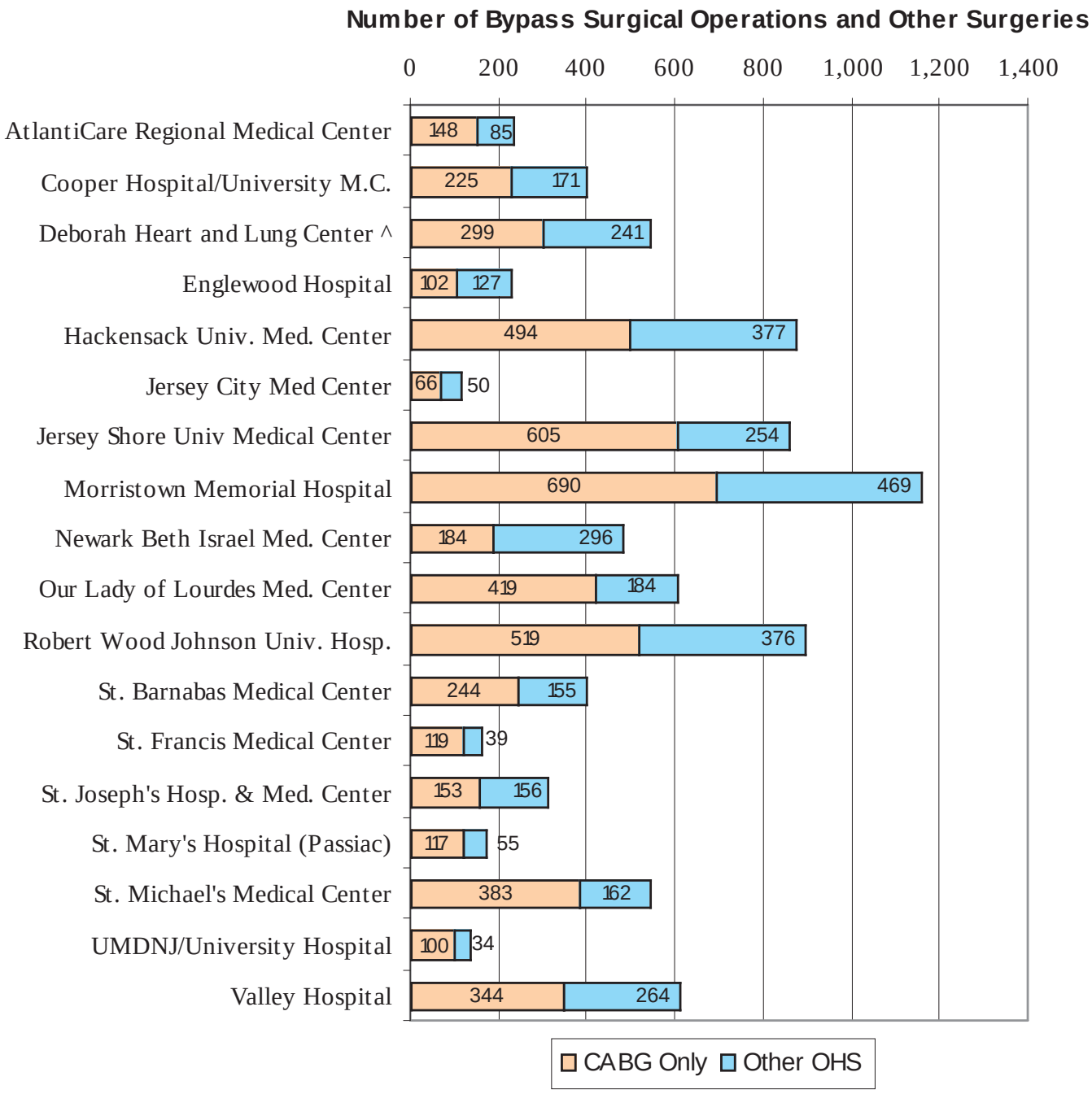
the statewide average indicating that this hospital had statistically significantly higher risk-adjusted mortality rate than the statewide average.

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 average 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

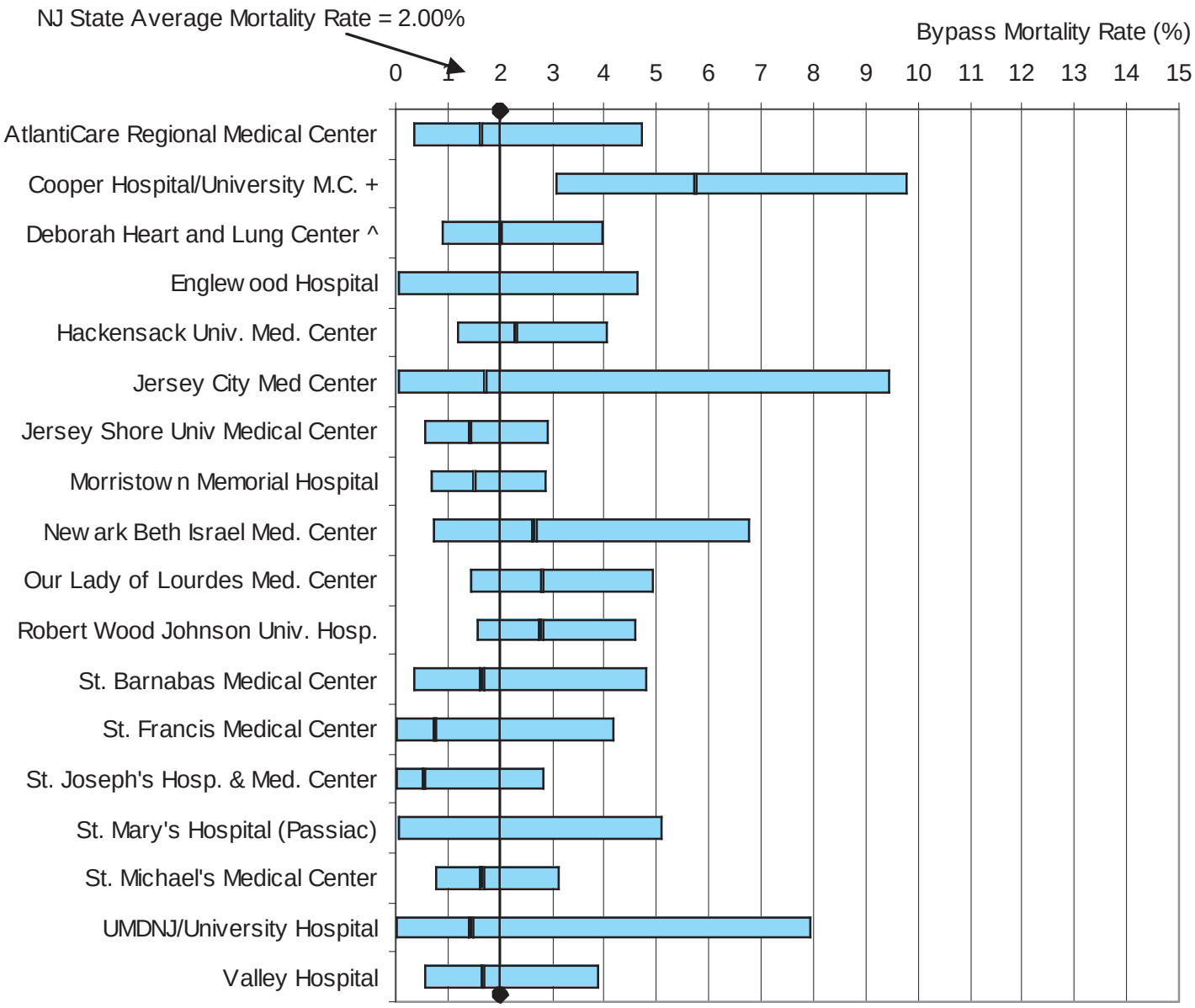
Number of Isolated Coronary Artery Bypass Graft Surgeries vs. Other Surgeries (2006)



Source: New Jersey Department of Health and Senior Services

^ Facility refused to sign-off on its data.

Figure 2
Risk-Adjusted Operative Mortality Rate* by Hospital (2006)



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.

^ Facility refused to sign-off on its data.

\+ Facility RAMR was statistically significantly higher than the statewide average.

Statewide CABG Surgery Related Infections

For the first time, 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 monitoring.

Infections reported in the Open Heart Surgery database included sternal-deep wound infection, 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 2.73 percent of CABG patients had pneumonia. A little over three percent had UTI and about two percent (1.82%) had septicemia. Statewide, over seven percent (7.50%) of bypass 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 (10.23%) and those who did not (1.33%). Also, patients who developed post-surgery infections stayed in the hospital about three times as long (19.94 days) as to those who had no infections (6.67 days).

Table 1
Statewide In-hospital Infection Rates for Isolated CABGs by Type, (2006)

	Number of Cases	Infection (%)	Operative Mortality*		Average Length of Stay (in Days)
			Number	Rate in % (Observed)	
Cases with Infections	**391**	**7.50**	**40**	**10.23**	**19.94**
Sternal-Deep	43	**0.83**	6	13.95	28.09
Thoracotomy	5	**0.10**	1	20.00	41.00
Leg	39	**0.75**	0	0.00	17.23
Septicemia	95	**1.82**	25	26.32	29.62
UTI	164	**3.15**	11	6.71	17.20
Pneumonia	142	**2.73**	22	15.49	27.06
Cases without Infections	**4,820**	**N.A.**	**64**	**1.33**	**6.67**
Total CABG cases	**5,211**	**N.A.**	**104**	**2.00**	**7.67**

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

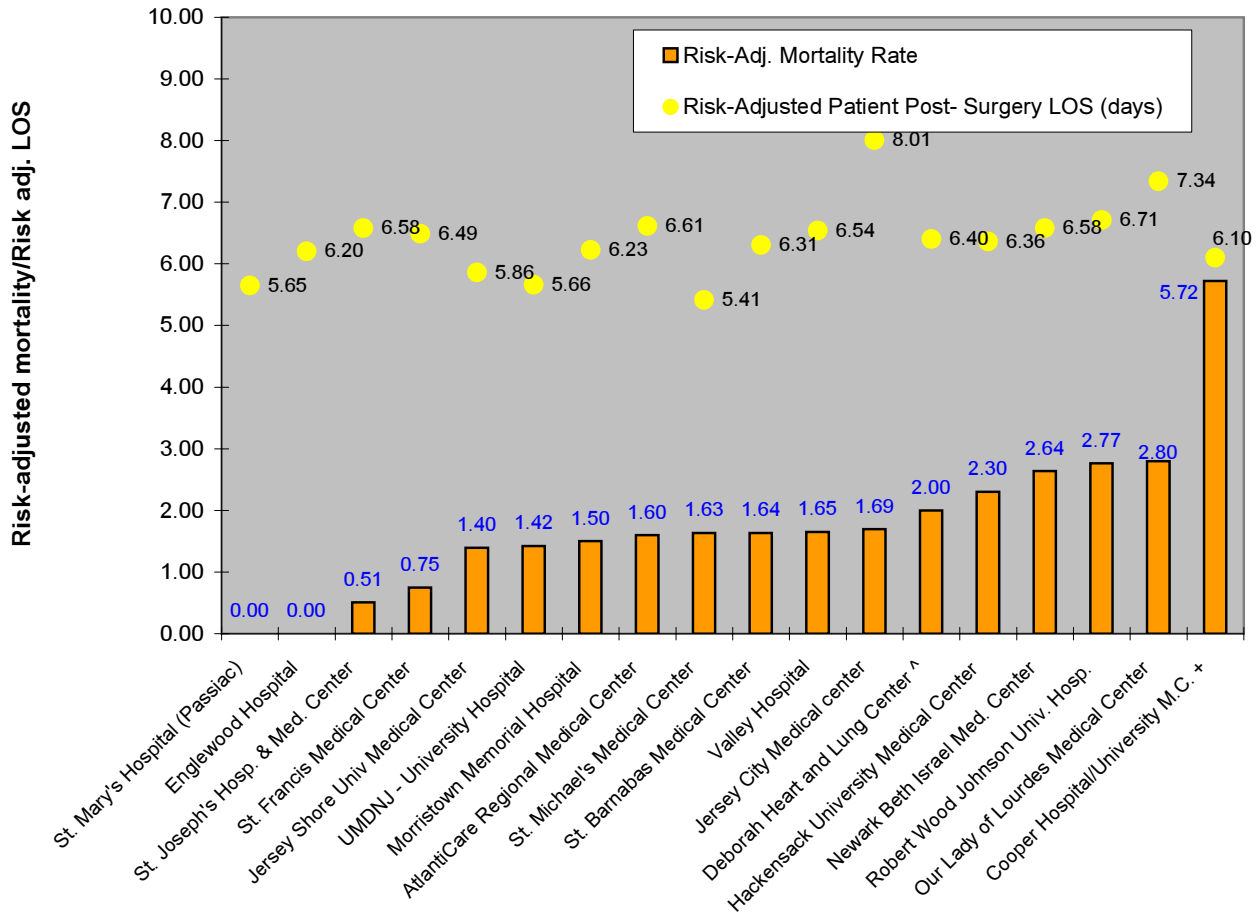
For the second time, the Department has included information on post-surgery length of stay as an additional tool to monitor hospital and surgeon performance on CABG surgery. The risk-adjustment model excluded in-hospital deaths, very low lengths of stay (low outliers) and very long lengths of stay (high 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 range is 5.41 days to 8.01 days and the statewide average is 6.32 days. Hospitals with high risk-adjusted mortality rates also tended to have longer lengths of stay but this tendency was not statistically significant at the 95 percent confidence level (p=0.83) (See Figure 3).

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

Figure 3
Risk-Adjusted Operative Bypass Mortality and Length of Stay by Hospital, 2006



^ Facility refused to sign-off on its data
\+ Facility RAMR was statistically significantly higher than the statewide average

Individual Surgeon Performance

Figure 4 and Table 2 show the risk-adjusted mortality rate for each of the 46 surgeons who performed at least 100 isolated bypass surgery operations in one hospital in New Jersey in the years 2005 and 2006 combined. In addition, Table 2 shows the risk-adjusted length of initial hospitalization.

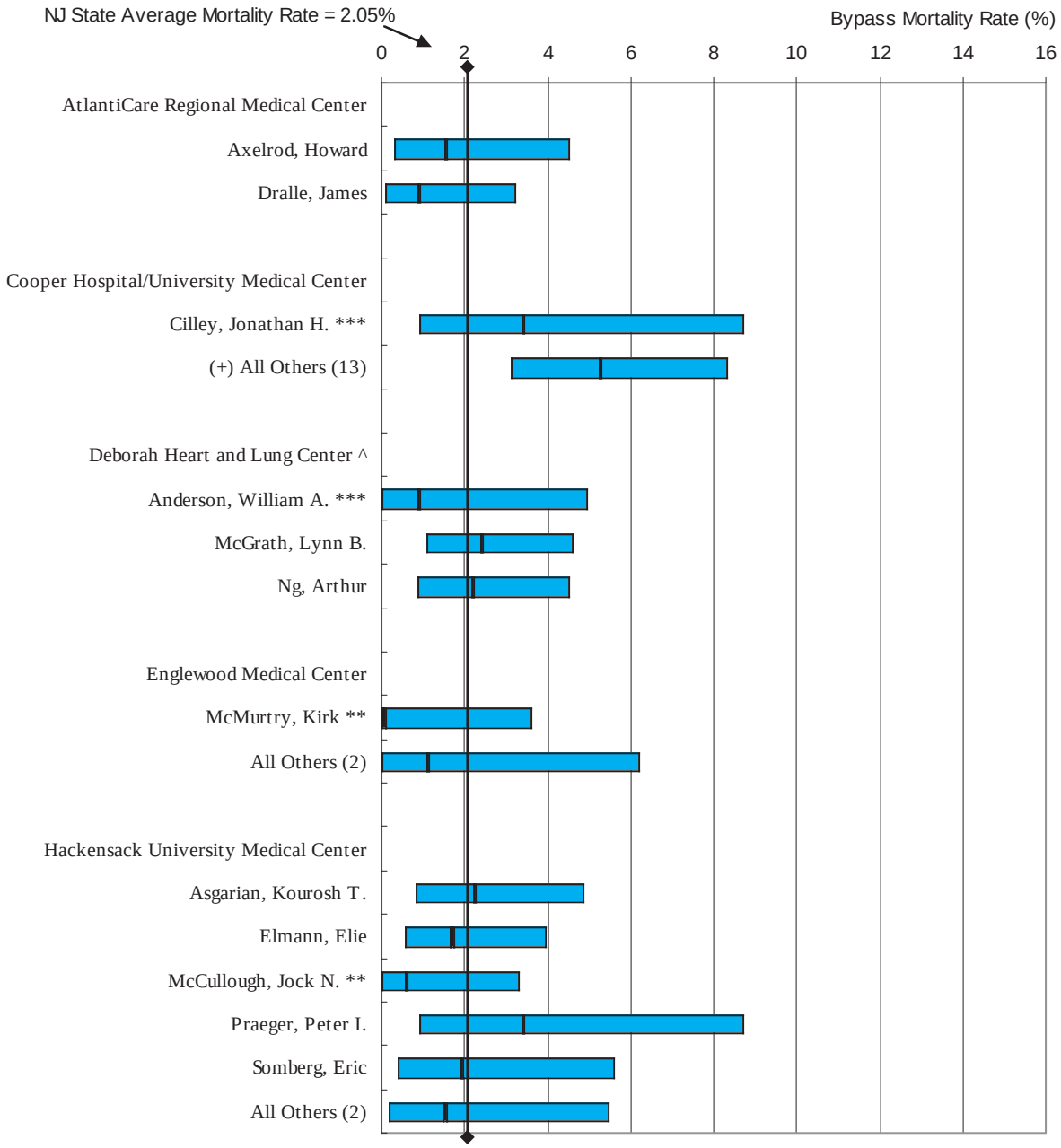
Figure 4 lists surgeons by name under the hospital at which they practice. At the end of each list of named surgeons, some hospitals have an **"All Others"** category. "All Others" includes all surgeons who performed too few procedures at that hospital for an individual risk-adjusted mortality rate to be calculated. The category "All Others" is only displayed on Figure 4 when it includes at least two or more surgeons. Figure 4 displays a bar for a surgeon only if 100 or more bypass surgeries were performed by the surgeon. For a group of surgeons (i.e. All Others) a bar is shown regardless of the number of surgeries performed by the group unless the group has only one surgeon. 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 2005-2006 combined. Note that, because two years' data are combined, the statewide operative mortality rate for surgeons is 2.05 percent, in contrast to the 2.00 percent mortality rate obtained from 2006 alone (Figure 2). If a surgeon has a bar completely to the left of the statewide average line, it means that the surgeon's mortality rate was significantly lower than the statewide average. In 2005-2006, there was no surgeon whose bar was completely to the left of the 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 average line. Though not intuitive, this happens because the bar is the result of an upper and lower bound which includes standard errors of estimation.

If a surgeon has a bar completely to the right of the statewide average line, it means that the surgeon's mortality rate was significantly higher than the statewide average for this two-year period. In 2005-2006, 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 2005-2006 reporting period. The statewide average length of stay for the 2005-2006 reporting period was 6.37 days. There is an important variation in length of stay by eligible surgeon where the shortest length of stay was 5.28 days while the longest was 7.99 days. The reasons behind the wide variation in mean lengths of stay are not clear and need further study.

Figure 4
Surgeon Risk-Adjusted Operative Mortality* Rate (2005-2006)



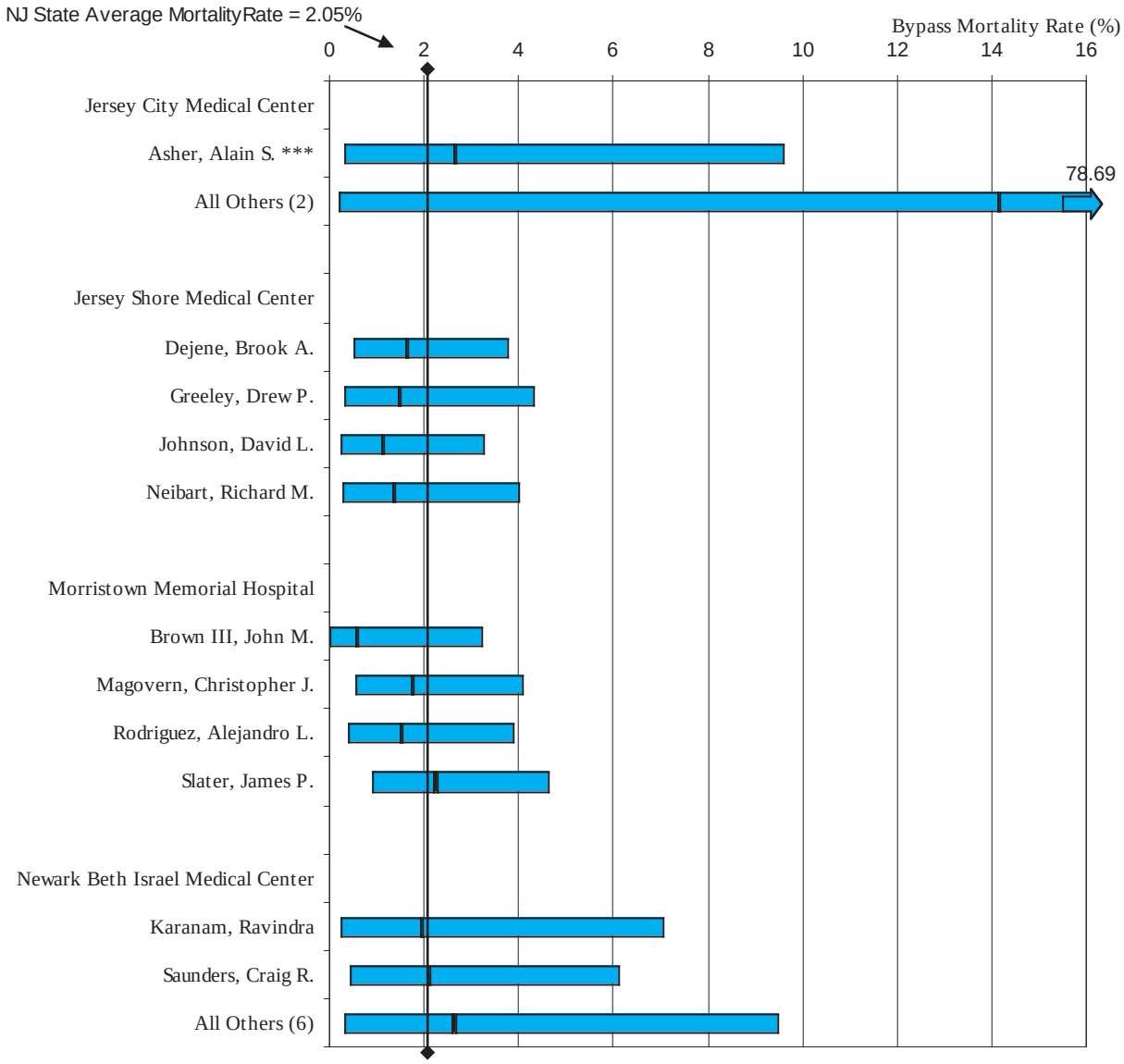
SOURCE: New Jersey Department of Health and Senior Services.

* = 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 mortality rate significantly lower than the New Jersey mortality rate, based on 95 percent confidence interval.
(+) = Risk-adjusted mortality rate significantly higher than the New Jersey mortality rate, based on 95 percent confidence interval.

^ Facility refused to sign-off on its data.
** = Surgeon not currently performing CABG surgery in this hospital.
*** = Surgeon not currently performing CABG surgery in New Jersey.

Figure 4 (continued)
Surgeon Risk-Adjusted Operative Mortality* Rate (2005-2006)



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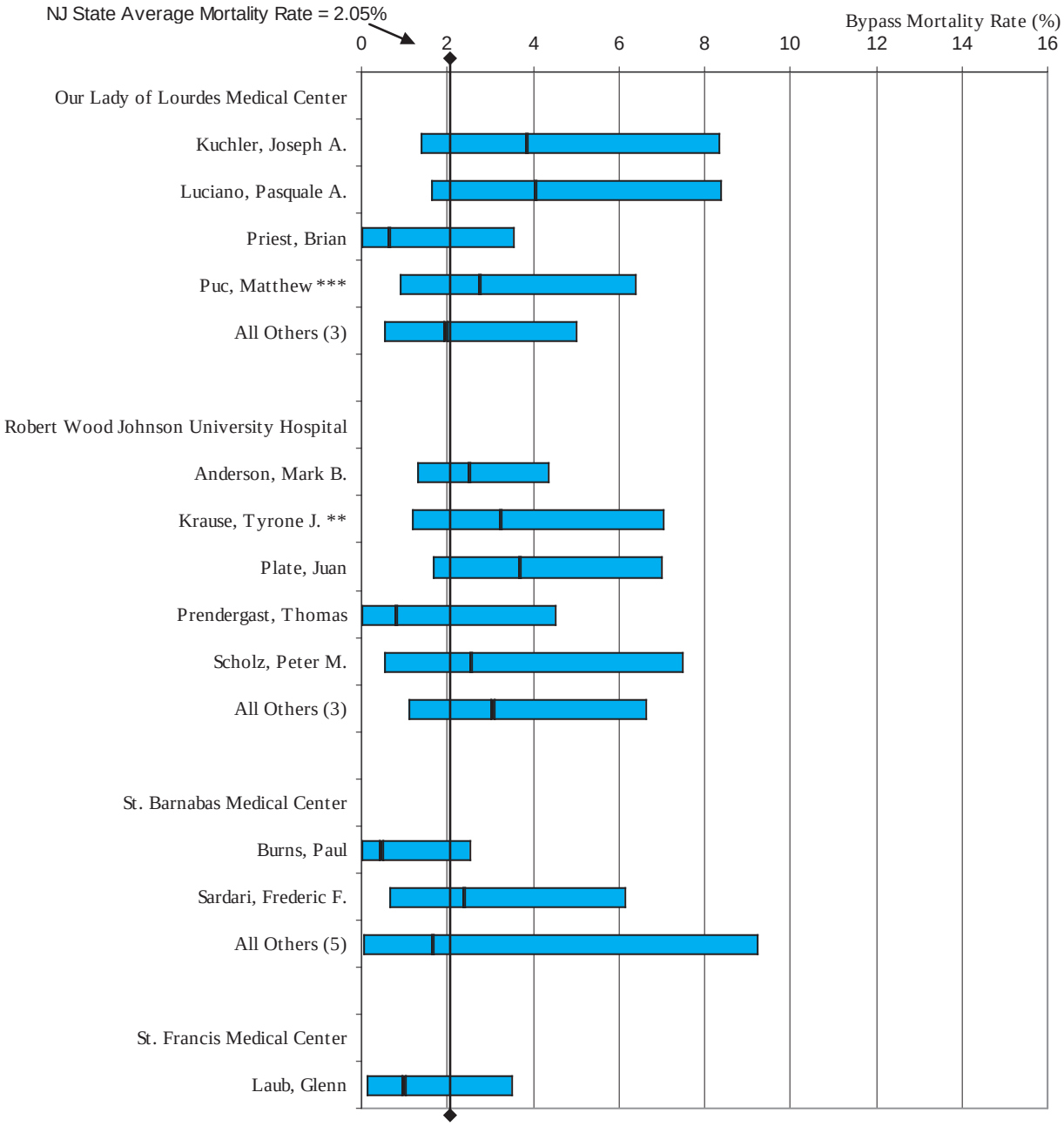

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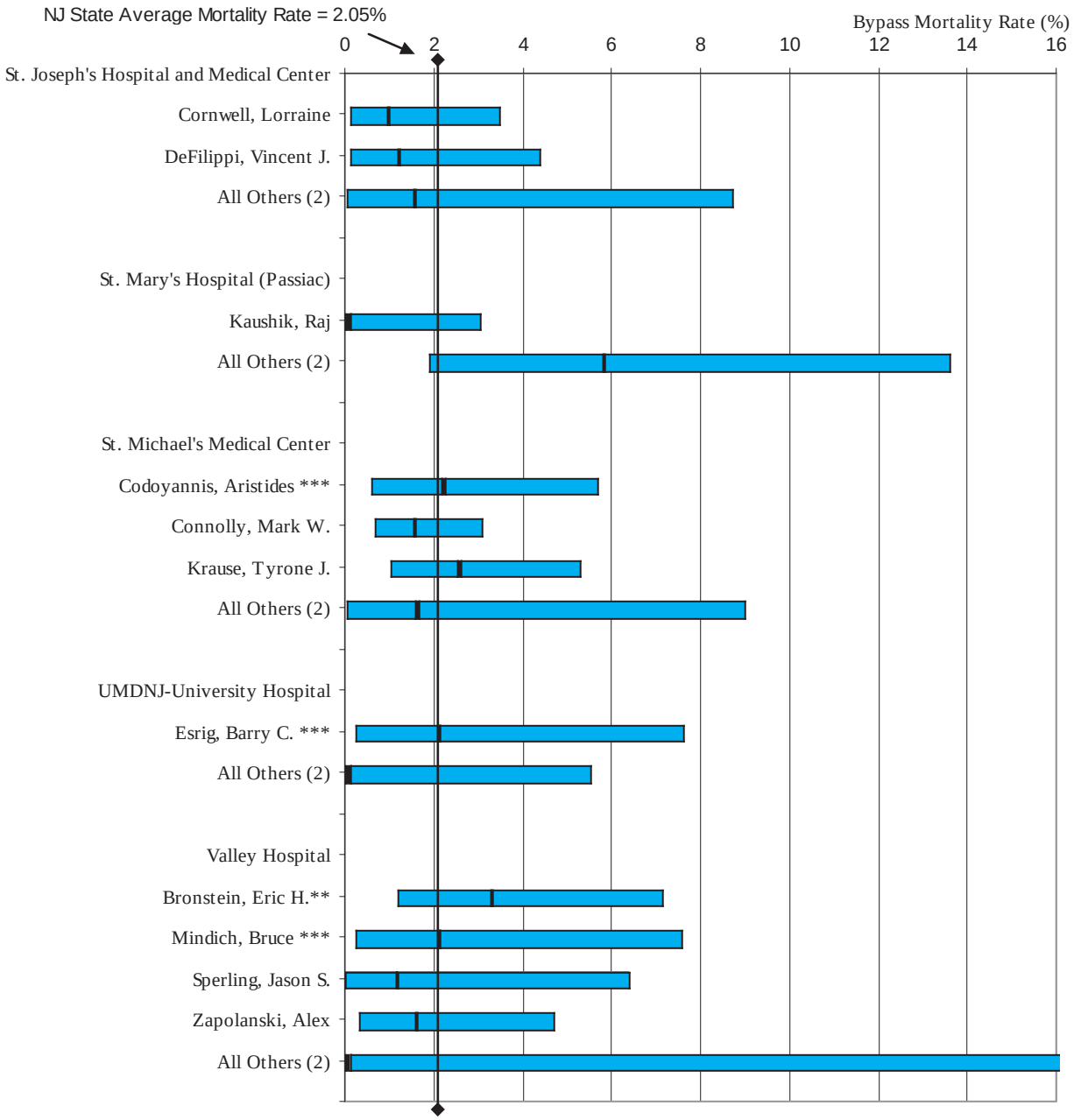

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(-) = Risk-adjusted mortality rate significantly lower than the New Jersey mortality rate, based on 95 percent confidence interval.
(+) = Risk-adjusted mortality rate significantly higher than the New Jersey mortality rate, based on 95 percent confidence interval.

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

Table 2

Patient Risk-Adjusted Operative Mortality* Rate for Surgeons (2005-2006)

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
AtlantiCare Regional Medical Center									
Axelrod, Howard	226	151	3	1.99	2.65	1.53		(0.31, 4.48)	6.23
Dralle, James	242	154	2	1.30	2.99	0.89		(0.10, 3.21)	6.05
Cooper Hospital/University Medical Center									
Cilley, Jonathan H. ++	228	133	4	3.01	1.81	3.40		(0.91, 8.69)	6.25
All Others (13)	594	326	18	5.52	2.15	5.26	**HI**	(3.12, 8.32)	6.26
Axelrad, Alexander ++	4	0	0						
Burns, Richard	3	0	0						
D'Andrea Joseph	6	0	0						
Deangelo, Frank ++	2	0	0						
DelRossi, Anthony J. ++	183	91	3						
Eakins, James ++	8	0	0						
El-Habre, Wassim ++	3	0	0						
Fusco, Cynthia ++	1	0	0						
Lotano, Vincent ++	118	73	4						
Marra, Steven W. ++	119	77	7						
Ross, Steven E.	5	0	0						
Simonetti, Vincent A. ++	138	85	4						
Sjoholm, Lars	4	0	0						
Deborah Heart and Lung Center ^									
Anderson, William A. ++	208	118	1	0.85	1.95	0.89		(0.01, 4.95)	6.53
McGrath, Lynn B.	569	311	9	2.89	2.47	2.40		(1.10, 4.56)	6.94
Ng, Arthur	322	185	7	3.78	3.55	2.19		(0.88, 4.50)	6.25
Englewood Hospital & Medical Center									
McMurtry, Kirk +	180	105	0	0.00	2.04	0.00		(0.00, 3.50)	5.82
All Others (2)	322	123	1	0.81	1.49	1.12		(0.01, 6.20)	5.96
Ergin, Arisan M.	115	35	0						
Klein, James	207	88	1						
Hackensack University Medical Center									
Asgarian, Kourosh T.	366	230	6	2.61	2.39	2.23		(0.82, 4.86)	5.82
Elmann, Elie	324	187	5	2.67	3.24	1.69		(0.54, 3.94)	6.32
McCullough, Jock N. +	370	201	1	0.50	1.73	0.59		(0.01, 3.28)	6.20
Praeger, Peter I.	200	133	4	3.01	1.82	3.39		(0.91, 8.68)	6.63
Somberg, Eric	255	180	3	1.67	1.78	1.92		(0.39, 5.60)	6.95
All Others (2)	249	121	2	1.65	2.24	1.51		(0.17, 5.46)	5.99
Alexander, John C. ++	161	78	1						
Masroor, Saqib ++	88	43	1						

* 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 state average mortality rate, based on 95 percent confidence interval.

HI = The risk-adjusted patient mortality is significantly higher than the state average mortality rate, based on 95 percent confidence interval.

^ Facility refused to sign-off on its data.

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

++= Surgeon not currently performing CABG surgery in New Jersey.

Table 2 (continued)

Patient Risk-Adjusted Operative Mortality* Rate for Surgeons (2005-2006)

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
Jersey City Medical Center								
Asher, Alain S. ++	158	101	2	1.98	1.53	2.65	(0.30, 9.57)	7.62
All Others (2)	33	15	1	6.67	0.97	14.14	(0.18, 78.69)	7.63
Aklog, Lishan ++	16	5	1					
Diluozzo, Gabriele ++	17	10	0					
Jersey Shore University Medical Center								
Dejene, Brook A.	424	306	5	1.63	2.08	1.61	(0.52, 3.76)	5.96
Greeley, Drew P.	436	285	3	1.05	1.46	1.47	(0.30, 4.30)	5.88
Johnson, David L.	436	304	3	0.99	1.83	1.11	(0.22, 3.23)	5.82
Neibart, Richard M.	425	322	3	0.93	1.40	1.36	(0.27, 3.98)	6.02
Morristown Memorial Hospital								
Brown III, John M.	773	294	1	0.34	1.21	0.58	(0.01, 3.21)	6.19
Magovern, Christopher J.	543	372	5	1.34	1.58	1.74	(0.56, 4.06)	5.95
Rodriguez, Alejandro L.	516	372	4	1.08	1.46	1.51	(0.41, 3.86)	6.25
Slater, James P.	524	375	7	1.87	1.71	2.23	(0.89, 4.60)	6.32
Newark Beth Israel Medical Center								
Karanam, Ravindra	289	147	2	1.36	1.43	1.95	(0.22, 7.03)	6.72
Saunders, Craig R.	395	153	3	1.96	1.93	2.08	(0.42, 6.09)	6.27
All Others (6)	326	104	2	1.92	1.50	2.62	(0.29, 9.48)	7.06
Burns, Paul +	2	0	0					
Camacho, Margarita	144	35	1					
Goldstein, Daniel J. ++	9	0	0					
Prendergast, Thomas ++	138	58	1					
Sardari, Frederic F. +	32	11	0					
Starr, Joanne ++	1	0	0					
Our Lady of Lourdes Medical Center								
Kuchler, Joseph A.	286	154	6	3.90	2.09	3.83	(1.40, 8.33)	7.99
Luciano, Pasquale A.	213	158	7	4.43	2.24	4.05	(1.62, 8.35)	7.94
Priest, Brian	185	132	1	0.76	2.46	0.63	(0.01, 3.51)	6.47
Puc, Matthew ++	135	121	5	4.13	3.10	2.73	(0.88, 6.37)	7.98
All Others (3)	274	174	4	2.30	2.42	1.95	(0.52, 4.99)	7.15
Derivaux, Christopher ++	45	36	0					
Metcalf, Randy	79	52	1					
Nayar, Amrit ++	150	86	3					
Robert Wood Johnson University Hospital								
Anderson, Mark B.	685	394	12	3.05	2.51	2.48	(1.28, 4.34)	6.43
Krause, Tyrone J. +	275	186	6	3.23	2.05	3.22	(1.18, 7.01)	6.59
Plate, Juan	214	166	9	5.42	3.03	3.67	(1.67, 6.97)	6.82
Prendergast, Thomas	180	132	1	0.76	1.92	0.81	(0.01, 4.49)	6.37
Scholz, Peter M.	349	158	3	1.90	1.52	2.55	(0.51, 7.46)	7.07
All Others (3)	216	143	6	4.20	2.82	3.05	(1.11, 6.63)	6.98
Batsides, George	101	66	4					
Scott, Gregory E. ++	94	71	2					
Vasseur, Bernard G. ++	21	6	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.

LO = The risk-adjusted patient mortality is significantly lower than the state average mortality rate, based on 95 percent confidence interval.

HI = The risk-adjusted patient mortality is significantly higher than the state average mortality rate, based on 95 percent confidence interval.

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

++= Surgeon not currently performing CABG surgery in New Jersey.

Table 2 (continued)

Patient Risk-Adjusted Operative Mortality* Rate for Surgeons (2005-2006)

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
St Barnabas Medical Center								
Burns, Paul	437	241	1	0.41	1.89	0.45	(0.01, 2.50)	6.46
Sardari, Frederic F.	288	197	4	2.03	1.74	2.39	(0.64, 6.11)	6.69
All Others (5)	126	62	1	1.61	1.99	1.66	(0.02, 9.23)	6.75
Camacho, Margarita +	5	2	0					
Goldenberg, Bruce +	6	6	0					
Goldstein, Daniel J. ++	64	38	1					
Karanam, Ravindra +	2	1	0					
Saunders, Craig R.	49	15	0					
St Francis Medical Center								
Laub, Glenn	277	196	2	1.02	2.15	0.97	(0.11, 3.51)	6.61
All Others (1)	49	45	2					
Costic, Joseph	49	45	2					
St Joseph's Hospital and Medical Center								
Cornwell, Lorraine	214	134	2	1.49	3.17	0.96	(0.11, 3.48)	6.69
DeFilippi, Vincent J.	360	143	2	1.40	2.36	1.22	(0.14, 4.39)	6.53
All Others (2)	134	88	1	1.14	1.49	1.56	(0.02, 8.70)	7.30
Kaushik, Raj +	2	2	0					
Mekhjian, Haroutune ++	132	86	1					
St. Mary's Hospital (Passiac)								
Kaushik, Raj	276	175	0	0.00	1.46	0.00	(0.00, 2.94)	5.89
All Others (2)	158	117	5	4.27	1.50	5.82	(1.88, 13.58)	5.64
Chuback, John ++	43	35	0					
Goldenberg, Bruce	115	82	5					
St Michael's Medical Center								
Codoyannis, Aristides ++	188	150	4	2.67	2.47	2.21	(0.59, 5.66)	6.65
Connolly, Mark W.	598	401	8	2.00	2.62	1.56	(0.67, 3.07)	5.73
Krause, Tyrone J.	258	188	7	3.72	2.98	2.56	(1.03, 5.28)	5.73
All Others (2)	64	53	1	1.89	2.40	1.61	(0.02, 8.98)	4.16
Patel, Nilesh	49	43	0					
Scott, Randolph P. ++	15	10	1					
UMDNJ University Hospital								
Esrig, Barry C. ++	175	132	2	1.52	1.48	2.10	(0.24, 7.59)	5.28
All Others (2)	122	90	0	0.00	1.53	0.00	(0.00, 5.44)	5.70
Banker, Michael ++	38	26	0					
Sambol, Justin	84	64	0					
Valley Hospital								
Bronstein, Eric H.+	343	233	6	2.58	1.61	3.28	(1.20, 7.14)	6.49
Mindich, Bruce ++	245	130	2	1.54	1.50	2.10	(0.24, 7.58)	7.55
Sperling, Jason S.	151	110	1	0.91	1.62	1.15	(0.02, 6.39)	7.06
Zapolanski, Alex	310	167	3	1.80	2.29	1.61	(0.32, 4.71)	6.41
All Others (2)	18	9	0	0.00	0.85	0.00	(0.00, 98.08)	8.09
Oz, Mehmet ++	11	4	0					
Smith, Craig ++	7	5	0					
State Total (2005 - 2006)	17,736	10,787	221	2.05	2.05	2.05		6.37

* 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 state average mortality rate, based on 95 percent confidence interval.

HI = The risk-adjusted patient mortality is significantly higher than the state average mortality rate, based on 95 percent confidence interval.

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

++= Surgeon not currently performing CABG surgery in New Jersey.

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

Figure 5 presents the statewide risk-adjusted mortality rates for years 1994 to 2006 derived by pooling data from all years.

Figure 5 also presents the trend in statewide observed isolated CABG operative mortality rates for years 1994-2006. 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 2006 dropped by 53.7 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 0.21percent per year (See Appendix D, Figure D1).

Figure 5
Trends in Statewide CABG Surgery Mortality Rates

Appendix A

Questions and answers

These 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 2006 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.

Copies may be obtained by writing to the New Jersey Department of Health and Senior Services, Office of Health Care Quality Assessment, P.O. Box 360, Trenton, NJ 08625, by calling (800) 418-1397 or by fax at (609) 984-7735. The report is also posted on our website at www.nj.gov/health/healthcarequality/cardiacsurgery.shtml.

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:

Year of Operation	Mortality Rate	
	In-hospital	Operative Mortality*
1994-1995	3.75	4.14
1996-1997	3.37	3.75
1998	2.60	3.01
1999	2.89	3.31
2000	2.22	2.68
2001	2.01	2.51
2002	1.80	2.15
2003	1.91	2.33
2004	1.54	1.98
2005	1.84	2.10
2006	1.73	2.00

* 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 procedure.

Appendix D

Summary of Methods Used in this Report

Background

Five states, including New Jersey, have issued reports on bypass surgery outcomes for hospitals, and sometimes surgeons. New York first published a bypass surgery report in 1990, presenting 1989 data with the latest being in March 2008 using 2003-2005 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 September 2008 using 2005-2006 data. California has also published several cardiac surgery reports, with the most recent released in December 2007 using 2005 data. Massachusetts published its first report on CABG surgery in October 2004 using 2002 data and released its latest report on fiscal year basis (October 1, 2005 to September 30, 2005) in February 2008. In 1997, New Jersey began reporting on patient mortality for bypass surgery hospitals and surgeons, using 1994 and 1995 data combined.

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

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 CABG surgery patients who underwent the 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 woman who has renal failure and peripheral vascular disease is at a higher risk of dying, when undergoing this surgery, than a 50 year-old woman with no history of chronic disease.

To undertake 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 a bypass surgery for a patient. Key elements of the health histories of patients who have undergone bypass surgery in the same period, as well as their socio-demographic characteristics, are taken into account to estimate the expected outcome of a bypass 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 a bypass 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:

$$Y_i = \sum_{k}^{K} \beta_k X_{ki} + \varepsilon_i \text{ , } Where X_{0i} = 1;$$

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

i = 1,2,…,n; k = 0,1,2,...,K,
β_k= Logistic regression coefficient for risk factor X_k,
K = Number of risk factors in the model,
n = Number of patients,
ε_i = Random error term i.

The statistically significant risk factors for this report (Xk) 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 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 bypass 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 is more than twice (odds ratio = 2.24) as likely to die during or after bypass surgery compared to a patient who did not have renal failure. 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 bypass surgery for a patient with a myocardial infarction (MI) within 24 hours is more than three times as likely (odds ratio= 3.38) compared with the odds of a patient who had no MI or had MI over 21 days prior to the 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 bypass 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:

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

$$\hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 X_{1i} + \hat{\beta}_2 X_{2i} + \hat{\beta}_3 X_{3i} + ... + \hat{\beta}_k X_{ki}$$

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 average patient mortality rate to produce the risk-adjusted patient mortality rate for the hospital or the surgeon.

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 bypass 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 bypass 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 those for patients who were discharged alive and were also alive 30 days after CABG surgery. The 2006 model C-statistic is 81.6 percent and is fairly high.

Table D1

Risk Factors Identified for Isolated Bypass Surgery Operative Mortality* (2006)

Patient Risk Factors Identified	Proportion of patients(%)	Logistic Regression Results		
		Coefficient	P-Value	Odds Ratio
Demographic factors				
Age (in years) Squared	---	0.0005	<.0001	1.000
Health factors				
Peripheral Vascular Disease	16.58	1.0941	<.0001	2.986
Renal Failure with or without Dialysis	5.62	0.8068	0.0032	2.241
NYHA Classification IV	17.39	0.9105	<.0001	2.486
Factors related to functioning of the heart				
Arrhythmia	11.76	0.4972	0.0360	1.644
Congestive Heart Failure	17.29	0.5003	0.0257	1.649
Myocardial Infarction <24 Hours	2.90	1.2188	0.0024	3.383
Myocardial Infarction 1 - 21 Days	22.61	0.7195	0.0017	2.053
Intercept		-7.3764		
C-Statistic		0.816		
Number of CABGs (N)		5,211		

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 state average in 2006;

(2) comparisons of the risk-adjusted patient mortality rates for surgeons in 2005 and 2006 combined to the statewide average for 2005 and 2006 combined;

(3) comparisons of the statewide risk-adjusted patient mortality rate for each year in 1994-2006 to the average 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*.

Patient CABG surgery mortality rate by hospital compared to the state average in 2006

The risk-adjusted patient mortality estimates from bypass surgery for each hospital in 2006 are presented in Table D2.

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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 average.

(Source: Breslow, NE & Day NE, Statistical Methods in Cancer Research: Vol II,The design and analysis of cohort studies, International Agency for Research on Cancer, Lyon, 1988.)

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

The observed operative mortality rate statewide in 2006 for bypass patients was 2.00 percent, based on 104 deaths out of 5,211 bypass operations performed. Table D2 (Col. 4) presents the observed CABG surgery mortality rate for each of the 18 hospitals.

Table D2

Comparing Hospitals' Patient Operative Mortality* from Bypass Surgery to the State Average (2006)

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	148	3	2.03	2.53	1.60	(0.32, 4.68)	6.61
Cooper Hospital/University M.C. +	225	13	5.78	2.02	5.72	(3.04, 9.78)	6.10
Deborah Heart and Lung Center ^	299	8	2.68	2.68	2.00	(0.86, 3.93)	6.40
Englewood Hospital	102	0	0.00	1.56	0.00	(0, 4.60)	6.20
Hackensack University Medical Center	494	12	2.43	2.11	2.30	(1.19, 4.02)	6.36
Jersey City Medical center	66	1	1.52	1.79	1.69	(0.02, 9.42)	8.01
Jersey Shore Univ Medical Center	605	7	1.16	1.66	1.40	(0.56, 2.87)	5.86
Morristown Memorial Hospital	690	9	1.30	1.73	1.50	(0.69, 2.85)	6.23
Newark Beth Israel Med. Center	184	4	2.17	1.64	2.64	(0.71, 6.76)	6.58
Our Lady of Lourdes Medical Center	419	12	2.86	2.04	2.80	(1.44, 4.89)	7.34
Robert Wood Johnson Univ. Hosp.	519	15	2.89	2.09	2.77	(1.55, 4.56)	6.71
St. Barnabas Medical Center	244	3	1.23	1.50	1.64	(0.33, 4.78)	6.31
St. Francis Medical Center	119	1	0.84	2.25	0.75	(0.01, 4.15)	6.49
St. Joseph's Hosp. & Med. Center	153	1	0.65	2.57	0.51	(0.01, 2.82)	6.58
St. Mary's Hospital (Passiac)	117	0	0.00	1.24	0.00	(0, 5.03)	5.65
St. Michael's Medical Center	383	9	2.35	2.87	1.63	(0.75, 3.1)	5.41
UMDNJ - University Hospital	100	1	1.00	1.40	1.42	(0.02, 7.92)	5.66
Valley Hospital	344	5	1.45	1.76	1.65	(0.53, 3.85)	6.54
State Total (2006)	5,211	104	2.00	2.00	2.00		6.32

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.

^ Facility refused to sign-off on its data.
\+ Facility RAMR was statistically significantly higher than the statewide average

Annual risk-adjusted mortality compared to the combined 1994-2006 risk-adjusted mortality

Table D3 presents the results of an analysis to identify the trend in the statewide mortality rate of patients who underwent bypass surgery using a statistical model based on the pooled data collected over the period 1994–2006. 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 average mortality rate obtained for the 1994-2006 period.

Table D3 also shows that between 2005 and 2006, the number of bypass surgeries performed in New Jersey declined from 5,576 to 5,211 or by 6.55 percent. Over the same time period, the number of deaths declined from 117 to 104 or by 11.1 percent. On risk-adjusted basis, the mortality rate declined by 5.1 percent between 2005 and 2006 and has declined by 53.7 percent since 1994.

The trend in operative CABG mortality between 1994 and 2006 was estimated by fitting a regression line to 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 0.21 percent per year between 1994 and 2006 ($R2 = 0.87$).

Table D3

Annual Risk-Adjusted Patient Operative Mortality Rate* Derived from the Pooled Data for the Period (1994-2006)

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	2.64	4.44	**HI**	----	----
1995	7,553	327	4.33	2.85	4.52	**HI**	0.08	1.8
1996	8,262	341	4.13	3.02	4.07	**HI**	-0.45	-8.3
1997	8,286	280	3.38	3.16	3.18	**SA**	-0.89	-28.4
1998	8,377	252	3.01	3.07	2.92	**SA**	-0.26	-34.3
1999	8,108	268	3.31	3.25	3.02	**SA**	0.11	-31.9
2000	8,220	220	2.68	2.90	2.75	**SA**	-0.28	-38.1
2001	8,045	202	2.51	2.98	2.51	**LO**	-0.24	-43.6
2002	7,391	159	2.15	3.00	2.13	**LO**	-0.37	-51.9
2003	6,817	159	2.33	3.02	2.30	**LO**	0.16	-48.2
2004	6,177	122	1.98	2.89	2.04	**LO**	-0.26	-54.1
2005	5,576	117	2.10	2.88	2.17	**LO**	0.13	-51.2
2006	5,211	104	2.00	2.89	2.06	**LO**	-0.11	-53.7
1994 - 2006	**94,980**	**2,825**	**2.97**	**2.97**	**2.97**			

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.

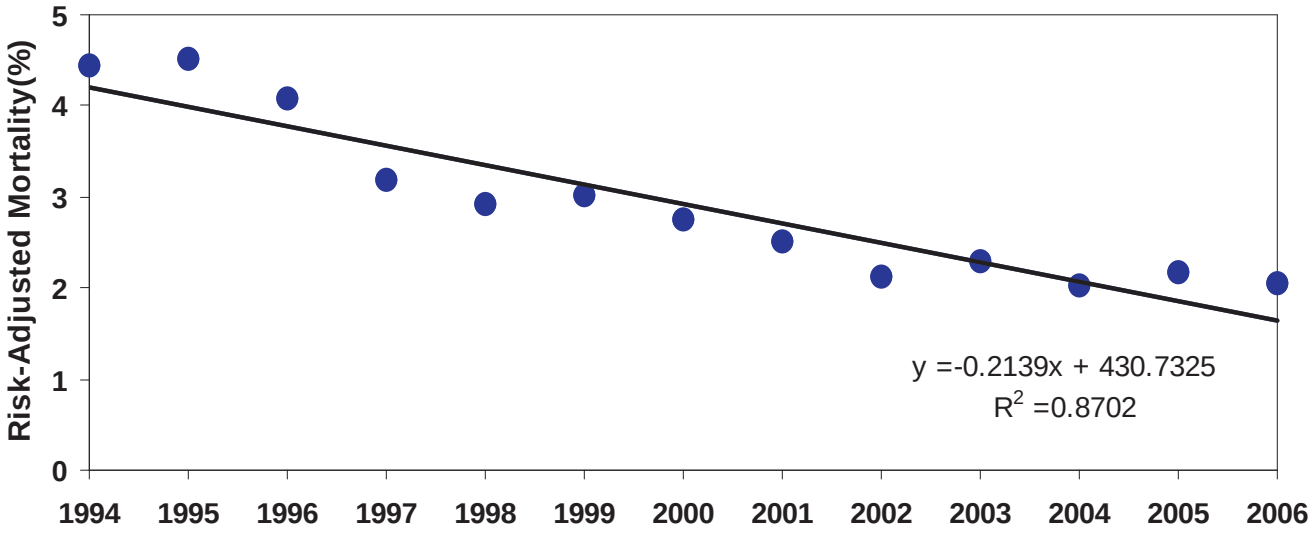
LO - The risk-adjusted patient mortality is significantly lower than the state average mortality for the 1994-2006 period when evaluated with a 95 percent confidence interval.

SA - The risk-adjusted patient mortality is same as the state average mortality for the 1994-2006 period when evaluated with a 95 percent confidence interval.

HI - The risk-adjusted patient mortality is significantly higher than the state average mortality for the 1994-2006 period when evaluated with a 95 percent confidence interval

Figure D1

Trend in Risk-Adjusted Operative Mortality* Rate (1994-2006)



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 provide a patient's average length of stay post-surgery, 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 average lengths 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 20.3 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 Bypass Surgery Length of Stay (2006)

Patient Risk Factors Identified	Proportion of patients(%)	Generalized Linear Regression Results	
		Coefficient	P-Value
Demographic factors			
Age (in years) Squared	---	0.0001	<0.0001
Female	24.71	0.0501	0.0001
African American	6.66	0.0843	0.0001
Health factors			
Diabetes - Insulin	10.66	0.1072	<0.0001
Diabetes - Oral Medication	23.76	0.0377	0.0039
Lung Disease - Mild	9.69	0.0716	<0.0001
Lung Disease - Moderate	4.36	0.1104	<0.0001
Lung Disease - Severe	2.38	0.1657	<0.0001
Obesity	11.06	0.0907	<0.0001
Peripheral Vascular Disease	15.95	0.0428	0.0046
Renal Failure with Dialysis	1.82	0.1753	<0.0001
Renal Failure without Dialysis	3.45	0.1993	<0.0001
Factors related to functioning of the heart			
Arrhythmia	11.21	0.0914	<0.0001
Cardiogenic Shock	1.51	0.1572	0.0010
Congestive Heart Failure	16.33	0.1175	<0.0001
Ejection Fraction less than 1 - 29%	7.27	0.1422	<0.0001
Myocardial Infarction < 24 Hours	2.64	0.1052	0.0070
Myocardial Infarction 1 - 21 Days	21.91	0.0417	0.0029
Number of Diseased Vessels - Three	76.24	0.0680	<0.0001
Urgent Status	59.58	0.0609	<0.0001
Emergent Status	3.94	0.2189	<0.0001
Previous Surgery	2.66	0.1410	<0.0001
Intercept	1.3230		
R-Square	20.28		
Number of CABGs (N)*	5,047		

SOURCE: New Jersey Department of Health and Senior Services.

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

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