The Fourth Annual HealthGrades Hospital Quality and Clinical Excellence Study

February 2006

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Executive Summary

For the fourth year in a row, HealthGrades researched the overall quality at each of the nation's more than 5,000 nonfederal hospitals. This study identifies hospitals that place in the top five percent in the nation in terms of risk-adjusted mortality and complication rates across a wide range of procedures and diagnoses, indicating institutional success in achieving high-quality outcomes. The study also investigates and quantifies the differences between hospitals in the top five percent and all others.

HealthGrades analysis is based on nearly 39 million Medicare hospital discharges in the years 2002, 2003 and 2004. We identify the top U.S. hospitals based on overall performance of risk-adjusted outcomes associated with the 26 common Medicare inpatient procedures and diagnoses. Of the 5,122 short-term, non-federal, acute care hospitals, only 277 hospitals ranked in the top five percent in the nation. These hospitals are designated as Distinguished Hospitals for Clinical Excellence™.

The Distinguished Hospitals for Clinical Excellence™ are then compared to all other U.S. hospitals to identify trends in outcomes, relative risk and improvement over the years 2002, 2003 and 2004.

Summary of Findings

Key findings from this study include:

1 Distinguished Hospitals for Clinical Excellence outperformed all other hospitals across all procedures and diagnoses studied during 2002-2004.

- On average, 27 percent lower risk of mortality and 36 percent more improvement in inhospital mortality associated with Cardiac Surgery, Angioplasty and Stent, Heart Attack and Heart Failure, Atrial Fibrillation, Chronic Obstructive Pulmonary Disease, Community Acquired Pneumonia, Stroke, Abdominal Aortic Aneurysm Repair, Bowel Obstruction, GI Bleed, Pancreatitis, Diabetic Acidosis and Coma, Pulmonary Embolism and Sepsis.
- On average, 14 percent lower risk of complications and 40 percent more improvement in inhospital post-operative complications associated with Orthopedic and Neurosurgery, Vascular Surgery, Prostate Surgery and Gall Bladder Surgery.

2 If all patients with any of the 26 conditions studied were treated at Distinguished Hospitals during 2002 to 2004, 152,966 lives may have been saved and 21,896 patients may have avoided a major post-operative complication.

3 Distinguished Hospitals for Clinical Excellence demonstrated significantly lower inhospital risk-adjusted mortality rates compared to other hospitals.

- The top five areas associated with the greatest risk reduction were noted in:
  - Diabetic Acidosis & Coma – approximately 35% lower
  - Pancreatitis – approximately 32% lower
  - Community Acquired Pneumonia – approximately 31% lower
  - Heart Failure – approximately 29% lower
  - Coronary Artery Bypass Surgery – approximately 29% lower

4 Distinguished Hospitals for Clinical Excellence demonstrated significantly lower inhospital risk-adjusted post-operative complication rates compared to other hospitals.

- Three of the five areas associated with the greatest risk reduction were noted in orthopedics:
  - Hip Fracture Repair-approximately 18% lower
  - Total Knee Replacement-approximately 16.5% lower
  - Total Hip Replacement-approximately 16% lower

Introduction

With the explosion of consumer directed health plans (CDHP) and predictions of the CDHP market to grow from $6.4 billion in 2004 to $289.5 billion in 2009 (Forrester Research), quality information is quickly becoming center-stage for consumers. As they bear higher out-of-pocket expenses, consumers are also demanding more information to assist them in making the most informed healthcare decisions. Although transparency and availability of hospital outcomes are increasing, consumers are still challenged to identify the best hospitals across the nation where they and their families can receive the best medical care.

Each year, HealthGrades takes on this very challenge by developing quality ratings on more than 5,000 U.S. hospitals across 29 procedures and diagnoses and publishing these free ratings on its website, www.Healthgrades.com. Over 2.5 million users visit the HealthGrades site each month. In addition to assessing each of the nation's hospital's quality annually, HealthGrades researches and identifies the top five percent of hospitals in the U.S., based on risk-adjusted complication and mortality rates across 26 diagnoses and procedures (does not include appendectomy, respiratory failure or GI procedures and surgery ratings). This elite group of hospitals is designated as Distinguished Hospitals for Clinical Excellence™. This year, HealthGrades analyzed approximately 39 million Medicare hospital discharges.

HealthGrades assigns quality ratings to hospitals according to their actual mortality and complication outcomes, compared to what would be expected to occur at each facility given their respective patient population, for each of 26 procedures and diagnoses. Hospitals that perform in the top five percent nationally for overall outcomes across the 26 medical procedures and diagnosis as rated by HealthGrades are then designated as recipients of the annual Distinguished Hospital Award for Clinical Excellence™ (DHA-CE). See Exhibit A or www.Healthgrades.com for full list of the 277 2006 recipients.

This study assesses and compares quality outcomes and trends of Distinguished Hospitals for Clinical Excellence (DH-CE) to all other U.S. hospitals across 26 of the most common surgical procedures and medial diagnoses among Medicare beneficiaries 65 years and older during the years 2002, 2003 and 2004.

Methodology

In order to evaluate overall hospital performance and to identify the best performing hospitals in clinical excellence across the U.S., HealthGrades uses a two-step methodology process:

- Mortality and Complication Based Outcomes Methodology
- Distinguished Hospital Award – Clinical Excellence Methodology

This study concentrates on the 26 of 27 cohorts (appendectomy not included in the DH-CE study) for which HealthGrades has developed a predictive logistic regression model. Appendectomy, which is based on all payer data, was not analyzed in this study. Two additional cohorts not included in the DH-CE study are rated using the APR-DRG methodology (GI Procedures and Surgery, Respiratory Failure). The 26 cohorts in the DH-CE study are as follows.

- Atrial Fibrillation
- Back and Neck Surgery (Spinal Fusion)
- Back and Neck Surgery (except Spinal Fusion)
- Bowel Obstruction
- Carotid Endarterectomy
- Cholecystectomy
- Chronic Obstructive Pulmonary Disease (COPD)
- Community Acquired Pneumonia
- Coronary Bypass Surgery
- Coronary Interventional Procedures
- Diabetic Acidosis and Coma
- Gastrointestinal Bleed
- Heart Attack
- Heart Failure
- Hip Fracture Repair
- Pancreatitis
- Partial Hip Replacement
- Peripheral Vascular Bypass
- Prostatectomy
- Pulmonary Embolism
- Resection / Replacement of Abdominal Aorta
- Sepsis
- Stroke
- Total Hip Replacement
- Total Knee Replacement
- Valve Replacement Surgery

Mortality and Complication Based Outcomes 2006 Methodology

To help consumers evaluate and compare hospital performance, HealthGrades analyzes patient outcome data for virtually every hospital in the country. HealthGrades purchases the initial data from the Centers for Medicare and Medicaid Services (CMS). The Medicare data (MedPAR file) from CMS contained the inpatient records for Medicare patients.

Ratings are based upon two different risk-adjustment methodologies.

- For 27 medical issues, the risk adjustment is based upon the HealthGrades methodology described in the Multivariate Logistic Regression-Based Ratings section of this white paper.
- For Respiratory Failure and for Gastrointestinal Procedures and Surgeries, the risk adjustment is 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 white paper.

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.

Visit www.HealthGrades.com to view hospital ratings and to read the complete methodology white paper *Hospital Report Card™ Mortality and Complication Based Outcomes 2006 Methodology White Paper* (or see in Exhibit D).

Distinguished Hospital Award – Clinical Excellence™ 2006 Methodology

Hospitals are segregated into two groups – teaching and non-teaching. Non-teaching hospitals are further segmented by size with community hospitals being non-teaching hospitals with fewer than 200 beds.

To be considered for the Distinguished Hospital Award for Clinical Excellence (DHA-CE), a hospital had to have had inhospital mortality or complication ratings in at least 21 of the 28 HealthGrades ratings using MedPAR* data.

MedPAR data comes from the Centers for Medicare and Medicaid Services (CMS). HealthGrades uses their claims data file, which contains inpatient records for Medicare patients. For more information on how HealthGrades uses this data for ratings, see the HealthGrades *Hospital Report Card™ – Mortality and Complication Based Outcomes 2006 Methodology White Paper* (Exhibit D).

After creating a list of hospitals that met the above criteria, HealthGrades takes the following steps to determine the DHA-CE recipients.

1 Calculates the average star rating for each hospital by averaging all their MedPAR-based ratings.

2 Ranks hospitals in descending order by their average star rating within the two groups–teaching and non-teaching.

3 Selects the top 20 percent of hospitals from each group.

4 Excludes hospitals whose average star was less than 3.30.

5 Designates the hospitals that remained on the list as the 2006 DHA-CE recipients.

Comparison of Distinguished Hospitals for Clinical Excellence Hospitals to All Other Hospitals

Another purpose of the second part of the study is to evaluate the variation in inhospital mortality across 26 diagnoses and procedures. In Part I, the actual (observed) and predicted (expected) mortality rates are calculated for each of the 26 procedures and diagnoses for each hospital. The inhospital observed and expected rates of all patients from Distinguished Hospitals for Clinical Excellence (DH-CE) - those in the top five percent - and all other hospital groups are aggregated for each of the 26 procedures and diagnoses to obtain a DH-CE and all other hospital observed and expected inhospital mortality rate by procedure and diagnosis.

Unadjusted (observed) mortality rates and numbers are evaluated for trends. Because sicker patients will have higher associated observed mortality, we also calculate and compare 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.

Results

Distinguished Hospitals for Clinical Excellence (DH-CE) consistently demonstrated significantly lower risk-adjusted inhospital mortality compared to all other hospitals the years 2002, 2003 and 2004. During the three years studied, DH-CE performed, on average, 27 percent better than all other hospitals in inhospital risk-adjusted mortality associated with Cardiac Surgery, Angioplasty and Stent, Heart Attack and Heart Failure, Atrial Fibrillation, Chronic Obstructive Pulmonary Disease, Community Acquired Pneumonia, Stroke, Abdominal Aortic Aneurysm Repair, Bowel Obstruction, GI Bleed, Pancreatitis, Diabetic Acidosis and Coma, Pulmonary Embolism and Sepsis. For details, see Exhibit B.

On Average, DH-CE had 31 Percent Lower Risk-Adjusted Inhospital Mortality

When comparing DH-CE to all other hospitals, the largest differences in inhospital risk-adjusted mortality were noted in the following areas.

Table 1
Largest Difference In Inhospital Risk-Adjusted Mortality

Diabetic Acidosis & Coma	35%
Pancreatitis	32%
Community Acquired Pneumonia	31%
Heart Failure	29%
Coronary Artery Bypass Surgery	29%

For these five areas associated with the greatest inhospital mortality differences, DH-CE had, on average, a 31 percent lower risk-adjusted inhospital. For details, see Exhibit B.

One Average, DH-CE Performed 14 Percent Better in Inhospital Post-operative Complications

Similar trends were also noted when evaluating inhospital risk-adjusted post-operative complications. Distinguished Hospitals for Clinical Excellence (DH-CE) demonstrated lower risk-adjusted inhospital post-operative complications compared to all other hospitals during 2002-2004. During the three years studied, DH-CE performed, on average, 14 percent better than all other hospitals in inhospital post-operative complications associated with Orthopedic and Neurosurgery, Vascular Surgery, Prostate Surgery and Gall Bladder Surgery. For details, see Exhibit C.

When comparing DH-CE to all other hospitals, the largest differences in inhospital risk-adjusted post-operative complications were noted in the following areas.

Table 2
Largest Difference In Inhospital Post-operative Complications

Hip Fracture Repair	18%
Total Knee Replacement	16.5%
Total Hip Replacement	16%

For these three areas associated with the greatest inhospital complication differences, DH-CE had, on average, a 17 percent lower risk-adjusted inhospital post-operative complications For details, see Exhibit C.

DH-CE Improved at Greater Rate

Although Distinguished Hospitals for Clinical Excellence had significantly lower inhospital risk-adjusted mortality and complications for all three years studied, they improved at a greater rate than all other hospitals. DH-CE risk-adjusted inhospital mortality and complications improved by 16.5 percent and 10.4 percent during 2002-2004, while all other hospitals lagged behind the DH-CE improvement rate by 27 percent and 29 percent, respectively.

Despite these apparent differences in rates of improvement, DH-CE and all other hospitals had the greatest improvements in the same areas: Heart Failure, Atrial Fibrillation, Chronic Obstructive Pulmonary Disease, Community Acquired Pneumonia, Total Knee Replacement, Total Hip Replacement, Carotid Endarterectomy and Peripheral Vascular Bypass. For details, see Exhibit B and C.

Interpretation of Results

As a group, Distinguished Hospitals for Clinical Excellence outperformed all other U.S. hospitals across all 26 diagnoses and procedures studied. Among the Medicare beneficiaries admitted to U.S. hospitals during 2002-2004, 152,966 lives may have been saved and 21,896 patients may have avoided a major post-operative complication if they had been treated at Distinguished Hospitals for Clinical Excellence.

Distinguished Hospitals for Clinical Excellence made a big impact during the three year study period. Not only did they have lower risk-adjusted mortality and complications for all three years studied, but they outpaced all other hospitals by improving their already better than expected outcomes better than all other hospitals. We believe that these hospitals explicitly define quality, set their aims high, commit to continuous improvement and excellence, and share their goals with all stakeholders.

In conclusion, our study identifies an overall quality benchmark that is quite high but demonstrably achievable by an elite group of distinguished hospitals. By identifying these Distinguished Hospitals for Clinical Excellence, HealthGrades is providing an objective measurement of overall quality and identifying the best of the best for all stakeholders, a benchmark that can be used for quality improvement and informed decision-making. Going forward, quality and safety will need to be continuously measured and accessible to patients and purchasers of healthcare. We believe the opportunities for improvement are tremendous, and this study demonstrated that the answers are within reach.

Exhibit A: List of Distinguished Hospitals for Clinical Excellence

Teaching Distinguished Hospitals for Clinical Excellence

DH-CE Teaching Hospitals	City	State
Abbott Northwestern Hospital Inc	Minneapolis	MN
Advocate Christ Medical Center	Oak Lawn	IL
Advocate Lutheran General Hospital	Park Ridge	IL
Advocate Ravenswood Medical Center	Chicago	IL
Akron General Medical Center	Akron	OH
Aspirus Wausau Hospital	Wausau	WI
Avera Mckennan Hosp & Univ Health Center	Sioux Falls	SD
Baylor University Medical Center	Dallas	TX
Beth Israel Deaconess Medical Center	Boston	MA
Billings Clinic	Billings	MT
Bon Secours Hospital	Grosse Pointe	MI
C J W Medical Center	Richmond	VA
Caritas Medical Center	Louisville	KY
Cedars Sinai Medical Center	Los Angeles	CA
Charleston Area Medical Center	Charleston	WV
Christ Hospital	Cincinnati	OH
Christus Santa Rosa Healthcare	San Antonio	TX
Christus Spohn Hospital Corpus Christi	Corpus Christi	TX
Cleveland Clinic Foundation	Cleveland	OH
Community Health Partners of OH West	Lorain	OH
Community Hospital East/ North	Indianapolis	IN
Danbury Hospital	Danbury	CT
Doctors Hospital	Coral Gables	FL
Easton Hospital	Easton	PA
Ellis Hospital	Schenectady	NY
Evanston Northwestern Healthcare	Evanston	IL
Fairview Hospital	Cleveland	OH
Florida Hospital - Ormond Memorial/Oceanside	Ormond Beach	FL
Franklin Square Hospital Center	Baltimore	MD
Genesys Regional Medical Center	Grand Blanc	MI
Glendale Adventist Medical Center	Glendale	CA
Good Samaritan Hospital	Los Angeles	CA

DH-CE Teaching Hospitals	City	State
Good Samaritan Hospital	Baltimore	MD
Grandview and Southview Hospitals	Dayton	OH
Greater Baltimore Medical Center	Baltimore	MD
Griffin Hospital	Derby	CT
Hackensack University Medical Center	Hackensack	NJ
Hamot Hospital	Erie	PA
Healtheast St Johns Hospital	Maplewood	MN
Healtheast St Joseph's Hospital	Saint Paul	MN
Henry Ford Wyandotte Hospital	Wyandotte	MI
Hillcrest Hospital	Mayfield Heights	OH
Hunterdon Medical Center	Flemington	NJ
Inova Fairfax Hospital	Falls Church	VA
Jersey Shore University Medical Center	Neptune	NJ
Jewish Hospital	Louisville	KY
Jewish Hospital The	Cincinnati	OH
JFK Medical Center	Atlantis	FL
Kendall Medical Center	Miami	FL
Kettering Medical Center	Kettering	OH
Lahey Clinic	Burlington	MA
Lancaster General Hospital	Lancaster	PA
Lehigh Valley Hospital	Allentown	PA
Lehigh Valley Hospital Muhlenberg	Bethlehem	PA
Little Company of Mary Hospital	Evergreen Park	IL
Lutheran Hospital of Indiana	Fort Wayne	IN
Lutheran Medical Center	Brooklyn	NY
Main Line Hospitals Lankenau	Wynnewood	PA
Margaret R Pardee Memorial Hospital	Hendersonville	NC
Mayo Clinic Hospital	Phoenix	AZ
Mcallen Heart Hospital/mcallen Medical Center	Mcallen	TX
Mclaren Regional Medical Center	Flint	MI
Medical Center of Aurora	Aurora	CO
Memorial Healthcare System Inc	Chattanooga	TN
Memorial Hermann Northwest/Southwest/Southeast	Houston	TX
Mercy General Health Partners	Muskegon	MI
Mercy Hospital and Medical Center	Chicago	IL
Mercy Hospital Inc	Miami	FL

DH-CE Teaching Hospitals	City	State
Mercy Hospital Scranton	Scranton	PA
Middlesex Hospital	Middletown	CT
MidMichigan Medical Center-Midland	Midland	MI
Midwest Regional Medical Center	Midwest City	OK
Mission Hospitals	Asheville	NC
Missouri Baptist Medical Center	St. Louis	MO
Monmouth Medical Center	Long Branch	NJ
Morton Plant Hospital	Clearwater	FL
Mount Sinai Medical Center	Miami Beach	FL
Mt Carmel Health	Columbus	OH
Munson Medical Center	Traverse City	MI
New York Presbyterian Hospital	New York	NY
Newton Wellesley Hospital	Newton	MA
North Memorial Health Care	Robbinsdale	MN
North Shore Medical Center	Salem	MA
Northside Hospital	Saint Petersburg	FL
Oakwood Annapolis Hospital	Wayne	MI
Oakwood Hospital and Medical Center Dearborn	Dearborn	MI
Ohio State University Hospitals East	Columbus	OH
Our Lady of The Resurrection Medical Center	Chicago	IL
Park Nicollet Health Services	Saint Louis Park	MN
Pennsylvania Hospital The	Philadelphia	PA
Penrose - St Francis Health Services	Colorado Springs	CO
Pomona Valley Hospital Medical Center	Pomona	CA
Porter Adventist Hospital	Denver	CO
Poudre Valley Hospital	Fort Collins	CO
Providence Hospital and Medical Centers	Southfield	MI
Robert Wood Johnson University Hospital	New Brunswick	NJ
Rose Medical Center	Denver	CO
Rush North Shore Medical Center	Skokie	IL
S S M Depaul Health Center	Bridgeton	MO
Saint Joseph Hospital	Chicago	IL
Scott and White Memorial Hospital	Temple	TX
Scottsdale Healthcare Osborn	Scottsdale	AZ
Scottsdale Healthcare Shea	Scottsdale	AZ
Sentara Virginia Beach General Hospital	Virginia Beach	VA

DH-CE Teaching Hospitals	City	State
Shawnee Mission Medical Center	Shawnee Mission	KS
Sibley Memorial Hospital	Washington	DC
Sioux Valley Hospital University Medical Center	Sioux Falls	SD
South Miami Hospital	Miami	FL
South Pointe Hospital	Warrensville Heights	OH
Southern Ohio Medical Center	Portsmouth	OH
Southwest General Health Center	Middleburg Heights	OH
St Alexius Medical Center	Hoffman Estates	IL
St Alexius Medical Center	Bismarck	ND
St Charles Mercy Hospital	Oregon	OH
St Elizabeth Medical Center	Edgewood	KY
St Francis Hospital and Health Center	Blue Island	IL
St Francis Hospital and Health Centers	Beech Grove	IN
St John West Shore Hospital	Westlake	OH
St Joseph Mercy Oakland	Pontiac	MI
St Joseph's Hospital	Marshfield	WI
St Luke's Episcopal-Presbyterian Hospital	Chesterfield	MO
St Lukes Hospital	Cedar Rapids	IA
St Lukes Hospital	Bethlehem	PA
St Mary Medical Center	Long Beach	CA
St Marys Health Center	Richmond Heights	MO
St Marys Hospital	Rochester	MN
St Mary's Medical Center	Duluth	MN
St Mary's Regional Medical Center	Enid	OK
St Thomas Hospital	Nashville	TN
St Vincent Charity Hospital	Cleveland	OH
St Vincent Hospital and Health Services	Indianapolis	IN
St Vincent Medical Center	Los Angeles	CA
St Vincent's Medical Center	Jacksonville	FL
St. Alphonsus Regional Medical Center	Boise	ID
Summa Health System	Akron	OH
Swedish Covenant Hospital	Chicago	IL
UHHS Bedford Medical Center	Bedford	OH
United Hospital Center	Clarksburg	WV
United Hospitals Inc	Saint Paul	MN
Unity Health System Park Ridge Hospital	Rochester	NY

DH-CE Teaching Hospitals	City	State
UPMC Mckeesport Hospital	Mc Keesport	PA
UT Southwestern University Hospital - St Paul	Dallas	TX
Virginia Baptist Hospital and Lynchburg General	Lynchburg	VA
Virginia Hospital Center- Arlington	Arlington	VA
Virginia Mason Medical Center	Seattle	WA
Waukesha Memorial Hospital	Waukesha	WI
West Allis Memorial Hsptl	West Allis	WI
William Beaumont Hospital	Royal Oak	MI
William Beaumont Hospital Troy	Troy	MI
Willis-Knighton Medical Center	Shreveport	LA
Winchester Medical Center Inc	Winchester	VA
York Hospital	York	PA

Non-Teaching Distinguished Hospitals for Clinical Excellence

DH-CE Non-Teaching Hospitals	City	State
Advocate Good Samaritan Hospital	Downers Grove	IL
Alexian Brothers Medical Center	Elk Grove Village	IL
Alle Kiski Medical Center	Natrona Heights	PA
Baptist Hospital East	Louisville	KY
Baptist Hospital of Miami Inc	Miami	FL
Bay Medical Center	Panama City	FL
Bayshore Medical Center	Pasadena	TX
Benefis Healthcare	Great Falls	MT
Bethesda Memorial Hospital	Boynton Beach	FL
Blake Medical Center	Bradenton	FL
Boca Raton Community Hospital Inc	Boca Raton	FL
Brandon Regional Hospital	Brandon	FL
Brotman Medical Center	Culver City	CA
Central Florida Regional Hospital	Sanford	FL
Centrastate Medical Center	Freehold	NJ
Chesapeake General Hospital	Chesapeake	VA
Clear Lake Regional Medical Center	Webster	TX
Community Hospital The	Munster	IN
Community Medical Center	Toms River	NJ
Deaconess Hospital	Cincinnati	OH
Delray Medical Center	Delray Beach	FL

DH-CE Non-Teaching Hospitals	City	State
E M H Regional Medical Center	Elyria	OH
Edward Hospital	Naperville	IL
El Camino Hospital	Mountain View	CA
Elmhurst Memorial Hospital	Elmhurst	IL
Exempla Lutheran Medical Center	Wheat Ridge	CO
Fairview Southdale Hospital	Edina	MN
Fawcett Memorial Hospital	Port Charlotte	FL
Flagler Hospital	Saint Augustine	FL
Florida Medical Center	Lauderdale Lakes	FL
Glendale Memorial Hospital and Health Center	Glendale	CA
Good Shepherd Medical Center	Longview	TX
Gwinnett Hospital System	Lawrenceville	GA
Heartland Regional Medical Center	Saint Joseph	MO
Henrico Doctors Hospital Forest Campus/ Parham Campus	Richmond	VA
Hoag Memorial Hospital Presbyterian	Newport Beach	CA
Holmes Regional Medical Center/Palm Bay Community Hospital	Melbourne	FL
Holy Cross Hospital	Fort Lauderdale	FL
Holy Name Hospital	Teaneck	NJ
Lake Hospital System Inc	Painesville	OH
Laredo Medical Center	Laredo	TX
Lawnwood Regional Medical Center & Heart Institute	Fort Pierce	FL
Lewis-Gale Medical Center	Salem	VA
Martin Memorial Medical Center	Stuart	FL
Marymount Hospital	Garfield Heights	OH
Mercy Medical Center of Springfield	Springfield	OH
Methodist Hospital of Southern California	Arcadia	CA
Munroe Regional Medical Center	Ocala	FL
Naples Community Hospital	Naples	FL
Northern Westchester Hospital	Mount Kisco	NY
Northwest Community Hospital	Arlington Heights	IL
Northwest Hospital Center	Randallstown	MD
Ocala Regional Medical Center	Ocala	FL
Palm Beach Gardens Medical Center	Palm Beach Gardens	FL
Palos Community Hospital	Palos Heights	IL
Parma Community General Hospital	Parma	OH
Regional Medical Center Bayonet Point	Hudson	FL

DH-CE Non-Teaching Hospitals	City	State
Rex Hospital	Raleigh	NC
Rio Grande Regional Hospital	Mcallen	TX
Rockingham Memorial Hospital	Harrisonburg	VA
RWJ University Hospital at Hamilton	Hamilton	NJ
Saint John's Health System	Anderson	IN
Saint Josephs Hospital of Atlanta	Atlanta	GA
Sarasota Memorial Hospital	Sarasota	FL
Sequoia Hospital	Redwood City	CA
Seton Medical Center	Austin	TX
Sherman Hospital	Elgin	IL
South Shore Hospital	South Weymouth	MA
St Francis Medical Center	Monroe	LA
St Johns Hospital Health Center	Santa Monica	CA
St Johns Regional Medical Center	Oxnard	CA
St Joseph's Hospital	Tampa	FL
St Josephs Mercy of Macomb	Clinton Township	MI
St Mary's Medical Center Inc	Knoxville	TN
St. Mary Mercy Hospital	Livonia	MI
University Hospital and Medical Center	Tamarac	FL
Washington Hospital	Fremont	CA
Westside Regional Medical Center	Plantation	FL
White Plains Hospital Center	White Plains	NY

Community Distinguished Hospitals for Clinical Excellence

DH-CE Community Hospitals	City	State
Advocate South Suburban Hospital	Hazel Crest	IL
Augusta Medical Center	Fishersville	VA
Bay Area Medical Center	Marinette	WI
Cape Canaveral Hospital	Cocoa Beach	FL
Charlotte Regional Medical Center	Punta Gorda	FL
Cleveland Clinic Florida Hospital Naples	Naples	FL
Crittenton Hospital Medical Center	Rochester Hills	MI
Del E Webb Memorial Hospital	Sun City West	AZ
Doctor's Community Hospital	Lanham	MD
Englewood Community Hospital	Englewood	FL
Ephrata Community Hospital	Ephrata	PA

DH-CE Community Hospitals	City	State
Florida Hospital Fish Memorial	Orange City	FL
Florida Hospital Heartland Division	Sebring	FL
Garfield Medical Center	Monterey Park	CA
Glenwood Regional Medical Center	West Monroe	LA
Hackley Hospital	Muskegon	MI
Hays Medical Center	Hays	KS
Helen Ellis Memorial Hospital	Tarpon Springs	FL
Jupiter Medical Center	Jupiter	FL
Lakewood Hospital	Lakewood	OH
Los Robles Regional Medical Center	Thousand Oaks	CA
Mease Countryside Hospital	Clearwater	FL
Mease Dunedin Hospital	Dunedin	FL
Memorial Medical Center	Woodstock	IL
Mercy Medical Center	Roseburg	OR
Mercy Medical Center Clinton	Clinton	IA
Meridia Euclid Hospital	Euclid	OH
Oak Hill Hospital	Brooksville	FL
Peace River Regional Medical Center	Port Charlotte	FL
Port Huron Hospital	Port Huron	MI
Providence Holy Cross Medical Center	Mission Hills	CA
San Leandro Hospital	San Leandro	CA
Scripps Memorial Hospital Encinitas	Encinitas	CA
Skaggs Community Health Center	Branson	MO
Skyline Medical Center	Nashville	TN
South Bay Hospital	Sun City Center	FL
SSM St Joseph Health Center	Saint Charles	MO
St Catherine Hospital	East Chicago	IN
St Lucie Medical Center	Port Saint Lucie	FL
St Luke's Cornwall Hospital Newburgh And Cornwall	Newburgh	NY
Union Hospital of Cecil County	Elkton	MD
UPMC Lee Regional	Johnstown	PA
Valley Regional Medical Center	Brownsville	TX
William W Backus Hospital	Norwich	CT
Willis Knighton Bossier Health Center	Bossier City	LA
Woodland Heights Medical Center	Lufkin	TX

Exhibit B: Inhospital Mortality Performance

Distinguished Hospitals for Clinical Excellence (DH-CE) Compared to All Other U.S. Hospitals (3-Year Aggregate Risk-Adjusted Inhospital Mortality Performance: 2002-2004)

Diagnosis or Procedure	Year	Total Number of All U.S. Medicare Hospitali-zations	Total Number of U.S. Medicare DH-CE Hospitali-zations	DH-CE Hospitals Average Observed Inhospital Mortality to Expected Inhospital Mortality Ratio[1]	% Improvement by DH-CE Hospitals	All Other U.S. Hospitals Average Observed Inhospital Mortality to Expected Inhospital Mortality Ratio[2]	% Improvement by All Other Hospitals	Relative Risk Reduction Associated with DH-CE Hospitals Compared to All Other U.S. Hospitals	Number of Lives That Could Have Been Saved If All Patients Treated at DH-CE Hospitals (2002-2004)[3]
Coronary Artery Bypass Surgery	2002			0.83		1.14			
	2003			0.74		1.06			
	2004			0.72		1.01			
	2002-2004	357,189	80,843	0.77	13.78%	1.07	11.33%	28.58%	2,690
Valve Replacement Surgery	2002			0.81		1.09			
	2003			0.83		1.05			
	2004			0.73		0.97			
	2002-2004	109,472	28,275	0.79	9.72%	1.06	10.74%	25.59%	1,742
Coronary Interventional Procedures (Angioplasty/ Stent)	2002			0.86		1.04			
	2003			0.79		1.02			
	2004			0.82		1.08			
	2002-2004	960,642	220,588	0.83	4.09%	1.05	-3.47%	21.66%	3,117
Heart Attack	2002			0.90		1.08			
	2003			0.83		1.02			
	2004			0.81		1.02			
	2002-2004	888,528	174,312	0.84	9.62%	1.04	5.44%	18.47%	17,170

Diagnosis or Procedure	Year	Total Number of All U.S. Medicare Hospitali-zations	Total Number of U.S. Medicare DH-CE Hospitali-zations	DH-CE Hospitals Average Observed Inhospital Mortality to Expected Inhospital Mortality Ratio[1]	% Improvement by DH-CE Hospitals	All Other U.S. Hospitals Average Observed Inhospital Mortality to Expected Inhospital Mortality Ratio[2]	% Improvement by All Other Hospitals	Relative Risk Reduction Associated with DH-CE Hospitals Compared to All Other U.S. Hospitals	Number of Lives That Could Have Been Saved If All Patients Treated at DH-CE Hospitals (2002-2004)[3]
Heart Failure	2002			0.86		1.16			
	2003			0.73		1.05			
	2004			0.67		0.97			
	2002-2004	2,000,361	325,649	0.75	21.44%	1.05	16.60%	29.15%	24,357
Atrial Fibrillation	2002			0.85		1.18			
	2003			0.81		1.08			
	2004			0.67		0.97			
	2002-2004	550,193	101,277	0.78	21.10%	1.06	17.88%	26.48%	1,928
Chronic Obstructive Pulmonary Disease (COPD)	2002			0.86		1.15			
	2003			0.73		1.03			
	2004			0.67		0.96			
	2002-2004	1,059,385	147,141	0.75	21.98%	1.05	16.63%	27.98%	7,390
Community Acquired Pneumonia	2002			0.80		1.14			
	2003			0.72		1.04			
	2004			0.65		0.96			
	2002-2004	1,669,399	217,591	0.72	19.47%	1.05	15.64%	30.92%	32,349
Stroke	2002			0.85		1.10			
	2003			0.78		1.02			
	2004			0.76		0.98			
	2002-2004	821,975	139,630	0.80	10.03%	1.04	10.60%	23.66%	19,493
Resection/Replacement of Abdominal Aorta	2002			0.73		1.06			
	2003			0.77		1.00			
	2004			0.83		0.82			
	2002-2004	37,182	8,615	0.79	-13.03%	0.96	22.11%	17.45%	337

Diagnosis or Procedure	Year	Total Number of All U.S. Medicare Hospitali-zations	Total Number of U.S. Medicare DH-CE Hospitali-zations	DH-CE Hospitals Average Observed Inhospital Mortality to Expected Inhospital Mortality Ratio[1]	% Improvement by DH-CE Hospitals	All Other U.S. Hospitals Average Observed Inhospital Mortality to Expected Inhospital Mortality Ratio[2]	% Improvement by All Other Hospitals	Relative Risk Reduction Associated with DH-CE Hospitals Compared to All Other U.S. Hospitals	Number of Lives That Could Have Been Saved If All Patients Treated at DH-CE Hospitals (2002-2004)[3]
Bowel Obstruction	2002			0.87		1.12			
	2003			0.78		1.04			
	2004			0.72		0.97			
	2002-2004	511,059	86,734	0.79	16.30%	1.05	13.87%	24.44%	6,838
Gastrointestinal Bleed	2002			0.88		1.16			
	2003			0.75		1.05			
	2004			0.70		0.96			
	2002-2004	126,417	126,417	0.77	19.81%	1.05	17.07%	26.54%	6,008
Pancreatitis	2002			0.89		1.15			
	2003			0.69		1.02			
	2004			0.63		0.91			
	2002-2004	134,206	25,352	0.72	29.56%	1.06	20.49%	31.98%	1,393
Diabetic Acidosis and Coma	2002			0.89		1.15			
	2003			0.60		1.09			
	2004			0.53		0.93			
	2002-2004	258,895	36,620	0.68	39.98%	1.05	18.98%	35.17%	
Pulmonary Embolism	2002			0.86		1.09			
	2003			0.79		0.99			
	2004			0.68		0.93			
	2002-2004	113,221	25,338	0.77	20.94%	1.01	15.21%	24.37%	1,478
Sepsis	2002			0.83		1.06			
	2003			0.75		1.00			
	2004			0.77		1.04			
	2002-2004	561,022	103,031	0.78	6.92%	1.05	2.67%	25.57%	26,677
Totals		10,159,146	1,847,413	-	-	-	-	-	152,966
3 Year Performance Averages[4]		-	-	0.77	16.53%	1.05	12.12%	26.66%	-

[1] All individual years and 3 year aggregate outcomes were statistically significantly better than expected ($p<0.05$) for DH-CE hospitals

[2] All individual years and 3 year aggregate outcomes were statistically significantly worse than expected ($p<0.05$) for All Other hospitals except for Resection/Replacement of Abdominal Aorta and Pulmonary Embolism which were not statistically significant different from expected

[3] Lives saved was calculated (data not shown): All Other hospitals' 3 year actual number of mortalities - (All Other hospitals' 3 year expected number of mortalities x DH-CE O/E ratio)

[4] All averages are weighted averages

Exhibit C: Hospitals for Clinical Excellence (DH-CE) Compared to All Other U.S. Hospitals (3 Year Aggregate Risk-Adjusted Inhospital Post-operative Complications Performance: 2002-2004)

Diagnosis or Procedure	Year	Total Number of U.S. Medicare Hospitali-zations	Total Number of U.S. Medicare DH-CE Hospitali-zations	DH-CE Hospitals Average Observed Inhospital Complications to Expected Inhospital Complications Ratio[1]	% Improvement by DH-CE Hospitals	All Other U.S. Hospitals Average Observed Inhospital Complications to Expected Inhospital Complications Ratio[2]	% Improvement by All Other Hospitals	Relative Risk Reduction Associated with DH-CE Hospitals Compared to All Other U.S. Hospitals	Number of Patients That Could Have Been Avoided Developing ≥1 Post-Op Complications If All Patients Treated at DH-CE Hospitals (2002-2004)[3]
Total Knee Replacement	2002			0.94		1.10			
	2003			0.88		1.06			
	2004			0.77		0.96			
	2002-2004	569,213	106,562	0.86	17.68%	1.03	13.13%	16.43%	3,308
Total Hip Replacement	2002			0.91		1.10			
	2003			0.89		1.05			
	2004			0.78		0.96			
	2002-2004	262,929	54,498	0.85	13.93%	1.01	12.89%	15.79%	1,906
Hip Fracture Repair	2002			0.89		1.05			
	2003			0.84		1.04			
	2004			0.80		1.00			
	2002-2004	377,848	63,023	0.85	10.00%	1.03	4.13%	17.70%	4,738
Partial Hip Replacement	2002			0.94		1.04			
	2003			0.91		1.04			
	2004			0.84		0.98			
	2002-2004	213,461	37,133	0.90	11.28%	1.02	6.25%	11.57%	2,341
Back and Neck Surgery (without Spinal Fusion)	2002			0.96		1.04			
	2003			0.89		0.99			
	2004			0.97		1.02			
	2002-2004	211,227	45,957	0.94	-1.32%	1.01	1.20%	6.79%	1,018

Diagnosis or Procedure	Year	Total Number of U.S. Medicare Hospitali-zations	Total Number of U.S. Medicare DH-CE Hospitali-zations	DH-CE Hospitals Average Observed Inhospital Complications to Expected Inhospital Complications Ratio[1]	% Improvement by DH-CE Hospitals	All Other U.S. Hospitals Average Observed Inhospital Complications to Expected Inhospital Complications Ratio[2]	% Improvement by All Other Hospitals	Relative Risk Reduction Associated with DH-CE Hospitals Compared to All Other U.S. Hospitals	Number of Patients That Could Have Been Avoided Developing >1 Post-Op Complications If All Patients Treated at DH-CE Hospitals (2002-2004)[3]
Spinal Fusion	2002			0.93		1.01			
	2003			0.85		1.04			
	2004			0.90		1.03			
	2002-2004	126,382	27,651	0.89	2.63%	1.03	-2.37%	13.14%	1,701
Carotid Endarterectomy	2002			0.97		1.03			
	2003			0.92		1.02			
	2004			0.81		0.85			
	2002-2004	243,070	51,030	0.92	16.67%	1.01	17.55%	8.62%	877
Peripheral Vascular Bypass	2002			1.06		1.06			
	2003			0.97		1.04			
	2004			0.92		0.94			
	2002-2004	78,260	16,741	0.95	13.68%	1.02	11.21%	7.44%	453
Prostatectomy	2002			0.88		1.05			
	2003			0.85		1.00			
	2004			0.83		1.04			
	2002-2004	258,052	47,160	0.85	5.54%	1.03	1.83%	16.94%	1,683
Cholecystectomy	2002			0.94		1.02			
	2003			0.87		1.02			
	2004			0.91		1.01			
	2002-2004	299,392	52,131	0.90	3.47%	1.02	0.90%	11.32%	3,872
Totals		2,639,834	501,886	-	-	-	-	-	21,896
3 Year Performance Averages[4]		-	-	0.88	10.44%	1.02	7.42%	13.71%	-

[1] All 3 year aggregate outcomes were statistically significantly better than expected ($p<0.05$) for DH-CE hospitals

[2] All 3 year aggregate outcomes were statistically significantly worse than expected ($p<0.05$) for All Other hospitals except for Total Hip Replacement, Back & Neck Surgery without Spinal Fusion, Carotid Endarterectomy and Peripheral Vascular Bypass which were not statistically significant different from expected

[3] Complications avoided calculated (data not shown): All Other hospitals' 3 year actual number of patients with > complications- (All Other hospitals' 3 year expected number of patients with >1 x DH-CE O/E ratio)

[4] All averages are weighted averages

Exhibit D: Hospital Report Card™ Mortality and Complication Based Outcomes 2006 Methodology White Paper

Introduction

To help consumers evaluate and compare hospital performance, HealthGrades analyzed patient outcome data for virtually every hospital in the country. HealthGrades purchased the initial data from the Centers for Medicare and Medicaid Services (CMS). The Medicare data (MedPAR file) from CMS contained the inpatient records for Medicare patients.

Ratings were based upon two different risk-adjustment methodologies.

- For 27 medical issues, the risk adjustment was based upon the HealthGrades methodology described in the Multivariate Logistic Regression-Based Ratings section of this white paper.
- 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 white paper.

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.

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 virtually 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. However, since the Appendectomy cohort includes very few cases over 65 years of age, all payer state data was used to rate hospitals in those states where state data are available.

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 (except Appendectomy)
- 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, 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

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 27 diagnoses and procedures on the HealthGrades Web site represent three years of patient discharges from 2002 to 2004 for MedPAR and three years of patient discharges from 2001 to 2003 for state data.

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 (Appendix C), 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. See Appendix C for a list of the top five risk factors for each procedure or diagnosis.

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.

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.

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.

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.

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.)

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

Patient Cohort	ICD-9-CM Procedure/Diagnosis Codes and Criteria
Appendectomy	Principal Procedures – Inclusions: 47.01, 47.09 Procedures – Exclusions: 37.5, 37.51, 37.52, 37.53, 37.54 Note: This cohort uses all payer data from states which provide it
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
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
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, 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
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 and Surgeries	APR-DRG: 220-224, 226, 229, 260, 261, 264

Patient Cohort	ICD-9-CM Procedure/Diagnosis Codes and Criteria
Heart Attack	Principal Diagnoses – Inclusions: 410.01, 410.11, 410.21, 410.31, 410.41, 410.51, 410.61, 410.71, 410.81, 410.91 Diagnoses – Exclusions: 414.06, 414.07, V66.7
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
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
Resection / Replacement of Abdominal Aorta	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
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
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, 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

Appendix B: Major Complications

Major Complications – Appendectomy			
427.31	ATRIAL FIBRILLATION	560.9	INTESTINAL OBSTRUCTN NOS
427.89	CARDIAC DYSRYTHMIAS NEC	584.9	ACUTE RENAL FAILURE, NOS
428.0	CONGESTIVE HEART FAILURE	593.9	KIDNEY & URETER DIS NOS
486	PNEUMONIA-ORGANISM NOS	682.2	CELLULITIS/ABSCESS-TRUNK
511.9	PLEURAL EFFUSION, NOS	997.1	CARDIAC COMPLICATION NEC
518.0	PULMONARY COLLAPSE	997.3	RESPIR COMPLICATIONS NEC
518.5	PULM INSUF PST TRAUM/SRG	997.4	DIGESTIVE SYST COMPL NEC
518.81	RESPIRATORY FAILURE	997.5	URINARY COMPLICATION NEC
560.1	PARALYTIC ILEUS	998.59	POSTOPERATIV INFECTN NEC

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

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

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

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

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

Major Complications – Peripheral Vascular Bypass			
038	SEPTICEMIA	481	PNEUMOCOCCAL PNEUMONIA
038.0	STREPTOCOCCAL SEPTICEMIA	482	OTHR BACTERIAL PNEUMONIA
038.1	STAPHYLOCOCCL SEPTICEMIA	482.0	PNEUMONIA-K. PNEUMONIAE
038.10	STAPHLOCOCC SEPTICEM NOS	482.1	PNEUMONIA DT PSEUDOMONAS
038.11	SEPTICEMIA-STAPH AUREUS	482.2	PNEUMONIA-H. INFLUENZAE
038.19	STAPHLOCOCC SEPTICEM NEC	482.3	PNEUMONIA-STREPTOCOCCUS
038.2	PNEUMOCOCCAL SEPTICEMIA	482.30	PNEUMONIA-STREPTOCOC NOS
038.3	SEPTICEMIA DT ANAEROBES	482.31	PNEUMONIA-GROUP A STREP
038.4	SEPTICEMIA GRAM-NEGS NEC	482.32	PNEUMONIA-GROUP B STREP
038.40	SEPTICEMIA GRAM-NEGS NOS	482.39	PNEUMONIA DT STREP NEC
038.41	SEPTICEMIA-H. INFLUENZAE	482.4	PNEUMONIA-STAPHYLOCOCCUS
038.42	SEPTICEMIA DT E. COLI	482.40	STAPH PNEUMONIA NOS
038.43	SEPTICEMIA - PSEUDOMONAS	482.41	STAPH AUREUS PNEUMONIA
038.44	SEPTICMIA DT SERRATIA	482.49	STAPH PNEUMONIA NEC
038.49	SEPTICEMIA GRAM-NEG NEC	482.8	PNEUMONIA-BACTERIA NEC
038.8	OTH SPECIFIED SEPTICEMIA	482.81	PNEUMONIA DT ANAEROBES
038.9	UNSPECIFIED SEPTICEMIA	482.82	PNEUMONIA-E. COLI
041.04	BACTR INF DT GRP D STREP	482.83	PNEUMONIA-GRM NG BAC NEC
041.11	BACTERL INF DT S. AUREUS	482.84	LEGIONNAIRES' DISEASE
041.7	PSEUDOMONAS IN OTHER DIS	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	518.5	PULM INSUF PST TRAUM/SRG
428.43	AC ON CH SYS/DIA HT FAIL	584.9	ACUTE RENAL FAILURE, NOS
428.9	HEART FAILURE, NOS	593.9	KIDNEY & URETER DIS NOS
480	VIRAL PNEUMONIA	996.74	COMP NEC-VASC DEV/GRAFT
480.0	PNEUMONIA DT ADENOVIRUS	997.1	CARDIAC COMPLICATION NEC
480.1	PNEUMONIA DUE TO RSV	997.3	RESPIR COMPLICATIONS NEC
480.2	PNEUMON-PARAINFLUENZA VR	998.11	HEMORRHAGE COMPLIC PROC
480.3	PNEUMONIA DT SARS	998.2	ACC PUNCTUR/LAC-PROC NEC
480.8	PNEUMONIA DT VIRUS NEC	998.59	POSTOPERATIV INFECTN NEC
480.9	VIRAL PNEUMONIA, NOS		

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		

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

Appendix C: Top Five Risk Factors by Procedure or Diagnosis

Proc = Procedure Code
Diag = Diagnosis Code

Appendectomy	
Diag 40.1	AC APPENDICIT-PERIT ABSC
Diag 540.0	AC APPENDIC-PERITONITIS
Diag 496	CHR AIRWAY OBSTRUCT NEC
Diag 276.8	HYPOPOTASSEMIA
Diag 038, 038.0, 038.1, 038.10, 038.11, 038.19, 038.2, 038.3, 038.4, 038.40, 038.41, 038.42, 038.43, 038.44, 038.49, 038.8, 038.9	SEPSIS
Atrial Fibrillation	
Diag 428.41	AC COMB SYS/DIAS HT FAIL
Diag 584.9	ACUTE RENAL FAILURE, NOS
Diag 433.01, 433.11, 433.21, 433.31, 433.81	OCCLUSION OF CEREBRAL ARTER WITH INFARCT
Diag 410.31, 410.41	INFERIOR WALL AMI
Diag 410.01, 410.11, 410.21, 410.51, 410.61, 410.81, 410.91	ANTERIOR/LATERAL WALL AMI
Back and Neck Surgery (Except Spinal Fusion)	
Proc 03.09	SP CANAL EXPL/DECOMP NEC
Diag 276.1	HYPOSMOLALITY/NATREMIA
Diag 276.8	HYPOPOTASSEMIA
Diag 403.11, 403.91	NON-MALIGNANT RENAL DISEASE WITH FAILURE
Diag 600, 600.0, 600.2, 600.20, 600.21, 600.3, 600.9, 600.90, 600.91	HYPERPLASIA OF PROSTATE
Back and Neck Surgery (Spinal Fusion)	
Proc 81.04	ANT DORSAL/DORSOLUMB FUS
Proc 81.05	POST DORSL/DORSOLUMB FUS
Proc 81.06	ANTERIOR LUMBAR/L-S FUSN
Proc 81.08	POSTER'R LUMBAR/L-S FUSN
Proc 81.64	FUSE/REFUSE >=9 VERTEBRA
Bowel Obstruction	
Diag 276.2	ACIDOSIS
Diag 428.9	HEART FAILURE, NOS
Diag 458.9	HYPOTENSION, UNSPECIFIED
Diag 518.81	RESPIRATORY FAILURE
Diag 557.0	AC VASC INSUFF-INTESTINE
Carotid Endarterectomy	
Proc 39.72	ENDOVASC REPR HD/NCK VES
Diag 342.90	HEMIPLEGIA NOS-SIDE NOS
Diag 780.39	OTHER CONVULSIONS
Diag 402.11, 402.91	NON-MALIGNANT HYPERTENSION WITH CHF
Diag 403.11, 403.91	NON-MALIGNANT RENAL DISEASE WITH FAILURE

Cholecystectomy	
Proc 51.21	OTH PART CHOLECYSTECTOMY
Proc 51.22	CHOLECYSTECTOMY
Diag 493.02, 493.12, 493.22, 493.92	ASTHMA WITH ACUTE EXACERBATION
Diag 260, 261, 262, 263.0, 263.1, 263.2, 263.8, 263.9	MALNUTRITION
Diag 038, 038.0, 038.1, 038.10, 038.11, 038.19, 038.2, 038.3, 038.4, 038.40, 038.41, 038.42, 038.43, 038.44, 038.49, 038.8, 038.9	SEPSIS
Chronic Obstructive Pulmonary Disease (COPD)	
Diag 162.9	MAL NEOPLASM OF LUNG NOS
Diag 492.8	OTHER EMPHYSEMA
Diag 496.	CHR AIRWAY OBSTRUCT NEC
Diag 518.81	RESPIRATORY FAILURE
Diag 584.5, 584.9	ACUTE RENAL FAILURE
Community Acquired Pneumonia	
Diag 162.9	MAL NEOPLASM OF LUNG NOS
Diag 276.2	ACIDOSIS
Diag 518.81	RESPIRATORY FAILURE
Diag 038, 038.0, 038.1, 038.10, 038.11, 038.19, 038.2, 038.3, 038.4, 038.40, 038.41, 038.42, 038.43, 038.44, 038.49, 038.8, 038.9	SEPSIS
Diag 584.5, 584.9	ACUTE RENAL FAILURE
Coronary Bypass Surgery	
Diag 428.9	HEART FAILURE, NOS
Diag 584.5	AC REN FAIL-LES TUBL NEC
Diag 584.9	ACUTE RENAL FAILURE, NOS
Diag 433.01, 433.11, 433.21, 433.31, 433.81	OCCLUSION OF CEREBRAL ARTER WITH INFARCT
Diag 441.00, 441.01, 441.02, 441.03	DISSECTION OF AORTA
Coronary Interventional Procedures	
Diag 428.1	LEFT HEART FAILURE
Diag 260, 261, 262, 263.0, 263.1, 263.2, 263.8, 263.9	MALNUTRITION
Diag 410.31, 410.41	INFERIOR WALL AMI
Diag 410.01, 410.11, 410.21, 410.51, 410.61, 410.81, 410.91	ANTERIOR/LATERAL WALL AMI
Diag 441.00, 441.01, 441.02, 441.03	DISSECTION OF AORTA
Diabetic Acidosis and Coma	
Diag 250.30	TYPE II DM WITH COMA NEC
Diag 250.31	TYPE I DM WITH COMA NEC
Diag 518.81	RESPIRATORY FAILURE
Diag 038, 038.0, 038.1, 038.10, 038.11, 038.19, 038.2, 038.3, 038.4, 038.40, 038.41, 038.42, 038.43, 038.44, 038.49, 038.8, 038.9	SEPSIS
Diag 410.01, 410.11, 410.21, 410.51, 410.61, 410.81, 410.91	ANTERIOR/LATERAL WALL AMI
Gastrointestinal Bleed	
Diag 518.81	RESPIRATORY FAILURE
Diag 433.01, 433.11, 433.21, 433.31, 433.81	OCCLUSION OF CEREBRAL ARTER WITH INFARCT
Diag 038, 038.0, 038.1, 038.10, 038.11, 038.19, 038.2, 038.3, 038.4, 038.40, 038.41, 038.42, 038.43, 038.44, 038.49, 038.8, 038.9	SEPSIS
Diag 410.31, 410.41	INFERIOR WALL AMI
Diag 410.01, 410.11, 410.21, 410.51, 410.61, 410.81, 410.91	ANTERIOR/LATERAL WALL AMI

Heart Attack	
Diag 276.2	ACIDOSIS
Diag 410.01	AMI-ANTEROLATERL-INITIAL
Diag 410.91	AMI-SITE NOS-INITIAL EPI
Diag 427.41	VENTRICULAR FIBRILLATION
Diag 584.5	AC REN FAIL-LES TUBL NEC
Heart Failure	
Diag 428.9	HEART FAILURE, NOS
Diag 433.01, 433.11, 433.21, 433.31, 433.81	OCCLUSION OF CEREBRAL ARTER WITH INFARCT
Diag 410.31, 410.41	INFERIOR WALL AMI
Diag 410.01, 410.11, 410.21, 410.51, 410.61, 410.81, 410.91	ANTERIOR/LATERAL WALL AMI
Diag 584.5, 584.9	ACUTE RENAL FAILURE
Hip Fracture Repair	
Proc 79.25	OP FX RED NO INT FIX-FEM
Diag 507.0	PNEUMONIT-INH FOOD/VOMIT
Diag 584.9	ACUTE RENAL FAILURE, NOS
Diag 821.01	CLOS FRACTUR-FEMUR SHAFT
Diag 260, 261, 262, 263.0, 263.1, 263.2, 263.8, 263.9	MALNUTRITION
Pancreatitis	
Diag 276.2	ACIDOSIS
Diag 428.40	CMB SYS/DIAS HT FAIL NOS
Diag 428.9	HEART FAILURE, NOS
Diag 518.81	RESPIRATORY FAILURE
Diag 038, 038.0, 038.1, 038.10, 038.11, 038.19, 038.2, 038.3, 038.4, 038.40, 038.41, 038.42, 038.43, 038.44, 038.49, 038.8, 038.9	SEPSIS
Partial Hip Replacement	
Diag 491.21	OBST CHR BRONCH-AC EXACR
Diag 507.0	PNEUMONIT-INH FOOD/VOMIT
Diag 584.9	ACUTE RENAL FAILURE, NOS
Diag 733.82	NONUNION OF FRACTURE
Diag 493.02, 493.12, 493.22, 493.92	ASTHMA WITH ACUTE EXACERBATION
Peripheral Vascular Bypass	
Diag 428.31	AC DIASTOL HEART FAILURE
Diag 453.8	EMBOLI/THROMBO-VEIN NEC
Diag 682.6	CELLULITIS/ABSCSS OF LEG
Diag 480, 480.0, 480.1, 480.2, 480.3, 480.8, 480.9, 481, 482, 482.0, 482.1, 482.2, 482.3, 482.30, 482.31, 482.32, 482.39, 482.4, 482.40, 482.41, 482.49, 482.8, 482.81, 482.82, 482.83, 482.84, 482.89, 482.9, 483, 483.0, 483.1, 483.8, 484, 484.1, 484.3, 484.5, 484.6, 484.7, 484.8, 485, 486	PNEUMONIA
Diag 584.5, 584.9	ACUTE RENAL FAILURE
Prostatectomy	
Diag 276.1	HYPOSMOLALITY/NATREMIA
Diag 276.8	HYPOPOTASSEMIA
Diag 788.21	INCOMPLET BLADDR EMPTYNG
Diag 788.29	RETENTION OF URINE, NEC
Diag 584.5, 584.9	ACUTE RENAL FAILURE

Pulmonary Embolism	
Diag 276.2	ACIDOSIS
Diag 428.9	HEART FAILURE, NOS
Diag 458.9	HYPOTENSION, UNSPECIFIED
Diag 518.81	RESPIRATORY FAILURE
Diag 433.01, 433.11, 433.21, 433.31, 433.81	OCCLUSION OF CEREBRAL ARTER WITH INFARCT
Resection/Replacement of Abdominal Aorta	
Proc 38.64	EXCISION NEC-ABD AORTA
Diag 441.3	ABDOMINAL ANEURYSM-RUPTR
Diag 557.0	AC VASC INSUFF-INTESTINE
Diag 785.59	SHOCK NEC-NO MENT TRAUMA
Diag 410.01, 410.11, 410.21, 410.51, 410.61, 410.81, 410.91	ANTERIOR/LATERAL WALL AMI
Sepsis	
Diag 197.7	2NDRY MAL NEOPLASM-LIVER
Diag 428.9	HEART FAILURE, NOS
Diag 518.81	RESPIRATORY FAILURE
Diag 785.59	SHOCK NEC-NO MENT TRAUMA
Diag 410.01, 410.11, 410.21, 410.51, 410.61, 410.81, 410.91	ANTERIOR/LATERAL WALL AMI
Stroke	
Diag 430.	SUBARACHNOID HEMORRHAGE
Diag 431.	INTRACEREBRAL HEMORRHAGE
Diag 518.81	RESPIRATORY FAILURE
Diag 780.01	COMA
Diag 410.01, 410.11, 410.21, 410.51, 410.61, 410.81, 410.91	ANTERIOR/LATERAL WALL AMI
Total Hip Replacement	
Diag 276.1	HYPOSMOLALITY/NATREMIA
Diag 276.5	VOLUME DEPLETION
Diag 427.89	CARDIAC DYSRYTHMIAS NEC
Diag 403.11, 403.91	NON-MALIGNANT RENAL DISEASE WITH FAILURE
Diag 81.51	BILATERAL HIP
Total Knee Replacement	
Diag 402.11, 402.91	NON-MALIGNANT HYPERTENSION WITH CHF
Diag 403.11, 403.91	NON-MALIGNANT RENAL DISEASE WITH FAILURE
Diag 404.11, 404.91	NON-MALIG HYPERTEN & REN WITH CHF
Diag 493.02, 493.12, 493.22, 493.92	ASTHMA WITH ACUTE EXACERBATION
Diag 260, 261, 262, 263.0, 263.1, 263.2, 263.8, 263.9	MALNUTRITION
Valve Replacement Surgery	
Diag 428.1	LEFT HEART FAILURE
Diag 428.9	HEART FAILURE, NOS
Diag 584.5	AC REN FAIL-LES TUBL NEC
Diag 584.9	ACUTE RENAL FAILURE, NOS
Diag 410.01, 410.11, 410.21, 410.51, 410.61, 410.81, 410.91	ANTERIOR/LATERAL WALL AMI

Appendix D: Methodology Enhancements for 2006 Ratings Models

The following changes were determined and implemented after input from outside coding and clinical experts. For the following service lines, we describe the changes for each rated cohort and provide the rationale behind these changes.

- All Service Lines
- Cardiac
- Critical Care
- Orthopedic
- Pulmonary
- Vascular

All Service Lines

Cohorts Affected	2006 Ratings' Model Change	Rationale for Changes
All	Combined 584.5 and 584.9 into "Acute Renal Failure" when assessing as a risk factor or comorbid.	To minimize the effect of coding variations, codes were combined that were clinically similar.
All	Removed "complication of medical care, NEC" (998.89) as a major complication.	Determined this code most often represented "post-operative fever" which was determined to not be a major complication.
All diagnosis cohorts, hip fracture repair, partial hip replacement	Excluded "encounter for palliative care" (V66.7) patients from cohort ratings analysis.	This code was found to represent 1% or more of these cohorts and given their certain mortality, they were excluded.

Cardiac

Cohorts Affected	2006 Ratings' Model Change	Rationale for Changes
Coronary Artery Bypass Graft Coronary Interventional Procedures Heart Attack	Removed cardiogenic shock (785.51), cardiac arrest (427.5) and anoxic brain (348.1) injury as risk factors.	After extensive analysis and benchmarking with data bases that have present on admission indicators (ex. California's OSHPD), it still remained unclear as to whether these were present on admission or a post-operative complication. As such, we developed models using all the other diagnosis codes that are known to be present on admission with these complicated patients. (C-statistics remained similar with and without these 3 diagnoses as predictors.)
Coronary Artery Bypass Graft Valve Surgery	Combined all anterior wall-related AMI codes (410.01, 410.11, 410.21, 410.51, 410.61, and 410.81) as one potential risk factor. Combined all inferior wall-related AMI codes (410.31, 410.41) as another potential risk factor.	To minimize the effect of coding variations, codes were combined that were clinically similar. Also, to address the low volumes associated with some of these individual diagnosis codes, clinically similar codes were combined to achieve statistical significance and remain in the final prediction model.
Coronary Artery Bypass Graft Surgery	Excluded all valve repairs (35.10 – 35.14).	This situation is very rare, but when it does occur, inadequate risk adjustment may occur due to the low volume of this patient population (and not reaching the statistical significance required to remain in the final prediction model), thus necessitating exclusion from the patient population evaluated.
Valve Surgery	Included combined codes for "other valve repair" (35.10, 35.11, 35.13, 35.14) and "mitral repair" (35.12) as potential (positive or negative) predictors of mortality.	Although rates of valve repairs are increasing across several institutions, there are still insufficient numbers associated with each valve repair procedure code to reach statistical significance. As such, like valve repair codes were combined to increase the likelihood of reaching statistical significance and be included in the final prediction model.
Coronary Interventions	Excluded patients who also received a Coronary Artery Bypass Graft (CABG) Surgery Valve Replacement, or Valve Repair in the same hospitalization.	With few exceptions, CABG is the main, and usually final, procedure in admissions where PCI and CABG are performed in the same hospitalization. Deaths that occur are most likely related to the CABG and should thus be linked only to this procedure (not to PCI).

Cardiac (continued)

Cohorts Affected	2006 Ratings' Model Change	Rationale for Changes
Acute Myocardial Infarction (Heart Attack)	Included CABG and PCI procedures (using the codes that define each of these cohorts, which can be found in Appendix A) as potential (positive or negative) predictors of mortality.	CABG and PCI can improve AMI outcomes. These are negative predictors of mortality ("protective benefit") and should be included to adequately risk adjust and differentiate the intervention patients from the medical management only patients.
Heart Failure	Excluded patients who received dialysis in the same hospitalization (39.95).	Dialysis patients often present in "fluid overload" from missed dialysis. In addition, "fluid overload" is not well differentiated from congestive heart failure, potentially resulting in a skewed population of highly complex patients (compared to the national average) for some hospitals with high rates of dialysis patients.

Critical Care

Cohorts Affected	2006 Ratings' Model Change	Rationale for Changes
Diabetic Acidosis and Coma	New cohort rating added 2006. Only inhospital and 30 day risk-adjusted mortality was rated. 180 day mortality was not rated.	Broaden the hospitals' Critical Care service line quality assessment for users.
Sepsis	Removed 771.81, 785.59, 995.93, and 995.94 from the cohort definition.	Removed based on recommendation of coders.

Orthopedic

Cohorts Affected	2006 Ratings' Model Change	Rationale for Changes
Primary Total Knee and Hip Replacement	Excluded patient with "removal of hardware" procedure codes (78.65, 78.67, 80.05, and 80.06).	Few patients who receive a primary joint replacement also get previous joint implants removed from a contralateral joint in the same hospitalization. This "failed hardware" is coded as a complication of the joint prosthesis or mechanical failure of the device in the secondary diagnoses field, which would appear to be a major post-operative complication of the primary joint replacement. Therefore, we identified the hardware removal procedure codes and excluded these patients from the Primary Total Knee and Hip Replacement analysis.
Primary Total Knee and Hip Replacement	Removed Deep Vein Thrombosis (458.9) as a major complication.	Deep Vein Thrombosis (DVT) is an important complication. Appropriate DVT prophylaxis is the only known effective prevention and is the standard of care in joint replacement patients. Sometimes however, despite adequate prophylaxis, DVTs will still develop. As such, any DVT that does occur post-operatively in primary joint replacement surgery patients is unlikely preventable and should not be used as a quality measure.
Primary Total Knee and Hip Replacement	Excluded patients from primary total knee replacement who also had a primary total hip and vice-versa.	This situation is very rare, but when it does occur, inadequate risk adjustment may occur due to the low volume of this patient population (and not reaching the statistical significance required to remain in the final prediction model), thus necessitating exclusion from the patient population evaluated.
Primary Total Knee and Hip Replacement	Excluded patients who also had a partial hip replacement (81.51, 81.52) in the same hospitalization.	Partial hip replacement overwhelmingly occurs as the principal procedure. However, when it does occur as a secondary procedure associated with Primary Total Knee or Hip Replacement, inadequate risk adjustment may occur due to the low volume of this patient population (and not reaching the statistical significance required to remain in the final prediction model), thus requiring exclusion from the patient population evaluated.

Orthopedic (continued)

Cohorts Affected	2006 Ratings' Model Change	Rationale for Changes
Partial Hip and Hip Fracture	Removed patients with open fractures. (820.10, 820.11, 820.12, 820.13, 820.19, 820.30, 820.31, 820.32, 820.9, 821.11, 821.30, 821.31, 821.32, 821.33, 821.39)	This situation is very rare, but when it does occur, inadequate risk adjustment may occur due to the low volume of this patient population (and not reaching the statistical significance required to remain in the final prediction model), thus necessitating exclusion from the patient population evaluated.

Pulmonary

Cohorts Affected	2006 Ratings' Model Change	Rationale for Changes
Aspiration Pneumonia	No longer rated.	Identified inconsistencies in coding aspiration pneumonia as final principal diagnosis.

Vascular

Cohorts Affected	2006 Ratings' Model Change	Rationale for Changes
Carotid Endarterectomy Abdominal Aortic Aneurysm Repair Peripheral Vascular Bypass	The patients evaluated in these cohort ratings had one of these procedures as their principal procedure.	These procedures overwhelmingly occur as the principal procedure. When it occurs in the secondary position, inadequate risk adjustment may occur due to the low volume of this patient population (and not reaching the statistical significance required to remain in the final prediction model), thus requiring exclusion from the patient population evaluated.
Carotid Endarterectomy	Excluded carotid stents (39.90).	Extremely low volume prohibited achieving the statistical significance required to remain in the final prediction model. This rare group also can represent the sickest, most frail population and be possibly under risk adjusted.
Abdominal Aortic Aneurysm Repair	Excluded aortic dissections (441.00 – 441.03), non-abdominal aneurysms (441.1, 441.2, 441.6, 441.7, 441.9) resection of thoracic vessel with replacement (38.45), and valve repairs (35.10 – 35.14) and replacements (35.20 – 35.28).	These codes are infrequently associated with AAA, but when they do occur, inadequate risk adjustment may occur due to the low volume of this patient population (and not reaching the statistical significance required to remain in the final prediction model), thus necessitating exclusion from the patient population evaluated.
Abdominal Aortic Aneurysm Repair	Respiratory failure (518.81) was not used as a predictor of mortality.	After extensive analysis and benchmarking with data bases that have present on admission indicators (e.g., California's OSHPD), it still remained unclear as to when this is present on admission and when it is a post-operative complication. As such, we developed models using all the other diagnosis codes that are known to be present on admission with these complicated patients.