# Fourth Annual Report on Women's Health Outcomes in U.S. Hospitals

## A HealthGrades Study

## June 2007

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## *Introduction*

In recent years much attention has been directed at improving outcomes for women in the area of cardiovascular disease (CVD). Over the last decade, a number of nationwide initiatives have emerged aimed at educating women about their risks and about recognizing the symptoms of CVD. Recent studies suggest that these initiatives are having a positive impact, that women are beginning to appreciate the significant threat they face from CVD, and that this awareness is leading to action.[1]

However, despite the growing attention to educate women about their CVD risks, women continue to have consistently worse outcomes than their male counterparts. The disparity in outcomes between the genders has been attributed to the lack of awareness of CVD risks by women and the underutilization of timely life-saving interventions by healthcare providers.[2,3,4] While the educational initiatives are successful in getting women to seek treatment sooner, much research is needed to identify and address the specific needs of women with cardiovascular disease within the healthcare system and to close the outcome gap between women and men.

## Women and Cardiovascular Disease Outcomes

The need for greater gender-specific research in the care and treatment of women with CVD is underscored by the prevalence of CVD among women. One-third of all adult U.S. women have some form of CVD and CVD remains the leading cause of death among women in the U.S. accounting for 39 percent of all adult female deaths.[4] In 2004, CVD was responsible for a death a minute among adult women.

For the fourth consecutive year, HealthGrades has studied heart disease and stroke outcomes in women admitted to U.S. hospitals. This study identifies the best-performing hospitals in 19 states specific to the care and treatment of women with CVD and highlights differences and trends in mortality outcomes between the best and worst hospitals during 2003 to 2005.

## Identifying Outcome Trends and Five-Star Hospitals

Given the significant gap in awareness and outcomes, access to information regarding CVD outcomes is critical in raising awareness through transparency. The aim of this study was to:

- Identify the best-performing U.S. hospitals in women's health from 2003 through 2005.
- Examine outcome trends for the inhospital treatment of heart disease and stroke in women from 2003 through 2005.

## Assessing Women's Health Outcomes Performance

In order to assess comparative outcomes by hospital, risk-adjusted inhospital mortality was calculated for every female hospital discharge related to the six cardiovascular cohorts listed from 19 states from 2003 through 2005.

- Coronary artery bypass graft (CABG) surgery
- Valve replacement surgery
- Interventional cardiology procedures (PCI)
- Acute myocardial infarction (AMI)
- Heart failure (HF)
- Stroke

The 19 states evaluated were:

- Arizona
- California
- Florida
- Iowa
- Maine
- Maryland
- Massachusetts
- Nevada
- New Jersey
- New York
- North Carolina
- Oregon
- Pennsylvania
- Rhode Island
- Texas
- Utah
- Virginia
- Washington
- Wisconsin

In order for a hospital to be evaluated for overall women's health outcomes, the hospital had to have all of the following:

- An open heart program in 2005.
- Over the three years, a minimum of 30 female discharges in coronary bypass surgery, 30 female discharges in stroke, and 30 female discharges in any three of the remaining four cardiac cohorts (valve replacement surgery, interventional cardiology procedures, acute myocardial infraction, or heart failure) for a minimum of 150 discharges total.
- For the most recent year, a minimum of 5 female discharges in coronary bypass surgery, 5 female discharges in stroke, and 5 female discharges in each of the three cohorts for which they met the 30 discharge criterion above.
- Transferred out less than 10 percent of stroke patients to another acute care hospital over three years (2003–2005). This implies that the hospital is more likely to have onsite neurosurgical services.

In all, our study included 513 hospitals in the 19 states studied. Full details on the risk adjustment and overall women's health outcomes performance assessment can be found in the *Methodology* section of this study.

## *Summary of Findings*

In our study, we analyzed more than 2.1 million hospitalizations during 2003 through 2005 and found:

- Overall, risk-adjusted mortality for cardiovascular disease for women improved on average 8.7 percent from 2003 through 2005.
- The best-performing hospitals had a 39-percent lower risk-adjusted mortality than the poor-performing hospitals and a 22-percent lower risk-adjusted mortality than average-performing hospitals.
- The largest quality gaps between the best-performing and poor-performing hospitals were in heart failure and interventional cardiology procedures. Compared to poor-performing hospitals, best-performing hospitals had a 46-percent lower risk-adjusted mortality for heart failure and a 44-percent lower risk-adjusted mortality for interventional cardiology procedures.
- All performance categories–best, average, and poor–showed improvement over the study period but the greatest improvement was among the poor-performing hospitals whose risk-adjusted mortality rates improved 10 percent from 2003 through 2005. While these hospitals showed the most improvement over the course of the study, their overall performance still lags considerably behind the best-performing hospitals.
- If all of the hospitals studied (n=513) performed at the level of the best-performing hospitals during 2003 through 2005, 15,925 deaths among women hospitalized for cardiovascular disease could have been potentially prevented at these 513 hospitals. The national number would be much higher.
- The greatest opportunity to reduce mortality is among women hospitalized for stroke and heart attack which combined represented 60 percent of the potentially preventable deaths.
- Wide variations were found across the 19 states evaluated. For example, Arizona had an overall risk-adjusted mortality that was 31 percent lower than Iowa during 2003-2005 across the six CVD areas studied.

## *Methodology*

To help consumers evaluate and compare hospital performance for women's health, HealthGrades analyzed patient outcome data for every hospital with an open heart program in 19 states. The state data contained inpatient records for all patients. The HealthGrades ratings are available on the Internet at www.healthgrades.com.

### Data Acquisition

HealthGrades purchased the initial patient-level data for every state where data are available. The data represent three years of discharges. These data were chosen because they represent all discharges for the associated states. The 19 states were as follows:

- Arizona
- California
- Florida
- Iowa
- Maine
- Maryland
- Massachusetts
- Nevada
- New Jersey
- New York
- North Carolina
- Oregon
- Pennsylvania
- Rhode Island
- Texas
- Utah
- Virginia
- Washington
- Wisconsin

### Methodology for Women's Health

The Women's Health ratings were based upon a hospital's inhospital risk-adjusted cardiac/stroke mortality and maternity care rating. (*Hospital Report Cards™ Maternity Care and Women's Health* methodology can be found at www.HealthGrades.com.) Hospitals had to have an overall rating from each area to be considered; however, this particular study focused on our findings specific to cardiac and stroke mortality outcomes in women only.

### Methodology for Cardiac and Stroke Mortality Ratings for Women

HealthGrades analyzed the following six procedures/diagnoses (cohorts) for each hospital's female patients:

- Coronary bypass surgery (CABG)
- Valve replacement surgery
- Interventional cardiology procedures (PCI)
- Acute myocardial infarction (AMI)
- Heart failure (HF)
- Stroke

## Risk-Adjustment Methodology

The purpose of risk adjustment is to obtain fair statistical comparisons between disparate populations or groups. Significant differences in demographic and clinical risk factors are found among patients treated in different hospitals. Risk adjustment of the data is needed to make accurate and valid comparisons of clinical outcomes at different hospitals.

Fair and valid comparisons between hospital providers can be made only to the extent that the risk-adjustment methodology considers important differences in patient demographic and clinical characteristics. The risk-adjustment methodology used by HealthGrades defines risk factors as those clinical and demographic variables that influence patient outcomes in significant and systematic ways. Risk factors may include age, specific procedure performed, and comorbid conditions such as hypertension, chronic renal failure, congestive heart failure, and diabetes.

## Statistical Models for Predicting Mortality

1. For each patient cohort, unique statistical, female only models were developed using logistic regression. Cohorts were defined by developing a list of specific diagnoses and procedures to be included in the cohort. A list of the codes used to identify patients in the six cohorts can be found in Exhibit A.

2. Outcomes were binary, with patients recorded as either alive or expired at hospital discharge.

3. Comorbid diagnoses (e.g., hypertension, chronic renal failure, anemia, diabetes), demographic characteristics (e.g., age), and specific procedures were classified as possible risk factors. Some diagnosis codes were merged together (e.g., primary and secondary pulmonary hypertension) to minimize the impact of coding differences. HealthGrades used logistic regression to determine which of these were actually risk factors and to what extent they were correlated with mortality. A risk factor stayed in the model if it had a positive odds ratio and was also statistically significant in explaining variation. Potential risk factors with odds ratios less than one are removed from the model except in a few cases. Complications were not considered as potential risk factors predicting mortality.

4. The statistical models were checked for validity and finalized. All of the models were highly significant, with p values not greater than 0.0001. These cohort specific models were then used to estimate the probability of death for each patient in the cohort.

5. Patients were then aggregated for each hospital to obtain the predicted outcome for each hospital.

## Assignment of Ratings for Cardiac/Stroke Services for Women

For each hospital, the actual mortality was summed for all of the six patient cohorts and the predicted mortality (risk adjusted) was summed for all of the six patient cohorts. The predicted mortality rate was compared to the actual mortality rate for each hospital and tested for statistical significance at 90 percent (using a z-score and a two-tailed test).

The following rating system was applied to the comparison of the actual mortality for all six patient cohorts and the predicted mortality rate for all six patient cohorts.

- Best-performing – Actual performance was better than predicted and the difference was statistically significant, limited to the top 15 percent of hospitals (by z-score).
- Average-performing – The middle 70 percent of hospitals (by z-score).

- Poor-performing – Actual performance was worse than predicted and the difference was statistically significant, limited to the bottom 15 percent of hospitals (by z-score).

In order for a hospital to be evaluated for overall women's health outcomes, the hospital had to have all of the following:

- An open heart program in 2005.
- Over the three years, a minimum of 30 female discharges in coronary bypass surgery, 30 female discharges in stroke, and 30 female discharges in any three of the remaining four cardiac cohorts (valve replacement surgery, interventional cardiology procedures, acute myocardial infraction, heart failure) for a minimum of 150 discharges total.
- For the most recent year, a minimum of 5 female discharges in coronary bypass surgery, 5 female discharges in stroke, and 5 female discharges in each of the three cohorts for which they met the 30 discharge criterion above.
- Transferred out less than 10 percent of stroke patients to another acute care hospital over three years (2003–2005). This implies that the hospital probably has onsite neurosurgical services.

## *Findings*

As with our previous *Women's Health Outcomes in U.S. Hospitals* studies, we found that in-hospital mortality for cardiovascular disease in women continues to improve.[7,8] Overall risk-adjusted mortality improved 8.7 percent from 2003 through 2005 in the 513 hospitals in the 19 states we studied. This improvement was seen across cohorts with the exception of interventional cardiology procedures (PCI) which saw an increase in risk-adjusted mortality of 13 percent from 2003 through 2005.

From 2003 through 2005, poor-performing hospitals showed improvement in mortality across every cohort and had the most improvement in CABG, AMI, and PCI (see *Appendix B*). Most notably, poor-performing hospitals made the most gain in their open heart surgery programs with their bypass mortality improving 30 percent from 2003 through 2005. Both the best-performing and poor-performing hospitals showed major improvements in the treatment of heart failure with mortality decreasing 18 percent and 14 percent, respectively.

Even with the improvements seen in the poor-performing hospitals over the period of study, the best-performing hospitals continue to show substantially better outcomes than the poor-performing hospitals (*See Appendix B* and *C*). For example:

- Overall, the best-performing hospitals had a 39-percent lower risk-adjusted mortality than the poor-performing hospitals and a 22-percent lower risk-adjusted mortality than the average-performing hospitals.
- The quality gap between the best-performing hospitals and the poor-performing hospitals exists across all cohorts. Best-performing hospitals demonstrated lower risk-adjusted mortality rates ranging from 45 percent to 34 percent better than poor-performing hospitals and 27 percent to 16 percent better than average-performing hospitals.
- The largest difference between the best-performing hospitals and poor-performing hospitals was in heart failure with the best hospitals having a 46-percent lower risk-adjusted mortality compared to poor-performing hospitals. The smallest gap between the best and worst performers was in valve replacement surgery where the best-performing hospitals have 34 percent lower risk-adjusted mortality than the poor-performing hospitals in this study.

These variations in outcomes were also noted from state to state (see *Appendix D*). Wide variations were found across the 19 states. For example, Arizona had risk-adjusted mortality that was 31 percent lower than Iowa during 2003–2005.

During 2003–2005, if all 513 hospitals in the 19 states studied performed at the level of the best-performing hospitals, 15,925 deaths among women admitted with cardiovascular disease could have been potentially prevented. Among these deaths, the greatest opportunity to potentially save lives is among women being admitted for stroke and heart attacks that combined represent 60 percent of the potential lives saved (see *Appendix E*).

## *Interpretation of Results*

### Despite Improvements Quality Gaps Persist

Despite improvements over the last several years, large disparities in outcomes between hospitals persist. This is seen at the community, regional and national levels. Our study concluded that if all 513 hospitals studied performed at the best-performing hospitals' average, more than 15,000 additional women in the 19 states studied with CVD could have potentially survived their hospitalization.

While this number demonstrates the impact that variances in care between hospitals can have on the patient outcome, this number vastly under represents the true number of potential lives lost due to poor quality care. Our 513 study hospitals represented less than half of the 1,064 open heart programs nationwide and only one-tenth of the nearly 5,000 acute-care hospitals. Therefore, one can conclude that the 15,000 lives that could have been potentially saved, represents only a fraction of the true number.

### Implications for Women

In recent years, public health campaigns aimed at raising awareness among women about their risks of cardiovascular disease have impacted early recognition of CVD symptoms and prompted women to seek treatment earlier. Interventions targeted at reducing the risk of late or no detection of CVD symptoms have likely contributed to the mortality improvements found in our study, and they will no doubt continue to improve outcomes for women in future years.

However, a comparable risk to women with heart disease and stroke is that wide variations in outcomes from hospital to hospital still persist. This variation represents an opportunity for improvement within the healthcare system. Targeted interventions to improve this variation will also undoubtedly improve mortality from CVD in women.

Women should research their own CVD risk, manage that risk aggressively, and proactively research a hospital to go to in the event they have signs and symptoms of CVD. Eighty-two percent of women look for healthcare information online and 31 percent of these women report looking for information online about a particular doctor or hospital.[9] Clearly this group of women understands that choosing the right healthcare provider could mean the difference between life and death. Women need to understand that not only are there outcome differences between men and women with CVD, they should also understand that hospitals are not the same when it comes to surviving a major cardiac or stroke hospitalization.

## *Limitations of the Risk-adjustment Models for Women's Health Performance Assessment*

It must be understood that while these models may be valuable in identifying hospital groups that perform better than others, one should recognize that these models are limited by the following factors:

- Cases may have been coded incorrectly or incompletely by the hospital.
- The models can only account for risk factors that are coded into the billing data. If a particular risk factor was not coded into the billing data, such as a patient's socioeconomic status and health behavior, then it was not accounted for with these models.

Although HealthGrades has taken steps to carefully compile these data using its proprietary methodology, no techniques are infallible, and therefore some information may be missing, outdated, or incorrect.

Although the 19 states we studied represented a large percentage of all U.S. hospital discharges from 2003 through 2005, our findings may not be generalized to the entire United States or to states that we did not study.

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## *Appendix A. Patient Cohorts and Related ICD-9-CM Codes*

| Patient Definitions | ICD-9-CM Procedure/Diagnosis Codes and Criteria |
|---|---|
| **Women's Cardiac and Stroke Mortality** | |
| Coronary Bypass Surgery | Procedure Codes: 36.10, 36.11, 36.12, 36.13, 36.14, 36.15, 36.16, 36.19.<br>Excluding patients with procedure codes: 35.1*, 35.10, 35.11, 35.12, 35.13, 35.14, 35.2*, 35.20, 35.21, 35.22, 35.23, 35.24, 35.25, 35.26, 35.27, 35.28, 35.55, 36.33, 36.34, 37.5*, 37.51, 37.52, 37.53, 37.54, 37.62, 37.63, 38.34, 38.44, 38.64, 39.71, 44.12.<br>Excluding patients with diagnosis code: 414.06, 414.07, 441.00, 441.01, 441.02, 441.03, V42.1. |
| Valve Replacement Surgery | Procedure Codes: 35.20, 35.21, 35.22, 35.23, 35.24, 35.25, 35.26, 35.27, 35.28.<br>Excluding patients with procedure codes: 35.1*, 35.33, 35.55, 36.33, 36.34, 37.*5, 37.51, 37.52, 37.53, 37.54, 37.62, 37.63, 38.12, 38.34, 38.44, 38.64, 39.71, 44.12.<br>Excluding patients with diagnosis codes: 414.06, 414.07, 441.00, 441.01, 441.02, 441.03, 441.2, V42.1. |
| Interventional Cardiology Procedures | Procedure Codes: 36.01, 36.02, 36.05, 36.06, 36.07, 36.09.<br>Excluding patients with procedure codes 35.10, 35.11, 35.12, 35.13, 35.14, 35.2*, 35.20, 35.21, 35.22, 35.23, 35.24, 35.25, 35.26, 35.27, 35.28, 36.10, 36.11, 36.12, 36.13, 36.14, 36.15, 36.16, 36.19, 37.5, 37.51, 37.52, 37.53, 37.54, 37.62, 37.63.<br>Excluding patients with diagnosis codes: 414.06, 414.07, V42.1. |
| Acute Myocardial Infarction (Heart Attack) | Principal Diagnoses: 410.11, 410.21, 410.31, 410.41, 410.51, 410.61, 410.71, 410.81, 410.91.<br>Excluding patients with procedure codes: 37.5*, 37.51, 37.52, 37.53, 37.54, 37.62, 37.63.<br>Excluding patients with diagnosis codes: 196.0, 196.1, 196.2, 196.3, 196.5, 196.6, 196.8, 196.9, 197.0, 197.1, 197.2, 197.3, 197.4, 197.5, 197.6, 197.7, 197.8, 198.0, 198.1, 198.2, 198.3, 198.4, 198.5, 198.6, 198.7, 198.8, 198.81, 198.82, 198.89, 414.06, 414.07, V42.1, V66.7. |
| Heart Failure | Principal Diagnoses: 398.91, 402.01,402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428.0, 428.1, 428.2, 428.20, 428.21, 428.22, 428.23, 428.3, 428.30, 428.31, 428.32, 428.33, 428.4, 428.40, 428.41, 428.42, 428.43, 42.89<br>Excluding patients with procedure codes: 37.51, 37.52, 37.53, 37.54, 37.62, 37.63, 39.95.<br>Excluding patients with diagnosis codes: 196.0, 196.1, 196.2, 196.3, 196.5, 196.6, 196.8, 196.9, 197.0, 197.1, 197.2, 197.3, 197.4, 197.5, 197.6, 197.7, 197.8, 198.0, 198.1, 198.2, 198.3, 198.4, 198.5, 198.6, 198.7, 198.8, 198.81, 198.82, 198.89, 414.06, 414.07, V42.1, V66.7. |
| Stroke | Principal Diagnoses: 430, 431, 432.9, 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91, 436.<br>Excluding patients with procedure codes: 37.51, 37.52, 37.53, 37.54, 37.62, 37.63.<br>Excluding patients with diagnosis codes: 196.0, 196.1, 196.2, 196.3, 196.5, 196.6, 196.8, 196.9, 197.0, 197.1, 197.2, 197.3, 197.4, 197.5, 197.6, 197.7, 197.8, 198.0, 198.1, 198.2, 198.3, 198.4, 198.5, 198.6, 198.7, 198.8, 198.81, 198.82, 198.89, V66.7. |

* Includes all sub-codes related to the ICD-9 grouping.

## *Appendix B. Cardiovascular Disease Outcomes Performance by Year (2003-2005)*

| Women's Health Outcomes Performance | Year | Observed Inhospital Mortality Rate | Expected Inhospital Mortality Rate | Observed-to-Expected Ratio | 95 percent CI for Ratio | Relative Improvement from 2003 |
|---|---|---|---|---|---|---|
| **Coronary Artery Bypass Surgery** (Overall relative improvement of 10.88 percent from 2003 through 2005)* | | | | | | |
| Best | 2003 | 2.26% | 3.19% | 0.71 | (0.57-0.84) | |
| | 2004 | 2.68% | 3.28% | 0.81 | (0.67-0.96) | |
| | 2005 | 2.82% | 3.64% | 0.77 | (0.63-0.92) | -9.60% |
| Average | 2003 | 3.09% | 2.87% | 1.08 | (1.00-1.15) | |
| | 2004 | 3.05% | 3.04% | 1.00 | (0.93-1.08) | |
| | 2005 | 3.24% | 3.35% | 0.97 | (0.89-1.04) | 10.24% |
| Poor | 2003 | 4.08% | 2.61% | 1.57 | (1.40-1.74) | |
| | 2004 | 3.48% | 2.83% | 1.23 | (1.05-1.41) | |
| | 2005 | 3.36% | 3.06% | 1.10 | (0.92-1.27) | 30.09% |
| **Valve Replacement Surgery** (Overall relative improvement of 8.93 percent from 2003 through 2005)* | | | | | | |
| Best | 2003 | 7.32% | 7.71% | 0.95 | (0.81-1.08) | |
| | 2004 | 6.22% | 7.85% | 0.79 | (0.66-0.92) | |
| | 2005 | 6.26% | 8.32% | 0.75 | (0.63-0.88) | 20.73% |
| Average | 2003 | 7.64% | 7.36% | 1.04 | (0.97-1.11) | |
| | 2004 | 6.90% | 7.32% | 0.94 | (0.87-1.01) | |
| | 2005 | 7.26% | 7.34% | 0.99 | (0.92-1.06) | 4.65% |
| Poor | 2003 | 9.50% | 7.11% | 1.34 | (1.16-1.51) | |
| | 2004 | 9.34% | 7.51% | 1.24 | (1.08-1.41) | |
| | 2005 | 8.64% | 7.29% | 1.19 | (1.01-1.36) | 11.36% |
| **Acute Myocardial Infarction** (Overall relative improvement of 6.78 percent from 2003 through 2005)* | | | | | | |
| Best | 2003 | 7.48% | 9.64% | 0.78 | (0.73-0.83) | |
| | 2004 | 7.50% | 9.29% | 0.81 | (0.76-0.86) | |
| | 2005 | 6.78% | 9.17% | 0.74 | (0.69-0.79) | 4.64% |
| Average | 2003 | 8.81% | 8.71% | 1.01 | (0.99-1.04) | |
| | 2004 | 8.33% | 8.26% | 1.01 | (0.98-1.04) | |
| | 2005 | 7.61% | 8.07% | 0.94 | (0.91-0.97) | 6.84% |
| Poor | 2003 | 11.22% | 8.59% | 1.31 | (1.25-1.37) | |
| | 2004 | 10.07% | 8.05% | 1.25 | (1.19-1.31) | |
| | 2005 | 9.40% | 7.85% | 1.20 | (1.14-1.26) | 8.21% |

continued

## *Appendix B. Cardiovascular Disease Outcomes Performance by Year (2003-2005) (continued)*

| Women's Health Outcomes Performance | Year | Observed Inhospital Mortality Rate | Expected Inhospital Mortality Rate | Observed-to-Expected Ratio | 95 percent CI for Ratio | Relative Improvement from 2003 |
|---|---|---|---|---|---|---|
| **Interventional Cardiology Procedures (Angioplasty/Stent)** (Overall relative improvement of -15.03 percent from 2003 through 2005)* | | | | | | |
| Best | 2003 | 0.79% | 1.29% | 0.61 | (0.50-0.73) | |
| | 2004 | 0.87% | 1.07% | 0.81 | (0.67-0.94) | |
| | 2005 | 0.85% | 1.04% | 0.81 | (0.68-0.95) | -32.65% |
| Average | 2003 | 1.05% | 1.16% | 0.91 | (0.84-0.97) | |
| | 2004 | 1.04% | 0.98% | 1.07 | (1.00-1.14) | |
| | 2005 | 0.99% | 0.93% | 1.06 | (0.99-1.13) | -17.19% |
| Poor | 2003 | 1.54% | 1.15% | 1.33 | (1.19-1.47) | |
| | 2004 | 1.25% | 0.92% | 1.36 | (1.21-1.51) | |
| | 2005 | 1.16% | 0.91% | 1.28 | (1.12-1.43) | 4.20% |
| **Heart Failure** (Overall relative improvement of 15.07% from 2003 through 2005)* | | | | | | |
| Best | 2003 | 3.33% | 4.20% | 0.79 | (0.73-0.85) | |
| | 2004 | 2.94% | 4.23% | 0.70 | (0.64-0.76) | |
| | 2005 | 2.78% | 4.28% | 0.65 | (0.59-0.71) | 17.98% |
| Average | 2003 | 3.99% | 3.86% | 1.03 | (1.00-1.07) | |
| | 2004 | 3.84% | 3.96% | 0.97 | (0.94-1.00) | |
| | 2005 | 3.43% | 3.88% | 0.89 | (0.85-0.92) | 14.32% |
| Poor | 2003 | 5.39% | 3.70% | 1.46 | (1.39-1.53) | |
| | 2004 | 4.49% | 3.66% | 1.23 | (1.16-1.30) | |
| | 2005 | 4.64% | 3.71% | 1.25 | (1.18-1.32) | 14.26% |
| **Stroke** (Overall relative improvement of 9.05% from 2003 through 2005)* | | | | | | |
| Best | 2003 | 9.86% | 12.28% | 0.80 | (0.75-0.86) | |
| | 2004 | 9.73% | 12.61% | 0.77 | (0.72-0.82) | |
| | 2005 | 9.96% | 12.84% | 0.78 | (0.73-0.83) | 3.34% |
| Average | 2003 | 12.39% | 12.13% | 1.02 | (1.00-1.05) | |
| | 2004 | 11.89% | 12.30% | 0.97 | (0.94-0.99) | |
| | 2005 | 11.21% | 12.24% | 0.92 | (0.89-0.94) | 10.37% |
| Poor | 2003 | 14.86% | 11.78% | 1.26 | (1.21-1.32) | |
| | 2004 | 14.02% | 11.72% | 1.20 | (1.14-1.25) | |
| | 2005 | 13.55% | 11.56% | 1.17 | (1.12-1.23) | 7.05% |
| **Average Improvement from 2003 through 2005** (*includes all U.S. hospitals in 19 states eligible to receive a Women's Health rating) | | | | | All* | 8.72% |
| | | | | | Best | 5.89% |
| | | | | | Average | 8.74% |
| | | | | | Poor | 10.14% |

## *Appendix C. Differences in Cardiovascular Inhospital Mortality Outcomes by Performance Category for 3 Years Combined (2003-2005)*

| Women's Health Outcomes Performance | Observed Inhospital Mortality Rate | Expected Inhospital Mortality Rate | Observed-to-Expected Ratio | 95 percent CI | Relative Mortality Risk Reduction Associated with Best- to Poor-Performing Women's Health Hospitals | Relative Mortality Risk Reduction Associated with Best- to Average-Performing Women's Health Hospitals |
|---|---|---|---|---|---|---|
| Coronary Artery Bypass Graft Surgery | | | | | | |
| Best | 2.56% | 3.36% | 0.76 | (0.68-0.85) | 41.13% | 24.77% |
| Average | 3.12% | 3.07% | 1.01 | (0.97-1.06) | | |
| Poor | 3.66% | 2.82% | 1.30 | (1.19-1.40) | | |
| Valve Replacement Surgery | | | | | | |
| Best | 6.60% | 7.96% | 0.83 | (0.75-0.90) | 33.99% | 16.27% |
| Average | 7.26% | 7.34% | 0.99 | (0.95-1.03) | | |
| Poor | 9.17% | 7.30% | 1.26 | (1.16-1.35) | | |
| Acute Myocardial Infarction (Heart Attack) | | | | | | |
| Best | 7.27% | 9.37% | 0.78 | (0.75-0.81) | 38.21% | 21.66% |
| Average | 8.26% | 8.35% | 0.99 | (0.97-1.01) | | |
| Poor | 10.25% | 8.17% | 1.25 | (1.22-1.29) | | |
| Interventional Cardiology Procedures (Angioplasty/Stent) | | | | | | |
| Best | 0.84% | 1.13% | 0.74 | (0.67-0.81) | 44.12% | 26.59% |
| Average | 1.03% | 1.02% | 1.01 | (0.97-1.05) | | |
| Poor | 1.31% | 0.99% | 1.32 | (1.24-1.41) | | |
| Heart Failure | | | | | | |
| Best | 3.02% | 4.24% | 0.71 | (0.68-0.75) | 45.75% | 26.08% |
| Average | 3.76% | 3.90% | 0.96 | (0.95-0.98) | | |
| Poor | 4.84% | 3.69% | 1.31 | (1.27-1.35) | | |
| Stroke | | | | | | |
| Best | 9.85% | 12.58% | 0.78 | (0.75-0.81) | 35.32% | 19.11% |
| Average | 11.83% | 12.22% | 0.97 | (0.95-0.98) | | |
| Poor | 14.14% | 11.69% | 1.21 | (1.18-1.24) | | |
| Overall Cardiovascular Disease (Heart Disease and Stroke) | | | | | | |
| Best | 4.31% | 5.64% | 0.76 | (0.75-0.78) | 39.23% | 21.91% |
| Average | 5.18% | 5.30% | 0.98 | (0.97-0.99) | | |
| Poor | 6.42% | 5.11% | 1.26 | (1.24-1.28) | | |

## *Appendix D. Cardiovascular Outcomes Performance by State Studied for 3 Years Combined (2003-2005)*

| State | Number of Hospitals Evaluated per State | Number of 5-star Hospitals per State | Inhospital Observed Mortality Rate | Inhospital Expected Mortality Rate | Observed-to-Expected Ratio | Z-score (most positive is best performance) | *p* value (2-tailed) |
|---|---|---|---|---|---|---|---|
| AZ | 21 | 11 | 4.06% | 5.22% | 0.78 | 10.71 | 0.0000 |
| CA | 90 | 13 | 5.82% | 5.93% | 0.98 | 1.78 | 0.0743 |
| FL | 62 | 21 | 4.88% | 5.31% | 0.92 | 8.58 | 0.0000 |
| IA | 7 | 0 | 4.92% | 4.35% | 1.13 | -3.45 | 0.0006 |
| MA | 14 | 1 | 5.35% | 5.47% | 0.98 | 1.22 | 0.2244 |
| MD | 7 | 0 | 4.12% | 4.34% | 0.95 | 1.84 | 0.0663 |
| ME | 3 | 0 | 4.96% | 4.93% | 1.01 | -0.13 | 0.8994 |
| NC | 20 | 0 | 5.82% | 5.29% | 1.10 | -6.55 | 0.0000 |
| NJ | 16 | 1 | 4.65% | 4.60% | 1.01 | -0.66 | 0.5074 |
| NV | 8 | 0 | 6.75% | 6.47% | 1.04 | -1.49 | 0.1367 |
| NY | 35 | 3 | 5.16% | 4.95% | 1.04 | -3.72 | 0.0002 |
| OR | 11 | 1 | 5.88% | 5.84% | 1.01 | -0.24 | 0.8135 |
| PA | 57 | 13 | 5.05% | 5.61% | 0.90 | 9.70 | 0.0000 |
| RI | 2 | 0 | 4.99% | 5.36% | 0.93 | 1.51 | 0.1311 |
| TX | 95 | 3 | 5.47% | 5.18% | 1.06 | -5.67 | 0.0000 |
| UT | 7 | 1 | 5.03% | 5.43% | 0.93 | 1.81 | 0.0710 |
| VA | 18 | 2 | 5.15% | 5.44% | 0.95 | 3.02 | 0.0026 |
| WA | 17 | 1 | 5.53% | 5.72% | 0.97 | 1.48 | 0.1383 |
| WI | 23 | 6 | 4.59% | 4.98% | 0.92 | 3.79 | 0.0001 |

## *Appendix E. Potential Lives Saved if All Hospitals Studied Performed at the Level of the Best-Performing Hospitals 3 Years Combined (2003-2005)*

| Women's Health Outcomes Performance | Discharges | Potential Lives Saves | Percent of Total Lives Saved |
|---|---|---|---|
| **Coronary Artery Bypass Graft Surgery** | | | |
| Best | 17,233 | N/A | |
| Average | 65,960 | 510 | |
| Poor | 12,871 | 194 | |
| | | 704 | 4.42% |
| **Valve Replacement Surgery** | | | |
| Best | 8,747 | N/A | |
| Average | 30,179 | 357 | |
| Poor | 5,368 | 167 | |
| | | 524 | 3.29% |
| **Acute Myocardial Infarction (Heart Attack)** | | | |
| Best | 45,606 | N/A | |
| Average | 177,250 | 3,173 | |
| Poor | 37,476 | 1,467 | |
| | | 4,640 | 29.14% |
| **Interventional Cardiology Procedures (Angioplasty/Stent)** | | | |
| Best | 64,850 | N/A | |
| Average | 242,230 | 663 | |
| Poor | 53,261 | 308 | |
| | | 971 | 6.10% |
| **Heart Failure** | | | |
| Best | 73,482 | N/A | |
| Average | 286,527 | 2,806 | |
| Poor | 65,698 | 1,456 | |
| | | 4,262 | 26.76% |
| **Stroke** | | | |
| Best | 35,166 | N/A | |
| Average | 141,301 | 3,193 | |
| Poor | 32,664 | 1,631 | |
| | | 4,824 | 30.29% |
| **Overall Cardiovascular Disease (Heart Disease and Stroke)** | | | |
| Best | 207,388 | N/A | |
| Average | 943,447 | 10,702 | |
| Poor | 245,084 | 5,224 | |
| | | 15,925 | 100% |