



# The Fifth Annual HealthGrades Women's Health Outcomes in American Hospitals Study

November 2008



**HEALTHGRADES®**  
**The Fifth Annual HealthGrades**  
**Women's Health in American Hospitals Study**  
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*For this report, HealthGrades identifies patient outcomes for maternity care and in-hospital treatment of cardiovascular disease (CVD) in women using three years of data (2004-2006) in 17 states. The maternity care analysis calculates maternal complication rates for vaginal, cesarean-section (C-section) and patient-choice C-section deliveries. It also includes neonatal mortality rates for all hospitals evaluated. The risk-adjusted analysis of in-hospital treatment of CVD identifies mortality rates for coronary bypass surgery, valve replacement surgery, coronary interventions, heart attack, heart failure, and stroke for women. The analysis identifies top-performing hospitals to establish a best-practice benchmark against which other hospitals can be evaluated. See [www.HealthGrades.com](http://www.HealthGrades.com) for a list of best-performing hospitals. Specific results for individual hospitals can be found at [www.healthgrades.com](http://www.healthgrades.com).*

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### **Introduction**

The *Fifth Annual HealthGrades Women's Health in American Hospitals* study analyzes the quality of care at U.S. hospitals for women and their newborns and for heart disease and stroke outcomes in women. The need to better understand the difference in quality outcomes for women seeking maternity care and in-hospital treatment for cardiovascular disease is essential given the combined impact these conditions have on the U.S. healthcare system.

Each year more women are hospitalized than men. In fact, women account for nearly 60 percent of all hospital admissions.<sup>1</sup> Primarily driven by pregnancy-related conditions, women make up 75 percent of the hospitalizations for patients ages 18-44.<sup>1</sup> For patients 65+, women represent 58 percent of all hospital stays, many of these are related to cardiovascular disease.<sup>1</sup> Childbirth is the most common reason for hospitalization in the U.S.<sup>1</sup> For many women, hospitalization due to childbirth is their first experience with inpatient care. For these women and their families, it is important to have comparative information about the quality differences that exist among hospital maternity care programs.

Cardiovascular disease kills one woman every minute in the U.S.; therefore, it is equally important for women to understand the differences that exist in the outcomes related to the in-hospital treatment of cardiovascular disease.<sup>2</sup> These differences exist despite significant gains in awareness, knowledge and perceptions related to cardiovascular disease. These gains have resulted in women taking positive action to lower the cardiovascular disease risk for both family members and themselves.<sup>2</sup>

Despite improvements in education and prevention, variations in outcomes for in-hospital care exist for women. The variations are twofold. First, there is a gap in how efficiently cardiovascular disease is identified in women and how effectively the disease is treated in women compared to men. Second, there is variation in outcomes from one hospital to another.<sup>1</sup>

## **Identifying Outcome Trends and Five-Star Hospitals**

Given that childbirth is the number one reason for hospital admissions<sup>1</sup> and cardiovascular disease is responsible for 1 in 2.6 female deaths in the U.S.<sup>2</sup>, information regarding the variation in outcomes-based performance among hospitals is essential to improving the quality of care in America. The primary aims of this study are to:

- Identify the best-performing U.S. hospitals in maternity care from 2004 through 2006.
- Examine the maternal complication trends for vaginal, caesarean section (C-section), and patient-choice C-section deliveries from 2004 through 2006.
- Examine the difference in neonatal mortality between best-, average-, and poor-performing hospitals.
- Identify the best-performing U.S. hospitals in women's health from 2004 through 2006.
- Examine outcome trends for the in-hospital treatment of heart disease and stroke in women from 2004 through 2006.

### **Assessing Maternity Care Outcomes**

HealthGrades analyzed more than 12.5 million hospital delivery and neonate records from 2004 through 2006 at over 1,440 hospitals in 17 states. To identify maternity care program performance, HealthGrades studied overall maternal complications rates for vaginal, C-section, and patient-choice C-sections (non-clinically indicated C-sections) as well as neonatal mortality. The best-performing hospitals are those hospitals that have combined rates of maternal complications and weight-stratified neonatal mortality low enough to place them among the top 15 percent of hospitals evaluated.

### **Assessing Cardiovascular Disease Outcomes in Women**

HealthGrades studied heart disease and stroke outcomes in women admitted to U.S. hospitals—more than one million discharges from 2004 through 2006. This study identifies the best-performing hospitals in 17 states specific to the care and treatment of women with cardiovascular disease and highlights differences and trends in mortality outcomes between the best and worst hospitals.

More information on both the maternity care and women's health methodology can be found in the *Hospital Report Cards™ Maternity Care and Women's Health 2008/2009 Methodology* white paper at [www.healthgrades.com](http://www.healthgrades.com).

## **Summary of Findings**

### **Maternity Care Outcomes**

HealthGrades analyzed over 12.5 million hospital delivery and neonate records from 2004 through 2006 in over 1,440 hospitals and found:

- The best-performing hospitals had almost 51 percent fewer maternal complications among women who had vaginal births compared to poor-performing hospitals.
- The best-performing hospitals had almost 76 percent fewer maternal complications among women who had C-sections compared to poor-performing hospitals.
- If all hospitals performed at the level of the best-performing hospitals from 2004 through 2006 across the 17 states studied, 188,673 women may have avoided developing one or more in-hospital major maternal obstetrics complications associated with vaginal or C-section delivery.
- Best-performing hospitals had 55 percent lower weight-stratified neonatal mortality compared to poor-performing hospitals. In fact, best-performing hospitals outperformed all other hospitals across all birth weight categories.

### **Women's Cardiovascular Outcomes**

HealthGrades analyzed more than one million hospitalizations from 2004 through 2006. To be included in the analysis, hospitals had to have an open heart program and transfer out less than 10 percent of their stroke patients. The findings include:

- Overall, risk-adjusted mortality for cardiovascular disease for women improved on average almost 15 percent from 2004 through 2006.
- The best-performing hospitals had almost 40 percent lower risk-adjusted mortality than the poor-performing hospitals and 22 percent lower risk-adjusted mortality than 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 48 to 30 percent better than poor-performing hospitals, and 30 to 19 percent better than average-performing hospitals.
- If all of the hospitals studied (in the 17 states) performed at the level of the best-performing hospitals from 2004 through 2006, 14,023 deaths among women hospitalized for cardiovascular disease could have been potentially prevented. The national number would be much higher.
- The greatest opportunity to reduce mortality is among women hospitalized for stroke and heart failure which, combined, represented almost 62 percent of the potentially preventable deaths.

## **Methodologies**

To help consumers evaluate and compare hospital performance for maternity care and cardiovascular disease in women, HealthGrades analyzed patient outcome data for every hospital in 17 states. The HealthGrades ratings are available on the Internet at [www.healthgrades.com](http://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 virtually all discharges for the associated states. The 17 states were as follows:

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

## Methodology for Women's Health Ratings

The women's health ratings were based upon a hospital's in-hospital risk-adjusted cardiac and stroke mortality and maternity care rating. (*Hospital Report Cards™ Maternity Care and Women's Health Methodology* can be found at [www.healthgrades.com](http://www.healthgrades.com).) Hospitals had to have an overall rating from each area to be considered.

## Methodology for Maternity Care Ratings

For maternity care ratings, HealthGrades analyzed the following factors for each hospital:

- Volume of vaginal and cesarean section (C-section) single live-born deliveries
- Maternal complication rate among women undergoing single live-born vaginal or C-section deliveries
- Maternal complication rate among women undergoing "patient-choice" or non-clinically indicated C-sections
- Newborn mortality rate stratified into eight weight categories

The four criteria measured were weighted using predetermined weights based on consensus from a physician panel. Each factor's percentile score was multiplied by its weight and then summed to create an overall score. Based upon each hospital's overall score, HealthGrades applied the following rating system.



Best – Top 15% of all hospitals within 17 states



Average – Middle 70% of all hospitals within 17 states



Poor – Bottom 15% of all hospitals within 17 states

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

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

- Coronary bypass surgery
- Valve replacement surgery
- Coronary interventional procedures including angioplasty and stent
- Acute myocardial infarction
- Heart failure
- 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 *Appendix G*.
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 were 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 cohort at each hospital to obtain actual and predicted outcomes.

## Ratings Assignment for Cardiac and 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** – Actual performance was typically as expected, limited to 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 cardiac and stroke services for women, the hospital had to have all of the following:

- An open heart program in 2006.
- 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, coronary interventional procedures, acute myocardial infarction, or heart failure) for a minimum of 150 discharges total.
- For the most recent year, a minimum of five female discharges in coronary bypass surgery, five female discharges in stroke, and five 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 (2004–2006). This implies that the hospital probably has onsite neurosurgical services.



## Maternity Care Findings

HealthGrades fifth annual analysis of hospital maternity care programs, found that the best-performing hospitals consistently outperformed all other hospitals for all maternal complication indicators as well as the weight-stratified neonatal mortality indicator.

- In the 17 states studied, 217 hospitals received a HealthGrades five-star rating for their maternity care programs. Of these, 144 had complication rates and weight-stratified neonatal mortality low enough to place them among the top 10 percent of hospitals studied. These 144 hospitals are recipients of the HealthGrades 2008/2009 Maternity Care Excellence Award™ (visit [www.HealthGrades.com](http://www.HealthGrades.com) for a list of award recipients).

## Maternal Complications

- For women having vaginal births, the best-performing hospitals had 50.72 percent fewer complications compared to poor-performing hospitals and 31.30 percent fewer complications compared to average-performing hospitals. The most frequent complications among women who had a vaginal delivery from 2004 through 2006 were third-degree perineal lacerations (3.11%) and injury to pelvic organs (2.93%) (see *Appendices A and B*).
- For women undergoing all types of C-section deliveries, the best-performing hospitals had 75.74 percent fewer complications compared to poor-performing hospitals, and 47.04 percent fewer complications compared to average-performing hospitals. Among women who had a C-section delivery, the most frequent complications were postpartum hemorrhage (1.49%) and postpartum infections (1.04%) (see *Appendices A and B*).
- Among women who had C-sections without a medical indication (“patient-choice” C-sections), the best-performing hospitals had lower complication rates than poor-performing hospitals. Specifically, best-performing hospitals had an average complication rate of 2.15 percent compared to 13.23 percent for the poor-performing hospitals, and 4.88 percent for average-performing hospitals (see *Appendix A*).
- If all hospitals performed at the level of the best-performing hospitals from 2004 through 2006 across the 17 states studied, 188,673 women may have avoided developing one or more in-hospital major maternal obstetrics complications associated with vaginal or C-section delivery (see *Appendix A*).

## Neonatal Mortality

- Best-performing hospitals had 54.55 percent lower weight-stratified neonatal mortality compared to poor-performing hospitals. In fact, best-performing hospitals outperformed all other hospitals across all birth weight categories (see *Appendix C*).
- Best-performing hospitals had 31.45 percent lower weight-stratified neonatal mortality than average-performing hospitals (see *Appendix C*).

## Women's Health Findings

In the 17 states studied, 66 hospitals received a HealthGrades five-star rating for women's health. Of these, 44 placed among the top 10 percent of hospitals studied. These 44 hospitals are recipients of the HealthGrades 2008/2009 Women's Health Excellence Award™ (visit [www.HealthGrades.com](http://www.HealthGrades.com) for a list of award recipients).

### Women's Cardiac and Stroke Outcomes

As with HealthGrades' previous *Women's Health Outcomes in U.S. Hospitals* studies, this year's research shows that in-hospital mortality for cardiovascular disease in women continues to improve. Overall risk-adjusted mortality improved 14.75 percent from 2004 through 2006 in the hospitals studied in the 17 states.

The best-performing hospitals continue to improve at a faster rate (18.06%) than average-performing (13.51%) and poor-performing (12.67%) hospitals. The best-performing hospitals had higher improvement rates in all cohorts measured except acute myocardial infarction where poor-performing hospitals improved 19.57 percent from 2004 through 2006 (see *Appendix D*). The most improvement noted is 28.19 percent for best-performing hospitals in coronary artery bypass surgery.

The areas with the most improvement across hospitals in each performance category include coronary bypass surgery and acute myocardial infarction. Best-, average- and poor-performing hospitals showed improvements ranging from 28.19, 22.69, and 20.48 percent respectively for coronary bypass surgery, and 15.73, 19.34, and 19.57 percent respectively for acute myocardial infarction.

From 2004 through 2006, poor-performing hospitals showed improvement in mortality across every cohort with the most improvement in valve replacement surgery, coronary bypass surgery, and acute myocardial infarction (see *Appendix D*). Most notably, poor-performing hospitals made the most gain in their open heart surgery programs with their coronary bypass mortality improving by 20.48 percent and the valve replacement mortality improving by 22.95 percent from 2004 through 2006.

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 *Appendices D and E*). For example:

- Overall, the best-performing hospitals had 39.87 percent lower risk-adjusted mortality than the poor-performing hospitals and 22.25 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 48.27 to 29.79 percent better than poor-performing hospitals and 30.15 to 18.94 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-performing hospitals having 48.27 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 29.79 percent lower risk-adjusted mortality than the poor-performing hospitals in this study.

During 2004–2006, if all hospitals studied in the 17 states studied performed at the level of the best-performing hospitals, 14,023 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 failure that combined represent 61.79 percent of the potential lives saved (see *Appendix F*).

## ***Interpretation of Results***

This study focuses on two major areas of care for women: first maternity care as it is the single largest reason for hospitalizations in the U.S.; and second cardiovascular disease, a chronic illness that often emerges in the middle years and remains an issue throughout a woman's senior years. Cardiovascular disease is the number one cause of mortality among women. The study shows that large variations in care exist for both maternity care and cardiovascular care.

The difference in quality of care between maternity care programs is substantial. For women undergoing all types of C-sections, the best-performing hospitals had nearly 76 percent fewer complications compared to poor-performing hospitals. Unexpected complications could mean a longer length of stay and longer recovery period. Expectant mothers should make use of available quality data to assist them when they determine where to give birth.

Large gaps also exist in cardiovascular disease outcomes for women in U.S. hospitals. HealthGrades' study found that the best-performing hospitals had almost 40 percent lower risk-adjusted mortality than the poor-performing hospitals. It is important to understand that hospitals are not the same when it comes to surviving a major cardiac or stroke hospitalization.

This study demonstrates that quality patient outcomes for women among U.S. hospitals are not equal. Wide gaps in quality outcomes exist. All patients need to take a more active role in their healthcare by seeking out quality outcomes information and including this information in their criteria for selecting a hospital.

## ***Limitations of the Maternity Care Performance Assessment and the Risk-Adjustment Models for Women's Health Performance***

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, some information may be missing, outdated, or incorrect.

Although the 17 states we studied represented a large percentage of all U.S. hospital discharges from 2004 through 2006, our findings may not be generalized to the entire United States or to states that we did not study.

## References

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2. American Heart Association. *Heart Disease and Stroke Statistics-2008 Update*. Dallas, Tex: American Heart Association; 2008. Available at: <http://www.americanheart.org/statistics>. Available at [www.americanheart.org](http://www.americanheart.org).

## Appendix A: Complication Rates by Delivery Type

Delivery Type	Hospital Maternity Care Performance	Number of Deliveries	Observed Inhospital Complication Rate	Number of Women Who Could Have Potentially Avoided Developing One or More Major Obstetrics Complications if Performed at Level of Best Hospitals	Reduction in Complication Rate if Performed at Level of Best Hospitals
Vaginal Delivery	Poor	324,212	16.92%	27,829	50.72%
Vaginal Delivery	Average	3,089,932	12.14%	117,430	31.30%
Vaginal Delivery	Best	1,022,077	8.34%		
C-section Delivery	Poor	126,215	11.33%	10,833	75.74%
C-section Delivery	Average	1,333,944	5.19%	32,581	47.04%
C-section Delivery	Best	506,636	2.75%		
Patient-choice C-section Deliveries	Poor	7,885	13.23%	873	83.73%
Patient-choice C-section Deliveries	Average	87,402	4.88%	2,383	55.88%
Patient-choice C-section Deliveries	Best	39,394	2.15%		
<b>Total</b>				<b>188,673</b>	

Total does not include patient-choice C-sections because they are included in the C-section delivery numbers.

## Appendix B: Top 3 Maternal Complications by Delivery Type

Delivery Type	ICD-9 Code	Description	Complication Rate
Vaginal Delivery	664.21	Third-degree perineal laceration	3.11%
	665.51	Other injury to pelvic organs	2.93%
	666.12	Other immediate postpartum hemorrhage	2.39%
C-section Delivery	666.12	Other immediate postpartum hemorrhage	1.49%
	670.02	Major puerperal infection (postpartum infection)	1.04%
	674.32	Other obstetrical surgical wound complication	0.87%

## Appendix C: Neonatal Mortality Rates

Hospital Maternity Care Performance	Number of Births	Observed Inhospital Mortality Rate	U.S. Average (Expected Inhospital Mortality Rate)	Observed-to-Expected Ratio	Relative Risk Reduction Associated with Best Compared to Poor Performers	Relative Risk Reduction Associated with Best Compared to Average Performers
Poor	461,723	0.49%	0.30%	1.66	54.55%	31.45%
Average	4,496,482	0.22%	0.19%	1.14		
Best	1,550,960	0.12%	0.16%	.76		

## Appendix D: Cardiovascular Disease Outcomes Performance by Year (2004-2006)

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 2004
<b>Coronary Artery Bypass Surgery</b>						
(Overall relative improvement of 23.43 percent from 2004 through 2006)*						
Best	2004	2.65%	3.01%	.88	(0.73-1.03)	
	2005	2.85%	3.31%	.86	(0.71-1.01)	
	2006	2.09%	3.31%	.63	(0.47-0.79)	28.19%
Average	2004	3.12%	2.76%	1.13	(1.05-1.21)	
	2005	3.19%	3.08%	1.04	(0.96-1.12)	
	2006	2.67%	3.06%	.87	(0.79-0.96)	22.69%
Poor	2004	3.36%	2.56%	1.31	(1.13-1.50)	
	2005	3.18%	2.75%	1.16	(0.97-1.34)	
	2006	2.82%	2.70%	1.04	(0.84-1.25)	20.48%
<b>Valve Replacement Surgery</b>						
(Overall relative improvement of 13.07 percent from 2004 through 2006)*						
Best	2004	6.48%	7.05%	.92	(0.77-1.07)	
	2005	6.10%	8.17%	.75	(0.61-0.88)	
	2006	5.62%	8.00%	.70	(0.56-0.84)	23.60%
Average	2004	7.06%	6.68%	1.06	(0.98-1.13)	
	2005	7.43%	7.09%	1.05	(0.97-1.12)	
	2006	6.99%	7.20%	.97	(0.90-1.05)	8.08%
Poor	2004	7.88%	6.32%	1.25	(1.08-1.42)	
	2005	8.03%	6.92%	1.16	(1.00-1.32)	
	2006	7.01%	7.29%	.96	(0.80-1.12)	22.95%
<b>Acute Myocardial Infarction</b>						
(Overall relative improvement of 18.90 percent from 2004 through 2006)*						
Best	2004	7.65%	8.77%	.87	(0.82-0.93)	
	2005	7.03%	8.99%	.78	(0.73-0.84)	
	2006	6.68%	9.08%	.74	(0.68-0.79)	15.73%
Average	2004	8.43%	7.78%	1.08	(1.05-1.11)	
	2005	7.75%	7.75%	1.00	(0.97-1.03)	
	2006	7.08%	8.10%	.87	(0.84-0.90)	19.34%
Poor	2004	9.94%	7.25%	1.37	(1.30-1.44)	
	2005	9.05%	7.25%	1.25	(1.18-1.32)	
	2006	8.22%	7.46%	1.10	(1.03-1.17)	19.57%

Continues...

Appendix D: Cardiovascular Disease Outcomes Performance by Year (2004-2006)  
(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 2004
<b>Interventional Cardiology Procedures (Angioplasty/Stent)</b>						
(Overall relative improvement of 9.20 percent from 2004 through 2006)*						
Best	2004	0.88%	1.05%	.84	(0.70-0.97)	
	2005	0.88%	1.04%	.85	(0.71-0.99)	
	2006	0.84%	1.13%	.74	(0.61-0.87)	11.58%
Average	2004	1.05%	1.03%	1.02	(0.95-1.08)	
	2005	1.02%	0.97%	1.05	(0.98-1.12)	
	2006	0.93%	1.01%	.92	(0.85-0.99)	9.38%
Poor	2004	1.06%	0.87%	1.22	(1.06-1.38)	
	2005	1.00%	0.80%	1.24	(1.08-1.40)	
	2006	0.97%	0.83%	1.17	(1.01-1.33)	3.96%
<b>Heart Failure</b>						
(Overall relative improvement of 10.30 percent from 2004 through 2006)*						
Best	2004	3.04%	4.24%	.72	(0.65-0.78)	
	2005	2.75%	4.12%	.67	(0.60-0.73)	
	2006	2.49%	4.06%	.61	(0.55-0.68)	14.47%
Average	2004	3.80%	3.75%	1.01	(0.98-1.05)	
	2005	3.42%	3.61%	.95	(0.91-0.98)	
	2006	3.19%	3.55%	.90	(0.86-0.93)	11.36%
Poor	2004	4.30%	3.37%	1.27	(1.20-1.35)	
	2005	4.51%	3.29%	1.37	(1.30-1.45)	
	2006	3.97%	3.25%	1.22	(1.14-1.30)	4.19%
<b>Stroke</b>						
(Overall relative improvement of 9.88 percent from 2004 through 2006)*						
Best	2004	9.73%	11.83%	.82	(0.77-0.87)	
	2005	9.55%	12.21%	.78	(0.73-0.83)	
	2006	8.44%	12.05%	.70	(0.65-0.75)	14.81%
Average	2004	11.55%	11.48%	1.01	(0.98-1.03)	
	2005	10.85%	11.19%	.97	(0.94-1.00)	
	2006	10.36%	11.47%	.90	(0.88-0.93)	10.24%
Poor	2004	14.03%	10.64%	1.32	(1.26-1.38)	
	2005	13.72%	10.56%	1.30	(1.24-1.36)	
	2006	13.77%	10.99%	1.25	(1.19-1.31)	4.88%
<b>Average Improvement from 2004 through 2006</b> (*includes all U.S. hospitals in 17 states eligible to receive a Women's Health rating)					All*	14.75%
					Best	18.06%
					Average	13.51%
					Poor	12.67%



## Appendix E: Differences in Cardiovascular Inhospital Mortality Outcomes by Performance Category for 3 Years Combined (2004-2006)

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
<b>Coronary Artery Bypass Graft Surgery</b>						
Best	2.55%	3.20%	0.79	(0.71-0.88)	32.50%	21.92%
Average	3.01%	2.95%	1.02	(0.97-1.07)		
Poor	3.14%	2.66%	1.18	(1.07-1.29)		
<b>Valve Replacement Surgery</b>						
Best	6.07%	7.74%	0.79	(0.70-0.87)	29.79%	23.40%
Average	7.16%	6.99%	1.03	(0.98-1.07)		
Poor	7.64%	6.83%	1.12	(1.02-1.21)		
<b>Acute Myocardial Infarction (Heart Attack)</b>						
Best	7.13%	8.94%	0.80	(0.77-0.83)	35.82%	19.29%
Average	7.78%	7.87%	0.99	(0.97-1.01)		
Poor	9.10%	7.32%	1.24	(1.20-1.28)		
<b>Interventional Cardiology Procedures (Angioplasty/Stent)</b>						
Best	0.87%	1.07%	0.81	(0.73-0.88)	33.36%	18.94%
Average	1.00%	1.00%	1.00	(0.96-1.04)		
Poor	1.01%	0.83%	1.21	(1.12-1.30)		
<b>Heart Failure</b>						
Best	2.77%	4.15%	0.67	(0.63-0.70)	48.27%	30.15%
Average	3.47%	3.64%	0.96	(0.94-0.97)		
Poor	4.26%	3.30%	1.29	(1.25-1.33)		
<b>Stroke</b>						
Best	9.24%	12.03%	0.77	(0.74-0.80)	40.43%	19.92%
Average	10.92%	11.38%	0.96	(0.94-0.98)		
Poor	13.84%	10.73%	1.29	(1.25-1.33)		
<b>Overall Cardiovascular Disease (Heart Disease and Stroke)</b>						
Best	4.14%	5.47%	0.76	(0.74-0.77)	39.87%	22.25%
Average	4.82%	4.95%	0.97	(0.96-0.98)		
Poor	5.62%	4.46%	1.26	(1.24-1.28)		

## Appendix F: Potential Lives Saved if All Hospitals Studied Performed at the Level of the Best-Performing Hospitals 3 Years Combined (2004-2006)

Women's Health Outcomes Performance	Discharges	Potential Lives Saves	Percent of Total Lives Saved
<b>Coronary Artery Bypass Graft Surgery</b>			
Best	15,400		
Average	58,463	385	
Poor	11,664	119	
		<b>504</b>	<b>3.60%</b>
<b>Valve Replacement Surgery</b>			
Best	7,507		
Average	29,348	492	
Poor	6,216	142	
		<b>633</b>	<b>4.52%</b>
<b>Acute Myocardial Infarction (Heart Attack)</b>			
Best	40,896		
Average	165,252	2,479	
Poor	33,939	1,106	
		<b>3,585</b>	<b>25.56%</b>
<b>Interventional Cardiology Procedures (Angioplasty/Stent)</b>			
Best	60,226		
Average	238,378	451	
Poor	54,920	185	
		<b>636</b>	<b>4.54%</b>
<b>Heart Failure</b>			
Best	69,968		
Average	278,307	2,916	
Poor	58,781	1,209	
		<b>4,125</b>	<b>29.42%</b>
<b>Stroke</b>			
Best	35,692		
Average	136,538	2,970	
Poor	28,063	1,570	
		<b>4,539</b>	<b>32.37%</b>
<b>Overall Cardiovascular Disease (Heart Disease and Stroke)</b>			
Best	229,689		
Average	906,286	9,693	
Poor	193,583	4,330	
		<b>14,023</b>	<b>100%</b>

Sums may not agree due to rounding.

## Appendix G: Patient Cohorts and Related ICD-9-CM Codes

Patient Definitions	ICD-9-CM Procedure/Diagnosis Codes and Criteria
<b>Maternity Care</b>	
Cesarean Section with Single Birth	Procedure Codes: 74.0 74.1, 74.2, 74.4, 74.99, excluding patients with diagnosis codes 651.00 through 651.93, 652.61, 660.51, V23.7, or V27.1 through V27.9
Vaginal Delivery with Single Birth	Principal Diagnoses: 650 or 640.0 through 676.9 (where fifth digit is 1 or 2), excluding patients with diagnosis codes 651.00 through 651.93, 652.61, 660.51, V23.7, or V27.1 through V27.9; excluding patients with procedure codes: 74.0 through 74.99
Patient-choice C-section	<p>Patients who had a cesarean section (cesarean procedure codes: 74.0 through 74.99); and did not labor (labor diagnosis codes like any of the following: 653*, 660*, 661*, 662*, 652.1*, 659.0*, 659.1*, 656.3*, or 663.0*); and did not have labor induction (procedure codes 73.0, 73.01, 73.09, 73.1, 73.4); and did not have a previous cesarean section (previous cesarean section diagnosis code: 654.21); and did not have any of the following diagnosis codes for these twelve clinical conditions:</p> <ul style="list-style-type: none"> <li>• Malpresentation: 652 through 652.03, 652.2 through 652.43, 652.6 through 652.93</li> <li>• Antepartum bleeding or placental abruption: like 641*, like 656.0*</li> <li>• Herpes: like 054*, like 647.6*</li> <li>• Severe hypertension: eclampsia and severe pre-eclampsia: like 642.5*, like 642.6*</li> <li>• Uterine scar unrelated to cesarean delivery: like 654.9*</li> <li>• Multiple gestation: like 651*, like 660.5*</li> <li>• Macrosomia: like 656.6*</li> <li>• Unengaged (high) fetal head: like 652.5*</li> <li>• Maternal soft tissue disorder (uterine abnormalities): like any of the following: 654.0*, 654.1*, 654.4*, 654.5*, 654.6*, 654.7*</li> <li>• Other types of hypertension: like 642* (where the fourth digit is not equal to 5 or 6)</li> <li>• Preterm gestation: like 644.2*</li> <li>• Congenital fetal CNS anomaly or chromosomal abnormality: like 655.0*, like 655.1*</li> <li>• Exclusion criteria: Patients that have a stillborn diagnosis (stillborn diagnosis codes: V27.1, V27.3, V27.4, V27.6, V27.7, like V32*, like V35*, like V36*, or between 651.30 and 651.63)</li> </ul>

Patient Definitions	ICD-9-CM Procedure/Diagnosis Codes and Criteria
<b>Newborn Mortality</b>	
500 to 749 grams	Diagnoses: 764.02 through 765.12 (where the fifth digit is 2), excluding patients with diagnosis codes 764.00, 764.10, 764.20, 764.90, 765.00, 765.10; excluding patients with procedure codes like 37.5*
750 to 999 grams	Diagnoses: 764.03 through 765.13 (where the fifth digit is 3), excluding patients with diagnosis codes 764.00, 764.10, 764.20, 764.90, 765.00, 765.10; excluding patients with procedure codes like 37.5*
1000 to 1249 grams	Diagnoses: 764.04 through 765.14 (where the fifth digit is 4), excluding patients with diagnosis codes 764.00, 764.10, 764.20, 764.90, 765.00, 765.10; excluding patients with procedure codes like 37.5*
1250 to 1499 grams	Diagnoses: 764.05 through 765.15 (where the fifth digit is 5), excluding patients with diagnosis codes 764.00, 764.10, 764.20, 764.90, 765.00, 765.10; excluding patients with procedure codes like 37.5*
1500 to 1749grams	Diagnoses: 764.06 through 765.16 (where the fifth digit is 6), excluding patients with diagnosis codes 764.00, 764.10, 764.20, 764.90, 765.00, 765.10; excluding patients with procedure codes like 37.5*
1750 to 1999 grams	Diagnoses: 764.07 through 765.17 (where the fifth digit is 7), excluding patients with diagnosis codes 764.00, 764.10, 764.20, 764.90, 765.00, 765.10; excluding patients with procedure codes like 37.5*
2000 to 2499 grams	Diagnoses: 764.08 through 765.18 (where the fifth digit is 8), excluding patients with diagnosis codes 764.00, 764.10, 764.20, 764.90, 765.00, 765.10; excluding patients with procedure codes like 37.5*
2500 plus grams or normal newborns	Diagnoses: 764.09 through 765.19 (where the fifth digit is 9), V30.00, V30.01, excluding patients with diagnosis codes 764.00, 764.10, 764.20, 764.90, 765.00, 765.10; excluding patients with procedure codes like 37.5*; and excluding patients in any of the above weight categories as well as the under 500 grams category
<b>Women's Cardiac and Stroke Mortality</b>	
Coronary Bypass Surgery	Principle Procedure Codes: 36.10, 36.11, 36.12, 36.13, 36.14, 36.15, 36.16, 36.19 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, 38.12, 38.34, 38.44, 38.64, 39.71, 44.12 Excluding patients with diagnosis code: 414.06, 414.07, 441.00, 441.01, 441.02, 441.03, V42.0, V42.1, V42.4 through V42.9
Valve Replacement Surgery	Principle or Secondary Procedure Codes: 35.20, 35.21, 35.22, 35.23, 35.24, 35.25, 35.26, 35.27, 35.28 Excluding patients with procedure codes: 35.33, 35.55, 36.33, 36.34, 37.51, 37.52, 37.53, 37.54, 37.62, 37.63, 38.12, 38.34, 38.44, 38.64, 39.71, 44.12 Excluding patients with diagnosis codes: 414.06, 414.07, 441.00, 441.01, 441.02, 441.03, 441.2, V42.0, V42.1, V42.4 through V42.9

Coronary Interventional Procedures	<p>Principal Procedure Codes: 36.01, 36.02, 36.05, 36.06, 36.07, 36.09</p> <p>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</p> <p>Excluding patients with diagnosis codes: 414.06, 414.07, V42.1, V42.0, V42.1, V42.4 through V42.9</p>
Acute Myocardial Infarction (Heart Attack)	<p>Principal Diagnoses: 410.01, 410.11, 410.21, 410.31, 410.41, 410.51, 410.61, 410.71, 410.81, 410.91</p> <p>Excluding patients with procedure codes: 37.5*, 37.51, 37.52, 37.53, 37.54, 37.62, 37.63</p> <p>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, V42.0, V42.1, V42.4 through V42.9, V66.7</p>
Heart Failure	<p>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</p> <p>Excluding patients with procedure codes: 37.51, 37.52, 37.53, 37.54, 37.62, 37.63, 39.95</p> <p>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, V42.0, V42.1, V42.4 through V42.9, V66.7</p>
Stroke	<p>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</p> <p>Excluding patients with procedure codes: 37.51, 37.52, 37.53, 37.54, 37.62, 37.63</p> <p>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, 432.1, V42.0, V42.1, V42.4 through V42.9, V66.7</p>

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

## Appendix H: Major Complications

Major Complications – Maternity Care			
Vaginal Delivery			
287.4	2ND THROMBOCYTOPENIA	996.62	INFECT D/T VASC DEVICE
512.0	SPONT TENS PNEUMOTHORAX	997.00	NERV SYST SURG COMP NOS
512.1	IATROGENIC PNEUMOTHORAX	997.01	CNS SURG COMP
512.8	SPONT PNEUMOTHORAX NEC	997.02	IATROGEN CV INFARCT/HEM
518.4	ACUTE LUNG EDEMA NOS	997.09	NERV SYST SURG COMP NEC
518.81	AC RESPIRATORY FAILURE	997.1	SURG COMP-HEART
584.5	ACUTE RENAL FAILURE	997.3	SURG COMP-RESP NEC
584.8	AC REN FAIL-PATH LES NEC	997.4	SURG COMP-DIGESTIVE
584.9	ACUTE RENAL FAILURE NOS	997.5	SURG COMP-URINARY NEC
664.21	DEL W 3 DEGREE LAC-DEL	997.91	SURG COMP-HYPERTENSION
664.31	DEL W 4 DEGREE LAC-DEL	998.0	POSTOPERATIVE SHOCK
665.31	LACERATION OF CERVIX-DEL	998.11	HEMORRHAGE COMP PX
665.41	HIGH VAGINAL LAC-DEL	998.2	ACCIDENTAL OP LACERATION
665.51	OB INJ PELV ORG NEC-DEL	998.3	POSTOP WOUND DISRUPTION
666.02	3RD STAGE PP HEMOR-DEL	998.4	FB LEFT DURING PROCEDURE
666.04	3RD STAGE PP HEMOR-PP	998.51	INFECTED POSTOP SEROMA
666.10	IMMED PP HEMOR NEC-NOS	998.59	POSTOP INFECTION NEC
666.12	IMMED PP HEMOR NEC-DEL	998.6	PERSIST POSTOP FISTULA
666.14	IMMED PP HEMOR NEC-PP	998.7	POSTOP FOREIGN SUBST RXN
666.20	DELAYED PP HEMOR-NOS	998.81	EMPHYSEMA DUE TO PX
666.22	DELAYED PP HEMOR-DEL PP	998.83	NON-HEALING SURG WND
666.24	DELAYED PP HEMOR-PP	998.9	SURGICAL COMP NOS
666.30	PP COAG DEFECT-NOS	999.1	AIR EMBOL COMP MED CARE
666.32	PP COAG DEFECT-DEL PP	999.2	VASC COMP MED CARE NEC
666.34	PP COAG DEFECT-PP	999.3	INFECT COMP MED CARE NEC
668.82	ANES COMP DEL NEC-DEL PP	999.4	ANAPHYLACTIC SHOCK-SERUM
670.02	MAJOR PP INFECT-DEL PP	999.5	SERUM REACTION NEC
674.32	OB SURG COMP NEC-DEL PP	999.6	ABO INCOMPATIBILITY RXN
785.51	CARDIOGENIC SHOCK	999.7	RH INCOMPATIBILITY RXN
785.59	SHOCK W/O TRAUMA NEC	999.8	TRANSFUSION REACTION NEC
996.31	MECH COMP URETHRAL CATH	999.9	COMP MED CARE NEC & NOS
996.60	INFECT DUE TO DEVICE NOS		

Major Complications – Maternity Care			
C-section Delivery			
287.4	2ND THROMBOCYTOPENIA	996.62	INFECT D/T VASC DEVICE
512.0	SPONT TENS PNEUMOTHORAX	997.00	NERV SYST SURG COMP NOS
512.1	IATROGENIC PNEUMOTHORAX	997.01	CNS SURG COMP
512.8	SPONT PNEUMOTHORAX NEC	997.02	IATROGEN CV INFARCT/HEM
518.4	ACUTE LUNG EDEMA NOS	997.09	NERV SYST SURG COMP NEC
518.81	AC RESPIRATORY FAILURE	997.1	SURG COMP-HEART
584.5	ACUTE RENAL FAILURE	997.3	SURG COMP-RESP NEC
584.8	AC REN FAIL-PATH LES NEC	997.4	SURG COMP-DIGESTIVE
584.9	ACUTE RENAL FAILURE NOS	997.5	SURG COMP-URINARY NEC
666.00	3RD STAGE PP HEMOR-NOS	997.91	SURG COMP-HYPERTENSION
666.02	3RD STAGE PP HEMOR-DEL	998.0	POSTOPERATIVE SHOCK
666.04	3RD STAGE PP HEMOR-PP	998.11	HEMORRHAGE COMP PX
666.10	IMMED PP HEMOR NEC-NOS	998.2	ACCIDENTAL OP LACERATION
666.12	IMMED PP HEMOR NEC-DEL	998.3	POSTOP WOUND DISRUPTION
666.14	IMMED PP HEMOR NEC-PP	998.4	FB LEFT DURING PROCEDURE
666.20	DELAYED PP HEMOR-NOS	998.51	INFECTED POSTOP SEROMA
666.22	DELAYED PP HEMOR-DEL PP	998.59	POSTOP INFECTION NEC
666.24	DELAYED PP HEMOR-PP	998.6	PERSIST POSTOP FISTULA
666.30	PP COAG DEFECT-NOS	998.7	POSTOP FOREIGN SUBST RXN
666.32	PP COAG DEFECT-DEL PP	998.81	EMPHYSEMA DUE TO PX
666.34	PP COAG DEFECT-PP	998.83	NON-HEALING SURG WND
667.02	RET PLAC S HEMOR-DEL PP	998.9	SURGICAL COMP NOS
668.82	ANES COMP DEL NEC-DEL PP	999.1	AIR EMBOL COMP MED CARE
669.42	OTH OB SURG COMP-DEL PP	999.2	VASC COMP MED CARE NEC
670.02	MAJOR PP INFECT-DEL PP	999.3	INFECT COMP MED CARE NEC
674.12	DISRUPT CD WND-DEL PP	999.4	ANAPHYLACTIC SHOCK-SERUM
674.32	OB SURG COMP NEC-DEL PP	999.5	SERUM REACTION NEC
785.50	SHOCK NOS	999.6	ABO INCOMPATIBILITY RXN
785.51	CARDIOGENIC SHOCK	999.7	RH INCOMPATIBILITY RXN
785.59	SHOCK W/O TRAUMA NEC	999.8	TRANSFUSION REACTION NEC
996.31	MECH COMP URETHRAL CATH	999.9	COMP MED CARE NEC & NOS
996.60	INFECT DUE TO DEVICE NOS		

## Appendix I: Congenital Anomalies

The following congenital anomalies were excluded from the study. These congenital anomalies are generally considered to be incompatible with life.

Central Nervous System	
740.0	Anencephalus
740.1	Craniorachischis
740.2	Inencephaly
742.1	Microcephalus
742.2	Reduction deformities of brain
Cardiac	
745.7	Cor biloculare
746.7	Hypoplastic left heart syndrome
746.82	Cor triatriatum
747.22	Atresia & stenosis of aorta
Renal	
753.0	Renal agenesis & dysgenesis (only if bilateral)
Chromosomal	
758.1	Patau's syndrome (trisomy 13)
758.2	Edward's syndrome (trisomy 18)
Respiratory	
748.5	Lung agenesis/Hypoplasia Aplasia of lung, Hypoplasia of lung (lobe), Sequestration of lung An argument can be made that not all are fatal (e.g., hypoplasia if unilateral). Due to the high frequency of associated malformations, the mortality rate is variable but high.
745.10	Complete transposition of great vessels