

STATISTICAL BRIEF #38

October 2007

Trends in Hospital Risk-Adjusted Mortality for Select Diagnoses and Procedures, 1994-2004

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Introduction

The quality of health care has been and continues to be a focal point of both past and current U.S. health care policy, particularly as it relates to the hospital setting, where nearly 30 percent of personal health care spending is directed.¹ One measure of the quality of inpatient care is the number of in-hospital deaths for certain diagnoses and procedures. The mortality rates for many conditions and procedures vary across institutions, and high mortality in some institutions may be associated with discrepancies in the quality of care provided.

The identification of areas for potential improvements in the quality of care in U.S. hospitals is important to policymakers, providers, and consumers because these enhancements could lead to better health outcomes and decreased costs. Changes in national hospital risk-adjusted mortality rates over time, particularly over a decade, may be attributable to a number of factors, such as improvements in quality of care, the successful implementation of new and improved treatments, and better technology. Variations in mortality rates over time can be affected by changes in populations hospitalized, improvements in coding practices, and earlier discharge of patients.

This Statistical Brief presents data from the Healthcare Cost and Utilization Project (HCUP) on changes in the rates of mortality during inpatient care. The Agency for Healthcare Research and Quality (AHRQ)'s Inpatient Quality Indicators (IQIs) are used to develop in-hospital risk-adjusted death rates among adults for select diagnoses and surgical procedures for which variations in mortality between hospitals may be associated with deficiencies in the quality of care.² Mortality rates for these conditions and procedures are evaluated over an 11-year period from 1994 to 2004. All differences between estimates noted in the text are statistically significant at the 0.05 level or better.

¹Centers for Medicare and Medicaid Services. National Healthcare Expenditure Projections: Table 2 National Health Expenditure Amounts and Annual Percent Change by Type of Expenditure: Selected Calendar Years 1998-2014. <http://www.cms.hhs.gov/NationalHealthExpendData/downloads/nheprojections2004-2014.pdf>

²Rates are adjusted by age, gender, age-gender interactions, and All Patient Refined Diagnosis-Related Groups (APR-DRG) risk of mortality score.

Highlights

- Between 1994 and 2004, risk-adjusted inpatient mortality rates for six selected diagnoses and six surgical procedures steadily decreased by 18 to 46 percent.
- Acute myocardial infarction (heart attack) had the largest reduction in hospital deaths per 1,000 admissions among all diagnoses and procedures examined, with 43 fewer in-hospital deaths per 1,000 admissions in 2004 compared with 1994, falling from 125 to 82 deaths per 1,000 admissions.
- The mortality for three other diagnoses—congestive heart failure, pneumonia, and stroke—dropped by roughly 30 deaths per 1,000 admissions between 1994 and 2004.
- Across the six diagnostic conditions examined (acute myocardial infarction, congestive heart failure, gastrointestinal hemorrhage, hip fracture, pneumonia, and stroke), there were an estimated 136,000 fewer inpatient deaths in 2004 than would have been expected if mortality rates had remained at 1994 levels.
- Abdominal aortic aneurysm (AAA) repair had the largest reduction in deaths per 1,000 admissions among the six procedures. Inpatient mortality for AAA repair dropped by 29 deaths per 1,000 admissions (from 103 to 74 deaths per 1,000 admissions) between 1994 and 2004.
- Between 1994 and 2004, mortality rates declined for AAA repair, carotid endarterectomy, coronary artery bypass graft, craniotomy, hip replacement, and percutaneous transluminal coronary angioplasty. An estimated 13,000 fewer inpatient deaths occurred in 2004 for patients receiving these six procedures than would be expected if mortality rates had remained at 1994 levels.

Findings

Between 1994 and 2004, risk-adjusted in-hospital mortality rates for six selected diagnoses and six surgical procedures steadily decreased by 18 to 46 percent (table 1).

Changes in inpatient mortality for select diagnoses

Figure 1 displays changes in risk-adjusted mortality rates for the selected diagnostic conditions. Overall, the in-hospital death rates for these diagnoses steadily declined between 1994 and 2004. Acute myocardial infarction (heart attack) had the largest reduction in deaths per 1,000 admissions of all diagnoses and procedures examined, with 43 fewer deaths per 1,000 admissions in 2004 compared with 1994, falling from 125 to 82 deaths per 1,000 admissions. Mortality for three other diagnoses—congestive heart failure, pneumonia, and stroke—dropped by roughly 30 deaths per 1,000 admissions between 1994 and 2004. During this period, inpatient mortality for congestive heart failure fell from 67 to 38 deaths per 1,000 admissions, pneumonia mortality dropped from 106 to 70 deaths per 1,000 admissions, and stroke mortality was reduced from 138 to 105 deaths per 1,000. The reductions in deaths per 1,000 admissions during the 11-year period were somewhat smaller for gastrointestinal hemorrhage and hip fracture. The mortality rate for gastrointestinal hemorrhage declined from 46 to 25 deaths per 1,000 admissions (a reduction of 21 deaths per 1,000 admissions), while hip fracture mortality dropped from 44 to 28 deaths per 1,000 admissions (a reduction of 16 deaths per 1,000 admissions).

Changes in inpatient mortality for select procedures

Figure 2 shows trends in the mortality rates associated with six select procedures. Abdominal aortic aneurysm (AAA) repair had the largest reduction in deaths per 1,000 admissions among the six procedures. Inpatient mortality for AAA repair dropped by 29 deaths per 1,000 admissions (from 103 to 74 deaths per 1,000 admissions) between 1994 and 2004. Inpatient mortality for coronary artery bypass graft (CABG) procedures decreased by 20 deaths per 1,000 admissions during this time period, dropping from 48 to 28 deaths per 1,000 admissions. The mortality rate for craniotomy (the surgical removal of a section of bone from the skull to operate on the brain) fell by 15 deaths per 1,000 admissions between 1994 and 2004 (from 83 to 68 deaths per 1,000 admissions). The three procedures with the lowest number of deaths per 1,000 admissions in all years (carotid endarterectomy [CEA], hip replacement, and percutaneous transluminal coronary angioplasty [PTCA]) had declines in inpatient mortality of 5 or fewer deaths per 1,000 admissions between 1994 and 2004. Mortality rates for CEA procedures declined from 12 deaths to 7 deaths per 1,000 admissions, while the mortality for hip replacement fell from 4 to 2 deaths per 1,000 admissions, and PTCA mortality dropped from 16 to 12 deaths per 1,000 admissions during the period.

Estimated aggregate reduction in inpatient deaths through improvements in inpatient mortality rates

Table 2 provides estimates of the aggregate reduction in the number of in-hospital deaths among patients admitted in 2004, based on improvements in mortality rates since 1994. The estimate for each of the selected diagnoses and procedures takes into consideration the total number of admissions in 2004 and how many fewer deaths per 1,000 admissions there were in 2004 compared with 1994. Across the six diagnostic conditions examined, there were an estimated 136,000 fewer inpatient deaths in 2004 than would have been expected if mortality rates had remained at 1994 levels. Pneumonia, congestive heart failure, and heart attack accounted for the bulk of the reduction in deaths. Although mortality rates declined for all surgical procedures over the period, the aggregate reduction in inpatient deaths was not as substantial for procedures as it was for the diagnoses. Still, an estimated 13,000 fewer inpatient deaths occurred in 2004 for patients receiving the six procedures than would have been expected if mortality rates had remained at 1994 levels.

Data Source

The estimates in this Statistical Brief are based upon data from the HCUP 2004 Nationwide Inpatient Sample (NIS). Historical data were drawn from the 1994, 1997, 2000, 2001, 2002, and 2003 NIS.

Definitions

Types of hospitals included in HCUP

HCUP is based on data from community hospitals, defined as short-term, non-Federal, general and other hospitals, excluding hospital units of other institutions (e.g., prisons). HCUP data include OB-GYN, ENT, orthopedic, cancer, pediatric, public, and academic medical hospitals. They exclude long-term care,

rehabilitation, psychiatric, and alcoholism and chemical dependency hospitals, but these types of discharges are included if they are from community hospitals.

Unit of analysis

The unit of analysis is the hospital discharge (i.e., the hospital stay), not a person or patient. This means that a person who is admitted to the hospital multiple times in one year will be counted each time as a separate "discharge" from the hospital.

Inpatient Quality Indicators and Risk-Adjustment

The AHRQ Inpatient Quality Indicators (IQI) (Version 3.0) were used for this analysis to identify the admissions of interest and for risk-adjustment. The IQIs, a component of the AHRQ QIs, are a set of measures that can be used with hospital inpatient discharge and administrative data to provide a perspective on quality. Mortality indicators for inpatient care include conditions and procedures for which mortality has been shown to vary across institutions and for which there is evidence that high mortality may be associated with poorer quality of care.

The IQI approach identified the admissions for the six diagnoses (based on ICD-9-CM principal diagnosis codes) and six procedures (based on all-listed ICD-9-CM procedures except craniotomy, which was based on the Diagnosis-Related Group [DRG]). The admissions included those age 18 years of age or older (40 years for CABG and PTCA) and excluded those that were transferred to another hospital and, with the exception of acute myocardial infarction (AMI), those that were obstetrical. There are notable exclusions to two procedure IQIs: craniotomy excludes trauma cases, and hip replacement excludes patients admitted for hip fracture. It should also be noted that some admissions may be included in more than one IQI measure. For example, patients admitted for AMI may be included in the AMI IQI and in the CABG or PTCA IQIs if they received those procedures during their admission.

As part of the IQI risk-adjustment approach, All Patient Refined Diagnosis-Related Groups (APR-DRG) software was applied to the data. The APR-DRG classification expands the DRG classification (used for Medicare reimbursement) to be applicable to non-Medicare populations and for uses beyond those related to resource consumption (i.e., for risk of mortality and severity of illness). Each admission is assigned an APR-DRG and a Risk of Mortality subclass (minor, moderate, major, or extreme) within the APR-DRG. The IQI risk adjustment variables were age, gender, age-gender interaction, and APR-DRG Risk of Mortality subclass. Regression-based standardization (designed by the developers of the IQI software) was used for risk adjustment.

The calculations take into account the clustering of patients within hospitals and the hospital stratification aspects of the sampling design (Houchens and Elixhauser, 2005). The in-hospital mortality rates were weighted for national estimates. Pairwise t-tests were used to test for statistical significance of differences in hospital mortality. (Additional detail on the risk adjustment methodology and statistical approach is available in Coffey et al., 2006).

Further information on the AHRQ QIs, including documentation and free software downloads, is available at <http://www.qualityindicators.ahrq.gov/index.htm>.

Diagnoses, Procedures, ICD-9-CM, and DRGs

ICD-9-CM is the International Classification of Diseases, Ninth Revision, Clinical Modification, which assigns numeric codes to diagnoses and procedures. There are about 12,000 ICD-9-CM diagnosis codes and 3,500 procedure codes.

DRGs comprise a patient classification system that categorizes patients into groups that are clinically coherent and homogeneous with respect to resource use. DRGs group patients according to diagnosis, type of treatment (procedures), age, and other relevant criteria. Each hospital stay has one DRG assigned to it.

About the NIS

The HCUP Nationwide Inpatient Sample (NIS) is a nationwide database of hospital inpatient stays. The NIS is nationally representative of all community hospitals (i.e., short-term, non-Federal, non-rehabilitation hospitals). The NIS is a sample of hospitals and includes all patients from each hospital, regardless of payer. It is drawn from a sampling frame that contains hospitals comprising about 90 percent of all discharges in the United States. The vast size of the NIS allows the study of topics at both the national

and regional levels for specific subgroups of patients. In addition, NIS data are standardized across years to facilitate ease of use.

About HCUP

HCUP is a family of powerful health care databases, software tools, and products for advancing research. Sponsored by the Agency for Healthcare Research and Quality (AHRQ), HCUP includes the largest all-payer encounter-level collection of longitudinal health care data (inpatient, ambulatory surgery, and emergency department) in the United States, beginning in 1988. HCUP is a Federal-State-Industry Partnership that brings together the data collection efforts of many organizations—such as State data organizations, hospital associations, private data organizations, and the Federal government—to create a national information resource.

For more information about HCUP, visit <http://www.hcup-us.ahrq.gov/>.

HCUP would not be possible without the contributions of the following data collection Partners from across the United States:

Arizona Department of Health Services
Arkansas Department of Health & Human Services
California Office of Statewide Health Planning & Development
Colorado Health & Hospital Association
Connecticut Integrated Health Information (Chime, Inc.)
Florida Agency for Health Care Administration
Georgia GHA: An Association of Hospitals & Health Systems
Hawaii Health Information Corporation
Illinois Health Care Cost Containment Council and Department of Public Health
Indiana Hospital & Health Association
Iowa Hospital Association
Kansas Hospital Association
Kentucky Cabinet for Health and Family Services
Maryland Health Services Cost Review Commission
Massachusetts Division of Health Care Finance and Policy
Michigan Health & Hospital Association
Minnesota Hospital Association
Missouri Hospital Industry Data Institute
Nebraska Hospital Association
Nevada Division of Health Care Financing and Policy, Department of Human Resources
New Hampshire Department of Health & Human Services
New Jersey Department of Health & Senior Services
New York State Department of Health
North Carolina Department of Health and Human Services
Ohio Hospital Association
Oklahoma Health Care Information Center for Health Statistics
Oregon Association of Hospitals and Health Systems
Rhode Island Department of Health
South Carolina State Budget & Control Board
South Dakota Association of Healthcare Organizations
Tennessee Hospital Association
Texas Department of State Health Services
Utah Department of Health
Vermont Association of Hospitals and Health Systems
Virginia Health Information
Washington State Department of Health
West Virginia Health Care Authority
Wisconsin Department of Health & Family Services

For additional HCUP statistics, visit HCUPnet, our interactive query system at www.hcup.ahrq.gov.

For More Information

For a detailed description of HCUP and more information on the design of the NIS and methods to calculate estimates, please refer to the following publications:

Steiner, C., Elixhauser, A., Schnaier, J. The Healthcare Cost and Utilization Project: An Overview. *Effective Clinical Practice* 5(3):143–51, 2002.

Design of the HCUP Nationwide Inpatient Sample, 2004. Online. August 8, 2006. U.S. Agency for Healthcare Research and Quality. http://www.hcup-us.ahrq.gov/db/nation/nis/reports/NIS_2004_Design_Report.pdf

Houchens, R., Elixhauser, A. *Final Report on Calculating Nationwide Inpatient Sample (NIS) Variances, 2001*. HCUP Methods Series Report #2003-2. Online. June 2005 (revised June 6, 2005). U.S. Agency for Healthcare Research and Quality. <http://www.hcup-us.ahrq.gov/reports/CalculatingNISVariances200106092005.pdf>

Houchens R. L., Elixhauser, A. *Using the HCUP Nationwide Inpatient Sample to Estimate Trends*. (Updated for 1988-2004). HCUP Methods Series Report #2006-05 Online. August 18, 2006. U.S. Agency for Healthcare Research and Quality. http://www.hcup-us.ahrq.gov/reports/2006_05_NISTrendsReport_1988-2004.pdf

For more information on the AHRQ Quality Indicators, inpatient quality, and how estimates were developed for this Statistical Brief, see the following publications:

AHRQ Quality Indicators—Guide to Inpatient Quality Indicators: Quality of Care in Hospitals—Volume, Mortality, and Utilization. Online. March 12, 2007. U.S. Agency for Healthcare Research and Quality http://www.qualityindicators.ahrq.gov/downloads/iqi/iqi_guide_v31.pdf

Coffey, R., Barrett, M., Houchens, R., Moy, E., Andrews, R. *Methods Applying AHRQ Quality Indicators to Healthcare Cost and Utilization Project (HCUP) Data for the Fourth National Healthcare Quality Report, 2006*. HCUP Methods Series Report # 2006-07. Online. October 30, 2006. U.S. Agency for Healthcare Research and Quality. http://www.hcup-us.ahrq.gov/reports/2006_7.pdf

Suggested Citation

Andrews, R. (AHRQ), Russo, C. A. (Thomson Healthcare), and Pancholi, M. (AHRQ). *Trends in Hospital Risk-Adjusted Mortality for Select Diagnoses and Procedures, 1994-2004*. HCUP Statistical Brief #38. October 2007. Agency for Healthcare Research and Quality, Rockville, MD. <http://www.hcup-us.ahrq.gov/reports/statbriefs/sb38.pdf>

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AHRQ welcomes questions and comments from readers of this publication who are interested in obtaining more information about access, cost, use, financing, and quality of health care in the United States. We also invite you to tell us how you are using this Statistical Brief and other HCUP data and tools, and to share suggestions on how HCUP products might be enhanced to further meet your needs. Please e-mail us at hcp@ahrq.gov or send a letter to the address below:

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Table 1. Inpatient risk-adjusted mortality rates for select diagnoses and procedures, 1994-2004

Inpatient hospital care	Deaths per 1,000 admissions						
	1994	1997	2000	2001	2002	2003	2004
<i>Diagnoses</i>							
Acute myocardial infarction (heart attack)	125	112*	104*	100*	100	86*	82*
Congestive heart failure	67	57*	53*	49*	47*	42*	38*
Gastrointestinal hemorrhage	46	39*	36*	34*	34*	29*	25*
Hip fracture	44	35*	36*	35*	35	31*	28*
Pneumonia	106	91*	91	89*	88*	76*	70*
Stroke	138	121*	121	120*	119	110*	105*
<i>Procedures</i>							
Abdominal aortic aneurysm (AAA) repair	103	101	95*	87*	94*	80*	74*
Carotid endarterectomy (CEA)	12	9*	8*	7*	8*	7*	7
Coronary artery bypass graft (CABG)	48	45*	40*	37*	35*	32*	28*
Craniotomy	83	79*	76*	76	78	71*	68*
Hip replacement	4	4*	3*	3	3*	2*	2
Percutaneous transluminal coronary angioplasty (PTCA)	16	16*	15*	15*	14	12*	12*

*The rate relative to the rate in the previous column is statistically different at $p < 0.05$.

Source: AHRQ, Center for Delivery, Organization, and Markets. Healthcare Cost and Utilization Project, Nationwide Inpatient Sample, 1994-2004.

Table 2. Estimated aggregate number of in-hospital deaths reduced in 2004 through improvements in hospital mortality rates since 1994 for selected diagnoses and surgical procedures

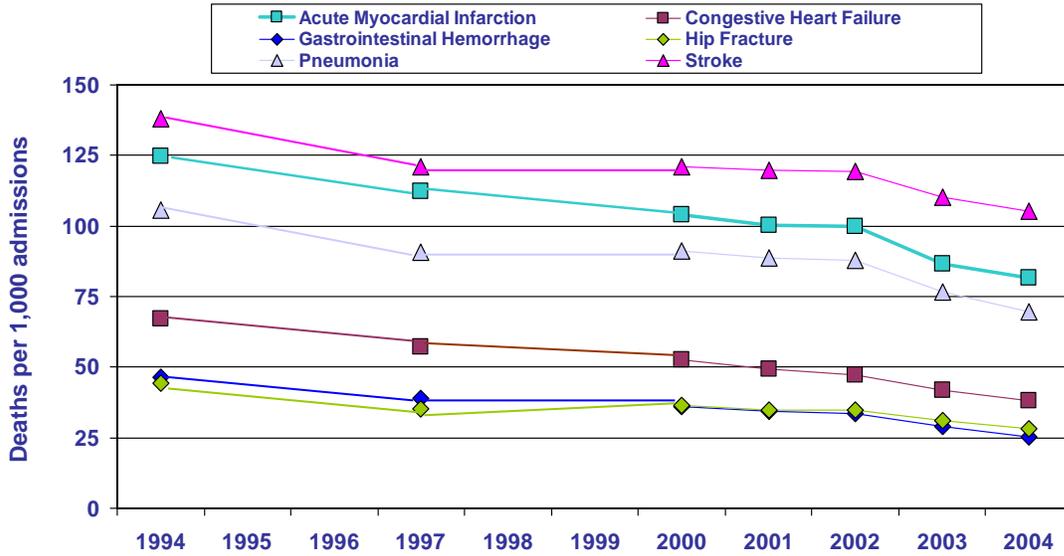
Inpatient hospital care	Number of admissions (2004)*	Estimated in-hospital deaths reduced (2004)
<i>Diagnoses</i>		
Acute myocardial infarction (heart attack)	582,700	25,200
Congestive heart failure	1,143,300	33,300
Gastrointestinal hemorrhage	531,000	11,200
Hip fracture	294,900	4,800
Pneumonia	1,234,400	44,400
Stroke	513,500	16,700
<i>Procedures</i>		
Abdominal aortic aneurysm (AAA) repair	39,200	1,200
Carotid endarterectomy (CEA)	127,600	700
Coronary artery bypass graft (CABG)	303,000	5,900
Craniotomy	111,700	1,600
Hip replacement	217,300	400
Percutaneous transluminal coronary angioplasty (PTCA)	772,100	3,100

*Admissions include those meeting the AHRQ IQI criteria for inclusion in the mortality measure.

Source: AHRQ, Center for Delivery, Organization, and Markets. Healthcare Cost and Utilization Project, Nationwide Inpatient Sample, 1994-2004.



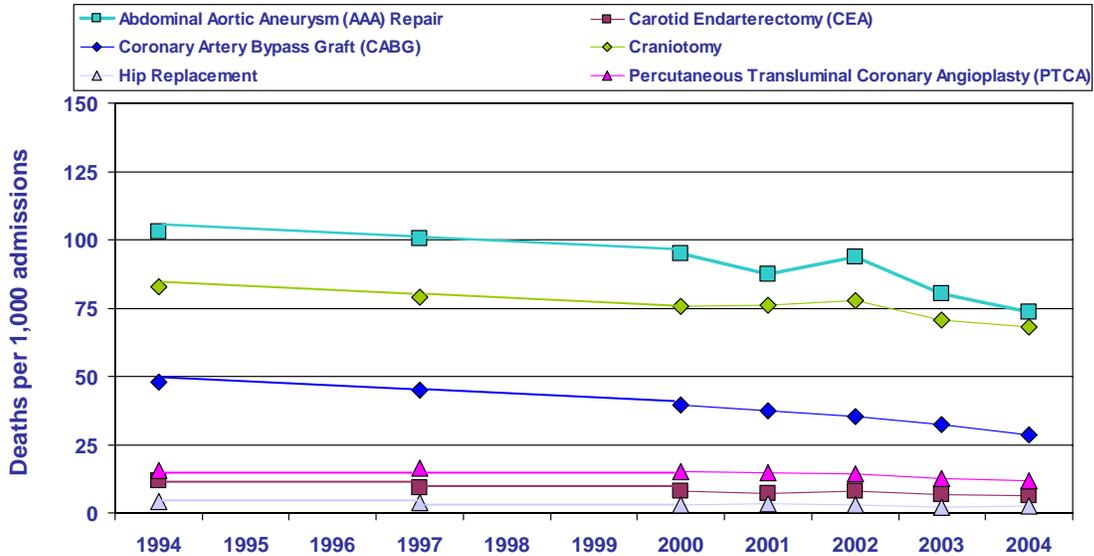
Figure 1. Inpatient risk-adjusted mortality rates for select diagnoses, 1994-2004



Source: AHRQ, Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project, Nationwide Inpatient Sample, 1994-2004.



Figure 2. Inpatient risk-adjusted mortality rates for select procedures, 1994-2004



Source: AHRQ, Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project, Nationwide Inpatient Sample, 1994-2004.