HCQA Health Care Quality Assessment

Cardiac Surgery in New Jersey 2004

Health Care Quality Assessment
Office of the Commissioner

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Jon S. Corzine
Governor

Fred M. Jacobs, M.D., J.D.
Commissioner

Message From The Commissioner

I am pleased to present Cardiac Surgery in New Jersey 2004, the state's ninth consumer report on coronary artery bypass graft surgery. This report summarizes the results of an analysis of mortality among patients who underwent bypass surgery in New Jersey hospitals in 2004.

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 54.5 percent reduction in operative mortality between 1994 and 2004. This is a remarkable tribute to the hospitals' and surgeons' commitment to making cardiac surgery safer.

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.

The Department 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 information on length of hospital stay after cardiac bypass surgery. It also provides information on the total number of cardiac surgeries physicians perform, 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.

Fred M. Jacobs, M.D., J.D.
Commissioner

NEW JERSEY DEPARTMENT of HEALTH and SENIOR SERVICES

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Executive Summary

The Department of Health and Senior Services collected data on patients undergoing open heart surgery at 17 hospitals in 2004. Of these patients, 6,177 had coronary artery bypass graft (CABG) surgery with no other major surgery during the same admission.

The primary 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 an expert clinical panel, 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 2004 data analysis are as follows:

- In 2004, there were 9,872 total open heart surgeries performed in New Jersey by hospitals covered in this report, of which 6,177 were isolated CABG surgeries.

- Of the 6,177 isolated CABG surgery patients, 122 died while in the hospital or within 30 days after surgery.

- The statewide observed operative mortality rate for isolated CABG surgery patients in 2004 was 1.98 percent and represents a 15 percent decline over 2003. When comparing 2003 and 2004 mortality rates on a risk-adjusted basis, the decline was 11.6 percent. This decline was not statistically significant.

- A review of ten years of pooled data suggests that the risk- adjusted patient mortality in New Jersey has declined by 54.5 percent between 1994 and 2004.

- In 2004, Hackensack University Medical Center had a significantly lower risk-adjusted mortality rate than the state average, while Our Lady of Lourdes Medical Center and UMDNJ-University Hospital had significantly higher risk-adjusted mortality rates. Notably, Englewood Hospital and Medical Center's observed mortality rate in 2004 was zero. However, this rate was not statistically significantly lower than the statewide average, when compared on a risk-adjusted basis.

- In the period 2003-2004, three surgeons, Dr. Jonathan H. Cilley of Cooper Hospital/University Medical Center, Dr. Christopher Derivaux of Our Lady of Lourdes Medical Center, and Dr. Raj Kaushik of PBI Regional Medical Center had significantly higher risk-adjusted mortality rates than the statewide average. By comparison, Dr. James Dralle of AtlantiCare Regional Medical Center, Dr. Mark W. Connolly of Cathedral - St. Michael's Medical Center, and Dr. Elie Elmann of Hackensack University Medical Center had significantly lower risk-adjusted mortality rates than the statewide average. Although these rates were not statistically significantly different from the statewide average, it is nevertheless notable that Dr. James Klein of Englewood Hospital and Medical Center and Dr. Frederic F. Sardari of Newark Beth Israel Medical Center had no deaths during this two-year period.

- As expected, the risk of death from isolated CABG surgery increases with age.

- Not surprisingly, sicker patients were at greater risk:
  - An isolated CABG surgery patient who had cerebrovascular disease prior to the surgery was 1.83 times as likely to die after an isolated CABG surgery compared with a patient who had no cerebrovascular disease.
  - An isolated CABG surgery patient with mild lung disease was more than twice (odds ratio = 2.39) as likely to die after CABG surgery

compared with a patient who had no lung disease. By comparison, a patient with severe lung disease was about five times (odds ratio = 4.84) as likely to die after isolated CABG surgery as a patient who had no lung disease.

— Previous heart surgery, low ejection fraction, and renal failure were also significantly associated with higher CABG surgery mortality among New Jersey patients*.

- The average length of hospital stay for a typical CABG surgery patient in 2004 was 6.43 days.
- There was a general tendency for high mortality hospitals to be associated with increased length of stay but this relationship was not statistically significant.
- There were more pronounced differences in length of stay by surgeon. Individual surgeon averages ranged from 5.64 days to 7.38 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. It provides mortality rates for the 17 hospitals that performed cardiac surgery in 2004 and the physicians performing this common cardiac surgical procedure in 2003-2004. As part of the Department's continued effort to provide information to consumers, this report also includes – for the first time – information on hospital length of stay. The report provides risk-adjusted length of initial hospital stay for CABG surgery patients, by hospital and by eligible surgeon.

For this study, the Department of Health and Senior Services collected data on the 6,177 patients who had bypass surgery with no other major surgery during the same admission in 2004. This is the most recent year for which a complete, audited data set is available. All data have been "risk-adjusted," which means that data 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 2004, the observed mortality rate of 1.98 percent is lower than the 2.33 percent mortality rate for 2003, suggesting a downward trend. When data from all years are pooled and analyzed, the resulting 11.6 percent decrease in the risk-adjusted mortality rate from 2003 to 2004 is not statistically significant.

Another goal of the report is to give patients and physicians information to use in discussing questions and issues related to bypass surgery. Please

remember that the numbers in this guide are just one factor 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 guide are from 2004, while surgeon data refer to 2003 and 2004 combined. These data may not reflect the current performance of specific hospitals, which may have revamped their programs since then.

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 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 current definition is discussed in greater detail later in this report.

Heart disease and cardiac surgery in New Jersey

Heart disease is the single largest killer of Americans. About 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, cardiovascular disease, including heart disease, is the leading cause of death, with heart disease alone accounting for 21,801 deaths in 2003 for an age-standardized death rate of 2.32 per 1,000. The age-standardized death rate was higher among males (death rates = 2.84 per 1,000) compared with females (death rates = 1.94 per 1,000). The New Jersey data also show variations in heart disease mortality by race where blacks died at the rate of 2.63 per 1,000 compared with 2.31 for whites (see http://njshad.doh.state.nj.us/).

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. It describes the performance records of 17 hospitals in New Jersey that offered this type of surgery in 2004 and the surgeons who performed this operation at least 100 times between January 2003 and December 2004. The information in this report can help you in discussions with your doctor about bypass surgery.

Performance data

In 2004, there were 6,177 isolated bypass surgeries performed in New Jersey. 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 122, or 1.98 percent of those who underwent the surgery. This number (i.e. the number of isolated bypass surgery deaths) is used to calculate a mortality rate that is used as a performance measure.

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.

Applying the revised definition 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 4. (See Appendix C for the statewide operative mortality rate estimates for years 1994-2004.)

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 lung disease and renal failure would be at higher risk during this surgery than a 60-year-old who had no history of chronic disease.

In order to produce fair comparisons, the Department applied a methodology that estimates risk-adjusted mortality rates. The risk-adjusted mortality rate gives "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 was black or African American
- whether the patient has various preoperative risk factors, such as renal failure, cerebrovascular disease, low ejection fraction, mild to severe lung disease;
- whether the patient has preoperative cardiac status, like:
  - cardiogenic shock;
  - severe activity limitation;
- whether the patient had any previous open heart surgery.

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 fairer 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 11.6 percent from 2003 to 2004. 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 suggests these reports

contribute to the decline in mortality rates and overall improvement in the quality of bypass surgery.

Hospitals

In 2004, 17 hospitals in New Jersey were licensed to perform coronary artery bypass graft surgery. Jersey City Medical Center, which was licensed in November 2004, will be included in future reports, when a full calendar year of data is available.

This report provides risk-adjusted mortality rates for each of the 17 hospitals. You will see that there are variations among the hospitals. Through statistical analysis, the Department is able to determine in which cases the variations reflect real differences in performance, and not different levels of risk among patients or random variation.

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 49 surgeons who performed at least 100 bypass operations in one hospital in the years 2003 and 2004 combined. Even though two years of data were combined, some surgeons still fell short of the 100 cases the Department considers the minimum needed to calculate reliable risk-adjusted mortality rates. 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 1). Please note that this report does indicate the total number of open heart and CABG-only surgeries the low volume surgeons performed, as well as their number of CABG-only 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 2004

Figure 1 shows the number of bypass operations performed in 2004 in each of the 17 hospitals. You can see that some hospitals do more of these procedures than others, with totals ranging from a low of 102 to a high of 755 with the median being 290. Bypass surgery volume has been declining in New Jersey as angioplasty increasingly is substituted. Since bypass is the most common type of cardiac surgery, between 2000 and 2006 the overall volume of cardiac surgery has declined by 25.4 percent.

Statewide performance

In 2004, the observed operative isolated CABG surgery mortality rate for the state was 1.98 percent, based on data on the 6,177 patients who underwent this surgery.

Hospital risk-adjusted mortality: 2004

Figure 2 shows the risk-adjusted mortality rate for each New Jersey hospital performing bypass surgery in 2004. 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.

The vertical line on Figure 2 represents New Jersey's statewide isolated CABG surgery operative mortality rate per 100 cases for 2004, i.e. 1.98. Each hospital's performance is displayed graphically in relation to this statewide average.

Figure 2 shows that one hospital - Hackensack University Medical Center - has its bar completely to the left of the statewide average line. This means that this hospital had a risk-adjusted mortality rate significantly below the statewide average. Two other hospitals – Our Lady of Lourdes Medical Center and UMDNJ-University Hospital – had their bars completely to the right of the statewide average line. This means that these hospitals had risk-adjusted mortality rates significantly above the statewide average.

The remaining 14 hospitals have bars that cross the statewide 1.98 percent average line. That means that their risk-adjusted mortality rates were not statistically different from the statewide average. Although it seems counterintuitive, Englewood Hospital and Medical Center's observed zero mortality rate in 2004 was not statistically significantly lower than the statewide average.

Statistical significance

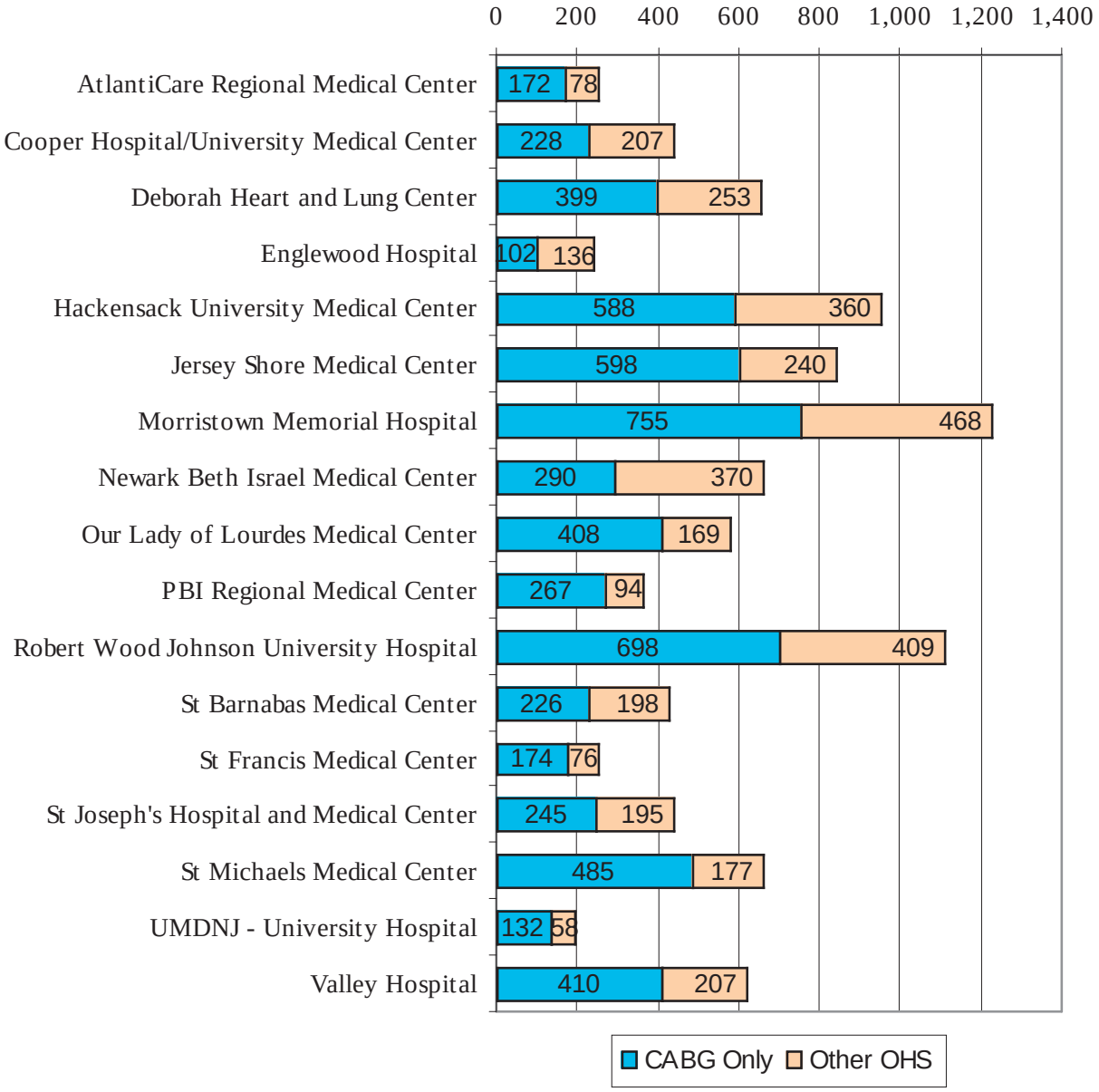
In trying to determine a hospital's or surgeon's performance, it is important to account for the fact that some differences occur simply due to chance or random variation. Statistical tests are conducted on the data so that we can be as certain as possible that the differences are due to actual differences in performance. A difference is called **"statistically significant"** when it is too large to be due to chance or random variation.

The dark line in the middle of each hospital's bar represents its risk-adjusted mortality rate. However, we cannot really be certain that this number is the precise rate. We can only be relatively sure that the true rate falls somewhere on 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 calculation of that 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 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.

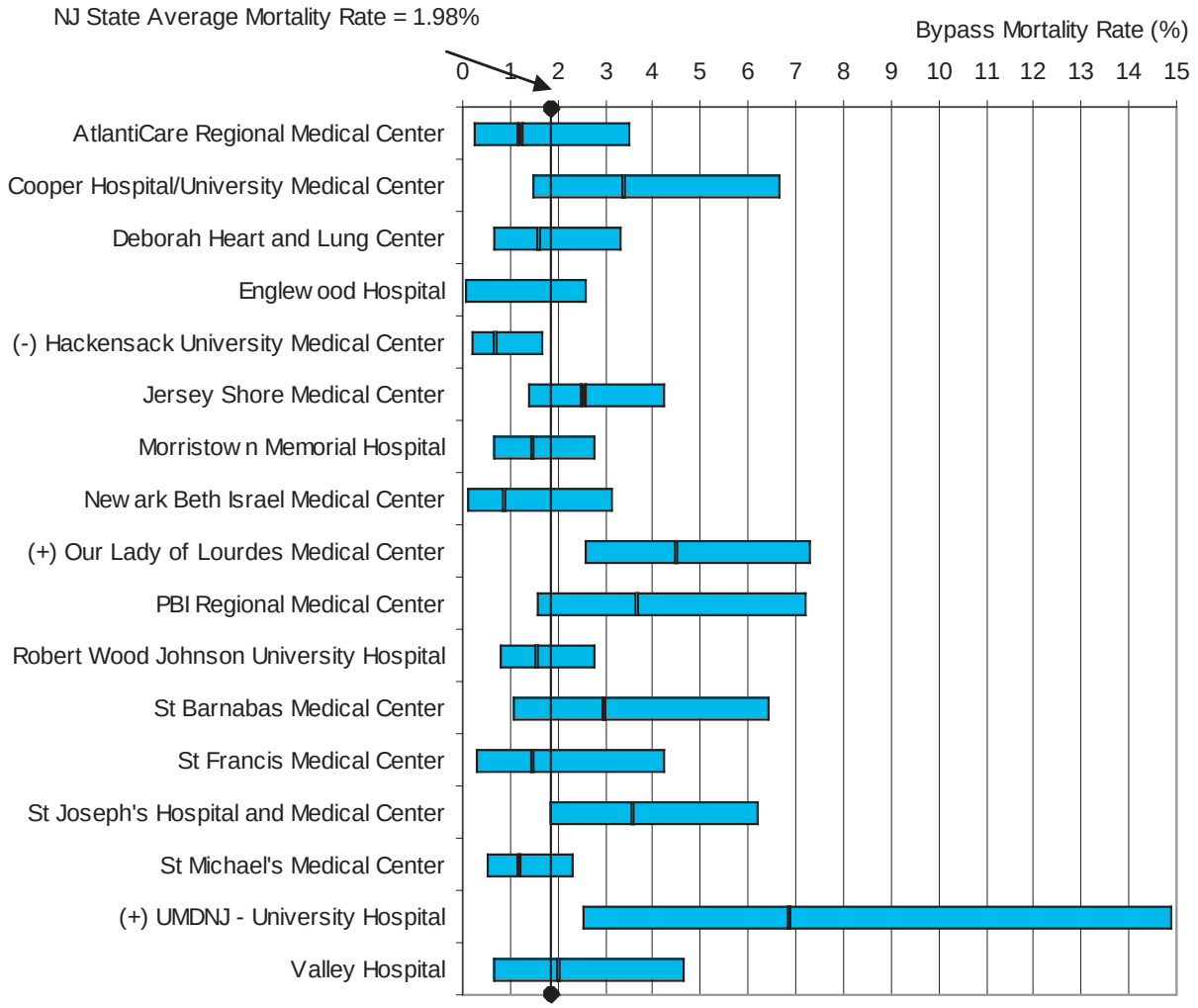
In examining the charts, you will see that some bars are shorter than others. The bar is shorter for hospitals or surgeons performing more surgeries, and longer for those with lower volumes. This reflects the fact that larger numbers -- in this case, more surgeries -- increase the precision of a statistic.

Figure 1
Number of Isolated Coronary Artery Bypass Graft Surgeries vs. Other Surgeries (2004)



SOURCE: New Jersey Department of Health and Senior Services

Figure 2
Risk-Adjusted Operative Mortality Rate* by Hospital (2004)



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 higher than the New Jersey mortality rate based on 95 percent confidence interval.

\- = Risk-adjusted mortality rate significantly lower than the New Jersey mortality rate based on 95 percent confidence interval.

Length of Stay by Hospital

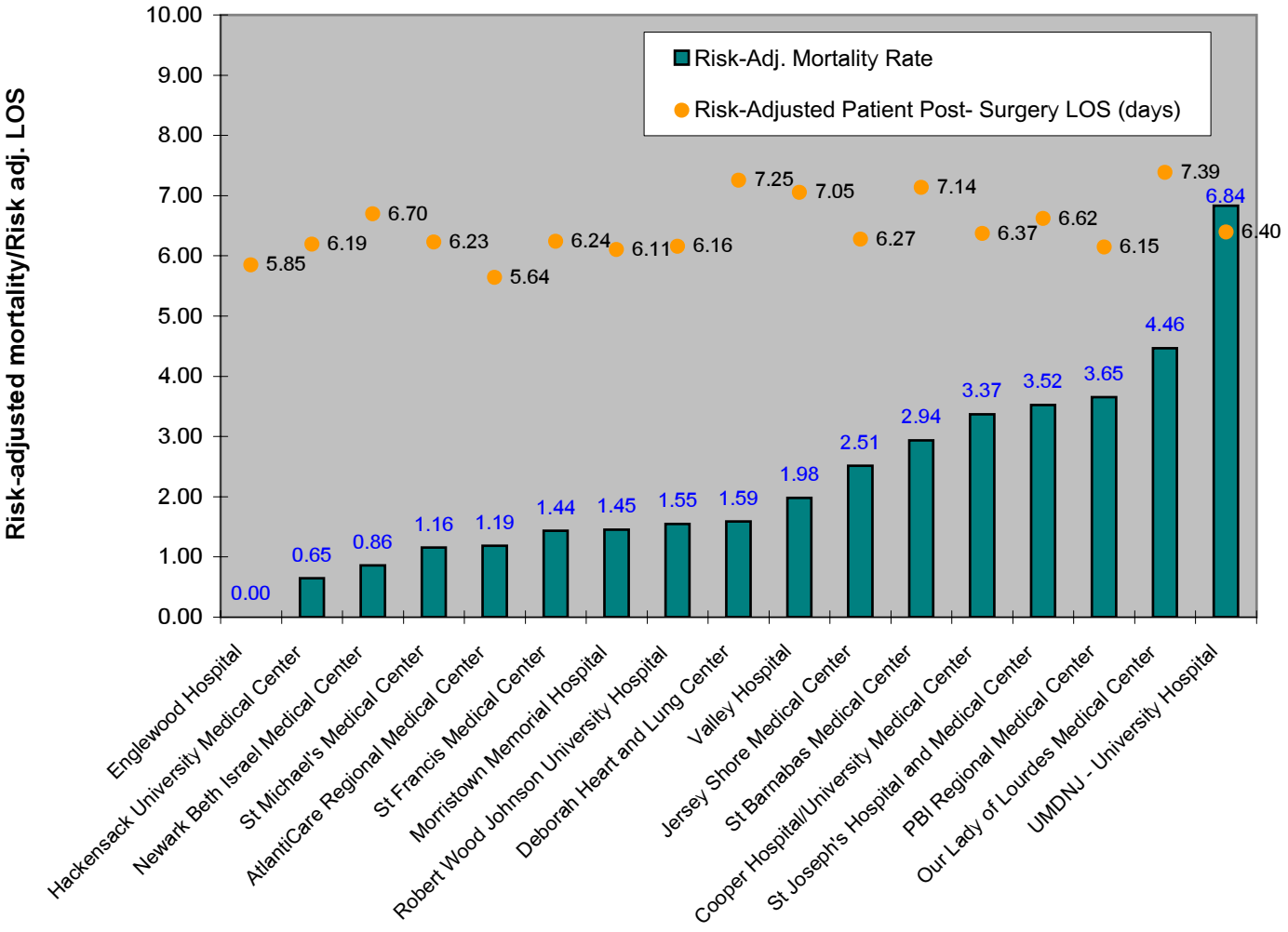
For the first time, the Department has included information on length of stay as an additional tool to monitor hospital and surgeon performance on CABG surgery. The risk-adjustment model excluded in-hospital deaths, very low lengths of stay (low outliers) and very long lengths of stay (high outliers) 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 5.64 days to 7.39 days and the statewide average is 6.43 days. Hospitals with high risk-adjusted mortality rates also tended to have longer lengths of stay, although the relationship was not statistically significant. (See Tables D2 and D4).

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, 2004



Individual surgeon performance

Figure 4 and Table 1 show the risk-adjusted mortality rate for each of the 49 surgeons who performed at least 100 isolated bypass surgery operations in one hospital in New Jersey in the years 2003 and 2004 combined. In addition, Table 1 shows the risk-adjusted length of initial hospital.

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 developed. 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 or a group of surgeons (i.e. "All Others") only if 100 or more bypass surgeries were performed by the.

Once again, the vertical line on Figure 4 represents the statewide operative mortality rate for 2003-2004 combined. Note that, because two years' data is combined, the statewide operative mortality rate for surgeons is 2.16 percent, in contrast to the 1.98 percent mortality rate obtained from 2004 only (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 2003-2004, three surgeons had bars 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.

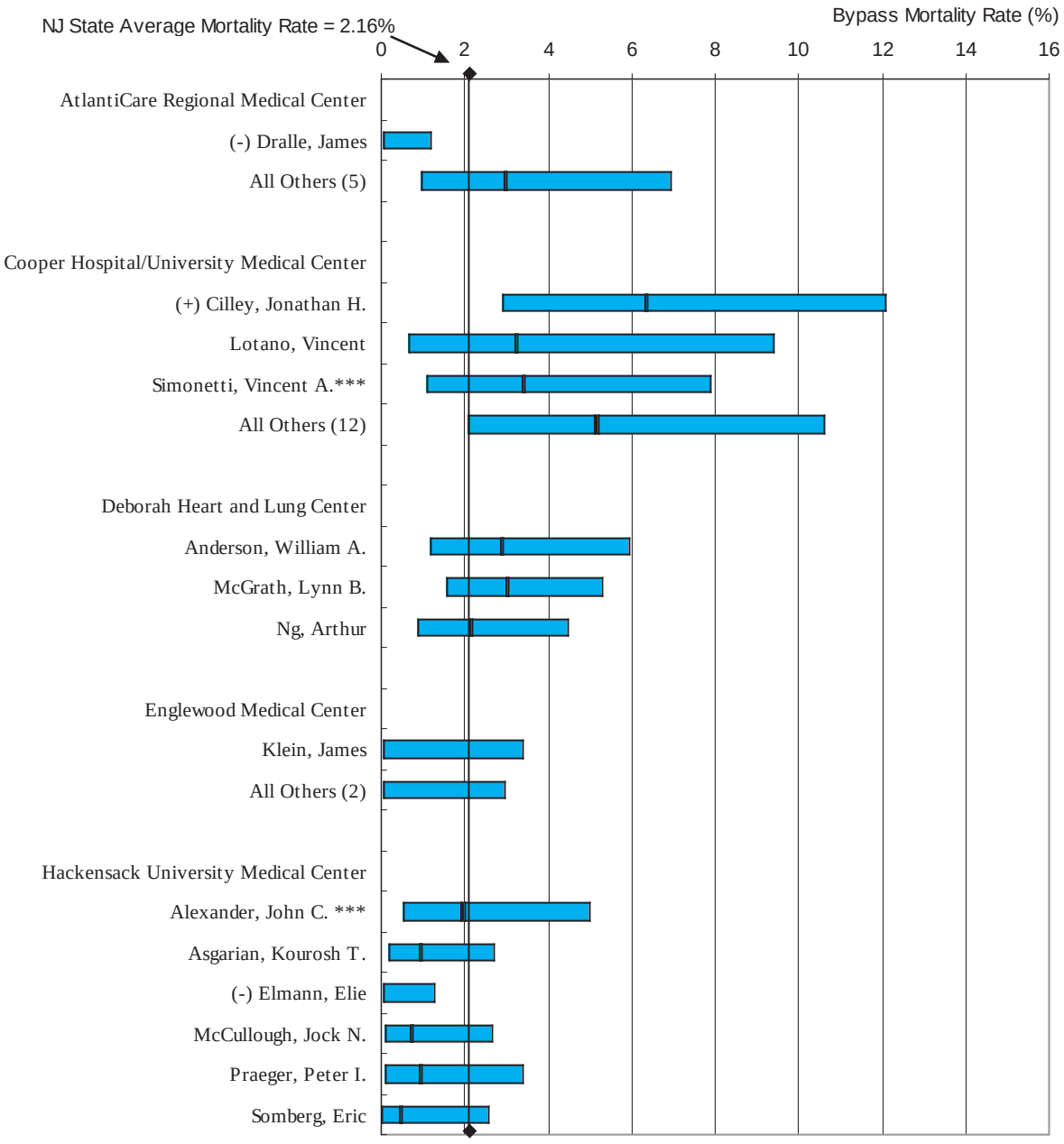
If a surgeon has a bar completely to the right of the statewide average line, it means that the surgeon's mortality rate was significantly higher than the statewide average for this two-year period.

Three surgeons in New Jersey, Dr. Jonathan H. Cilley of Cooper Hospital/University Medical Center, Dr. Christopher Derivaux of Our Lady of Lourdes Medical Center, and Dr. Raj Kaushik of PBI Regional Medical Center, had bars completely to the right of the line, indicating statistically significantly higher mortality rates. On the other hand, Dr. James Dralle of AtlantiCare Regional Medical Center, Dr. Mark W. Connolly of Cathedral - St. Michael's Medical Center, and Dr. Elie Elmann of Hackensack University Medical Center had bars completely to the left of the line, indicating statistically significantly lower mortality rates. It is notable that one surgeon, Dr. James Klein of Englewood Hospital and Medical Center, had no deaths during this two-year period. However, although it seems counterintuitive, his corresponding risk-adjusted mortality rate was not statistically significantly lower than the statewide average.

For the first time in this report, the Department also presents length of stay associated with each surgeon who has performed at least 100 CABG surgeries. Length of stay is provided here as an additional tool for consumers, physicians and family members to help them make informed decisions.

In addition to risk-adjusted mortality for surgeons, Table 1 also shows risk-adjusted patient length of stay for each surgeon who performed at least 100 CABG surgeries in the 2003-2004 reporting period. The statewide average length of stay for the 2003-2004 reporting period was 6.44 days. There is an important variation in length of stay by eligible surgeon where the shortest length of stay was 5.61 days while the longest was 7.79 days. The median risk-adjusted length of stay was 6.37 days, which is about the same as the statewide average of 6.44 days.

Figure 4
Surgeon Risk-Adjusted Operative Mortality* Rate (2003-2004)



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.

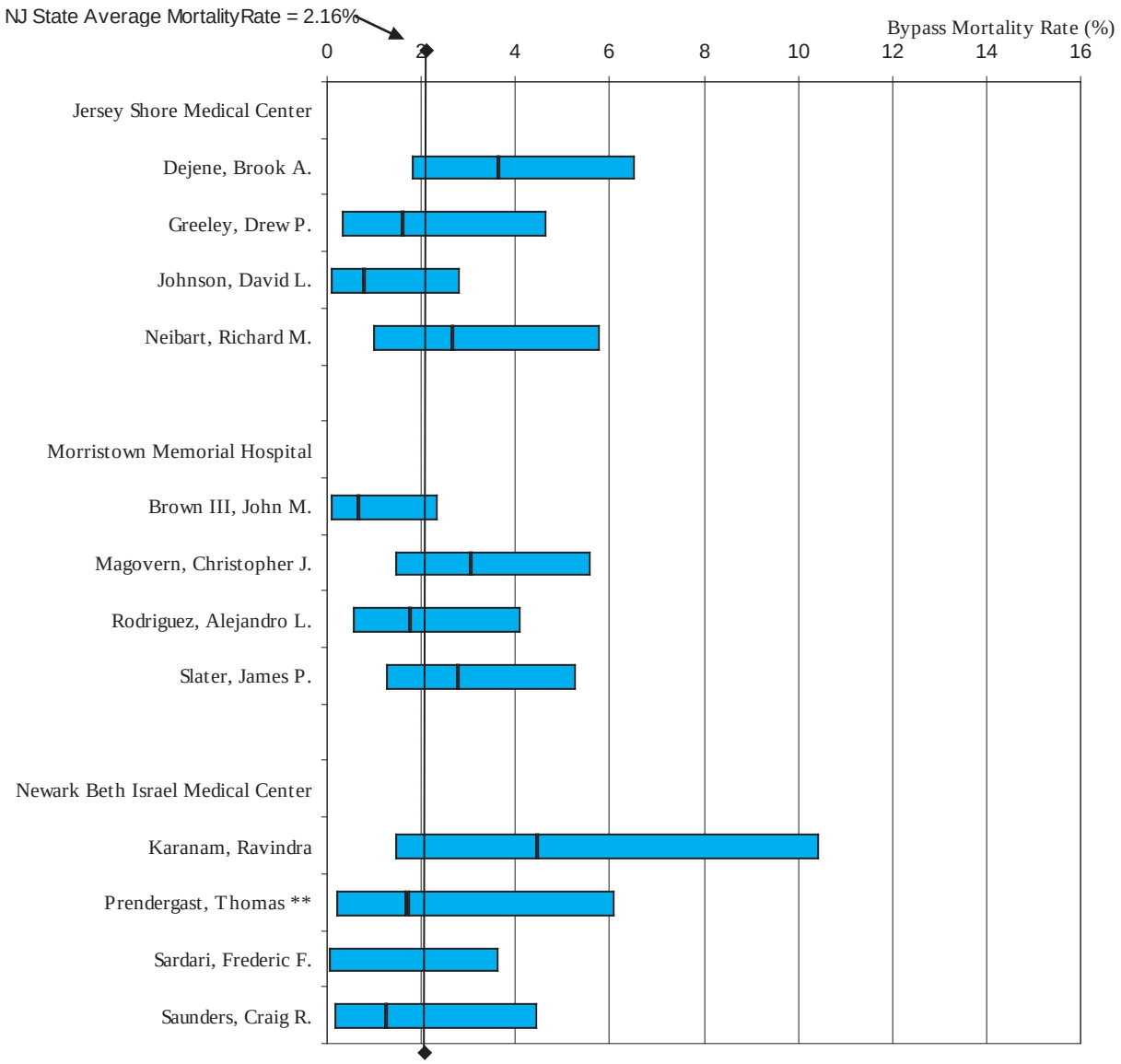
(-) = Risk-adjusted mortality rate significantly lower than the New Jersey mortality rate, based on 95 percent confidence interval.

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

** = 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 (2003-2004)



SOURCE: New Jersey Department of Health and Senior Services.

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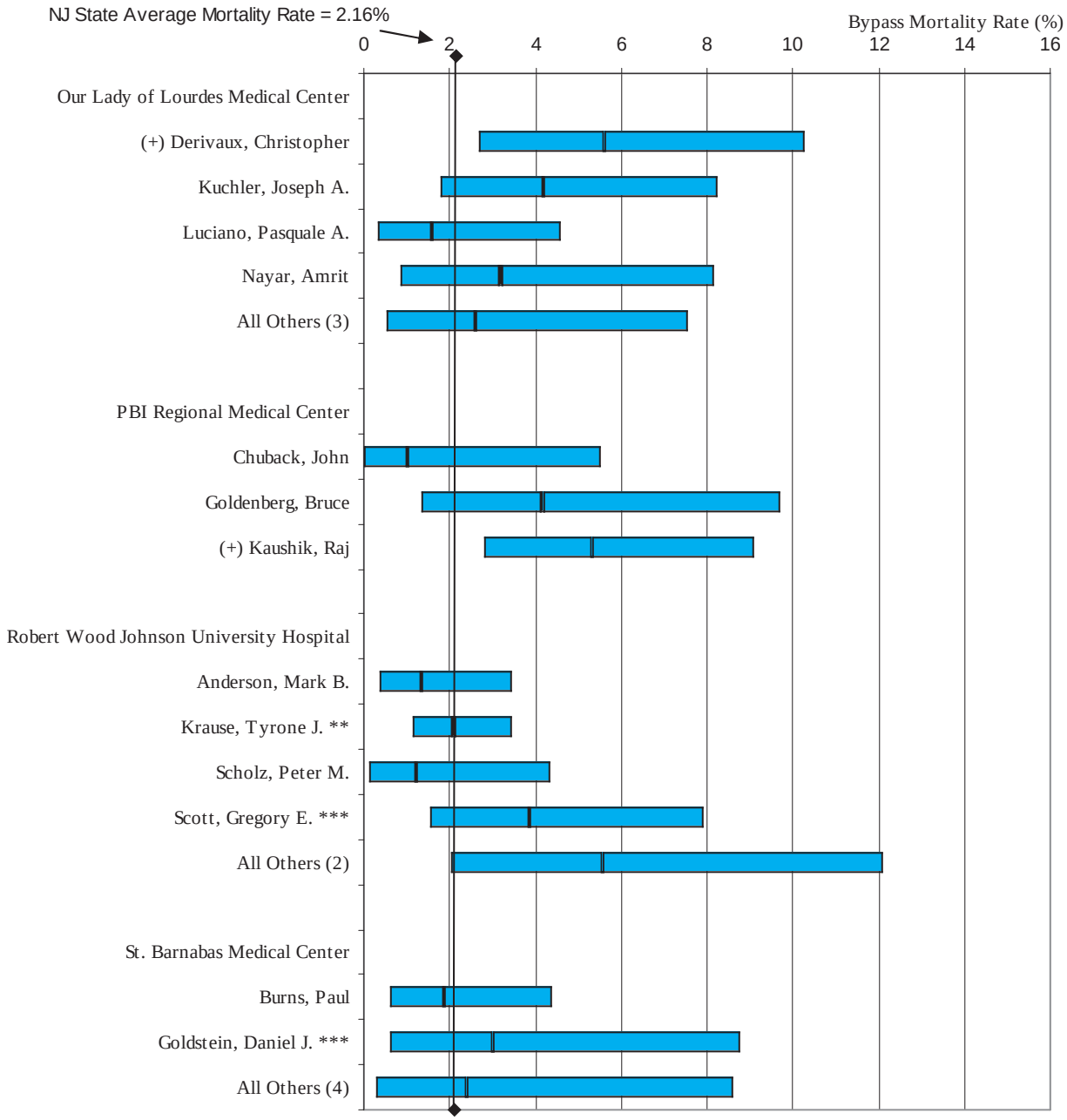
Figure 4 (continued)
Surgeon Risk-Adjusted Operative Mortality* Rate (2003-2004)



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

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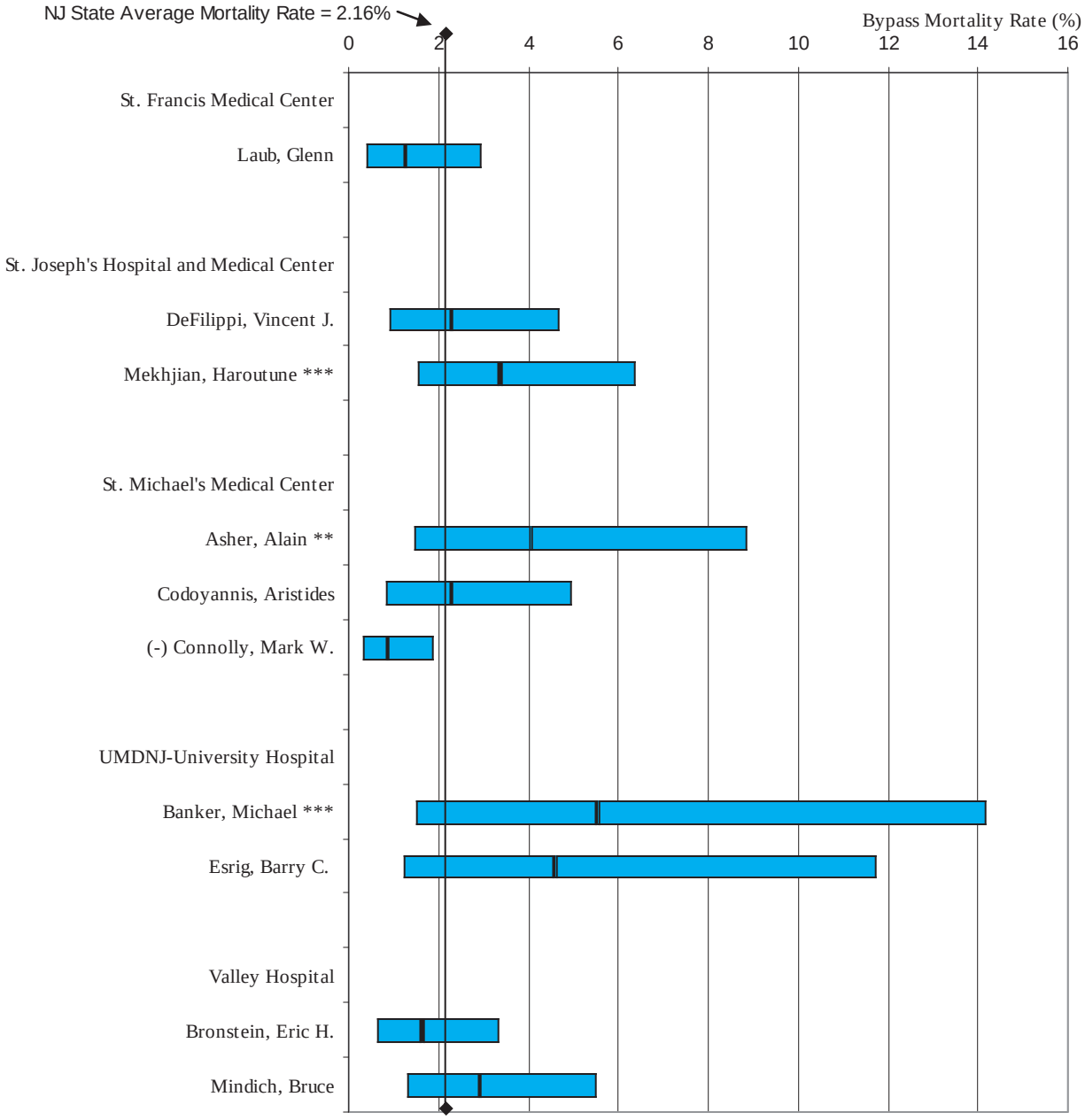
*** = Surgeon not currently performing CABG surgery in New Jersey.

Figure 4 (continued)
Surgeon Risk-Adjusted Operative Mortality* Rate (2003-2004)



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.

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

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

Table 1

Patient Risk-Adjusted Operative Mortality* Rate for Surgeons (2003-2004)

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	Post-Surgery Length of Stay
AtlantiCare Regional Medical Center									
Dralle, James	322	224	0	0.00	3.06	0.00	**LO**	(0.0, 1.16)	5.80
All Others (5)	163	125	5	4.00	2.91	2.97		(0.96, 6.94)	5.85
Axelrod, Howard	59	39	1						
Ciuffo, Giovanni ++	7	4	0						
Eugene, Grossi ++	16	10	1						
Schwartz, Charles ++	2	2	0						
Yun, Jaime ++	79	70	3						
Cooper Hospital/University Medical Center									
Cilley, Jonathan H.	200	112	9	8.04	2.74	6.34	**HI**	(2.90, 12.05)	6.34
Lotano, Vincent	164	115	3	2.61	1.76	3.20		(0.64, 9.36)	6.39
Simonetti, Vincent A. ++	193	119	5	4.20	2.69	3.38		(1.09, 7.88)	6.52
All Others (12)	260	102	7	6.86	2.88	5.15		(2.06, 10.61)	6.78
Antinori, Charles H. ++	28	19	2						
Burns, Richard	3	0	0						
Dandrea, Joseph	1	0	0						
DelRossi, Anthony J.	165	57	3						
Eakins, James	1	0	0						
Karam, Joseph A. ++	1	0	0						
Marra, Steven W.	50	25	2						
Monk, Scott ++	2	0	0						
Robinson, Donald ++	3	0	0						
Ross, Steven E.	2	0	0						
Sariol, Hector ++	3	0	0						
Villanueva, Dioscoro S. ++	1	1	0						
Deborah Heart and Lung Center									
Anderson, William A.	354	240	7	2.92	2.19	2.88		(1.15, 5.93)	7.30
McGrath, Lynn B.	683	401	12	2.99	2.15	3.01		(1.55, 5.26)	7.79
Ng, Arthur	382	224	7	3.13	3.13	2.16		(0.86, 4.45)	7.40
Englewood Hospital & Medical Center									
Klein, James	233	112	0	0.00	2.11	0.00		(0.00, 3.35)	6.09
All Others (2)	245	108	0	0.00	2.50	0.00		(0.00, 2.93)	5.97
Ergin, Arisan M.	176	69	0						
McMurtry, Kirk	69	39	0						
Hackensack University Medical Center									
Alexander, John C. ++	321	158	4	2.53	2.81	1.95		(0.52, 4.98)	6.15
Asgarian, Kourosh T.	374	229	3	1.31	3.10	0.92		(0.18, 2.67)	6.08
Elmann, Elie	327	194	0	0.00	3.34	0.00	**LO**	(0.00, 1.23)	6.44
McCullough, Jock N.	343	207	2	0.97	2.86	0.73		(0.08, 2.64)	5.82
Praeger, Peter I.	244	175	2	1.14	2.65	0.93		(0.10, 3.36)	6.51
Somberg, Eric	311	220	1	0.45	2.14	0.46		(0.01, 2.56)	6.52

* 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 1 (continued)

Patient Risk-Adjusted Operative Mortality* Rate for Surgeons (2003-2004)

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	Post-Surgery Length of Stay
Jersey Shore University Medical Center								
Dejene, Brook A.	411	320	11	3.44	2.05	3.62	(1.81, 6.48)	6.16
Greeley, Drew P.	423	278	3	1.08	1.48	1.57	(0.32, 4.60)	5.78
Johnson, David L.	439	320	2	0.63	1.76	0.77	(0.09, 2.77)	6.18
Neibart, Richard M.	416	316	6	1.90	1.55	2.65	(0.97, 5.76)	6.09
Morristown Memorial Hospital								
Brown III, John M.	736	379	2	0.53	1.79	0.64	(0.07, 2.31)	6.00
Magovern, Christopher J.	574	390	10	2.56	1.83	3.03	(1.45, 5.56)	5.93
Rodriguez, Alejandro L.	545	392	5	1.28	1.59	1.74	(0.56, 4.06)	6.53
Slater, James P.	557	396	9	2.27	1.78	2.76	(1.26, 5.23)	6.15
All Others (1)	177	55	0					
Parr, Grant V. S. ++	175	55	0					
Newark Beth Israel Medical Center								
Karanam, Ravindra	311	153	5	3.27	1.59	4.45	(1.43, 10.39)	6.34
Prendergast, Thomas +	360	186	2	1.08	1.39	1.68	(0.19, 6.05)	6.69
Sardari, Frederic F.	221	127	0	0.00	1.76	0.00	(0.00, 3.56)	6.60
Saunders, Craig R.	355	144	2	1.39	2.45	1.23	(0.14, 4.43)	6.40
All Others (2)	103	31	0	0.00	1.28	0.00	(0.00, 19.92)	5.58
Burns, Paul	4	4	0					
Goldstein, Daniel J. ++	99	27	0					
Our Lady of Lourdes Medical Center								
Derivaux, Christopher	188	168	10	5.95	2.31	5.57 **HI**	(2.67, 10.25)	7.49
Kuchler, Joseph A.	351	214	8	3.74	1.95	4.15	(1.79, 8.18)	7.43
Luciano, Pasquale A.	297	230	3	1.30	1.82	1.55	(0.31, 4.54)	7.36
Nayar, Amrit	209	123	4	3.25	2.22	3.17	(0.85, 8.12)	7.14
All Others (3)	177	126	3	2.38	2.00	2.57	(0.52, 7.51)	8.21
DiPaola, Douglas J. ++	70	51	1					
Eisen, Morris M. ++	70	53	1					
Heim, John A. ++	37	22	1					
PBI Regional Medical Center								
Chuback, John	172	138	1	0.72	1.59	0.98	(0.01, 5.48)	6.35
Goldenberg, Bruce	200	140	5	3.57	1.87	4.14	(1.33, 9.66)	5.91
Kaushik, Raj	341	232	13	5.60	2.29	5.29 **HI**	(2.81, 9.04)	6.37
All Others (1)	21	19	0					
Jihayel, Ayad K. ++	21	19	0					
Robert Wood Johnson University Hospital								
Anderson, Mark B.	471	308	4	1.30	2.10	1.33	(0.36, 3.42)	6.15
Krause, Tyrone J. +	1,054	731	15	2.05	2.15	2.07	(1.16, 3.41)	6.36
Scholz, Peter M.	348	166	2	1.20	2.19	1.19	(0.13, 4.30)	7.11
Scott, Gregory E. ++	243	157	7	4.46	2.52	3.83	(1.53, 7.89)	6.79
All Others (2)	167	111	6	5.41	2.11	5.54	(2.02, 12.06)	5.92
Plate, Juan	16	14	0					
Vasseur, Bernard G. ++	151	97	6					

* 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 1 (continued)

Patient Risk-Adjusted Operative Mortality* Rate for Surgeons (2003-2004)

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
St Barnabas Medical Center								
Burns, Paul	431	273	5	1.83	2.13	1.86		(0.6, 4.34)
Goldstein, Daniel J. ++	220	120	3	2.50	1.81	2.99		(0.6, 8.74)
All Others (4)	191	95	2	2.11	1.92	2.37		(0.27, 8.56)
Karanam, Ravindra	3	2	0					
Prendergast, Thomas +	4	1	0					
Sardari, Frederic F.	87	56	2					
Saunders, Craig R.	97	36	0					
St Francis Medical Center								
Laub, Glenn	401	291	5	1.72	2.97	1.25		(0.4, 2.92)
All Others (2)	105	63	0					
Costic, Joseph	97	63	0					
Seinfeld, Fredric ++	8	0	0					
St Joseph's Hospital and Medical Center								
DeFilippi, Vincent J.	427	208	7	3.37	3.23	2.25		(0.9, 4.64)
Mekhjian, Haroutune ++	364	250	9	3.60	2.33	3.35		(1.53, 6.35)
All Others (2)	67	34	3					
Cornwell, Lorraine	63	34	3					
Nguyen ++	4	0	0					
St Michael's Medical Center								
Asher, Alain +	199	140	6	4.29	2.29	4.05		(1.48, 8.81)
Codoyannis, Aristides	254	214	6	2.80	2.67	2.27		(0.83, 4.94)
Connolly, Mark W.	930	657	6	0.91	2.30	0.86	**LO**	(0.31, 1.87)
All Others (1)	29	25	0					
Scott, Randolph P. ++	29	25	0					
UMDNJ University Hospital								
Banker, Michael ++	140	108	4	3.70	1.45	5.52		(1.49, 14.14)
Esrig, Barry C.	242	168	4	2.38	1.13	4.57		(1.23, 11.69)
Valley Hospital								
Bronstein, Eric H.	616	487	7	1.44	1.93	1.61		(0.65, 3.33)
Mindich, Bruce	703	412	9	2.18	1.63	2.89		(1.32, 5.49)
All Others (1)	37	34	0					
Sperling, Jason S..	37	34	0					
State Total (2003 - 2004)	20,340	12,994	281	2.16	2.16	2.16		

* Operative Mortality includes: (1) all deaths occurring during the hospitalization in which the operation was performed, even after 30 days; an 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.

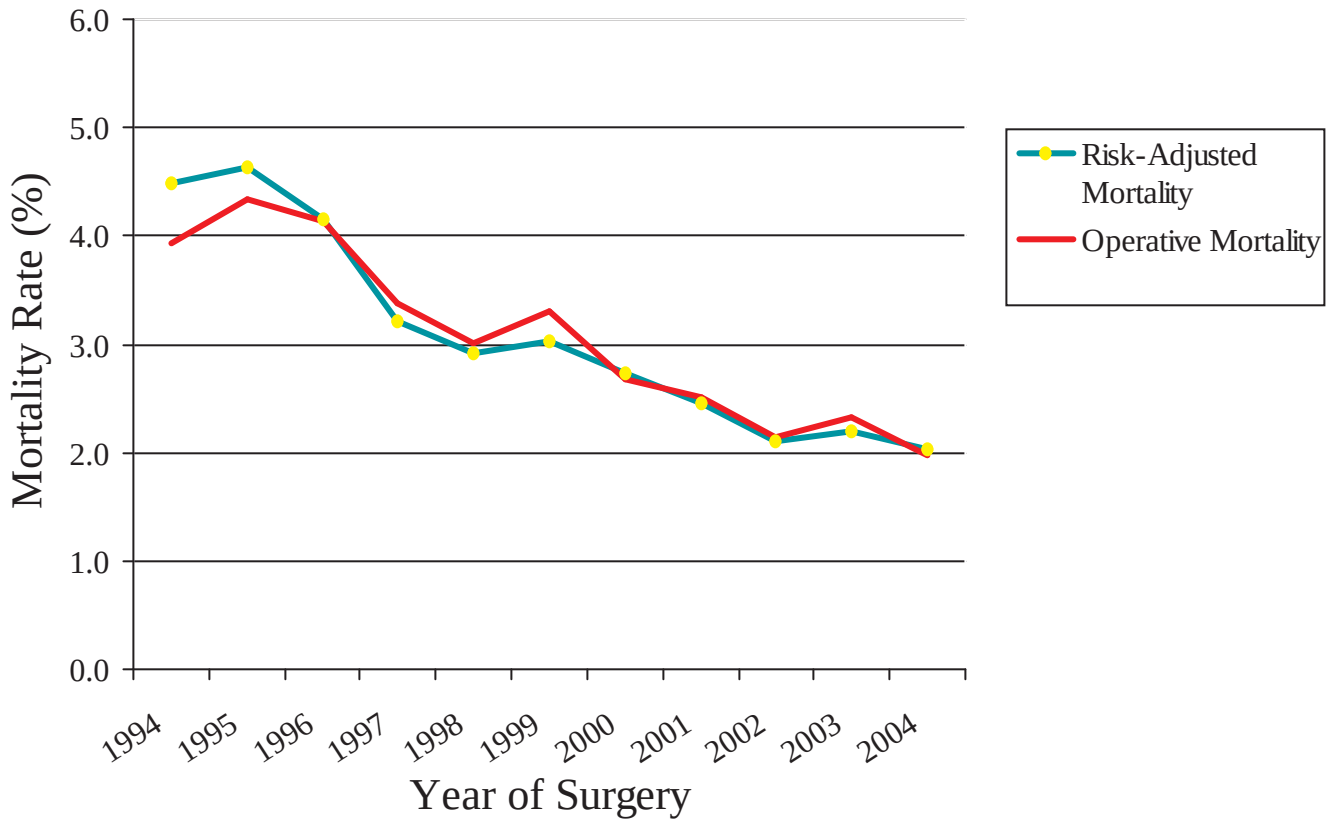
Statewide trends in risk-adjusted CABG Surgery mortality rates: Pooled estimates

Figure 5 presents the statewide risk-adjusted mortality rates for years 1994 to 2004 derived by pooling data from all years.

Figure 5 also presents the trend in statewide observed isolated CABG operative mortality rates for years 1994-2004. The observed operative mortality rate estimates exhibit a declining trend that is similar to the risk-adjusted mortality estimates. (See also Appendix C for trends in statewide in-hospital mortality rate estimates). When compared with 1994, the risk-adjusted patient mortality in 2004 dropped by 54.5 percent.

When a linear regression line is fitted to the pooled annual estimates, mortality rate has been declining, in absolute terms, at the rate of 0.26 percent 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 2004 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. 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) 530-7478. 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

* 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 card in 1990, presenting 1989 data with the latest being in June 2006 using 2002-2004 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 February 2006 using 2004 data. California has also published several cardiac surgery reports, with the most recent released in February 2006 using 2003 data. Massachusetts published its first report on CABG surgery in October 2004 using 2002 data and released its latest report on 2004 data in October 2006. 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.

Identifying 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 lung disease is at a higher risk of dying, when undergoing this surgery, than a 50 year-old woman with no history of chronic disease or previous cardiac surgery.

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 below.

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

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

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 severe lung disease is almost five times (odds ratio = 4.84) as likely to die during or after bypass surgery compared to a patient who did not have lung disease. 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 previous open heart surgery are over two times as likely (odds ratio= 2.31) compared with the odds of a patient who had no previous open heart surgery. Also, the odds of dying for a patient with renal failure are about twice as likely (odds ratio= 1.77) to die compared with a patient who had no renal failure.

In another example, a black or African American patient is more than twice (odds ratio =2.11) as likely to die during or after surgery compared with a patient who is not black or African American.

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 similar 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 2004 model C-statistic is 79.8 percent and is considered fairly high.

Table D1

Risk Factors Identified for Isolated Bypass Surgery Operative Mortality* (2004)

Patient Risk Factors Identified	Proportion of patients(%)	Logistic Regression Results		
		Coefficient	P-Value	Odds Ratio
Demographic factors				
Ages 75 to 79	15.09	0.8813	0.0002	2.414
Ages 80 to 84	9.07	0.9649	0.0003	2.625
Ages 85 and over	2.12	1.9069	<.0001	6.733
African American	6.83	0.7453	0.0117	2.107
Health factors				
Cerebrovascular Disease	13.00	0.6046	0.0065	1.830
Lung Disease - Mild	9.23	0.8726	0.0008	2.393
Lung Disease - Moderate	4.19	1.0401	0.0017	2.830
Lung Disease - Severe	2.41	1.5776	<.0001	4.843
Renal Failure with or without Dialysis	5.99	0.5704	0.0343	1.769
Factors related to functioning of the heart				
Cardiogenic Shock	1.52	1.3896	0.0003	4.013
Ejection Fraction less than 30%	6.86	1.3402	<.0001	3.820
Ejection Fraction 30% - 49%	34.43	0.6014	0.0053	1.825
NYHA Classification IV	18.00	0.6633	0.0013	1.941
Previous Open Heart Surgery	3.19	0.8376	0.0234	2.311
Intercept		-5.5031		
C-Statistic		0.798		
Number of CABGs (N)		6,177		

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 2004;

(2) comparisons of the risk-adjusted patient mortality rates for surgeons in 2003 and 2004 combined to the statewide average for 2003 and 2004 combined;

(3) comparisons of the statewide risk-adjusted patient mortality rate for each year in 1994-2004 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 2004

The risk-adjusted patient mortality estimates from bypass surgery for each hospital in 2004 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 2004 for bypass patients was 1.98 percent, based on 122 deaths out of 6,177 bypass operations performed. Table D2 (Col. 4) presents the observed CABG surgery mortality rate for each of the 17 hospitals.

Table D2

Comparing Hospitals' Patient Operative Mortality* from Bypass Surgery to the State Average (2004)

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	172	3	1.74	2.90	1.19		(0.24, 3.47)	5.64
Cooper Hospital/University Medical Center	228	8	3.51	2.06	3.37		(1.45, 6.63)	6.37
Deborah Heart and Lung Center	399	7	1.75	2.18	1.59		(0.64, 3.28)	7.25
Englewood Hospital	102	0	0.00	2.78	0.00		(0.00, 2.56)	5.85
Hackensack University Medical Center	588	4	0.68	2.08	0.65	**LO**	(0.17, 1.66)	6.19
Jersey Shore Medical Center	598	14	2.34	1.84	2.51		(1.37, 4.22)	6.27
Morristown Memorial Hospital	755	9	1.19	1.62	1.45		(0.66, 2.76)	6.11
Newark Beth Israel Medical Center	290	2	0.69	1.59	0.86		(0.10, 3.09)	6.70
Our Lady of Lourdes Medical Center	408	16	3.92	1.74	4.46	**HI**	(2.55, 7.25)	7.39
PBI Regional Medical Center	267	8	3.00	1.62	3.65		(1.57, 7.20)	6.15
Robert Wood Johnson University Hospital	698	11	1.58	2.01	1.55		(0.77, 2.77)	6.16
St Barnabas Medical Center	226	6	2.65	1.79	2.94		(1.07, 6.39)	7.14
St Francis Medical Center	174	3	1.72	2.37	1.44		(0.29, 4.19)	6.24
St Joseph's Hospital and Medical Center	245	12	4.90	2.74	3.52		(1.82, 6.16)	6.62
St Michael's Medical Center	485	8	1.65	2.82	1.16		(0.50, 2.28)	6.23
UMDNJ - University Hospital	132	6	4.55	1.31	6.84	**HI**	(2.50, 14.88)	6.40
Valley Hospital	410	5	1.22	1.21	1.98		(0.64, 4.63)	7.05
State Total (2004)	6,177	122	1.98	1.98	1.98			6.43

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.

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

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

Annual risk-adjusted mortality compared to the combined 1994-2003 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 1994–2004. For each of the eight 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 over the eight-year period.

Table D3 also shows that between 2003 and 2004, the number of bypass surgeries performed in New Jersey declined precipitously from 6,817 to 6,177 or by about 9.4 percent. Over the same time period, the number of deaths declined to 122. On risk-adjusted basis, the mortality rate declined by 11.6 percent between 2003 and 2004 and it has declined by 54.5 percent since 1994.

The trend in operative CABG mortality between 1994 and 2004 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 0.26 percent per year between 1994 and 2004 ($R^2 = .91$).

Table D3

Annual Risk-Adjusted Patient Operative Mortality Rate* Derived from the Pooled Data for the Period (1994-2004)

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	2.73	4.46	**HI**	----	----
1995	7,553	327	4.33	2.94	4.56	**HI**	0.09	2.1
1996	8,262	341	4.13	3.12	4.10	**HI**	-0.46	-8.2
1997	8,286	280	3.38	3.27	3.20	**SA**	-0.90	-28.3
1998	8,377	252	3.01	3.18	2.93	**SA**	-0.27	-34.4
1999	8,108	268	3.31	3.36	3.04	**SA**	0.12	-31.8
2000	8,220	220	2.68	3.00	2.76	**SA**	-0.29	-38.3
2001	8,045	202	2.51	3.09	2.51	**LO**	-0.24	-43.7
2002	7,391	159	2.15	3.11	2.14	**LO**	-0.37	-52.1
2003	6,817	159	2.33	3.14	2.30	**LO**	0.16	-48.5
2004	6,177	122	1.98	3.01	2.03	**LO**	-0.27	-54.5
1994 - 2004	**84,193**	**2,604**	**3.09**	**3.09**	**3.09**			

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.

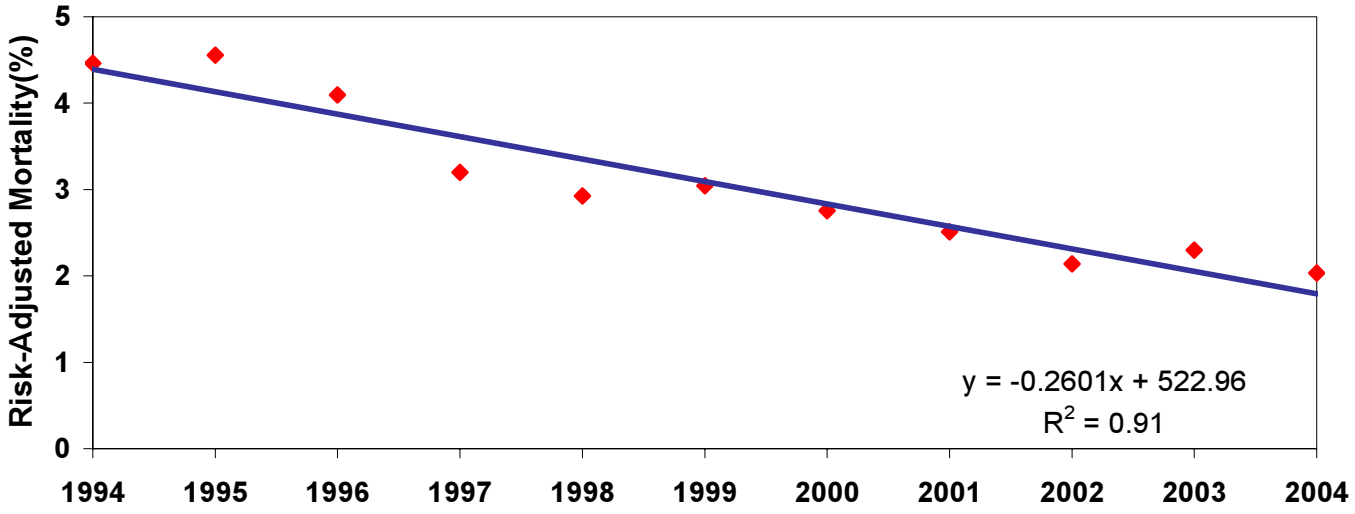
LO - The risk-adjusted patient mortality is significantly lower than the state average mortality for the 1994-2003 period when evaluated with a 95 percent confidence interval.

SA - The risk-adjusted patient mortality is same as the state average mortality for the 1994-2003 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 1994-2003 period when evaluated with a 95 percent confidence interval.

Figure D1

Trend in Risk-Adjusted Operative Mortality* Rate (1994-2004)



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 had 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 surgeon 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 17.54 percent). Such low predictive power is usually common when one fits a regression model using individual level data that is as large as ours.

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

Table D4

Risk Factors Identified for Isolated Bypass Surgery Length of Stay (2004)

Patient Risk Factors Identified	Proportion of patients(%)	Generalized Linear Regression Results Coefficient	P-Value
Demographic factors			
Ages 60 to 64	14.93	0.0541	0.0007
Ages 65 to 69	16.07	0.0969	<.0001
Ages 70 to 74	15.62	0.1480	<.0001
Ages 75 to 79	14.82	0.2217	<.0001
Ages 80 to 84	8.94	0.2479	<.0001
Ages 85 and over	2.03	0.2478	<.0001
Female	26.73	0.0473	<.0001
African American	6.73	0.0937	<.0001
Medicaid, Indigent and Self-pay	8.17	0.0455	0.0147
Health factors			
Cerebrovascular Disease	12.72	0.0540	0.0004
Diabetes	38.84	0.0302	0.0042
Lung Disease - Mild	8.93	0.0819	<.0001
Lung Disease - Moderate	3.93	0.0973	0.0002
Lung Disease - Severe	2.23	0.1673	<.0001
Obesity	10.50	0.1035	<.0001
Peripheral Vascular Disease	17.67	0.0400	0.0034
Renal Failure with Dialysis	4.03	0.2046	<.0001
Renal Failure without Dialysis	1.56	0.1500	<.0001
Factors related to functioning of the heart			
Arrhythmia - Afib/Flutter	5.62	0.1622	<.0001
Arrhythmia - Sust VT/VF	2.03	0.1306	0.0003
Cardiogenic Shock	1.33	0.1817	<.0001
Congestive Heart Failure	15.17	0.1037	<.0001
Ejection Fraction less than 1 - 19%	1.44	0.1884	<.0001
Ejection Fraction less than 20 - 29%	4.95	0.0543	0.0219
Ejection Fraction 30% - 39%	11.69	0.0585	0.0003
NYHA Classification IV	17.48	0.0299	0.0365
Myocardial Infarction	42.43	0.0416	0.0001
Number of Diseased Vessels - Two	19.75	0.1228	<.0001
Number of Diseased Vessels - Three	75.76	0.1342	<.0001
Unstable Angina	41.41	0.0371	0.0009
Prior PCI <=6 Hours	1.14	0.1380	0.0035
Intercept	1.4644		
R-Square	17.54		
Number of CABGs (N)*	5,960		

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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