The Eighth Annual HealthGrades Hospital Quality in America Study

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Executive Summary

Since 1998, HealthGrades has studied the quality of care at the nation's 5,000 plus hospitals and published the results of its annual research on the Web to assist consumers in choosing a hospital. For the first part of the *Eighth Annual HealthGrades Hospital Quality in America Study*, millions of Medicare discharges from every U.S. hospital from 2002 through 2004 were analyzed. Risk-adjusted mortality and complication rates were calculated and hospitals were assigned a 1-star (poor), 3-star (as expected), or 5-star (best) quality rating for 28 diagnoses and procedures from heart failure to hip replacement to pneumonia. Individual hospital quality results from this study are available at www.healthgrades.com.

Although quality is improving and mortality rates are declining, this study demonstrates that considerable variation in quality continues to persist among the nation's hospitals. This persistent–and often stark–variation in quality underscores the value of this information's being readily available to prospective patients when making decisions about where to get their medical treatments. For the second part of this study, HealthGrades analyzed the inhospital mortality rates associated with 18 diagnoses and procedures to assess differences between 1-, 3-, and 5-star rated hospitals. This analysis compared inhospital risk-adjusted mortality rates for Medicare patients from 2002 through 2004 and found that these rates have improved, but vary widely across hospitals, diagnoses and procedures. The diagnoses and procedures covered by the second part of this study include:

- Abdominal Aortic Aneurysm Repair
- Acute Myocardial Infarction – Heart Attack
- Atrial Fibrillation
- Bowel Obstruction
- Chronic Obstructive Pulmonary Disease
- Community Acquired Pneumonia
- Coronary Bypass Surgery
- Coronary Interventional Procedures
- Diabetic Acidosis and Coma
- Gastrointestinal (GI) Bleed
- Gastrointestinal (GI) Procedures and Surgeries
- Heart Failure
- Pancreatitis
- Pulmonary Embolus
- Respiratory Failure
- Sepsis
- Stroke
- Valve Replacement Surgery

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Summary of Findings

Key findings of this study include:

1 Since 2002, mortality and performance have improved across a wide array of procedures and diagnoses, but large gaps exist and remain unchanged between the "best" and the "worst" hospitals.

- The nation's inhospital risk-adjusted mortality rate improved, on average, 12 percent from 2002 to 2004, but the degree of improvement varied widely by procedure and diagnosis studied (range: -2.09% to 22.15%).
- Five-star rated hospitals had significantly lower risk-adjusted mortality rates across all three years studied and improved 21 percent more than the U.S. hospital average and 45 percent more than 1-star rated hospitals.
- A typical patient would have, on average, a 65 percent lower chance of dying in a 5-star rated hospital compared to a 1-star rated hospital.
- A typical patient would have, on average, a 45 percent lower chance of dying in a 5-star rated hospital compared to the U.S. hospital average.

2 If all hospitals performed at the level of a 5-star rated hospital across the 18 procedures and diagnoses studied, 273,137 Medicare lives could have potentially been saved from 2002-2004.

- 50 percent (n=135,385) of the potentially preventable deaths were associated with just four diagnoses:
  1) Heart Failure (n=34,380)
  2) Community Acquired Pneumonia (n=40,986)
  3) Sepsis (n=29,874)
  4) Respiratory Failure (30,145)

3 Five-star rated hospitals have higher volumes and higher rate of intensivists staffing their ICUs.

- Higher volumes are associated with better outcomes for Abdominal Aortic Aneurysm Repair.
- Higher rate of Intensive Care Units (ICUs) staffed with intensivists is associated with better outcomes for Diabetic Acidosis and Coma and Pulmonary Embolism.

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Introduction

HealthGrades' annual research has found significant variation in the quality of care provided by the nation's hospitals that has persisted over the last seven years despite numerous quality initiatives at the hospital, local, state and federal level. Numerous studies, including the HealthGrades annual Hospital Quality in America studies, have shown that the quality of care is variable and often inadequate.[1-3] As such, it is imperative for patients to gather information and learn as much about their health care and prospective providers as possible.

Without publicly available hospital-specific quality measures, patients will be left only with subjective measures of quality, such as reputation. Reputation is a common but highly subjective measure and, when used alone, is insufficient in making informed decisions about providers. For example, academic status and areas of expertise do not predict high quality or consistent outcomes across a wide array of diagnoses and procedures.

A recent study by Jha et al. found that although major academic teaching hospitals modestly outperformed non-academic hospitals across acute myocardial infarction (heart attack) and heart failure evidence-based process measures, they underperformed in pneumonia care.[4] Jha et al.'s study examined the hospital performance on 10 indicators of quality of care for acute myocardial infarction, heart failure, and pneumonia. These process indicators and performance by hospital can be found at www.hospitalcompare.hhs.gov.

Although the process indicators analyzed by Jha et al. are undeniably important measures of hospital quality, they are somewhat limited in their usefulness because they are focused on only three diagnoses, lack mortality measurements, and are not well understood by the general public. The *Eighth Annual Hospital Quality in America Study* attempts to address these three limitations by broadening the scope of hospital quality assessment, measuring risk-adjusted inhospital mortality, and simplifying the reporting of hospital performance across 18 diagnoses and procedures by using a star rating system.

HealthGrades' star rating system tells consumers whether a particular hospital has performed "best" (5-star), "as expected" (3-star), or "poor" (1-star) on a particular procedure or diagnosis. Hospital ratings are based on patient outcomes, specifically, risk-adjusted mortality or complications. Because no two hospitals or their patients' risk profiles are alike, HealthGrades has developed extensive risk-adjustment algorithms to ensure that it is making fair, apples-to-apples comparisons.

Consumers are exercising more control than ever over life choices. They are becoming increasingly knowledgeable about quality differences among hospitals and are using quality information to make better informed health care choices.[5] The primary goal of this study is to provide the foundation for rating more than 5,000 hospitals across the country and identify and report new and changing trends in the quality of hospital care nationwide.

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Methods Part I:
The Eighth Annual Hospital Quality Ratings Methods

HealthGrades rated nearly 5,000 hospitals in the following categories (ratings for specific hospitals are available at www.healthgrades.com):

1 Abdominal Aortic Aneurysm (AAA)
2 Acute Myocardial Infarction (AMI)-Heart Attack
3 Atrial Fibrillation (AFIB)
4 Back and Neck Surgery (except Spinal Fusion)
5 Back and Neck Surgery (Spinal Fusion)
6 Bowel Obstruction
7 Carotid Endarterectomy
8 Cholecystectomy (gallbladder surgery)
9 Chronic Obstructive Pulmonary Disease (COPD)
10 Community Acquired Pneumonia (CAP)
11 Coronary Bypass Surgery (CABG)
12 Coronary Interventional Procedures
13 Diabetic Acidosis and Coma
14 Gastrointestinal (GI) Bleed
15 Gastrointestinal (GI) Procedures and Surgeries
16 Heart Failure
17 Hip Fracture Repair
18 Pancreatitis
19 Partial Hip Replacement
20 Peripheral Vascular Bypass
21 Prostatectomy
22 Pulmonary Embolus (PE)
23 Respiratory Failure
24 Sepsis
25 Stroke
26 Total Hip Replacement
27 Total Knee Replacement
28 Valve Replacement Surgery

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HealthGrades analyzed patient outcome data for virtually every hospital in the country using initial data purchased from the Centers for Medicare and Medicaid Services (CMS). The Medicare data (MedPAR file) from CMS contained the inpatient records for Medicare patients.

Each set of ratings was based upon one of two different risk-adjustment methodologies.

- For 26 medical issues, the risk adjustment was based upon the HealthGrades methodology described in the *Multivariate Logistic Regression-Based Ratings* section of this study.
- For Respiratory Failure and for Gastrointestinal Procedures and Surgeries, the risk adjustment was based upon APR-DRG methodology developed by 3M™ Corporation. APR-DRG stands for All Patient Refined Diagnosis Related Group. (All copyrights in and to APR-DRGs are owned by 3M™. All rights reserved.) This methodology is described in the APR-DRG-Based Ratings section of this study.

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 necessary to make accurate and valid comparisons of clinical outcomes at different hospitals.

Data Acquisition

The MedPAR data was selected for several reasons. First, it included virtually every hospital in the country, with the exception of military and Veterans Administration hospitals. Second, hospitals were required by law to submit complete and accurate information with substantial penalties for those that report inaccurate or incomplete data. Third, the Medicare population represented a majority of the patients for all of the clinical categories studied, with approximately 55 percent to 60 percent of all cardiac patients and 75 percent to 80 percent of all joint replacement surgeries, for example.

For Multivariate Logistic Regression-Based Ratings (see below), HealthGrades conducted a series of data quality checks to preserve the integrity of the ratings. Based on the results of these checks, we excluded a limited number of cases because they were inappropriate for inclusion in the database or miscoded.

Examples of excluded patient records were:

- Patients under the age of 65
- Patients who left the hospital against medical advice or who were transferred to another acute care hospital
- Patients discharged alive with a length of stay equal to or less than one day (except for Coronary Interventional Procedures, Acute Myocardial Infraction (Heart Attack), Heart Failure, Carotid Endarterectomy, Back and Neck Surgery (Spinal Fusion), Back and Neck Surgery (except Spinal Fusion), Chronic Obstructive Pulmonary Disease, Community Acquired Pneumonia, Peripheral Vascular Bypass, and Atrial Fibrillation)
- Patients who were still in the hospital when the Medicare claim was filed
- Patients with an invalid gender

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Methodology for Ratings

Our methodology takes into account patient characteristics such as age, sex, and underlying medical conditions that could increase the patient's risk of mortality or complication. Specifics about the statistical methods used are provided here and include:

- Multivariate Logistic Regression-Based Ratings
- APR-DRG-Based Ratings

Multivariate Logistic Regression-Based Ratings

The inhospital data for 28 diagnoses and procedures for more than 5,000 hospitals on the HealthGrades Web site represent three years of patient discharges from 2002 to 2004.

In the initial analysis of the data, a separate data set was created for each group of patients having a specific procedure or diagnosis based on ICD-9-CM coding (e.g., coronary bypass surgery, total hip replacement). Each group of patients was defined by using the information on diagnoses and procedures coded in the patient records. See Appendix A for a list of the diagnosis and procedure codes that define each patient cohort. The quality measure for some cohorts was mortality, whereas–for other cohorts–the quality measure was major complications.

For each patient cohort, we developed a list of specific procedures (e.g., quadruple bypass surgery), a list of risk factors, and a list of post-surgical complications. These latter two lists were developed in two steps:

1. We identified all diagnoses occurring in more than one percent of the patients for the current analysis and the previous analysis.
2. We used a team of clinical and coding experts to identify the complications in the list created in Step One.

Some diagnosis codes were merged together (e.g., primary and secondary pulmonary hypertension) to minimize the impact of coding variations.

Outcomes were binary, with documented major/minor complications either present or not, and patients recorded as either alive or expired. See Appendix B for a list of complications included in the quality measure "Major Complications." In cohorts where the quality measure is major complications, mortality is considered a complication.

Risk-Adjustment Methodology

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, sex, specific procedure performed, and comorbid conditions such as hypertension, chronic renal failure, heart failure, and diabetes. The methodology is disease-specific and outcome-specific. This means that individual risk models are constructed and tailored for each clinical condition or procedure, and also for each outcome.

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Developing the HealthGrades ratings involved four steps for each cohort (e.g., coronary bypass surgery) and quality measure (e.g., inhospital mortality).

1. First, the predicted value (e.g., predicted mortality) was obtained using logistic regression models discussed in the next section.
2. Second, the predicted value was compared with the actual, or observed, value (e.g., actual mortality).
3. Third, a test was conducted to determine whether the difference between the predicted and actual values was statistically significant. This test was performed to make sure that differences were very unlikely to be caused by chance alone.
4. Fourth, a star rating was assigned based upon the outcome of the statistical test.

Statistical Models

Unique statistical models were developed for each patient cohort and each outcome using logistic regression.

Comorbid diagnoses (e.g., hypertension, chronic renal failure, anemia, diabetes), demographic characteristics (e.g., age and sex), and specific procedures (where clinically relevant) were classified as potential risk factors. We used logistic regression to determine which of these were actually risk factors and to what extent they were correlated with the quality measure (e.g., mortality). A risk factor stayed in the model if it had an odds ratio greater than one (excluding clinically relevant procedures or cohort defining principal diagnosis) and was also statistically significant ($p<0.05$) in explaining variation. Exceptions to this rule should be noted for the cardiac service line (specifically CABG, PCI and AMI) where cardiogenic shock, anoxic brain injury, and cardiac arrest were excluded from the final model as risk factors. Complications were ***not*** counted as risk factors as they were considered a result of care received during the admission.

The statistical models were checked for validity and finalized. All of the models were highly significant, with C-statistics ranging from ~ 0.6 to ~ 0.9. These cohort and outcome-specific models were then used to estimate the probability of the outcome for each patient in the cohort. Patients were then aggregated for each hospital to obtain the predicted outcome for each hospital.

Statistical significance tests were performed to identify, by hospital, whether the actual and predicted rates were significantly different. We used a binomial distribution to establish an approximate 90% confidence interval.

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Assignment of Star Ratings

The following rating system was applied to the data for all procedures and diagnoses:

★★★★★ Actual performance was better than predicted and the difference was statistically significant.

★★★ Actual performance was not significantly different from what was predicted.

★ Actual performance was worse than predicted and the difference was statistically significant.

In general, 70 percent to 80 percent of hospitals in each procedure/diagnosis are classified as three stars, with actual results statistically the same as predicted results. Approximately 10 percent to 15 percent were one-star hospitals and 10 percent to 15 percent were five-star hospitals. The data fell out in a fairly well structured bell-shaped curve.

APR-DRG-Based Ratings

For Gastrointestinal Procedures and Surgeries and Respiratory Failure, the risk adjustment was based upon APR-DRGs, a methodology developed by 3M™ Corporation. APR-DRGs are an enhanced extension of the basic DRG (diagnosis related group) concept developed by 3M™'s Clinical Research Group, the National Association of Children's Hospitals and Research Institutes (NACHRI), and several physician groups.

While DRGs focus on the Medicare population, APR-DRGs describe a complete cross-section of acute care patients and are specifically designed to adjust data for severity of illness (How sick is the patient?) and risk of mortality (How likely is it that the patient will die?).

The fundamental principle of APR-DRGs is that the severity of illness and risk of mortality are both dependent on the patient's underlying condition. High severity of illness and risk of mortality are characterized by multiple serious diseases and the interactions between the disorders.

The 3M™ APR-DRG methodology is the most widely used severity-of-illness and risk-of-mortality adjustment tool available today. It has become the standard for adjusting large volumes of data to account for differences related to the individual's severity of illness or risk of mortality. As a result, the focus can be on the differences in clinical care, thus providing equitable comparisons of quality and cost of care. APR-DRGs are also recognized as the tool of choice by commissions, state agencies, and others who disseminate comparative performance data to regulators, payers and the general public.

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Data Analysis

The output from the APR-DRG software was twofold:

- It told us how many patients had Respiratory Failure or Gastrointestinal Procedures or Surgeries in each hospital.
- It identified each patient as being in one of four subclasses of mortality risk:
  - Minor
  - Moderate
  - Major
  - Extreme

HealthGrades then took the above APR-DRG output and went through these steps:

1. For each patient, a predicted probability of death was calculated based on the average national mortality rate for that mortality risk class in that APR-DRG.
2. Based on the observed and predicted deaths, a z-score was calculated for each hospital across the APR-DRGs, which define the cohort.
3. Any hospital that did not have at least 30 cases across three years of data was removed, and any hospital that did not have at least one case in the most current year was removed.

This z-score methodology was compared with the previously used chi-squared test and shown to produce nearly identical results.

Assignment of Star Ratings

The following rating system was applied to the data for all procedures and diagnoses:

Actual performance was better than predicted and the difference was statistically significant.

Actual performance was not significantly different from what was predicted.

Actual performance was worse than predicted and the difference was statistically significant.

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Limitations of the Data Models

It must be understood that while these models may be valuable in identifying hospitals that perform better than others, one should not use this information alone to determine the quality of care provided at each hospital. The 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 Health Grades, Inc. has taken steps to carefully compile these data using its methodology, no techniques are infallible, and therefore some information may be missing, outdated or incorrect.

Please note that a high ranking for a particular hospital is not a recommendation or endorsement by Health Grades, Inc. of a particular hospital; it means that the data associated with a particular hospital has met the foregoing qualifications. Only individual patients can decide whether a particular hospital is suited for their unique needs.

Also note that if more than one hospital reported to CMS under a single provider ID, HealthGrades analyzed patient outcome data for those hospitals as a single unit. (Throughout this document, therefore, "hospital" refers to one hospital or a group of hospitals reporting under a single provider ID.)

Methods Part II: Hospital Quality in America Study

The purpose of the second part of the study was to evaluate the variation in inhospital mortality across 18 diagnoses and procedures. These 18 were chosen from the list of 28 in Part I because their outcome measurement was mortality. In Part I, the actual (observed) and predicted (expected) mortality rates were calculated for each of the 18 procedures and diagnoses for each hospital. The inhospital observed and expected rates of all patients from each of the three hospital star rating groups (5-star, 3-star, and 1-star) were aggregated for each of the 18 procedures and diagnoses to obtain a 5-star, 3-star, and 1 star observed and expected inhospital mortality rate by procedure and diagnosis.

Unadjusted (observed) mortality rates and numbers were evaluated for trends. Because sicker patients will have higher associated observed mortality, we also calculated and compared observed (O) to expected (E) ratios by procedure or diagnosis and by year for each star rating.

- An O/E ratio of less than 1 means that the procedure/diagnoses measured had fewer deaths than expected given its patient population.
- An O/E of greater than 1 means that the procedure/diagnoses measured had more deaths than expected given its patient population.

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Results Part 1: Hospital Quality Ratings

HealthGrades' ratings of nearly 5,000 hospitals, based on the *Eighth Annual HealthGrades Hospital Quality in America Study*, can be found at www.healthgrades.com. For all of the specific diagnoses and procedures rated, 10-15 percent of hospitals stand out as "best" performers (5-star rated), while another 10-15 percent stand out as "poor" performers (1-star rated). The remaining hospitals are "as expected" (3-star rated).

Results Part 2: Hospital Quality in America Study

Since 2002, U.S. mortality rates have improved across a wide array of diagnoses and procedures for many hospitals, but large gaps continue to exist between the "best" and the "worst" hospitals, and more importantly, these gaps are not closing. However, across the 18 diagnoses and procedures studied, U.S. inhospital unadjusted and adjusted mortality rates improved. (See Appendix C1, C2, C3 and D.) Risk-adjusted mortality rates improved, on average, 12 percent from 2002 to 2004, but the degree of improvement varied widely by diagnosis and procedure. (range: -2.09% to 22.15%). (See Appendix D and E.)

Five-Star Rated Hospitals Have Significantly Lower Mortality

Most notably, 5-star rated hospitals had significantly and consistently lower mortality rates across all three years studied, compared to other rated hospitals. (See Appendix C, D and E.) Five-star rated hospitals also improved, on average, 12 percent from 2002 to 2004, which was 21 percent more than the U.S. hospital average and 45 percent more than 1-star rated hospitals. (See Table 1.) The lower mortality associated with 5-star rated hospitals means that a typical patient would have, on average, a 65 percent and 45 percent lower chance of dying in a 5-star rated hospital as compared to a 1-star rated hospital and the U.S. hospital average, respectively. If all hospitals had performed at the level of a 5-star rated hospital across the 18 diagnoses and procedures studied, 273,137 Medicare lives could have potentially been saved during 2002-2004. (See Appendix E.)

Table 1: Average Risk-Adjusted Mortality Rate Improvements* Across All Diagnoses and Procedures by Hospital Star Rating Category 2002-2004

Overall Average Improvement Rate	Hospital Quality			
	U.S.	5-star	3-star	1-star
	12.00%	14.00%	11.57%	9.67%

*Improvement was calculated for each of the 18 diagnoses and procedures by subtracting the corresponding 2004 O/E ratios from 2002 O/E ratios (found in Appendix D) then dividing by the 2002 O/E ratio and multiplying by 100. The average overall improvement rate was determined by taking the average of each of the 18 diagnoses and procedures calculated improvement rate.

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Five-Star Rated Hospitals Save Medicare Lives

Of the total 273,137 Medicare deaths associated with the 18 diagnoses and procedures studied, 50 percent of the potentially preventable deaths were associated with just four common hospital diagnoses:

1) Heart Failure (n=34,380)
2) Community Acquired Pneumonia (n=40,986)
3) Sepsis (n=29,874)
4) Respiratory Failure (30,145)

We found some of the largest quality gaps between 5-star and 1-star rated hospitals associated with Abdominal Aortic Aneurysm (AAA) repair and Diabetic Acidosis and Coma inhospital mortality. (See Appendix E.)

- For AAA repair, we found a 75 percent and 52 percent lower risk-adjusted mortality among 5-star rated hospitals as compared to 1-star rated hospitals and U.S. hospital average, respectively.
- For Pulmonary Embolism, we found an 80 percent and 59 percent lower risk-adjusted mortality among 5-star rated hospitals as compared to 1-star rated hospitals and U.S. hospital average, respective.
- For Diabetic Acidosis and Coma, we found even larger differences (93% to 83%).

Volume Matters

Numerous studies have demonstrated positive volume-outcome relationships. Consequently, higher volume is used as a hospital quality indicator by the Leapfrog Group[6] and AHRQ[7]. We therefore hypothesized that the 5-star rated hospitals performed significantly better in AAA repair and Diabetic Acidosis and Coma partly because they had higher volumes than 1-star rated hospitals. To assess this relationship, we compared the average volume for each cohort by star rating. Five-star rated hospitals had significantly more Medicare AAA repair and Diabetic Acidosis and Coma cases during 2002-2004 as compared to 1-star and 3-star rated hospitals. (See Table 2.)

Table 2: Hospital Quality Ratings and Average Three-Year Medicare

Star Rating	Average Three-Year Medicare Volume by Star Rating	
	AAA Repair	Diabetic Acidosis and Coma
1-star	52	93
3-star	66	95
5-star	93	155

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Intensivists Matter

Diabetic Acidosis and Coma and Pulmonary Embolism are associated with critically ill patients who have very high mortality risk. Consequently, these patients are most appropriately managed in the Intensive Care Unit (ICU) setting. In light of the studies demonstrating lower ICU mortality rates when intensivists are used[8], we postulated that the Diabetic Acidosis and Coma and Pulmonary Embolism 5-star rated hospitals had lower risk-adjusted mortality because they had a higher rate of intensivist use in their ICUs than other rated hospitals.

To assess this possibility, we used the Leapfrog Group's definition of intensivist[9] and its ICU Physician Staffing (IPS) survey results (Q2 2005) and calculated the percentage of 5-star, 3-star and 1-star rated hospitals that reported full implementation of the ICU Physician Staffing. Full implementation is defined by the Leapfrog Group as ICUs that are managed or co-managed by intensivists who are present during daytime hours and provide clinical care exclusively in the ICU. In addition, during off-hours, they can respond within five minutes.

For Diabetic Acidosis and Coma, 5-star rated hospitals were five times more likely than 1-star rated hospitals and two times more likely than the average (3-star rated) hospital to have full ICU physician staffing. For Pulmonary Embolism, the difference was not as great, but 5-star rated hospitals were noted to have the highest rate of full ICU physician staffing.

Table 3: Diabetic Acidosis and Coma and Pulmonary Embolism Hospital Quality and Percent of Hospitals that Reported Full Implementation of ICU Physician Staffing

Diagnosis	1-star Hospitals	3-star Hospitals	5-star Hospitals
Diabetic Acidosis and Coma	2.22%	5.86%	10.98%
Pulmonary Embolism	8.59%	7.29%	9.43%

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Interpretation of Results

What are the implications of this study for the future of improvements in quality in the U.S. hospital industry?

- First, they establish that outcomes can and have improved, even as patients are becoming increasingly complex.
- Second, this study confirms that variation in hospital performance persists, at least for 18 diagnoses and procedures, and the quality gap between the best and the worst has not changed since 2002.
- Third, this study also confirms that better than expected outcomes are achievable and hundreds of thousands of lives could have been saved if all hospitals performed similarly to 5-star rated hospitals.

The implications of this study for the future of consumerism are enormous. As patients become more engaged in their own well-being, more aware of the real differences among hospitals, and become armed with intelligent hospital-quality information, they will make informed decisions that could save their or their family member's life. Increased patient autonomy, broader access to information, expanding clinical options, rising costs, ascendancy of chronic illness, complex tradeoffs, and greater accommodation of personal values have been implicated as reasons for more engaged consumers.[5] There is little doubt that all of these factors will increase and as such, consumers' demand for guidance will only grow.

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Appendix A
Patient Cohorts and Related ICD-9-CM Codes

Patient Cohort	ICD-9-CM Procedure/Diagnosis Codes and Criteria
Abdominal Aorta Aneurysm Repair	Principal Procedures – Inclusions: 38.34, 38.44, 38.64, 39.71 Procedures – Exclusions: 35.10, 35.11, 35.12, 35.13, 35.14, 35.20, 35.21, 35.22, 35.23, 35.24, 35.25, 35.26, 35.27, 35.28, 36.1, 36.10, 36.11, 36.12, 36.13, 36.14, 36.15, 36.16, 36.17, 36.19, 37.5, 37.51, 37.52, 37.53, 37.54, 38.08, 38.16, 38.18, 38.36, 38.45, 39.24, 39.25, 39.29, 39.50, 39.59 Diagnoses – Exclusions: 441.00, 441.01, 441.02, 441.03, 441.1, 441.2, 441.6, 441.7, 441.9
Atrial Fibrillation	Principal Diagnoses – Inclusions: 427.31 Procedures – Exclusions: 37.5, 37.51, 37.52, 37.53, 37.54 Diagnoses – Exclusions: 414.06, 414.07, V66.7
Acute Myocardial Infraction (Heart Attack)	Principal Diagnoses – Inclusions: 410.01, 410.21, 410.31, 410.41, 410.51, 410.61, 410.71, 410.81, 410.91 Diagnoses – Exclusions: 414.06, 414.07, V66.7
Back and Neck Surgery (Spinal Fusion)	Principal Procedures – Inclusions: 81.00, 81.01, 81.02, 81.03, 81.04, 81.05, 81.06, 81.07, 81.08, 81.61, 81.62, 81.63, 81.64 Procedures – Exclusions: 03.02, 37.5, 37.51, 37.52, 37.53, 37.54, 81.3, 81.30, 81.31, 81.32, 81.33, 81.34, 81.35, 81.36, 81.37, 81.38, 81.39 Diagnoses – Exclusions: 722.80, 722.81, 722.82, 722.83, V45.4
Back and Neck Surgery (except Spinal Fusion)	Principal Procedures – Inclusions: 03.09, 03.53, 80.50, 80.51, 80.59 Procedures – Exclusions: 03.02, 37.5, 37.51, 37.52, 37.53, 37.54, 81.00, 81.01, 81.02, 81.03, 81.04, 81.05, 81.06, 81.07, 81.08, 81.09, 81.3, 81.30, 81.31, 81.32, 81.33, 81.34, 81.35, 81.36, 81.37, 81.38, 81.39, 81.61, 81.62, 81.63, 81.64 Diagnoses – Exclusions: 722.80, 722.81, 722.82, 722.83, V45.4

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Bowel Obstruction	Principal Diagnoses – Inclusions: 277.01, 532.01, 532.11, 532.21, 532.31, 532.41, 532.51, 532.61, 532.71, 532.91, 534.01, 534.11, 534.21, 534.31, 534.41, 534.51, 534.61, 534.71, 534.91, 537.2, 537.3, 550.10, 550.11, 550.12, 550.13, 552.00, 552.01, 552.02, 552.03, 552.1, 552.20, 552.21, 552.29, 552.8, 552.9, 557.0, 560.0, 560.1, 560.2, 560.30, 560.31, 560.39, 560.81, 560.89, 560.9, 751.1, 751.2, 777.1, 777.2, 777.4, 936, 937 Procedures – Exclusions: 37.5, 37.51, 37.52, 37.53, 37.54 Diagnoses – Exclusions: V66.7
Carotid Endarterectomy	Principal Procedures – Inclusions: 38.12, 39.72 Procedures – Exclusions: 36.1, 36.10, 36.11, 36.12, 36.13, 36.14, 36.15, 36.16, 36.17, 36.19, 37.5, 37.51, 37.52, 37.53, 37.54, 38.08, 38.16, 38.18, 38.36, 39.24, 39.25, 39.29, 39.50, 39.59, 39.90
Cholecystectomy	Principal Procedures – Inclusions: 51.21, 51.22, 51.23, 51.24 Procedures – Exclusions: 37.5, 37.51, 37.52, 37.53, 37.54
Chronic Obstructive Pulmonary Disease (COPD)	Principal Diagnoses – Inclusions: 491.1, 491.20, 491.21, 491.8, 491.9, 492.8, 493.20, 493.21, 493.22, 494, 494.0, 494.1, 496 Procedures – Exclusions: 37.5, 37.51, 37.52, 37.53, 37.54 Diagnoses – Exclusions: 480.3, V66.7
Community Acquired Pneumonia	Principal Diagnoses – Inclusions: 480.0, 480.1, 480.2, 480.8, 480.9, 481, 482.2, 482.30, 482.31, 482.32, 482.39, 482.9, 483.0, 483.1, 483.8, 485, 486, 487.0 Procedures – Exclusions: 37.5, 37.51, 37.52, 37.53, 37.54 Diagnoses – Exclusions: 480.3, V66.7
Coronary Bypass Surgery	Principal Procedures – Inclusions: 36.10, 36.11, 36.12, 36.13, 36.14, 36.15, 36.16, 36.19 Procedures – Exclusions: 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, 37.5, 37.51, 37.52, 37.53, 37.54, 38.12 Diagnoses – Exclusions: 414.06, 414.07

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Coronary Interventional Procedures	Principal or Secondary Procedures – Inclusions: 36.01, 36.02, 36.05, 36.06, 36.07, 36.09 Procedures – Exclusions: 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, 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 Diagnoses – Exclusions: 414.06, 414.07
Diabetic Acidosis and Coma	Principal or Secondary Procedures – Inclusions: 250.10, 250.11, 250.12, 250.13, 250.20, 250.21, 250.22, 250.23, 250.30, 250.31, 250.32, 250.33, 250.80, 250.81, 250.82, 250.83 Procedures – Exclusions: 37.5, 37.51, 37.52, 37.53, 37.54 Diagnoses – Exclusions: V66.7
Gastrointestinal Bleed	Principal Diagnoses – Inclusions: 456.0, 456.20, 530.21, 530.7, 530.82, 531.00, 531.01, 531.20, 531.21, 531.40, 531.41, 531.60, 531.61, 532.00, 532.01, 532.20, 532.21, 532.40, 532.41, 532.60, 532.61, 533.00, 533.01, 533.20, 533.21, 533.40, 533.41, 533.60, 533.61, 534.0, 534.00, 534.01, 534.20, 534.21, 534.40, 534.41, 534.60, 534.61, 535.01, 535.11, 535.21, 535.31, 535.41, 535.51, 535.61, 537.83, 537.84, 562.02, 562.03, 562.12, 562.13, 569.3, 569.85, 569.86, 578, 578.9, 751.0 Procedures – Exclusions: 37.5, 37.51, 37.52, 37.53, 37.54 Diagnoses – Exclusions: V66.7
Gastrointestinal Procedures & Surgeries	APR-DRG: 220-224, 226, 229, 260, 261, 264
Heart Failure	Principal Diagnoses – Inclusions: 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, 428.9 Procedures – Exclusions: 39.95 Diagnoses – Exclusions: 414.06,414.07, V66.7
Hip Fracture Repair	Principal Procedures – Inclusions: 79.05, 79.15, 79.25, 79.35 Procedures – Exclusions: 37.5, 37.51, 37.52, 37.53, 37.54, 81.54, 81.55 Diagnoses – Exclusions: 800.6, 820.10, 820.11, 820.12, 820.13, 820.19, 820.30, 820.31, 820.32, 820.9, 821.10, 821.11, 821.30, 821.31, 821.32, 821.33, 821.39, V66.7

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Pancreatitis	Principal Diagnoses – Inclusions: 577.0, 577.1 Procedures – Exclusions: 37.5, 37.51, 37.52, 37.53, 37.54
Partial Hip Replacement	Principal Procedures – Inclusions: 81.52 Procedures – Exclusions: 37.5, 37.51, 37.52, 37.53, 37.54, 81.54, 81.55 Diagnoses – Exclusions: 800.6, 820.10, 820.11, 820.12, 820.13, 820.19, 820.20, 820.22, 820.30, 820.31, 820.32, 820.9, 821.10, 821.11, 821.30, 821.31, 821.32, 821.33, 821.39, V66.7
Peripheral Vascular Bypass	Principal Procedures – Inclusions: 39.29 Principal Diagnoses – Inclusions: 250.60, 250.61, 250.62, 250.63, 250.70, 250.71, 250.72, 250.73, 250.80, 250.81, 250.82, 250.83, 440.20, 440.21, 440.22, 440.23, 440.24, 440.29, 440.30, 440.32, 442.2, 442.3, 443.89, 443.9, 444.22, 444.81, 445.02, 447.1, 681.10, 682.6, 682.7, 686.8, 707.10, 707.12, 707.13, 707.14, 707.15, 707.19, 707.8, 730.06, 730.07, 730.16, 730.17, 730.18, 730.26, 730.27, 785.4, 902.53, 904.41 Procedures – Exclusions: 37.5, 37.51, 37.52, 37.53, 37.54, 39.25, 39.49 Diagnoses – Exclusions: 440.31, 445.01
Prostatectomy	Principal Procedures – Inclusions: 60.21, 60.29, 60.3, 60.4, 60.5, 60.61, 60.62, 60.69 Procedures – Exclusions: 37.5, 37.51, 37.52, 37.53, 37.54
Pulmonary Embolism	Principal Diagnoses – Inclusions: 415.11, 415.19 Procedures – Exclusions: 37.5, 37.51, 37.52, 37.53, 37.54 Diagnoses – Exclusions: V66.7
Respiratory Failure	APR-DRG: 130, 133
Sepsis	Principal Diagnoses – Inclusions: 003.1, 022.3, 027.0, 036.2, 036.3, 038.0, 038.10, 038.11, 038.19, 038.2, 038.3, 038.40, 038.41, 038.42, 038.43, 038.44, 038.49, 038.8, 038.9, 054.5, 785.52, 995.90, 995.91, 995.92, 999.3 Procedures – Exclusions: 37.5, 37.51, 37.52, 37.53, 37.54 Diagnoses – Exclusions: V66.7

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Stroke	Principal Diagnoses – Inclusions: 430, 431, 432.0, 432.1, 432.9, 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91, 436 Procedures – Exclusions: 37.5, 37.51, 37.52, 37.53, 37.54 Diagnoses – Exclusions: V66.7
Total Hip Replacement	Principal Procedures – Inclusions: 81.51 Procedures – Exclusions: 37.5, 37.51, 37.52, 37.53, 37.54, 78.65, 78.67, 80.05, 80.06, 81.53, 81.54, 81.55 Diagnoses – Exclusions: E800, E800.0, E800.1, E800.2, E800.3, E800.8, E800.9, E801, E801.0, E801.1, E801.2, E801.3, E801.8, E801.9, E802, E802.0, E802.1, E802.2, E802.3, E802.8, E802.9, E803, E803.0, E803.1, E803.2, E803.3, E803.8, E803.9, E804, E804.0, E804.1, E804.2, E804.3, E804.8, E804.9, E805, E805.0, E805.1, E805.2, E805.3, E805.8, E805.9, E806, E806.0, E806.1, E806.2, E806.3, E806.8, E806.9, E807, E807.0, E807.1, E807.2, E807.3, E807.8, E807.9, E810, E810.0, E810.1, E810.2, E810.3, E810.4, E810.5, E810.6, E810.7, E810.8, E810.9, E811, E811.0, E811.1, E811.2, E811.3, E811.4, E811.5, E811.6, E811.7, E811.8, E811.9, E812, E812.0, E812.1, E812.2, E812.3, E812.4, E812.5, E812.6, E812.7, E812.8, E812.9, E813, E813.0, E813.1, E813.2, E813.3, E813.4, E813.5, E813.6, E813.7, E813.8, E813.9, E814, E814.0, E814.1, E814.2, E814.3, E814.4, E814.5, E814.6, E814.7, E814.8, E814.9, E815, E815.0, E815.1, E815.2, E815.3, E815.4, E815.5, E815.6, E815.7, E815.8, E815.9, E816, E816.0, E816.1, E816.2, E816.3, E816.4, E816.5, E816.6, E816.7, E816.8, E816.9, E817, E817.0, E817.1, E817.2, E817.3, E817.4, E817.5, E817.6, E817.7, E817.8, E817.9, E818, E818.0, E818.1, E818.2, E818.3, E818.4, E818.5, E818.6, E818.7, E818.8, E818.9, E819, E819.0, E819.1, E819.2, E819.3, E819.4, E819.5, E819.6, E819.7, E819.8, E819.9, E820, E820.0, E820.1, E820.2, E820.3, E820.4, E820.5, E820.6, E820.7, E820.8, E820.9, E821, E821.0, E821.1, E821.2, E821.3, E821.4, E821.5, E821.6, E821.7, E821.8, E821.9, E822, E822.0, E822.1, E822.2, E822.3, E822.4, E822.5, E822.6, E822.7, E822.8, E822.9, E823, E823.0, E823.1, E823.2, E823.3, E823.4, E823.5, E823.6, E823.7, E823.8, E823.9, E824, E824.0, E824.1, E824.2, E824.3, E824.4, E824.5, E824.6, E824.7, E824.8, E824.9, E825, E825.0, E825.1, E825.2, E825.3, E825.4, E825.5, E825.6, E825.7, E825.8, E825.9, E826, E826.0, E826.1, E826.2, E826.3, E826.4, E826.8, E826.9, E827, E827.0, E827.2, E827.3, E827.4, E827.8, E827.9, E828, E828.0, E828.2, E828.4, E828.8, E828.9, E829, E829.0, E829.4, E829.8, E829.9, E830, E830.0, E830.1, E830.2, E830.3, E830.4, E830.5, E830.6, E830.8, E830.9, E831, E831.0, E831.1, E831.2, E831.3, E831.4, E831.5, E831.6, E831.8, E831.9, E832, E832.0, E832.1, E832.2, E832.3, E832.4, E832.5, E832.6, E832.8, E832.9, E833, E833.0, E833.1, E833.2, E833.3, E833.4, E833.5, E833.6, E833.8, E833.9, E834, E834.0, E834.1, E834.2, E834.3, E834.4, E834.5, E834.6, E834.8, E834.9, E835, E835.0, E835.1, E835.2, E835.3, E835.4, E835.5, E835.6, E835.8, E835.9, E836, E836.0, E836.1, E836.2, E836.3, E836.4, E836.5, E836.6, E836.8, E836.9, E837, E837.0, E837.1, E837.2, E837.3, E837.4, E837.5, E837.6, E837.8,

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	E837.9, E838, E838.0, E838.1, E838.2, E838.3, E838.4, E838.5, E838.6, E838.8, E838.9, E840, E840.0, E840.1, E840.2, E840.3, E840.4, E840.5, E840.6, E840.7, E840.8, E840.9, E841, E841.0, E841.1, E841.2, E841.3, E841.4, E841.5, E841.6, E841.7, E841.8, E841.9, E842, E842.6, E842.7, E842.8, E842.9, E843, E843.0, E843.1, E843.2, E843.3, E843.4, E843.5, E843.6, E843.7, E843.8, E843.9, E844, E844.0, E844.1, E844.2, E844.3, E844.4, E844.5, E844.6, E844.7, E844.8, E844.9, E845, E845.0, E845.8, E845.9, E846, E847, E848, E849, E849.0, E849.1, E849.2, E849.3, E849.4, E849.5, E849.6, E849.7, E849.8, E849.9, E880, E880.0, E880.1, E880.9, E881, E881.0, E881.1, E882, E883, E883.0, E883.1, E883.2, E883.9, E884, E884.0, E884.1, E884.2, E884.3, E884.4, E884.5, E884.6, E884.9, E885, E885.0, E885.1, E885.2, E885.3, E885.4, E885.9, E886, E886.0, E886.9, E887, E888, E888.0, E888.1, E888.8, E888.9, E890.0, E890.8, E891.0, E891.8, E916, E917.0, E917.1, E917.2, E917.3, E917.4, E917.5, E917.6, E917.7, E917.8, E917.9, E918, E919.0, E919.1, E919.2, E919.3, E919.4, E919.5, E919.6, E919.7, E919.8, E919.9, E920, E920.0, E920.1, E920.2, E920.3, E920.4, E920.5, E920.8, E920.9, E921, E921.0, E921.1, E921.8, E921.9, E922, E922.0, E922.1, E922.2, E922.3, E922.4, E922.5, E922.8, E922.9, E923, E923.0, E923.1, E923.2, E923.8, E923.9, E928.8, E928.9, E929, E929.0, E929.1, E929.2, E929.3, E929.4, E929.5, E929.8, E929.9, E955.0, E955.1, E955.2, E955.3, E955.4, E955.5, E955.6, E955.7, E955.9, E956, E957.0, E957.1, E957.2, E957.9, E958.0, E958.5, E958.6, E960.0, E965.0, E965.1, E965.2, E965.3, E965.4, E965.5, E965.6, E965.7, E965.8, E965.9, E966, E968.1, E968.2, E968.5, E968.6, E969, E970, E971, E973, E974, E977, E985, E985.0, E985.1, E985.2, E985.3, E985.4, E985.5, E985.6, E985.7, E986, E987, E987.0, E987.1, E987.2, E987.9, E988, E988.0, E988.5, E988.6, E989, V15.5, V58.43
Total Knee Replacement	Principal Procedures – Inclusions: 81.54 Procedures – Exclusions: 37.5, 37.51, 37.52, 37.53, 37.54, 78.65, 78.67, 80.05, 80.06, 81.51, 81.52, 81.53
Valve Replacement Surgery	Principal or Secondary Procedures – Inclusions: 35.20, 35.21, 35.22, 35.23, 35.24, 35.25, 35.26, 35.27, 35.28 Procedures – Exclusions: 35.1, 35.33, 37.5, 37.51, 37.52, 37.53, 37.54, 38.12 Diagnoses – Exclusions: 414.06, 414.07, 441.2

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Appendix B
Major Complications

Major Complications – Back and Neck Surgery (Spinal Fusion)	
427.31	ATRIAL FIBRILLATION
427.89	CARDIAC DYSRYTHMIAS NEC
428.0	CONGESTIVE HEART FAILURE
428.1	LEFT HEART FAILURE
428.2	SYSTOLIC HEART FAILURE
428.20	SYSTOLC HEART FAILUR NOS
428.21	AC SYSTOLC HEART FAILURE
428.23	AC ON CHR SYSTOL HT FAIL
428.3	DIASTOLIC HEART FAILURE
428.30	DIASTOLC HEART FAILR NOS
428.31	AC DIASTOL HEART FAILURE
428.33	AC ON CHR DIASTL HT FAIL
428.4	CMB SYST & DIAST HT FAIL
428.40	CMB SYS/DIAS HT FAIL NOS
428.41	AC COMB SYS/DIAS HT FAIL
428.43	AC ON CH SYS/DIA HT FAIL
428.9	HEART FAILURE, NOS
480	VIRAL PNEUMONIA
480.0	PNEUMONIA DT ADENOVIRUS
480.1	PNEUMONIA DUE TO RSV
480.2	PNEUMON-PARAINFLUENZA VR
480.3	PNEUMONIA DT SARS
480.8	PNEUMONIA DT VIRUS NEC
480.9	VIRAL PNEUMONIA, NOS
481	PNEUMOCOCCAL PNEUMONIA
482	OTHR BACTERIAL PNEUMONIA
482.0	PNEUMONIA-K. PNEUMONIAE
482.1	PNEUMONIA DT PSEUDOMONAS
482.2	PNEUMONIA-H. INFLUENZAE
482.3	PNEUMONIA-STREPTOCOCCUS
482.30	PNEUMONIA-STREPTOCOC NOS
482.31	PNEUMONIA-GROUP A STREP
482.32	PNEUMONIA-GROUP B STREP
482.39	PNEUMONIA DT STREP NEC
482.4	PNEUMONIA-STAPHYLOCOCCUS
482.40	STAPH PNEUMONIA NOS
482.41	STAPH AUREUS PNEUMONIA
482.49	STAPH PNEUMONIA NEC
482.8	PNEUMONIA-BACTERIA NEC
482.81	PNEUMONIA DT ANAEROBES
482.82	PNEUMONIA-E. COLI
482.83	PNEUMONIA-GRM NG BAC NEC
482.84	LEGIONNAIRES' DISEASE
482.89	PNEUMONIA-BACTERIA NEC
482.9	BACTERIAL PNEUMONIA, NOS
483	PNEUMONIA-OTHER ORGANISM
483.0	PNEUMONIA-M. PNEUMONIAE
483.1	PNEUMONIA DT CHLAMYDIA
483.8	PNEUMONIA DT ORGANSM NEC
484	PNEUMONIA-OTH INFECT DIS
484.1	PNEUMONIA-CM INCLUSN DIS
484.3	PNEUMONIA-WHOOPING COUGH
484.5	PNEUMONIA IN ANTHRAX
484.6	PNEUMONIA-ASPERGILLOSIS
484.7	PNEUMON-SYST MYCOSES NEC
484.8	PNEUMON IN INFCT DIS NEC
485	BRONCHOPNEUM-ORGNISM NOS
486	PNEUMONIA-ORGANISM NOS
518.0	PULMONARY COLLAPSE
518.5	PULM INSUF PST TRAUM/SRG
560.1	PARALYTIC ILEUS
996.4	MECH COMPL-INT ORTHO DEV
996.77	COMP NEC-INTRN JT PROSTH
996.78	COMP NEC-ORTHOPD DEV NEC
997.1	CARDIAC COMPLICATION NEC
997.3	RESPIR COMPLICATIONS NEC
997.4	DIGESTIVE SYST COMPL NEC
997.5	URINARY COMPLICATION NEC
998.11	HEMORRHAGE COMPLIC PROC
998.2	ACC PUNCTUR/LAC-PROC NEC
998.59	POSTOPERATIV INFECTN NEC

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Major Complications – Back and Neck Surgery (except Spinal Fusion)			
427.31	ATRIAL FIBRILLATION	518.0	PULMONARY COLLAPSE
427.89	CARDIAC DYSRYTHMIAS NEC	518.5	PULM INSUF PST TRAUM/SRG
428.0	CONGESTIVE HEART FAILURE	593.9	KIDNEY & URETER DIS NOS
428.1	LEFT HEART FAILURE	996.4	MECH COMPL-INT ORTHO DEV
428.2	SYSTOLIC HEART FAILURE	996.77	COMP NEC-INTRN JT PROSTH
428.20	SYSTOLC HEART FAILUR NOS	996.78	COMP NEC-ORTHOPD DEV NEC
428.21	AC SYSTOLC HEART FAILURE	997.00	NERVOUS SYST COMPLIC NOS
428.23	AC ON CHR SYSTOL HT FAIL	997.02	IATROGN C-VSC INFRCT/HEM
428.3	DIASTOLIC HEART FAILURE	997.09	NERVOUS SYST COMPLIC NEC
428.30	DIASTOLC HEART FAILR NOS	997.1	CARDIAC COMPLICATION NEC
428.31	AC DIASTOL HEART FAILURE	997.3	RESPIR COMPLICATIONS NEC
428.33	AC ON CHR DIASTL HT FAIL	997.4	DIGESTIVE SYST COMPL NEC
428.4	CMB SYST & DIAST HT FAIL	997.5	URINARY COMPLICATION NEC
428.40	CMB SYS/DIAS HT FAIL NOS	998.11	HEMORRHAGE COMPLIC PROC
428.41	AC COMB SYS/DIAS HT FAIL	998.2	ACC PUNCTUR/LAC-PROC NEC
428.43	AC ON CH SYS/DIA HT FAIL	998.59	POSTOPERATIV INFECTN NEC
428.9	HEART FAILURE, NOS		

Major Complications – Carotid Endarterectomy			
427.31	ATRIAL FIBRILLATION	428.41	AC COMB SYS/DIAS HT FAIL
427.89	CARDIAC DYSRYTHMIAS NEC	428.43	AC ON CH SYS/DIA HT FAIL
428.0	CONGESTIVE HEART FAILURE	428.9	HEART FAILURE, NOS
428.1	LEFT HEART FAILURE	458.2	IATROGENIC HYPOTENSION
428.2	SYSTOLIC HEART FAILURE	997.00	NERVOUS SYST COMPLIC NOS
428.20	SYSTOLC HEART FAILUR NOS	997.01	CENTRL NERV SYST COMPLIC
428.21	AC SYSTOLC HEART FAILURE	997.02	IATROGN C-VSC INFRCT/HEM
428.23	AC ON CHR SYSTOL HT FAIL	997.09	NERVOUS SYST COMPLIC NEC
428.3	DIASTOLIC HEART FAILURE	997.1	CARDIAC COMPLICATION NEC
428.30	DIASTOLC HEART FAILR NOS	997.3	RESPIR COMPLICATIONS NEC
428.31	AC DIASTOL HEART FAILURE	997.4	DIGESTIVE SYST COMPL NEC
428.33	AC ON CHR DIASTL HT FAIL	998.11	HEMORRHAGE COMPLIC PROC
428.4	CMB SYST & DIAST HT FAIL	998.2	ACC PUNCTUR/LAC-PROC NEC
428.40	CMB SYS/DIAS HT FAIL NOS	998.59	POSTOPERATIV INFECTN NEC

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Major Complications – Cholecystectomy			
038	SEPTICEMIA	482.1	PNEUMONIA DT PSEUDOMONAS
038.0	STREPTOCOCCAL SEPTICEMIA	482.2	PNEUMONIA-H. INFLUENZAE
038.1	STAPHYLOCOCCL SEPTICEMIA	482.3	PNEUMONIA-STREPTOCOCCUS
038.10	STAPHLOCOCC SEPTICEM NOS	482.30	PNEUMONIA-STREPTOCOC NOS
038.11	SEPTICEMIA-STAPH AUREUS	482.31	PNEUMONIA-GROUP A STREP
038.19	STAPHLOCOCC SEPTICEM NEC	482.32	PNEUMONIA-GROUP B STREP
038.2	PNEUMOCOCCAL SEPTICEMIA	482.39	PNEUMONIA DT STREP NEC
038.3	SEPTICEMIA DT ANAEROBES	482.4	PNEUMONIA-STAPHYLOCOCCUS
038.4	SEPTICEMIA GRAM-NEGS NEC	482.40	STAPH PNEUMONIA NOS
038.40	SEPTICEMIA GRAM-NEGS NOS	482.41	STAPH AUREUS PNEUMONIA
038.41	SEPTICEMIA-H. INFLUENZAE	482.49	STAPH PNEUMONIA NEC
038.42	SEPTICEMIA DT E. COLI	482.8	PNEUMONIA-BACTERIA NEC
038.43	SEPTICEMIA - PSEUDOMONAS	482.81	PNEUMONIA DT ANAEROBES
038.44	SEPTICMIA DT SERRATIA	482.82	PNEUMONIA-E. COLI
038.49	SEPTICEMIA GRAM-NEG NEC	482.83	PNEUMONIA-GRM NG BAC NEC
038.8	OTH SPECIFIED SEPTICEMIA	482.84	LEGIONNAIRES' DISEASE
038.9	UNSPECIFIED SEPTICEMIA	482.89	PNEUMONIA-BACTERIA NEC
427.31	ATRIAL FIBRILLATION	482.9	BACTERIAL PNEUMONIA, NOS
427.89	CARDIAC DYSRYTHMIAS NEC	483	PNEUMONIA-OTHER ORGANISM
428.0	CONGESTIVE HEART FAILURE	483.0	PNEUMONIA-M. PNEUMONIAE
428.1	LEFT HEART FAILURE	483.1	PNEUMONIA DT CHLAMYDIA
428.2	SYSTOLIC HEART FAILURE	483.8	PNEUMONIA DT ORGANSM NEC
428.20	SYSTOLC HEART FAILUR NOS	484	PNEUMONIA-OTH INFECT DIS
428.21	AC SYSTOLC HEART FAILURE	484.1	PNEUMONIA-CM INCLUSN DIS
428.23	AC ON CHR SYSTOL HT FAIL	484.3	PNEUMONIA-WHOOPING COUGH
428.3	DIASTOLIC HEART FAILURE	484.5	PNEUMONIA IN ANTHRAX
428.30	DIASTOLC HEART FAILR NOS	484.6	PNEUMONIA-ASPERGILLOSIS
428.31	AC DIASTOL HEART FAILURE	484.7	PNEUMON-SYST MYCOSES NEC
428.33	AC ON CHR DIASTL HT FAIL	484.8	PNEUMON IN INFCT DIS NEC
428.4	CMB SYST & DIAST HT FAIL	485	BRONCHOPNEUM-ORGNISM NOS
428.40	CMB SYS/DIAS HT FAIL NOS	486	PNEUMONIA-ORGANISM NOS
428.41	AC COMB SYS/DIAS HT FAIL	511.9	PLEURAL EFFUSION, NOS
428.43	AC ON CH SYS/DIA HT FAIL	518.0	PULMONARY COLLAPSE
428.9	HEART FAILURE, NOS	518.5	PULM INSUF PST TRAUM/SRG
480	VIRAL PNEUMONIA	518.81	RESPIRATORY FAILURE
480.0	PNEUMONIA DT ADENOVIRUS	560.1	PARALYTIC ILEUS
480.1	PNEUMONIA DUE TO RSV	584.9	ACUTE RENAL FAILURE, NOS
480.2	PNEUMON-PARAINFLUENZA VR	997.1	CARDIAC COMPLICATION NEC
480.3	PNEUMONIA DT SARS	997.3	RESPIR COMPLICATIONS NEC
480.8	PNEUMONIA DT VIRUS NEC	997.4	DIGESTIVE SYST COMPL NEC
480.9	VIRAL PNEUMONIA, NOS	997.5	URINARY COMPLICATION NEC
481	PNEUMOCOCCAL PNEUMONIA	998.11	HEMORRHAGE COMPLIC PROC
482	OTHR BACTERIAL PNEUMONIA	998.2	ACC PUNCTUR/LAC-PROC NEC
482.0	PNEUMONIA-K. PNEUMONIAE	998.59	POSTOPERATIV INFECTN NEC

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Major Complications – Hip Fracture Repair			
410.71	AMI-SUBEND INFRCT-INIT'L	482.41	STAPH AUREUS PNEUMONIA
427.31	ATRIAL FIBRILLATION	482.49	STAPH PNEUMONIA NEC
427.89	CARDIAC DYSRYTHMIAS NEC	482.8	PNEUMONIA-BACTERIA NEC
428.0	CONGESTIVE HEART FAILURE	482.81	PNEUMONIA DT ANAEROBES
428.1	LEFT HEART FAILURE	482.82	PNEUMONIA-E. COLI
428.2	SYSTOLIC HEART FAILURE	482.83	PNEUMONIA-GRM NG BAC NEC
428.20	SYSTOLC HEART FAILUR NOS	482.84	LEGIONNAIRES' DISEASE
428.21	AC SYSTOLC HEART FAILURE	482.89	PNEUMONIA-BACTERIA NEC
428.23	AC ON CHR SYSTOL HT FAIL	482.9	BACTERIAL PNEUMONIA, NOS
428.3	DIASTOLIC HEART FAILURE	483	PNEUMONIA-OTHER ORGANISM
428.30	DIASTOLC HEART FAILR NOS	483.0	PNEUMONIA-M. PNEUMONIAE
428.31	AC DIASTOL HEART FAILURE	483.1	PNEUMONIA DT CHLAMYDIA
428.33	AC ON CHR DIASTL HT FAIL	483.8	PNEUMONIA DT ORGANSM NEC
428.4	CMB SYST & DIAST HT FAIL	484	PNEUMONIA-OTH INFECT DIS
428.40	CMB SYS/DIAS HT FAIL NOS	484.1	PNEUMONIA-CM INCLUSN DIS
428.41	AC COMB SYS/DIAS HT FAIL	484.3	PNEUMONIA-WHOOPING COUGH
428.43	AC ON CH SYS/DIA HT FAIL	484.5	PNEUMONIA IN ANTHRAX
428.9	HEART FAILURE, NOS	484.6	PNEUMONIA-ASPERGILLOSIS
480	VIRAL PNEUMONIA	484.7	PNEUMON-SYST MYCOSES NEC
480.0	PNEUMONIA DT ADENOVIRUS	484.8	PNEUMON IN INFCT DIS NEC
480.1	PNEUMONIA DUE TO RSV	485	BRONCHOPNEUM-ORGNISM NOS
480.2	PNEUMON-PARAINFLUENZA VR	486	PNEUMONIA-ORGANISM NOS
480.3	PNEUMONIA DT SARS	507.0	PNEUMONIT-INH FOOD/VOMIT
480.8	PNEUMONIA DT VIRUS NEC	518.0	PULMONARY COLLAPSE
480.9	VIRAL PNEUMONIA, NOS	518.5	PULM INSUF PST TRAUM/SRG
481	PNEUMOCOCCAL PNEUMONIA	518.81	RESPIRATORY FAILURE
482	OTHR BACTERIAL PNEUMONIA	560.1	PARALYTIC ILEUS
482.0	PNEUMONIA-K. PNEUMONIAE	584.9	ACUTE RENAL FAILURE, NOS
482.1	PNEUMONIA DT PSEUDOMONAS	593.9	KIDNEY & URETER DIS NOS
482.2	PNEUMONIA-H. INFLUENZAE	996.4	MECH COMPL-INT ORTHO DEV
482.3	PNEUMONIA-STREPTOCOCCUS	996.77	COMP NEC-INTRN JT PROSTH
482.30	PNEUMONIA-STREPTOCOC NOS	996.78	COMP NEC-ORTHOPD DEV NEC
482.31	PNEUMONIA-GROUP A STREP	997.02	IATROGN C-VSC INFRCT/HEM
482.32	PNEUMONIA-GROUP B STREP	997.1	CARDIAC COMPLICATION NEC
482.39	PNEUMONIA DT STREP NEC	997.3	RESPIR COMPLICATIONS NEC
482.4	PNEUMONIA-STAPHYLOCOCCUS	998.11	HEMORRHAGE COMPLIC PROC
482.40	STAPH PNEUMONIA NOS	998.59	POSTOPERATIV INFECTN NEC

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Major Complications – Partial Hip Replacement			
292.81	DRUG-INDUCED DELIRIUM	482.40	STAPH PNEUMONIA NOS
293.0	ACUTE DELIRIUM 4	482.41	STAPH AUREUS PNEUMONIA
410.71	AMI-SUBEND INFRCT-INIT'L	482.49	STAPH PNEUMONIA NEC
427.31	ATRIAL FIBRILLATION	482.8	PNEUMONIA-BACTERIA NEC
427.89	CARDIAC DYSRYTHMIAS NEC	482.81	PNEUMONIA DT ANAEROBES
428.0	CONGESTIVE HEART FAILURE	482.82	PNEUMONIA-E. COLI
428.1	LEFT HEART FAILURE	482.83	PNEUMONIA-GRM NG BAC NEC
428.2	SYSTOLIC HEART FAILURE	482.84	LEGIONNAIRES' DISEASE
428.20	SYSTOLC HEART FAILUR NOS	482.89	PNEUMONIA-BACTERIA NEC
428.21	AC SYSTOLC HEART FAILURE	482.9	BACTERIAL PNEUMONIA, NOS
428.23	AC ON CHR SYSTOL HT FAIL	483	PNEUMONIA-OTHER ORGANISM
428.3	DIASTOLIC HEART FAILURE	483.0	PNEUMONIA-M. PNEUMONIAE
428.30	DIASTOLC HEART FAILR NOS	483.1	PNEUMONIA DT CHLAMYDIA
428.31	AC DIASTOL HEART FAILURE	483.8	PNEUMONIA DT ORGANSM NEC
428.33	AC ON CHR DIASTL HT FAIL	484	PNEUMONIA-OTH INFECT DIS
428.4	CMB SYST & DIAST HT FAIL	484.1	PNEUMONIA-CM INCLUSN DIS
428.40	CMB SYS/DIAS HT FAIL NOS	484.3	PNEUMONIA-WHOOPING COUGH
428.41	AC COMB SYS/DIAS HT FAIL	484.5	PNEUMONIA IN ANTHRAX
428.43	AC ON CH SYS/DIA HT FAIL	484.6	PNEUMONIA-ASPERGILLOSIS
428.9	HEART FAILURE, NOS	484.7	PNEUMON-SYST MYCOSES NEC
480	VIRAL PNEUMONIA	484.8	PNEUMON IN INFCT DIS NEC
480.0	PNEUMONIA DT ADENOVIRUS	485	BRONCHOPNEUM-ORGNISM NOS
480.1	PNEUMONIA DUE TO RSV	486	PNEUMONIA-ORGANISM NOS
480.2	PNEUMON-PARAINFLUENZA VR	507.0	PNEUMONIT-INH FOOD/VOMIT
480.3	PNEUMONIA DT SARS	518.0	PULMONARY COLLAPSE
480.8	PNEUMONIA DT VIRUS NEC	518.5	PULM INSUF PST TRAUM/SRG
480.9	VIRAL PNEUMONIA, NOS	518.81	RESPIRATORY FAILURE
481	PNEUMOCOCCAL PNEUMONIA	560.1	PARALYTIC ILEUS
482	OTHR BACTERIAL PNEUMONIA	584.9	ACUTE RENAL FAILURE, NOS
482.0	PNEUMONIA-K. PNEUMONIAE	593.9	KIDNEY & URETER DIS NOS
482.1	PNEUMONIA DT PSEUDOMONAS	996.4	MECH COMPL-INT ORTHO DEV
482.2	PNEUMONIA-H. INFLUENZAE	996.77	COMP NEC-INTRN JT PROSTH
482.3	PNEUMONIA-STREPTOCOCCUS	996.78	COMP NEC-ORTHOPD DEV NEC
482.30	PNEUMONIA-STREPTOCOC NOS	997.02	IATROGN C-VSC INFRCT/HEM
482.31	PNEUMONIA-GROUP A STREP	997.1	CARDIAC COMPLICATION NEC
482.32	PNEUMONIA-GROUP B STREP	997.3	RESPIR COMPLICATIONS NEC
482.39	PNEUMONIA DT STREP NEC	998.11	HEMORRHAGE COMPLIC PROC
482.4	PNEUMONIA-STAPHYLOCOCCUS	998.59	POSTOPERATIV INFECTN NEC

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Major Complications – Peripheral Vascular Bypass	
038	SEPTICEMIA
038.0	STREPTOCOCCAL SEPTICEMIA
038.1	STAPHYLOCOCCL SEPTICEMIA
038.10	STAPHLOCOCC SEPTICEM NOS
038.11	SEPTICEMIA-STAPH AUREUS
038.19	STAPHLOCOCC SEPTICEM NEC
038.2	PNEUMOCOCCAL SEPTICEMIA
038.3	SEPTICEMIA DT ANAEROBES
038.4	SEPTICEMIA GRAM-NEGS NEC
038.40	SEPTICEMIA GRAM-NEGS NOS
038.41	SEPTICEMIA-H. INFLUENZAE
038.42	SEPTICEMIA DT E. COLI
038.43	SEPTICEMIA - PSEUDOMONAS
038.44	SEPTICMIA DT SERRATIA
038.49	SEPTICEMIA GRAM-NEG NEC
038.8	OTH SPECIFIED SEPTICEMIA
038.9	UNSPECIFIED SEPTICEMIA
041.04	BACTR INF DT GRP D STREP
041.11	BACTERL INF DT S. AUREUS
041.7	PSEUDOMONAS IN OTHER DIS
427.31	ATRIAL FIBRILLATION
427.89	CARDIAC DYSRYTHMIAS NEC
428.0	CONGESTIVE HEART FAILURE
428.1	LEFT HEART FAILURE
428.2	SYSTOLIC HEART FAILURE
428.20	SYSTOLC HEART FAILUR NOS
428.21	AC SYSTOLC HEART FAILURE
428.23	AC ON CHR SYSTOL HT FAIL
428.3	DIASTOLIC HEART FAILURE
428.30	DIASTOLC HEART FAILR NOS
428.31	AC DIASTOL HEART FAILURE
428.33	AC ON CHR DIASTL HT FAIL
428.4	CMB SYST & DIAST HT FAIL
428.40	CMB SYS/DIAS HT FAIL NOS
428.41	AC COMB SYS/DIAS HT FAIL
428.43	AC ON CH SYS/DIA HT FAIL
428.9	HEART FAILURE, NOS
480	VIRAL PNEUMONIA
480.0	PNEUMONIA DT ADENOVIRUS
480.1	PNEUMONIA DUE TO RSV
480.2	PNEUMON-PARAINFLUENZA VR
480.3	PNEUMONIA DT SARS
480.8	PNEUMONIA DT VIRUS NEC
480.9	VIRAL PNEUMONIA, NOS
481	PNEUMOCOCCAL PNEUMONIA
482	OTHR BACTERIAL PNEUMONIA
482.0	PNEUMONIA-K. PNEUMONIAE
482.1	PNEUMONIA DT PSEUDOMONAS
482.2	PNEUMONIA-H. INFLUENZAE
482.3	PNEUMONIA-STREPTOCOCCUS
482.30	PNEUMONIA-STREPTOCOC NOS
482.31	PNEUMONIA-GROUP A STREP
482.32	PNEUMONIA-GROUP B STREP
482.39	PNEUMONIA DT STREP NEC
482.4	PNEUMONIA-STAPHYLOCOCCUS
482.40	STAPH PNEUMONIA NOS
482.41	STAPH AUREUS PNEUMONIA
482.49	STAPH PNEUMONIA NEC
482.8	PNEUMONIA-BACTERIA NEC
482.81	PNEUMONIA DT ANAEROBES
482.82	PNEUMONIA-E. COLI
482.83	PNEUMONIA-GRM NG BAC NEC
482.84	LEGIONNAIRES' DISEASE
482.89	PNEUMONIA-BACTERIA NEC
482.9	BACTERIAL PNEUMONIA, NOS
483	PNEUMONIA-OTHER ORGANISM
483.0	PNEUMONIA-M. PNEUMONIAE
483.1	PNEUMONIA DT CHLAMYDIA
483.8	PNEUMONIA DT ORGANSM NEC
484	PNEUMONIA-OTH INFECT DIS
484.1	PNEUMONIA-CM INCLUSN DIS
484.3	PNEUMONIA-WHOOPING COUGH
484.5	PNEUMONIA IN ANTHRAX
484.6	PNEUMONIA-ASPERGILLOSIS
484.7	PNEUMON-SYST MYCOSES NEC
484.8	PNEUMON IN INFCT DIS NEC
485	BRONCHOPNEUM-ORGNISM NOS
486	PNEUMONIA-ORGANISM NOS
518.5	PULM INSUF PST TRAUM/SRG
584.9	ACUTE RENAL FAILURE, NOS
593.9	KIDNEY & URETER DIS NOS
996.74	COMP NEC-VASC DEV/GRAFT
997.1	CARDIAC COMPLICATION NEC
997.3	RESPIR COMPLICATIONS NEC
998.11	HEMORRHAGE COMPLIC PROC
998.2	ACC PUNCTUR/LAC-PROC NEC
998.59	POSTOPERATIV INFECTN NEC

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Major Complications – Prostatectomy			
427.31	ATRIAL FIBRILLATION	428.4	CMB SYST & DIAST HT FAIL
427.89	CARDIAC DYSRYTHMIAS NEC	428.40	CMB SYS/DIAS HT FAIL NOS
428.0	CONGESTIVE HEART FAILURE	428.41	AC COMB SYS/DIAS HT FAIL
428.1	LEFT HEART FAILURE	428.43	AC ON CH SYS/DIA HT FAIL
428.2	SYSTOLIC HEART FAILURE	428.9	HEART FAILURE, NOS
428.20	SYSTOLC HEART FAILUR NOS	518.5	PULM INSUF PST TRAUM/SRG
428.21	AC SYSTOLC HEART FAILURE	560.1	PARALYTIC ILEUS
428.23	AC ON CHR SYSTOL HT FAIL	584.9	ACUTE RENAL FAILURE, NOS
428.3	DIASTOLIC HEART FAILURE	997.1	CARDIAC COMPLICATION NEC
428.30	DIASTOLC HEART FAILR NOS	997.4	DIGESTIVE SYST COMPL NEC
428.31	AC DIASTOL HEART FAILURE	997.5	URINARY COMPLICATION NEC
428.33	AC ON CHR DIASTL HT FAIL	998.11	HEMORRHAGE COMPLIC PROC

Major Complications – Total Hip Replacement			
427.31	ATRIAL FIBRILLATION	428.9	HEART FAILURE, NOS
428.0	CONGESTIVE HEART FAILURE	518.0	PULMONARY COLLAPSE
428.1	LEFT HEART FAILURE	518.5	PULM INSUF PST TRAUM/SRG
428.2	SYSTOLIC HEART FAILURE	560.1	PARALYTIC ILEUS
428.20	SYSTOLC HEART FAILUR NOS	593.9	KIDNEY & URETER DIS NOS
428.21	AC SYSTOLC HEART FAILURE	996.4	MECH COMPL-INT ORTHO DEV
428.23	AC ON CHR SYSTOL HT FAIL	996.77	COMP NEC-INTRN JT PROSTH
428.3	DIASTOLIC HEART FAILURE	996.78	COMP NEC-ORTHOPD DEV NEC
428.30	DIASTOLC HEART FAILR NOS	997.1	CARDIAC COMPLICATION NEC
428.31	AC DIASTOL HEART FAILURE	997.3	RESPIR COMPLICATIONS NEC
428.33	AC ON CHR DIASTL HT FAIL	997.4	DIGESTIVE SYST COMPL NEC
428.4	CMB SYST & DIAST HT FAIL	997.5	URINARY COMPLICATION NEC
428.40	CMB SYS/DIAS HT FAIL NOS	998.11	HEMORRHAGE COMPLIC PROC
428.41	AC COMB SYS/DIAS HT FAIL	998.59	POSTOPERATIV INFECTN NEC
428.43	AC ON CH SYS/DIA HT FAIL		

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Major Complications – Total Knee Replacement			
427.31	ATRIAL FIBRILLATION	428.41	AC COMB SYS/DIAS HT FAIL
427.89	CARDIAC DYSRYTHMIAS NEC	428.43	AC ON CH SYS/DIA HT FAIL
428.0	CONGESTIVE HEART FAILURE	428.9	HEART FAILURE, NOS
428.1	LEFT HEART FAILURE	518.0	PULMONARY COLLAPSE
428.2	SYSTOLIC HEART FAILURE	518.5	PULM INSUF PST TRAUM/SRG
428.20	SYSTOLC HEART FAILUR NOS	593.9	KIDNEY & URETER DIS NOS
428.21	AC SYSTOLC HEART FAILURE	996.4	MECH COMPL-INT ORTHO DEV
428.23	AC ON CHR SYSTOL HT FAIL	996.77	COMP NEC-INTRN JT PROSTH
428.3	DIASTOLIC HEART FAILURE	996.78	COMP NEC-ORTHOPD DEV NEC
428.30	DIASTOLC HEART FAILR NOS	997.1	CARDIAC COMPLICATION NEC
428.31	AC DIASTOL HEART FAILURE	997.3	RESPIR COMPLICATIONS NEC
428.33	AC ON CHR DIASTL HT FAIL	997.4	DIGESTIVE SYST COMPL NEC
428.4	CMB SYST & DIAST HT FAIL	998.11	HEMORRHAGE COMPLIC PROC
428.40	CMB SYS/DIAS HT FAIL NOS	998.59	POSTOPERATIV INFECTN NEC

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Appendix C.1
Unadjusted Mortality Rates and Change by Year Associated with Common Medicare Hospitalizations in 5-Star Rated Hospitals from 2002-2004

Hospitalization Diagnosis or Procedure	Observed Mortality Rate 2002-2004	Observed Mortality Rate 2002	Observed Mortality Rate 2003	Observed Mortality Rate 2004	Change 2002-2003	Change 2003-2004	Change 2002-2004
Abdominal Aortic Aneurysm Repair	2.42%	2.15%	3.11%	2.09%	44.39%	-32.87%	-3.08%
Acute Myocardial Infarction	8.47%	8.93%	8.49%	8.01%	-4.90%	-5.73%	-10.35%
Atrial Fibrillation	0.39%	0.39%	0.42%	0.37%	7.76%	-13.05%	-6.31%
Bowel Obstruction	4.13%	4.28%	4.17%	3.95%	-2.51%	-5.29%	-7.67%
Chronic Obstructive Pulmonary Disease	1.62%	1.79%	1.56%	1.50%	-12.79%	-4.25%	-16.49%
Community Acquired Pneumonia	4.95%	5.42%	4.98%	4.46%	-8.24%	-10.32%	-17.71%
Coronary Bypass Surgery	1.71%	1.80%	1.56%	1.76%	-13.44%	12.95%	-2.24%
Coronary Interventional Procedures	1.00%	1.09%	1.03%	0.90%	-6.23%	-11.89%	-17.38%
Diabetic Acidosis and Coma	0.41%	0.51%	0.48%	0.24%	-5.75%	-49.49%	-52.40%
GI Bleed	1.99%	2.15%	2.02%	1.81%	-6.04%	-10.46%	-15.87%
GI Surgery and Procedures	4.56%	4.87%	4.61%	4.20%	-5.33%	-8.82%	-13.68%
Heart Failure	3.33%	3.69%	3.24%	3.10%	-12.08%	-4.46%	-16.00%
Pancreatitis	1.68%	1.71%	1.68%	1.65%	-1.89%	-2.17%	-4.02%
Pulmonary Embolism	3.28%	4.13%	3.20%	2.79%	-22.33%	-13.02%	-32.44%
Respiratory Failure	18.70%	20.64%	18.86%	17.15%	-8.62%	-9.08%	-16.91%
Sepsis	16.45%	16.92%	16.04%	16.44%	-5.18%	2.46%	-2.84%
Stroke	9.11%	9.33%	9.06%	8.93%	-2.89%	-1.40%	-4.25%
Valve Replacement Surgery	4.38%	4.39%	4.33%	4.43%	-1.40%	2.29%	0.86%

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Appendix C.2
Unadjusted Mortality Rates and Change by Year Associated with Common Medicare Hospitalizations in 3-Star Rated Hospitals from 2002-2004

Hospitalization Diagnosis or Procedure	Observed Mortality Rate 2002-2004	Observed Mortality Rate 2002	Observed Mortality Rate 2003	Observed Mortality Rate 2004	Change 2002-2003	Change 2003-2004	Change 2002-2004
Abdominal Aortic Aneurysm Repair	5.71%	6.31%	5.81%	4.89%	-7.92%	-15.83%	-22.49%
Acute Myocardial Infarction	10.83%	11.42%	10.69%	10.41%	-6.40%	-2.61%	-8.85%
Atrial Fibrillation	1.42%	1.51%	1.40%	1.36%	-7.36%	-2.58%	-9.75%
Bowel Obstruction	6.38%	6.71%	6.39%	6.07%	-4.74%	-4.99%	-9.49%
Chronic Obstructive Pulmonary Disease	2.68%	3.00%	2.64%	2.42%	-12.22%	-8.24%	-19.45%
Community Acquired Pneumonia	6.73%	7.33%	6.73%	6.14%	-8.22%	-8.84%	-16.34%
Coronary Bypass Surgery	3.14%	3.32%	3.07%	3.00%	-7.72%	-2.21%	-9.76%
Coronary Interventional Procedures	1.84%	2.00%	1.80%	1.74%	-10.09%	-3.45%	-13.19%
Diabetic Acidosis and Coma	1.81%	2.09%	1.80%	1.59%	-14.17%	-11.58%	-24.12%
GI Bleed	3.29%	3.58%	3.26%	3.04%	-9.05%	-6.82%	-15.25%
GI Surgery and Procedures	6.96%	7.33%	6.94%	6.60%	-5.31%	-4.90%	-9.95%
Heart Failure	4.75%	5.07%	4.68%	4.52%	-7.67%	-3.28%	-10.69%
Pancreatitis	3.71%	4.08%	3.71%	3.41%	-9.03%	-7.99%	-16.29%
Pulmonary Embolism	6.29%	6.66%	6.46%	5.88%	-2.98%	-9.00%	-11.72%
Respiratory Failure	26.99%	28.79%	27.37%	25.36%	-4.92%	-7.37%	-11.93%
Sepsis	22.06%	21.91%	22.02%	22.21%	0.50%	0.86%	1.37%
Stroke	11.52%	11.94%	11.43%	11.16%	-4.31%	-2.31%	-6.52%
Valve Replacement Surgery	8.00%	8.03%	8.33%	7.64%	3.70%	-8.30%	-4.91%

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Appendix C.3
Mortality Rates and Change by Year Associated with Common Medicare Hospitalization In 1-Star Rated Hospitals

Hospitalization Diagnosis or Procedure	Observed Mortality Rate 2002-2004	Observed Mortality Rate 2002	Observed Mortality Rate 2003	Observed Mortality Rate 2004	Change 2002-2003	Change 2003-2004	Change 2002-2004
Abdominal Aortic Aneurysm Repair	8.00%	7.69%	6.98%	9.59%	-9.30%	37.44%	24.66%
Acute Myocardial Infarction	13.15%	13.60%	13.19%	12.67%	-2.98%	-3.99%	-6.86%
Atrial Fibrillation	3.29%	3.19%	3.58%	3.10%	12.14%	-13.51%	-3.01%
Bowel Obstruction	9.83%	10.30%	9.88%	9.31%	-4.07%	-5.80%	-9.64%
Chronic Obstructive Pulmonary Disease	4.85%	5.40%	4.79%	4.35%	-11.27%	-9.24%	-19.47%
Community Acquired Pneumonia	10.28%	11.01%	10.33%	9.50%	-6.11%	-8.05%	-13.67%
Coronary Bypass Surgery	5.45%	5.24%	5.74%	5.39%	9.40%	-6.06%	2.77%
Coronary Interventional Procedures	2.83%	2.90%	2.95%	2.65%	1.59%	-10.15%	-8.72%
Diabetic Acidosis and Coma	4.74%	5.02%	5.18%	4.07%	3.18%	-21.58%	-19.09%
GI Bleed	5.65%	6.02%	5.75%	5.21%	-4.56%	-9.36%	-13.50%
GI Surgery and Procedures	9.99%	10.42%	9.86%	9.67%	-5.40%	-1.93%	-7.22%
Heart Failure	6.90%	7.21%	6.87%	6.62%	-4.78%	-3.66%	-8.27%
Pancreatitis	7.35%	8.18%	6.83%	6.97%	-16.56%	2.11%	-14.81%
Pulmonary Embolism	11.36%	11.71%	10.85%	11.47%	-7.39%	5.74%	-2.07%
Respiratory Failure	37.39%	39.51%	37.72%	35.43%	-4.53%	-6.09%	-10.34%
Sepsis	29.82%	29.47%	29.39%	30.45%	-0.26%	3.62%	3.35%
Stroke	15.74%	15.74%	15.81%	15.68%	0.46%	-0.82%	-0.36%
Valve Replacement Surgery	12.53%	13.32%	12.39%	11.86%	-7.00%	-4.20%	-10.91%

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Appendix D: Risk-adjusted Performance by Year Across 18 Diagnoses and Procedures from 2002 through 2004

Hospitalization Diagnosis or Procedure	Year	U.S. Observed to Expected Ratio	1-Star Observed to Expected Ratio (95% CI)	3-Star Observed to Expected Ratio	5-Star Observed to Expected Ratio (95% CI)
Abdominal Aortic Aneurysm Repair	2002	0.896	2.195 (1.193-3.196)	0.980	0.373 (0.165-0.581)
	2003	0.853	1.191 (.453-1.928)	0.911	0.502 (0.266-0.738)
	2004	0.779	1.679 (.836-2.522)	0.834	0.350 (0.098-0.602)
	3-year aggregate	0.848	1.613 (1.127-2.100)	0.915	0.407 (0.275-0.540)
Acute Myocardial Infarction	2002	1.039	1.325 (1.300-1.350)	1.048	0.788 (0.766-0.810)
	2003	0.985	1.293 (1.267-1.318)	0.980	0.753 (0.731-0.775)
	2004	0.972	1.282 (1.257-1.308)	0.978	0 .717 (0.695-0.738)
	3-year aggregate	0.999	1.300 (1.285-1.314)	1.002	0.752 (0.740-0.765)
Atrial Fibrillation	2002	1.114	2.096 (1.980-2.211)	1.051	0.251 (0.103-0.400)
	2003	1.018	2.247 (2.133-2.361)	0.913	0.257 (0.108-0.406)
	2004	0.906	1.837 (1.727-1.948)	0.836	0.215 (0.070-0.360)
	3-year aggregate	1.010	2.055 (1.990-2.121)	0.930	0.241 (0.156-0.326)
Bowel Obstruction	2002	1.068	1.709 (1.657-1.761)	1.058	0.629 (0.585-0.673)
	2003	0.984	1.527 (1.477-1.576)	0.980	0.590 (0.548-0.632)
	2004	0.915	1.441 (1.392-1.491)	0.915	0.537 (0.496-0.578)
	3-year aggregate	0.987	1.555 (1.527-1.584)	0.982	0.583 (0.559-0.608)
Chronic Obstructive Pulmonary Disease	2002	1.101	1.904 (1.857-1.951)	1.059	0.536 (0.492-0.580)
	2003	0.977	1.753 (1.705-1.802)	0.932	0.473 (0.429-0.518)
	2004	0.908	1.584 (1.536-1.632)	0.876	0 .456 (0.412-0.500)
	3-year aggregate	0.996	1.749 (1.721-1.777)	0.956	0.488 (0.463-0.514)
Community Acquired Pneumonia	2002	1.089	1.612 (1.592-1.632)	1.078	0.706 (0.688-0.723)
	2003	0.995	1.487 (1.467-1.507)	0.982	0.636 (0.619-0.653)
	2004	0.914	1.387 (1.367-1.407)	0.898	0.587 (0.570-0.604)
	3-year aggregate	0.999	1.495 (1.483-1.506)	0.985	0.643 (0.633-0.652)

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Hospitalization Diagnosis or Procedure	Year	U.S. Observed to Expected Ratio	1-Star Observed to Expected Ratio (95% CI)	3-Star Observed to Expected Ratio	5-Star Observed to Expected Ratio (95% CI)
Coronary Bypass Surgery	2002	1.063	1.748 (1.671-1.825)	1.053	0.548 (0.480-0.617)
	2003	0.986	1.838 (1.760-1.917)	0.944	0.465 (0.395-0.535)
	2004	0.939	1.648 (1.567-1.730)	0.906	0.516 (0.445-0.587)
	3-year aggregate	0.998	1.748 (1.702-1.793)	0.970	0.510 (0.470- 0.550)
Coronary Interventional Procedures	2002	0.999	1.511 (1.449-1.572)	0.997	0.557 (0.499-0.614)
	2003	0.970	1.567 (1.506-1.627)	0.939	0.560 (0.503-0.617)
	2004	1.020**	1.606 (1.543-1.670)	1.012	0.547 (0.489-0.606)
	3-year aggregate	0.996	1.560 (1.525-1.596)	0.982	0.555 (0.521-0.588)
Diabetic Acidosis and Coma	2002	1.100	2.543 (2.352-2.734)	1.045	0.221 (0.035-0.406)
	2003	0.999	2.536 (2.357-2.715)	0.926	0.189 (0.017-0.360)
	2004	0.860	2.153 (1.969-2.337)	0.810	0.107 (-0.075-0.289)
	3-year aggregate	0.981	2.408 (2.301-2.514)	0.922	0.171 (0.067-0.275)
GI Bleed	2002	1.105	1.863 (1.806-1.920)	1.074	0.562 (0.508-0.617)
	2003	0.995	1.702 (1.647-1.757)	0.960	0.516 (0.463-0.569)
	2004	0.912	1.546 (1.492-1.600)	0.887	0.459 (0.408-0.511)
	3-year aggregate	1.000	1.698 (1.666-1.730)	0.970	0.510 (0.480-0.541)
GI Surgery and Procedures	2002	0.999	1.463 (1.431-1.495)	0.995	0.664 (0.636-0.692)
	2003	0.996	1.486 (1.453-1.520)	0.989	0 .666 (0.638-0.695)
	2004	0.994	1.513 (1.478-1.548)	0.992	0.642 (0.613-0.671)
	3-year aggregate	0.996	1.486 (1.467-1.505)	0.992	0.658 (0.641-0.674)
Heart Failure	2002	1.104	1.629 (1.604-1.654)	1.095	0.727 (0.706-0.749)
	2003	0.986	1.510 (1.486-1.535)	0.979	0.621 (0.600-0.641)
	2004	0.912	1.399 (1.376-1.423)	0.911	0.570 (0.551-0.590)
	3-year aggregate	0.996	1.510 (1.496-1.524)	0.992	0.635 (0.623-0.647)

**The relatively large Observed to Expected ratio for 2004 was caused by a change in the data. Effective in 2004, drug eluting stents were coded with their own ICD-9 code, and this code was one of the predictors used to create the expected value. This code decreased the "expected" for 2004 only, resulting in a larger ratio for that year.

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Hospitalization Diagnosis or Procedure	Year	U.S. Observed to Expected Ratio	1-Star Observed to Expected Ratio (95% CI)	3-Star Observed to Expected Ratio	5-Star Observed to Expected Ratio (95% CI)
Pulmonary Embolism	2002	1.015	1.863 (1.649-2.077)	1.017	0.518 (0.363-0.673)
	2003	0.924	1.461 (1.271-1.650)	0.953	0.400 (0.258-0.543)
	2004	0.844	1.702 (1.536-1.868)	0.842	0.348 (0.224-0.473)
	3-year aggregate	0.916	1.668 (1.560-1.776)	0.926	0.410 (0.330-0.491)
Pancreatitis	2002	1.070	2.152 (1.924-2.381)	1.033	0.414 (0.191-0.637)
	2003	0.923	1.944 (1.686-2.202)	0.913	0.363 (0.173-0.552)
	2004	0.833	1.834 (1.584-2.084)	0.829	0.340 (0.168-0.512)
	3-year aggregate	0.931	1.985 (1.843-2.126)	0.915	0.366 (0.256-0.477)
Respiratory Failure	2002	0.989	1.345 (1.327-1.363)	0.987	0.736 (0.721-0.752)
	2003	0.989	1.325 (1.307-1.343)	1.002	0.726 (0.710-0.741)
	2004	0.984	1.326 (1.309-1.343)	1.003	0.710 (0.696-0.725)
	3-year aggregate	0.987	1.331 (1.321-1.342)	0.998	0.723 (0.715-0.732)
Sepsis	2002	1.013	1.394 (1.374-1.413)	1.026	0.749 (0.733-0.764)
	2003	0.948	1.309 (1.291-1.326)	0.977	0.683 (0.669-0.696)
	2004	0.978	1.361 (1.345-1.377)	0.997	0.708 (0.695-0.721)
	3-year aggregate	0.978	1.353 (1.343-1.363)	0.998	0.711 (0.703-0.719)
Stroke	2002	1.051	1.421 (1.399-1.442)	1.067	0.754 (0.737-0.772)
	2003	0.978	1.374 (1.353-1.395)	0.985	0.695 (0.678-0.712)
	2004	0.940	1.333 (1.311-1.354)	0.941	0.670 (0.654-0.687)
	3-year aggregate	0.989	1.376 (1.364-1.388)	0.998	0.706 (0.696-0.716)
Valve Replacement Surgery	2002	1.002	1.729 (1.622-1.836)	1.009	0.552 (0.470-0.633)
	2003	0.981	1.499 (1.396-1.601)	1.029	0.535 (0.456-0.613)
	2004	0.902	1.511 (1.405-1.617)	0.913	0.550 (0.474-0.626)
	3-year aggregate	0.961	1.578 (1.517-1.639)	0.982	0.545 (0.500-0.591)

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Appendix E: Improvement and Relative Risk Reductions

Hospitalization Diagnosis or Procedure	Year	Percent of Improvement U.S. Average (2002-2004)	Relative Risk Reduction Associated with 5-Star Hospitals Compared to 1-Star	Relative Risk Reduction Associated with 5-Star Hospitals Compared to National	Reduction in Deaths if All Hospitals Operated at 5-Star Level (2002-2004)
Abdominal Aortic Aneurysm Repair	2002		83.01%	58.37%	
	2003		57.85%	41.17%	
	2004		79.16%	55.07%	
	2002-2004	13.04%	74.75%	52.00%	428
Acute Myocardial Infarction	2002		40.52%	24.19%	
	2003		41.71%	23.55%	
	2004		44.12%	26.27%	
	2002-2004	6.44%	42.13%	24.90%	26,431
Atrial Fibrillation	2002		88.00%	77.47%	
	2003		88.55%	74.76%	
	2004		88.29%	76.28%	
	2002-2004	18.65%	88.28%	76.23%	5,718
Bowel Obstruction	2002		63.19%	41.12%	
	2003		61.34%	40.02%	
	2004		62.75%	41.32%	
	2002-2004	14.32%	62.50%	40.92%	11,653
Chronic Obstructive Pulmonary Disease	2002		71.85%	51.30%	
	2003		73.00%	51.59%	
	2004		71.21%	49.80%	
	2002-2004	17.46%	72.08%	51.79%	14,630
Community Acquired Pneumonia	2002		56.24%	35.16%	
	2003		57.22%	36.08%	
	2004		57.67%	35.81%	
	2002-2004	16.02%	57.02%	35.60%	40,986

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Hospitalization Diagnosis or Procedure	Year	Percent of Improvement U.S. Average (2002-2004)	Relative Risk Reduction Associated with 5-Star Hospitals Compared to 1-Star	Relative Risk Reduction Associated with 5-Star Hospitals Compared to National	Reduction in Deaths if All Hospitals Operated at 5-Star Level
Coronary Bypass Surgery	2002		68.63%	48.43%	
	2003		74.73%	52.86%	
	2004		68.70%	45.02%	
	2002-2004	11.68%	70.81%	48.89%	5,537
Coronary Interventional Procedures	2002		63.14%	44.25%	
	2003		64.27%	42.27%	
	2004		65.94%	46.38%	
	2002-2004	-2.09%**	64.45%	44.28%	7,811
Diabetic Acidosis and Coma	2002		91.32%	79.91%	
	2003		92.55%	81.07%	
	2004		95.02%	87.55%	
	2002-2004	21.88%	92.89%	82.57%	2,884
GI Bleed	2002		69.81%	49.16%	
	2003		69.68%	48.13%	
	2004		70.30%	49.65%	
	2002-2004	17.53%	69.95%	49.02%	11,903
GI Surgery and Procedures	2002		54.61%	33.57%	
	2003		55.16%	33.12%	
	2004		57.58%	35.41%	
	2002-2004	0.55%	55.75%	34.77%	18,371
Heart Failure	2002		55.35%	34.13%	
	2003		58.90%	37.02%	
	2004		59.25%	37.48%	
	2002-2004	17.38%	57.92%	36.27%	34,380

**The negative value was caused by a change in the data. Effective in 2004, drug eluting stents were coded with their own ICD-9 code, and this code was one of the predictors used to create the expected value. This code decreased the "expected" for 2004 only, resulting in a larger ratio for that year.

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Hospitalization Diagnosis or Procedure	Year	Percent of Improvement U.S. Average (2002-2004)	Relative Risk Reduction Associated with 5-Star Hospitals Compared to 1-Star	Relative Risk Reduction Associated with 5-Star Hospitals Compared to National	Reduction in Deaths if All Hospitals Operated at 5-Star Level
Pancreatitis	2002		80.78%	61.31%	
	2003		81.35%	60.69%	
	2004		81.45%	59.19%	
	2002-2004	22.15%	81.54%	60.68%	1,307
Pulmonary Embolism	2002		72.20%	48.97%	
	2003		72.58%	56.73%	
	2004		79.53%	58.78%	
	2002-2004	16.82%	75.41%	55.26%	1,972
Respiratory Failure	2002		45.25%	25.58%	
	2003		45.22%	26.57%	
	2004		46.42%	27.87%	
	2002-2004	0.46%	45.67%	27.06%	30,145
Sepsis	2002		46.29%	26.07%	
	2003		47.85%	27.99%	
	2004		47.97%	27.62%	
	2002-2004	3.44%	47.46%	27.42%	29,874
Stroke	2002		46.92%	28.24%	
	2003		49.40%	28.96%	
	2004		49.68%	28.69%	
	2002-2004	10.58%	48.70%	28.64%	26,134
Valve Replacement Surgery	2002		68.09%	44.93%	
	2003		64.32%	45.48%	
	2004		63.60%	39.05%	
	2002-2004	9.97%	65.43%	43.79%	2,973
					273,137

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