

Outcomes Trends for Acute Myocardial Infarction, Congestive Heart Failure, and Pneumonia, 2005-2009

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Cardiovascular disease (CVD) remains the number one disease affecting Americans and consumes the most healthcare dollars.^{1,2} The American Heart Association's statistical update on heart disease and stroke reports that CVD outpaces all cancers in healthcare resource consumption and mortality.² CVD consumed \$316.4 billion in 2010 and causes 1 in 3 deaths per year. The major contributors to these figures are acute myocardial infarction (AMI) and congestive heart failure (CHF); 1 in 9 death certificates indicates heart failure as a cause of death.^{1,3}

Overall, pneumonia ranks as the fifth-most frequent cause of admission, but the second-most frequent cause for those aged less than 17 years and more than 85 years.³ There were 1.1 million discharges with the primary diagnosis of pneumonia in 2010.³ Pneumonia also accounts for 16.1 deaths per 100,000 people, consumes \$10.5 billion annually, and contributes 2.9% to annual costs for all hospitalizations.^{4,5}

Given the impact of these 3 core diseases—AMI, CHF, and pneumonia—on our public health, and the financial costs to our healthcare system, major efforts have been focused on improving their outcomes. In 2002, hospitals accredited by the Joint Commission started collecting data on standardized care process measures to improve care. In 2004, the Joint Commission and CMS synergized their efforts and developed the National Hospital Quality Measures, standard measure sets common to both organizations. Currently, there are 12 broad classifications covering major areas of potential improvement including AMI, CHF, and pneumonia.^{6,7}

In 2012, CMS continued efforts to improve quality care and to control costs by introducing the hospital value-based purchasing (VBP) program, funded through a 1% reduction in diagnosis-related group (DRG) payments for discharges. Of this 1% portion, 70% can be “earned back” based on adherence to the approved clinical processes of care for selected patient outcomes. The core measures of AMI, CHF, and pneumonia were selected for the fiscal year 2013 hospital

ABSTRACT

Objectives: The CMS core conditions—acute myocardial infarction (AMI), congestive heart failure (CHF), and pneumonia—are a focus of hospital quality reporting and its value-based purchasing program. The study's purpose was to assess national trends of in-hospital mortality and resource utilization for these core measures.

Study Design: A time series study using outcomes from the 5 yearly cycles of the Nationwide Inpatient Sample (2005-2009).

Methods: Stratum-specific χ^2 test for independence (binary or categorical parameters) or *t* test for a contrasted mean (continuous parameters) were used to identify parameters that changed significantly over time (in-hospital mortality, length of stay, cost, charges, severity of illness, diagnoses per case, procedures per case). Multiple logistic and linear regression models were used to identify factors associated with in-hospital deaths, hospital charges, and length of stay (LOS).

Results: In-hospital mortality decreased for AMI, CHF, and pneumonia. LOS was unchanged for CHF, but decreased for AMI and pneumonia. Average inflation-adjusted charges per case increased for all 3 conditions, while the average inflation-adjusted cost per case decreased for CHF and remained stable for AMI and pneumonia. The proportion of patients with extreme disability and extreme likelihood of dying, as defined by All-Patient-Refined Diagnosis Related Group, increased for all 3 diagnoses. The number of diagnoses and procedures were independently associated with LOS, cost, and charges for all 3 conditions.

Conclusions: Many measures of quality of inpatient care and resource utilization for CMS core conditions improved despite increases in patient complexity and risk of mortality. Further research is necessary to determine the exact causes of these improvements.

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Take-Away Points

It will be essential to review outcomes from the implementation of national programs to control healthcare costs. Our study provides the benchmark foundation from which to evaluate 3 core measures that have increased healthcare expenditures.

- Acute myocardial infarction, congestive heart failure, and pneumonia, the 3 core measures discussed in this study, have seen an increase in patient complexity.
- While charges have increased in the care of these patients, costs have remained stable.
- Inpatient mortality and hospitalizations have decreased over time, suggesting that ambulatory care settings may be absorbing more of the care of these complex patients.

VBP program.⁸ Hospitals responded with several initiatives (ie, broader use of new care delivery systems, such as telemedicine and hospital-based disease management programs) to reduce costs, hospital readmissions, length of stay (LOS), and inpatient mortality.⁹⁻¹³

The goal of this paper, then, was to establish a base of comparison for VBP by examining—prior to its implementation—national trends for inpatient mortality, LOS, cost, and charges related to these 3 core measures in a population of all-payers and all patients 18 years or older.

METHODS

Patient Population and Data Source

For this study, we used the National Inpatient Sample (NIS) database, an all-payer database of hospital discharges maintained as part of the Healthcare Cost and Utilization Project by the Agency for Healthcare Research and Quality. The NIS approximates a 20% stratified sample of community hospitals in the United States. The sampling frame in each of the study's surveys was a sample of hospitals that represented 90% to 95% of all hospital discharges for the particular year. Specifically, between 2005 and 2009, each NIS cycle included information on approximately 8 million discharges from approximately 1000 hospitals located in 37 (in 2005) to 44 (in 2009) states. Each NIS record represents a single hospital discharge and includes a unique identifier; basic demographics for the patient; admission and disposition type; up to 15 primary and secondary diagnoses; a list of potential comorbidities; up to 15 primary and secondary procedures; expected primary insurance payer; total hospital charges excluding physician and other professional services; LOS; type of hospital (teaching/nonteaching), bed size, and location; and mean cost-to-charge ratio.¹⁴

Furthermore, the severity of illness scores defined by the All Patient Refined Diagnosis-Related Groups (APR-DRGs)¹³ were evaluated and reported together with the respective risk of mortality scores. The APR-DRGs ex-

pand the basic DRG structure by adding 4 severity-of-illness and 4 risks-of-mortality subclasses to each DRG: for severity of illness, minor, moderate, major, or extreme loss of function; for mortality risk, minor, moderate, major, or extreme likelihood of dying. The APR-DRG severity scores of 3 and 4 (major/extreme loss of function), likelihood-of-dying scores of 3 and 4 (major/extreme likelihood of dying), and the number of diagnoses were used as markers

for the severity and complexity of cases, respectively. The outcomes included in this study were in-hospital mortality and resource utilization, which included the length of inpatient stay, as well as the total costs and charges per discharge. These outcomes were assessed in each calendar year and in patient subgroups as described below.

Eligibility Criteria

We included all adult (18 years or older) discharges from the NIS between 2005 and 2009 with the principal diagnoses of AMI, CHF, or pneumonia. The diagnoses and procedures were identified using the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)*. **Table 1** summarizes the multiple ICD-9-CM codes for each principal diagnosis used for the study.

Statistical Analysis

We obtained national estimates for the total number of hospitalizations for each of the 3 diagnoses and total resource utilization parameters by calendar year, by totaling individual discharge sampling weights (which are the inverse of probability selection for the sample from the entire population). Since not all participating hospitals had reported their average cost-to-charge ratios, the national estimates of total costs were reweighted to account for all discharges where cost estimates were missing.¹⁴ All charges and costs were adjusted to the year 2009 using medical consumer price indices for the study years.

All available clinical and socioeconomic parameters were compared for change between years using a stratum-specific χ^2 test for independence (for binary or categorical parameters) or a *t* test for a contrasted mean (for continuous parameters). Additionally, resource utilization was studied separately for 2 age groups: 18 to 64 years and 65 years or older. Taylor series linearization was used to account for the stratum units used in NIS to sample hospitals based on geographic region, control, location, teaching status, and bed size.

Multiple logistic models were used to identify factors associated with in-hospital deaths while accounting for

■ **Table 1.** ICD-9-CM Codes Used in the Study

Diagnosis	ICD-9-CM Codes
Pneumonia	Diagnosis 480.0, 480.1, 480.2, 480.3, 480.8, 480.9, 481, 482.0, 482.1, 482.2, 482.30, 482.31, 482.32, 482.39, 482.40, 482.41, 482.49, 482.81, 482.82, 482.83, 482.84, 482.89, 482.9, 483.0, 483.1, 483.8, 485, 486, 487.0
	Procedures Tracheostomy, temporary and permanent: 31.1, 31.21, 31.29 Diagnostic bronchoscopy and biopsy of bronchus: 33.22, 33.23, 33.24 Incision of pleura; thoracentesis; chest drainage: 34.04, 34.06, 34.09, 34.91 Other operating room procedures on respiratory system and mediastinum: 34.51, 34.52 Computed tomography scan, chest: 87.41 Routine chest x-ray: 87.44 Respiratory intubation and mechanical ventilation: 93.90, 96.01, 96.02, 96.03, 96.04, 96.05, 96.70, 96.71, 96.72
Acute myocardial infarction	Diagnosis 410.00, 410.01, 410.10, 410.11, 410.20, 410.21, 410.30, 410.31, 410.40, 410.41, 410.50, 410.51, 410.60, 410.61, 410.70, 410.71, 410.80, 410.81, 410.90, 410.91
	Procedures Coronary artery bypass graft: 36.10, 36.11, 36.12, 36.13, 36.14, 36.15, 36.16, 36.17, 36.19 Diagnostic cardiac catheterization; coronary arteriography: 37.22, 37.23 Systemic thrombolytics: 99.10 Stent placement: 36.06, 36.07
Congestive heart failure	Diagnosis 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428, 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 Implantation of cardiac devices: 37.94, 00.50, 00.51 Implantation of ventricular assist device: 37.62, 37.65, 37.66, 37.68 Heart transplant: 37.51 Diagnostic ultrasound of heart (echocardiogram): 88.72 Diagnostic cardiac catheterization; coronary arteriography: 37.21, 37.23

ICD-9-CM indicates *International Classification of Diseases, Ninth Revision, Clinical Modification*.

potential confounders. Similarly, factors that impacted hospital charges and LOS were assessed using multiple linear regressions after logarithmic transformation of the respective outcomes. Coefficients from these models were exponentiated to yield a percentage change in the outcomes associated with each predictor. All *P* values of .05 or less were considered to be statistically significant.

All analyses were run with SAS version 9.1 (SAS Institute, Cary, North Carolina) and SUDAAN version 10.0 (RTI International, Research Triangle Park, North Carolina). The study was reviewed and approved as meeting the exempt criteria by the Inova Health System Institutional Review Board.

RESULTS

Overall, 33.3 million hospitalizations were included in the 5 years of NIS, ranging from 6.54 to 6.84 million yearly, representing 164.14 million hospitalizations nationwide. Of those 33.3 million, the overall numbers of pneumonia, AMI, and CHF cases decreased. The decrease for pneumonia was from 1.17 million in 2005 (3.64% of all hospitalizations) to 1.01 million in 2009 (3.04%); for AMI, 662,000 in 2005 (2.07%)

to 633,000 in 2009 (1.91%); and for CHF, 1.09 million in 2005 (3.39%) to 1.02 million (3.09%) in 2009 (Table 2).

Pneumonia

Over time, approximately 53% of patients were female; 77% were white. Reported ethnicities for the remainder, were, on average, 10.5% black, 7.5% Hispanic, 2% Asian, and less than 1% Native American. Sixty percent of the patients were 65 years or older; of these, the majority were Medicare patients, although the proportion of Medicare patients in the entire pneumonia cohort decreased from 70.22% in 2005 to 63.68% in 2009 ($P < .0001$) (Table 3).

The in-hospital mortality for pneumonia decreased from 4.56% in 2005 to 3.98% in 2009 ($P < .0001$). The LOS decreased from 5.80 days in 2005 to 5.55 days in 2009 ($P = .0002$) (Table 4). The average charges per case increased from \$25,543 in 2005 to \$30,256 in 2009 ($P < .001$), while the average cost per case did not change (Table 4 and Table 5 by the age groups).

Over the 5 years, the proportion of cases with a major loss of function increased from 36.08% to 39.74%; those with an extreme loss of function increased from 7.08% to 12.02%. Also, the proportion of patients with a major and extreme likelihood of dying increased: respectively, from

Table 2. Yearly Nationwide Trends in Number of Hospitalizations and In-Hospital Mortality (mean [SE])

	2005	2006	2007	2008	2009	P
Pneumonia						
Hospitalizations, n	1,169,036 (45,537)	1,055,288 (41,598)	1,015,887 (38,120)	1,007,191 (38,432)	1,007,153 (39,191)	
Proportion of all hospitalizations, %	3.65 (0.06)	3.22 (0.06)	3.11 (0.06)	3.01 (0.06)	3.04 (0.05)	<.0001
In-hospital mortality, %	4.56 (0.08)	4.18 (0.07)	3.98 (0.08)	4.15 (0.08)	3.98 (0.07)	<.0001
Acute myocardial infarction						
Hospitalizations, n	658,097 (36,538)	670,719 (36,617)	620,826 (33,114)	640,455 (33,743)	629,337 (34,596)	
Proportion of all hospitalizations, %	2.05 (0.06)	2.05 (0.06)	1.90 (0.05)	1.91 (0.05)	1.90 (0.05)	.046
In-hospital mortality, %	6.81 (0.14)	6.22 (0.11)	6.12 (0.11)	6.01 (0.11)	5.56 (0.08)	<.0001
Congestive heart failure						
Hospitalizations, n	1,131,729 (48,862)	1,135,764 (49,788)	1,068,497 (46,429)	1,065,190 (46,621)	1,086,579 (48,039)	
Proportion of all hospitalizations, %	3.53 (0.05)	3.46 (0.06)	3.27 (0.06)	3.18 (0.05)	3.28 (0.05)	<.0001
In-hospital mortality, %	3.78 (0.07)	3.49 (0.07)	3.22 (0.07)	3.29 (0.07)	3.21 (0.06)	<.0001

SE indicates standard error.

16.40% in 2005 to 24.93% in 2009, and from 4.38% in 2005 to 8.62% in 2009 ($P < .0001$). The number of procedures per case increased as well, from 0.68 in 2005 to 0.75 in 2009 ($P = .0019$) (Table 4, eAppendix Table 1 for the individual procedures [eAppendices available at www.ajmc.com]).

After multivariate analysis, major or extreme disability and the number of procedures were independent predictors of in-hospital mortality. Major or extreme disability, likelihood of death, number of diagnoses, and number of procedures were independently associated with LOS, charges, and cost (eAppendix Table 2)

Acute Myocardial Infarction

The majority of patients admitted with acute myocardial infarction (AMI) were male; in 2005 and 2009, 40.72% and 39.51% were female, respectively (Table 3). The majority, 77.94%, were white. Blacks, Hispanics, Asians, and Native Americans represented an average of 8.77%, 7.16%, 2.07%, and 0.62% of patients, respectively. Fifty-eight percent of patients were aged 65 years or more, which closely paralleled the 57% of the sample who were insured by Medicare, the largest payer group. The figure, however, decreased over time, from 59.17% in 2005 to 55.94% in 2009 ($P < .0001$).

In-hospital mortality also decreased, from 6.81% in 2005 to 5.56% in 2009 ($P < .0001$). Average LOS decreased, too, from 5.23 days in 2005 with to 4.95 days in 2009 ($P = .001$) (Table 4). The average charges per case increased from \$54,546 in 2005 to \$62,917 in 2009 ($P = .0004$), while the average cost per case did not change.

The proportion of patients with major or extreme loss of function increased over the 5-year period, from 24.39% in 2005 to 27.93% in 2009, and from 13.52% in 2005 to 16.99% in 2009, respectively ($P < .0001$). The proportion of patients with a major or extreme likelihood of dying increased also, from 27.18% in 2005 to 27.68% in 2009, and 11.93% in 2005 to 15.95% in 2009, respectively ($P < .0001$). The total number of diagnoses per case also increased from 8.19 in 2005 to 10.51 in 2009 ($P < .0001$). The number of procedures per case increased from 3.93 in 2005 to 4.89 in 2009 ($P < .0001$) (Table 4, Table 5 by the age groups; eAppendix Table 1 for the individual procedures).

After multivariate analysis, major or extreme disability were the only independent predictors of in-hospital mortality. The number of diagnoses per case and number of procedures per case were inversely proportional to in-hospital mortality. Major or extreme disability, risk of mortality, number of diagnoses, and number of procedures were independently associated with LOS, charges, and cost (eAppendix Table 2).

Congestive Heart Failure

Female patients represented 51% of all cases of congestive heart failure (CHF) (Table 3). The majority (70.18%) of patients were white, while blacks, Hispanics, Asians, and Native Americans represented 18.71%, 8.01%, 1.68%, and 0.57% of patients, respectively. The overwhelming majority of patients (73%, a figure that remained stable throughout the 5-year period) were 65 years or older. Medicare was the larg-

est payer group, but with a decreasing trend (dropping from 76.63% in 2005 to 74.09% in 2009; $P = .0005$).

In-hospital mortality decreased from 3.78% in 2005 to 3.21% in 2009 ($P < .0001$). The overall LOS remained stable, 5.37 days on average over the 5-year time period. Average charges increased from \$31,028 in 2005 to \$35,551 in 2009 ($P = .0045$) in inflation-adjusted dollars. In contrast, the average cost per case decreased (\$11,006 in 2005 to \$10,377 in 2009; $P = .06$).

The proportion of patients with major or extreme loss of function increased from 34.07% in 2005 to 44.89% in 2009, and from 5.85% in 2005 to 9.68% in 2009, respectively. A similar increase was found for the proportion of admissions with major or extreme risk of dying: from 23.86% in 2005 to 33.28% in 2009, and from 6.90% in 2005 to 11.52% in 2009, respectively. The complexity of illness, reflected by the total number of diagnoses per case, increased from 8.98 diagnoses per case in 2005 to 12.22 diagnoses per case in 2009 ($P < .0001$). However, the number of procedures per case did not change (Table 4, Table 5 by the age groups, eAppendix Table 1 for the individual procedures).

After adjustment for major socioeconomic confounders, the independent predictors of in-hospital mortality were found to be major or extreme disability, mortality risk, and the number of procedures per case. The number of diagnoses per case was inversely proportional to in-hospital mortality. Major or extreme disability, mortality risk, number of diagnoses, and number of procedures were independently associated with LOS, charges, and cost (eAppendix Table 2). For illustrative purposes, using eAppendix Table 2, for individuals admitted to the hospitals included in the NIS database with the primary diagnosis of CHF, each additional diagnosis on the record was associated with a 2.43% longer length of stay, 1.61% higher charges, 1.41% higher cost of treatment, and 0.975 lower odds of in-hospital death.

Table 3. Demographics and Clinical Presentation of Patients Admitted to US Hospitals for AMI, CHF, and Pneumonia, 2005-2009 (mean [SE])

Parameter	AMI	Pneumonia	HF
Discharge records in NIS, n	652,641	1,059,849	1,110,034
Age, years	67.67 (0.10) ^b	68.85 (0.11) ^b	72.63 (0.13)
Aged <45 years, %	5.74 (0.06)	10.51 (0.13) ^a	4.27 (0.09)
Aged ≥65 years, %	57.77 (0.28) ^b	64.70 (0.28) ^b	72.92 (0.35)
Female, %	40.15 (0.17) ^b	53.29 (0.09)	51.10 (0.14) ^b
Race			
White, %	77.94 (0.75)	76.96 (0.62) ^b	68.68 (0.85) ^b
Black, %	8.77 (0.40) ^a	10.42 (0.39) ^a	18.71 (0.72) ^a
Hispanic, %	7.16 (0.45)	7.44 (0.38)	8.01 (0.46)
Asian, %	2.07 (0.14)	1.95 (0.13)	1.68 (0.12)
Native American, %	0.62 (0.11)	0.71 (0.09)	0.57 (0.08)
Income			
1st (lowest) quartile, %	27.76 (0.75)	31.88 (0.66)	33.20 (0.72)
2nd quartile, %	27.43 (0.59)	27.92 (0.52)	26.68 (0.52)
3rd quartile, %	23.92 (0.50)	22.26 (0.44)	22.03 (0.46)
4th (highest) quartile, %	20.88 (0.93)	17.94 (0.61)	18.08 (0.67)
Payer			
Medicare, %	56.98 (0.30) ^b	67.44 (0.29) ^b	74.86 (0.33) ^b
Medicaid, %	5.30 (0.14) ^a	8.12 (0.16) ^a	7.46 (0.20)
Private including HMO, %	28.80 (0.34)	18.09 (0.21) ^a	12.47 (0.20) ^a
Self-pay, %	5.58 (0.16) ^a	3.88 (0.11) ^a	3.17 (0.14)
No charge, %	0.56 (0.09)	0.42 (0.08)	0.34 (0.06)
Severity of illness			
Minor, %	22.18 (0.19)	8.87 (0.10)	8.62 (0.11)
Moderate, %	36.98 (0.16)	45.19 (0.17)	45.18 (0.22)
Major, %	25.97 (0.16)	37.38 (0.17)	39.25 (0.24)
Extreme, %	14.88 (0.15) ^a	8.56 (0.10) ^a	6.95 (0.09) ^a
Likelihood of dying			
Minor, %	28.31 (0.20)	27.78 (0.21)	13.44 (0.20)
Moderate, %	30.73 (0.16)	46.90 (0.17)	49.79 (0.16)
Major, %	27.47 (0.23)	19.53 (0.13)	28.46 (0.16)
Extreme, %	13.48 (0.13) ^a	5.79 (0.07) ^a	8.30 (0.10) ^a

AMI indicates acute myocardial infarction; CHF, congestive heart failure; HMO, health maintenance organization; NIS, National Inpatient Sample; SE, standard error.
^aIncreased between 2005-2009 ($P < .05$).
^bDecreased between 2005-2009 ($P < .05$).

DISCUSSION

Our large analysis demonstrates that in the United States between 2005 and 2009, many measures of inpatient quality of care and resource utilization for pneumonia, AMI, and CHF improved—despite a universal increase in the proportion of patients with major or extreme severity of illness and likelihood of dying. In addition, charges in-

Table 4. Yearly Trends in Resource Utilization (mean [SE])

	2005	2006	2007	2008	2009	P
Pneumonia						
Diagnoses, n	8.04 (0.06)	8.53 (0.08)	9.17 (0.08)	9.83 (0.09)	10.36 (0.09)	<.0001
Procedures, n	0.68 (0.02)	0.67 (0.02)	0.77 (0.03)	0.74 (0.02)	0.75 (0.02)	.019
Length of stay, days	5.80 (0.05)	5.62 (0.04)	5.64 (0.05)	5.62 (0.05)	5.55 (0.05)	.0002
Average charge ^a	25,543 (649)	25,816 (587)	28,094 (765)	29,414 (764)	30,256 (775)	<.0001
Average cost ^a	9331 (178)	9319 (135)	9707 (207)	9818 (180)	9570 (113)	.24
Acute myocardial infarction						
Diagnoses, n	8.19 (0.08)	8.62 (0.10)	9.32 (0.10)	10.09 (0.11)	10.51 (0.12)	<.0001
Procedures, n	3.93 (0.08)	4.50 (0.10)	4.56 (0.10)	4.74 (0.10)	4.89 (0.09)	<.0001
Length of stay, days	5.23 (0.07)	5.13 (0.07)	5.04 (0.06)	4.98 (0.06)	4.95 (0.06)	.0012
Average charge ^a	54,546 (1602)	57,151 (1640)	57,833 (1723)	61,135 (1906)	62,917 (1846)	.0004
Average cost ^a	19,049 (501)	19,240 (379)	18,673 (346)	18,868 (315)	18,360 (311)	.24
Congestive heart failure						
Diagnoses, n	8.98 (0.08)	9.51 (0.10)	10.39 (0.11)	11.48 (0.13)	12.22 (0.13)	<.0001
Procedures, n	1.03 (0.02)	1.02 (0.03)	1.07 (0.03)	1.06 (0.03)	1.06 (0.03)	.46
Length of stay, days	5.37 (0.05)	5.29 (0.05)	5.26 (0.05)	5.29 (0.05)	5.27 (0.06)	.17
Average charge ^a	31,028 (928)	32,300 (954)	33,492 (1002)	34,576 (1105)	35,551 (1282)	.0030
Average cost ^a	11,006 (274)	11,050 (223)	10,797 (201)	10,816 (215)	10,377 (212)	.06

SE indicates standard error.
^a2009 US dollars.

creased but the cost of care actually decreased. These findings indicate that the push to improve quality through mandatory reporting may be contributing to improving patient outcomes and reducing cost of care.

In-hospital mortality improved for these 3 high-impact diagnoses, even after adjustment for sociodemographic changes and higher patient acuity. During the same time period, hospital LOS decreased for patients with pneumonia and AMI, and remained stable for those with CHF. The exact causes of improvement in in-hospital mortality cannot be determined from our analysis. However, LOS may have been partially impacted by the significant increase in the number of patients discharged to another hospital or care facility, or to home with healthcare assistance. Indeed, for pneumonia, discharge disposition to another hospital increased from 1.90% to 2.28% ($P = .0017$); and for CHF discharge disposition to home with assistance increased from 16.31% to 18.94% ($P < .0001$). These changes in discharge disposition have become common as cost-saving measures instituted under the case management model.⁸ Therefore, simply reporting of length of stay may be somewhat misleading and create a false sense of a decreased LOS.

Other events, occurring simultaneously with the CMS initiatives, which may have had a direct impact on the im-

provement in the care measures, include the increased use of outpatient services, telemedicine, and evidence-based care guidelines. The impact of diagnostic coding must also be taken into account.¹¹⁻²⁹ Another factor may have been patients' increased use of ambulatory care settings to access preventive care, rather than relying on the acute care provided by hospitals' emergency departments (EDs). Also, over the past several years, ambulatory care walk-in clinics have become more widespread, allowing patients to obtain care at lower costs. In addition, the earlier discharge patterns of hospitals have pushed ambulatory care, home health, and rehabilitation centers to absorb the care of patients at earlier stages of recovery.¹⁷⁻¹⁹

Another likely reason for the reported improvements of the care measures has been the rigorous implementation of evidenced-based guidelines to deliver appropriate and timely care. The American Heart Association developed the "Get with the Guideline Campaign" to improve care for patients with heart disease, specifically CHF and AMI. Recent studies on management strategies for CHF and AMI have found that use of these guidelines resulted in lower risk-adjusted mortality.²²⁻²⁹

In 2007, the Infectious Diseases Society of America/American Thoracic Society developed a consensus guide-

line on the management of community-acquired pneumonia in adults,²⁸⁻³⁰ which was updated in 2009 by the American College of Emergency Physicians. The guideline addressed 2 issues: drawing blood cultures only if clinically indicated, and administering the first dose of empiric antibiotics to the patient before they leave the ED. These changes have resulted in more timely and efficient care.^{30,31} The use of electronic medical records and an electronic decision tool to standardize care in the ED have also been useful in reducing inpatient mortality among patients with pneumonia.³²

The increase in the severity of disease may be a result of the medical coding process. An investigation into the association of diagnostic coding with hospitalization and mortality trends for patients with pneumonia found a significant decline in hospitalizations for a primary diagnosis of pneumonia but a tripling for patients admitted with a primary diagnosis of sepsis. When the groups were combined, there was little change in hospitalizations or mortality, suggesting it was the change in coding that made the difference, not a change in the quality of care.³³

Our study also addressed inpatient charges for all types of payers, as opposed to the traditional focus on Medicare patients. After adjusting for inflation, charges for all diagnoses increased over the time period. However, costs remained the same for AMI and pneumonia while decreasing for CHF, suggesting that these results may be due to differences in the cost-to-charge ratios set by hospital systems. Nonetheless, the stability of costs in the setting of increasing patient complexity and severity may signify that the cost-cutting measures hospitals have implemented in the face of the new Medicare reimbursement rules and the Affordable Care Act are having the desired effect.^{8,32-44}

Others argue that costs and outcomes are not associated.^{43,44} A recent study from Oregon, where Medicaid program monies are rationed, found that patients who were awarded health insurance through Medicaid did seek and receive appropriate care. However, there were no significant

differences in patient outcomes between those who received care and those who did not.⁴⁵ In another study, funded by the Institute of Medicine to study payment reforms, it was found that an area of the correct size of a healthcare facility must be targeted, and the authors suggested the use of accountable care organizations—small enough to assign accountability but large enough to pool risk and even out individual variability.⁴⁶

Limitations

The limitations of our study include the lack of data about specific process measures and postdischarge outcomes, and the unknown impact of documentation practices. Lack of process measures, such as medication usage,

■ **Table 5. Resource Utilization by Age Groups (mean [SE])**

	Aged 18-64 Years	Aged ≥65 Years
Pneumonia		
Hospitalizations, n	1,855,097 (39,615)	3,399,457 (60,329)
Proportion of all hospitalizations, %	1.921 (0.022)	5.031 (0.045)
In-hospital mortality, %	1.89 (0.04)	5.43 (0.05) ^a
Diagnoses, n	8.06 (0.05) ^b	9.73 (0.05) ^b
Procedures, n	0.77 (0.02) ^b	0.69 (0.02) ^b
Length of stay, days	5.17 (0.03) ^a	5.91 (0.03) ^a
Average charge ^c	27,912.09 (417.90) ^b	27,636.75 (410.89) ^b
Average cost ^c	9504.08 (127.07) ^b	9562.01 (87.81) ^b
Acute myocardial infarction		
Hospitalizations, n	1,359,622 (41,162)	1,859,811 (48,213)
Proportion of all hospitalizations, %	1.408 (0.030)	2.752 (0.036)
In-hospital mortality, %	2.68 (0.04)	8.69 (0.08) ^a
Diagnoses, n	8.13 (0.05) ^b	10.21 (0.07) ^b
Procedures, n	5.41 (0.05) ^b	3.86 (0.06) ^{ab}
Length of stay, days	4.30 (0.04) ^b	5.63 (0.04) ^{ab}
Average charge ^c	61,292.55 (1024.90) ^a	56,765.14 (983.52) ^b
Average cost ^c	19,714.08 (198.66) ^a	18,213.09 (213.27) ^a
Congestive heart failure		
Hospitalizations, n	1,486,052 (37,420)	4,001,708 (79,857)
Proportion of all hospitalizations, %	1.539 (0.023)	5.922 (0.039)
In-hospital mortality, %	1.57 (0.03)	4.09 (0.04) ^a
Diagnoses, n	10.05 (0.07) ^b	10.65 (0.07) ^b
Procedures, n	1.28 (0.02) ^b	0.96 (0.02) ^b
Length of stay, days	5.15 (0.05) ^b	5.35 (0.03) ^a
Average charge ^c	37,585.44 (881.69) ^b	31,780.79 (534.37) ^b
Average cost ^c	12,029.20 (201.07) ^a	10,363.18 (112.05) ^a
SE indicates standard error.		
^a Decreased between 2005-2009 ($P < .05$).		
^b Increased between 2005-2009 ($P < .05$).		
^c 2009 US dollars.		

hinders the identification of exactly what improved outcomes over this time period. Postdischarge follow-up (readmission rates and 30-day mortality rates) was unavailable; however, many argue that most readmissions are not preventable, are an imperfect measure of hospital quality, and are inversely proportional to mortality. Furthermore, the argument continues, inpatient mortality correlates well with 30-day mortality, although this measure favors hospitals with lower LOS.³⁶⁻⁴⁰ Finally, documentation practices, either because of electronic health records or coding, may account for observed increases in severity of illness.⁴⁴

CONCLUSIONS

Many clinically meaningful outcomes related to the inpatient care of AMI, CHF, and pneumonia improved—in the context, notably, of more complex and severe disease. Hospital charges increased but costs remained stable, suggesting improvement in the quality of care. However, cost-effectiveness research is needed to determine how costs are actually related to these outcomes. Further research is also needed to discern which factors most influence the improved patient outcomes, and to account for any results that may accrue from coding changes. However, the trends noted in this review have laid the foundation for outcome comparison as a result of VBP.

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eAppendix Table 1. Procedures (mean [SE])

Procedure	2005	2006	2007	2008	2009	P
Acute myocardial infarction						
CABG, %	9.09 (0.44)	9.68 (0.39)	9.02 (0.38)	8.70 (0.35)	9.12 (0.34)	.31
Diagnostic cardiac catheterization; coronary arteriography, %	56.74 (1.21)	57.30 (1.20)	58.59 (1.16)	59.39 (1.10)	61.76 (1.15)	.0148
Systemic thrombolytics, %	1.85 (0.15)	1.75 (0.15)	1.41 (0.10)	1.42 (0.12)	1.28 (0.13)	.0122
Stent placement, %	35.93 (1.10)	38.60 (1.01)	37.35 (0.98)	38.96 (0.92)	40.86 (0.84)	.003
Pneumonia						
Tracheostomy; temporary and permanent, %	0.32 (0.02)	0.31 (0.02)	0.32 (0.02)	0.36 (0.02)	0.40 (0.02)	.006
Diagnostic bronchoscopy and biopsy of bronchus, %	3.97 (0.16)	4.08 (0.18)	4.44 (0.20)	4.26 (0.20)	4.68 (0.20)	.0088
Other OR procedures on respiratory system and mediastinum, %	0.25 (0.01)	0.25 (0.01)	0.27 (0.01)	0.34 (0.02)	0.34 (0.02)	<.0001
CT scan chest, %	1.38 (0.20)	1.32 (0.22)	2.10 (0.34)	1.63 (0.25)	1.62 (0.28)	.11
Routine chest x-ray, %	0.34 (0.13)	0.13 (0.05)	0.25 (0.10)	0.09 (0.05)	0.11 (0.08)	.51
Respiratory intubation and mechanical ventilation, %	4.47 (0.11)	4.63 (0.12)	4.97 (0.12)	5.53 (0.14)	6.49 (0.15)	<.0001
Congestive heart failure						
Implantation of cardiac devices, %	4.28 (0.31)	4.92 (0.36)	4.36 (0.26)	3.89 (0.24)	3.57 (0.22)	.007
Implantation of VAD, %	0.03 (0.01)	0.03 (0.01)	0.05 (0.01)	0.09 (0.02)	0.12 (0.03)	.0027
Heart transplant, %	0.06 (0.02)	0.06 (0.02)	0.06 (0.02)	0.11 (0.03)	0.07 (0.02)	.25
Diagnostic ultrasound of heart (echocardiogram), %	5.14 (0.51)	5.27 (0.62)	5.77 (0.64)	6.04 (0.67)	5.79 (0.63)	.79
Diagnostic cardiac catheterization; coronary arteriography, %	2.88 (0.15)	2.96 (0.19)	2.95 (0.18)	3.43 (0.23)	3.54 (0.24)	.07

CABG indicates coronary artery bypass grafting; CT, computer tomography; OR, operating room; VAD, ventricular assist device.

eAppendix Table 2. Independent Predictors of In-Hospital Mortality and Resource Utilization

Predictor	LOS Increase, % (95% CI)	Cost Increase, % (95% CI)	Charge Increase, % (95% CI)	Mortality, OR (95% CI)
Acute myocardial infarction				
Calendar year	-5.26 (-5.73 to -4.69)	-4.30 (-5.26 to -3.44)	-0.80 (-2.08 to +0.50)	0.936 (0.925 to 0.948)
Died in the hospital	-45.23 (-45.99 to -44.46)	-18.78 (-19.91 to -17.63)	-18.94 (-20.23 to -17.63)	N/A
Aged <45 years	-2.86 (-3.54 to -2.18)	-0.10 (-0.80 to +0.60)	-0.80 (-1.69 to +0.20)	0.634 (0.580 to 0.693)
Female	+6.50 (+6.08 to +7.04)	-1.19 (-1.69 to -0.70)	-1.00 (-1.69 to -0.40)	0.983 (0.960 to 1.006)
Neighborhood income (per quartile)	-2.96 (-3.73 to -2.18)	+1.31 (+0.20 to +2.43)	+0.50 (-1.49 to +2.43)	0.977 (0.961 to 0.994)
Elective admission	-5.82 (-8.61 to -2.86)	-4.50 (-7.60 to -1.39)	-2.66 (-7.41 to +2.22)	1.019 (0.954 to 1.089)
Hospital: large (bed size: upper tertile in the state)	+8.87 (+5.55 to +12.41)	+4.92 (+1.21 to +8.65)	+16.65 (+8.87 to +24.98)	1.023 (0.980 to 1.068)
Hospital: urban	+15.60 (+12.30 to +19.01)	+6.72 (+2.22 to +11.52)	+50.08 (+42.05 to +58.57)	0.900 (0.853 to 0.951)
Hospital: teaching	+4.08 (+1.21 to +6.93)	+6.50 (+2.74 to +10.30)	+2.43 (-3.73 to +8.98)	0.980 (0.937 to 1.024)
Hospital location: midwest	-9.06 (-12.28 to -5.64)	-3.44 (-8.79 to +2.33)	-9.15 (-16.81 to -0.90)	1.199 (1.119 to 1.284)
Hospital location: south	-3.82 (-7.78 to +0.20)	-7.50 (-12.80 to -1.78)	-2.86 (-12.45 to +7.68)	1.232 (1.155 to 1.315)
Hospital location: west	-14.44 (-17.63 to -11.13)	+10.96 (+4.39 to +17.82)	+34.18 (+22.02 to +47.55)	1.216 (1.130 to 1.308)
Payer: Medicare	+6.61 (+5.87 to +7.36)	-1.59 (-2.27 to -0.90)	-1.19 (-2.27 to -0.10)	1.173 (1.131 to 1.217)
Payer: Medicaid	+8.00 (+6.61 to +9.42)	+2.74 (+0.70 to +4.92)	+4.60 (+2.12 to +7.14)	0.981 (0.918 to 1.048)
Minor severity of illness	-9.06 (-9.61 to -8.52)	-8.06 (-8.70 to -7.50)	-8.70 (-9.43 to -7.96)	1.009 (0.932 to 1.093)
Major or extreme severity of illness	+29.30 (+28.27 to +30.34)	+27.51 (+26.49 to +28.66)	+29.69 (+28.27 to +31.13)	2.513 (2.414 to 2.616)
Minor likelihood of dying	-14.10 (-14.70 to -13.58)	-0.70 (-1.29 to -0.10)	-1.00 (-1.88 to 0.00)	0.238 (0.210 to 0.269)
Major or extreme likelihood of dying	+28.79 (+27.76 to +29.95)	+11.52 (+10.63 to +12.52)	+12.30 (+10.85 to +13.88)	6.921 (6.559 to 7.303)
Comorbidity: congestive heart failure	+106.47 (+99.37 to +113.83)	+82.21 (+75.77 to +88.70)	+82.58 (+74.54 to +90.79)	0.742 (0.674 to 0.817)
Comorbidity: diabetes with chronic complications	-2.37 (-3.44 to -1.29)	-1.09 (-1.98 to -0.20)	-1.19 (-2.57 to +0.10)	0.670 (0.638 to 0.704)
Comorbidity: renal failure	+5.97 (+5.13 to +6.72)	+1.92 (+1.21 to +2.74)	+3.15 (+2.02 to +4.29)	0.847 (0.823 to 0.872)
CABG	+91.75 (+87.39 to +96.21)	+136.79 (+130.25 to +143.27)	+132.10 (+123.67 to +141.09)	0.208 (0.191 to 0.225)
Diagnostic cardiac catheterization; coronary arteriography	-5.82 (-7.32 to -4.40)	+10.74 (+8.44 to +13.20)	+14.68 (+11.52 to +17.94)	0.278 (0.264 to 0.292)
Systemic thrombolytics	-12.10 (-14.27 to -9.88)	+1.92 (-0.80 to +4.71)	+5.02 (+0.70 to +9.42)	0.804 (0.716 to 0.903)
Stent placement	-13.58 (-15.13 to -12.01)	+39.10 (+35.66 to +42.48)	+37.85 (+33.64 to +42.19)	0.334 (0.314 to 0.355)
Diagnoses, n	+2.63 (+2.33 to +2.84)	+1.31 (+1.11 to +1.61)	+1.11 (+0.50 to +1.61)	0.955 (0.951 to 0.960)
Procedures, n	+6.61 (+6.29 to +6.93)	+10.74 (+10.19 to +11.29)	+11.40 (+10.74 to +12.08)	1.242 (1.229 to 1.254)

Pneumonia

Calendar year	-3.34 (-3.73 to -2.96)	-1.39 (-1.98 to -0.70)	+1.11 (0.00 to +2.22)	0.900 (0.890 to 0.911)
Died in the hospital	-27.02 (-27.82 to -26.14)	-17.80 (-19.02 to -16.64)	-18.94 (-20.07 to -17.72)	N/A
Aged <45 years	-3.92 (-4.88 to -3.05)	+0.40 (-0.60 to +1.51)	+0.90 (-0.20 to +2.12)	0.336 (0.312 to 0.362)
Female	+7.36 (+7.04 to +7.68)	+2.94 (+2.53 to +3.25)	+3.25 (+2.84 to +3.67)	0.978 (0.957 to 0.999)
Neighborhood income (per quartile)	-1.29 (-1.88 to -0.70)	+2.12 (+1.21 to +2.94)	+2.22 (+0.50 to +3.98)	1.017 (1.003 to 1.032)
Elective admission	+14.91 (+12.19 to +17.59)	-3.05 (-5.16 to -0.90)	-3.34 (-6.39 to -0.20)	1.314 (1.242 to 1.389)
Hospital: large (bed size: upper tertile in the state)	+2.94 (+1.41 to +4.50)	-4.11 (-6.48 to -1.59)	+16.42 (+11.40 to +21.65)	0.912 (0.878 to 0.948)
Hospital: urban	+3.46 (+1.71 to +5.23)	-2.76 (-5.35 to -0.20)	+41.91 (+36.21 to +47.85)	0.739 (0.704 to 0.776)
Hospital: teaching	-6.48 (-8.15 to -4.69)	-3.54 (-6.57 to -0.30)	-1.19 (-6.48 to +4.39)	0.866 (0.826 to 0.908)
Hospital location: midwest	-11.22 (-13.41 to -8.97)	-9.88 (-13.84 to -5.73)	-15.89 (-21.89 to -9.43)	0.809 (0.762 to 0.858)
Hospital location: south	-4.50 (-6.95 to -1.88)	-12.28 (-16.22 to -8.06)	-2.18 (-9.88 to +6.18)	0.913 (0.862 to 0.966)
Hospital location: west	-16.05 (-18.45 to -13.58)	+3.98 (-1.29 to +9.42)	+28.79 (+18.18 to +40.49)	0.886 (0.828 to 0.947)
Payer: Medicare	+7.68 (+7.04 to +8.33)	0.00 (-1.00 to +1.01)	+0.40 (-0.90 to +1.61)	1.211 (1.160 to 1.264)
Payer: Medicaid	+5.02 (+4.08 to +5.97)	+5.13 (+3.87 to +6.40)	+6.08 (+3.98 to +8.22)	0.850 (0.799 to 0.905)
Minor severity of illness	-12.54 (-13.06 to -11.93)	-13.84 (-14.44 to -13.15)	-13.24 (-14.02 to -12.45)	0.995 (0.885 to 1.119)
Major or extreme severity of illness	+19.01 (+18.29 to +19.60)	+21.90 (+21.05 to +22.75)	+21.77 (+20.68 to +22.75)	1.354 (1.305 to 1.405)
Minor likelihood of dying	-8.33 (-8.79 to -7.96)	-5.35 (-6.01 to -4.69)	-4.21 (-4.97 to -3.54)	0.145 (0.132 to 0.159)
Major or extreme likelihood of dying	+14.11 (+13.43 to +14.80)	+16.18 (+15.37 to +17.12)	+18.06 (+16.88 to +19.24)	4.000 (3.878 to 4.126)
Comorbidity: congestive heart failure	+0.80 (+0.30 to +1.31)	+1.61 (+0.80 to +2.43)	+1.92 (+1.01 to +2.84)	1.068 (1.041 to 1.095)

Comorbidity: chronic pulmonary disease	+5.13 (+4.71 to +5.55)	+5.34 (+4.60 to +6.08)	+6.29 (+5.44 to +7.14)	0.652 (0.636 to 0.669)
Tracheostomy; temporary and permanent	+78.07 (+70.23 to +86.26)	+72.46 (+62.58 to +82.76)	+77.54 (+66.86 to +88.70)	0.650 (0.592 to 0.713)
Diagnostic bronchoscopy and biopsy of bronchus	+35.80 (+33.24 to +38.40)	+40.92 (+36.89 to +45.21)	+49.33 (+44.63 to +54.03)	0.864 (0.823 to 0.907)
Other OR Rx procedures on respiratory system and mediastinum	+52.50 (+47.26 to +58.09)	+60.00 (+52.50 to +68.03)	+64.21 (+55.43 to +73.50)	0.309 (0.247 to 0.386)
CT scan chest	-15.13 (-17.88 to -12.37)	-9.88 (-16.31 to -2.96)	-12.10 (-20.63 to -2.76)	0.555 (0.489 to 0.628)
Routine chest x-ray	-28.82 (-37.50 to -18.86)	-32.83 (-42.42 to -21.73)	-30.58 (-44.95 to -12.45)	0.551 (0.347 to 0.873)
Respiratory intubation and mechanical ventilation	+2.33 (+0.10 to +4.71)	+29.95 (+26.24 to +33.91)	+32.05 (+27.63 to +36.75)	5.678 (5.454 to 5.911)
Diagnoses, n	+2.02 (+1.92 to +2.22)	+2.33 (+2.12 to +2.53)	+2.43 (+2.02 to +2.84)	0.980 (0.975 to 0.984)
Procedures, n	+14.68 (+13.77 to +15.60)	+19.01 (+17.59 to +20.44)	+18.77 (+17.23 to +20.32)	1.092 (1.084 to 1.101)

Congestive heart failure

Calendar year	-4.11 (-4.50 to -3.63)	-2.86 (-3.54 to -2.08)	+0.40 (-0.90 to +1.71)	0.911 (0.899 to 0.922)
Died in the hospital	-18.13 (-19.27 to -17.06)	-13.67 (-15.30 to -12.10)	-15.30 (-16.97 to -13.67)	N/A
Aged <45 years	-5.35 (-6.39 to -4.30)	-1.00 (-2.08 to +0.10)	-1.98 (-3.44 to -0.40)	0.588 (0.534 to 0.647)
Female	+7.47 (+7.14 to +7.90)	+3.77 (+3.46 to +4.08)	+3.46 (+3.05 to +3.87)	1.035 (1.012 to 1.059)
Neighborhood income (per quartile)	-1.98 (-2.57 to -1.39)	+2.12 (+1.21 to +3.05)	+1.11 (-0.80 to +3.05)	1.037 (1.021 to 1.054)
Elective admission	-3.73 (-5.54 to -1.78)	-3.73 (-5.45 to -1.98)	-3.63 (-6.01 to -1.19)	1.420 (1.321 to 1.527)
Hospital: large (bed size: upper tertile in the state)	+3.67 (+1.71 to +5.65)	-0.80 (-3.44 to +1.92)	+16.07 (+10.30 to +22.26)	0.903 (0.863 to 0.944)
Hospital: urban	+3.25 (+1.21 to +5.23)	+1.51 (-1.19 to +4.39)	+47.26 (+40.64 to +54.03)	0.682 (0.642 to 0.724)
Hospital: teaching	-2.66 (-4.88 to -0.50)	+0.40 (-2.76 to +3.67)	+0.10 (-5.64 to +6.29)	0.887 (0.842 to 0.935)
Hospital location: midwest	-13.24 (-15.80 to -10.68)	-13.06 (-17.39 to -8.42)	-20.31 (-27.02 to -13.06)	0.782 (0.734 to 0.833)
Hospital location: south	-10.33 (-12.98 to -7.60)	-18.86 (-22.97 to -14.53)	-14.44 (-22.20 to -5.82)	0.815 (0.766 to 0.868)
Hospital location: west	-21.02 (-23.28 to -18.62)	-0.30 (-5.64 to +5.23)	+23.00 (+11.96 to +35.12)	0.882 (0.822 to 0.945)
Payer: Medicare	+4.92 (+4.08 to +5.76)	-0.20 (-1.29 to +0.80)	+0.10 (-1.39 to +1.61)	0.941 (0.886 to 1.000)
Payer: Medicaid	+8.55 (+7.25 to +9.86)	+5.23 (+3.77 to +6.61)	+6.18 (+3.67 to +8.87)	0.638 (0.588 to 0.691)
Minor severity of illness	-12.01 (-12.63 to -11.40)	-14.96 (-15.63 to -14.27)	-14.96 (-15.89 to -14.02)	1.511 (1.329 to 1.717)
Major or extreme severity of illness	+14.68 (+13.88 to +15.37)	+27.12 (+26.24 to +28.02)	+26.87 (+25.73 to +28.15)	1.723 (1.668 to 1.779)
Minor likelihood of dying	-9.61 (-10.15 to -8.97)	+1.21 (+0.50 to +2.02)	+0.60 (-0.40 to +1.71)	0.298 (0.269 to 0.331)
Major or extreme likelihood of dying	+26.36 (+25.61 to +27.25)	+15.95 (+15.37 to +16.53)	+16.53 (+15.49 to +17.59)	4.820 (4.658 to 4.988)
Implantation of cardiac devices	-42.94 (-44.95 to -40.84)	+258.23 (+244.87 to +272.48)	+267.30 (+252.54 to +283.05)	0.124 (0.110 to 0.140)

Implantation of VAD	+158.57 (+118.37 to +206.18)	+330.17 (+249.73 to +428.57)	+322.07 (+243.15 to +418.62)	1.833 (1.388 to 2.422)
Heart transplant	+82.03 (+55.27 to +113.61)	+202.22 (+146.70 to +269.88)	+205.57 (+140.37 to +288.84)	0.140 (0.071 to 0.278)
Diagnostic ultrasound of heart (echocardiogram)	-3.34 (-5.45 to -1.19)	-8.33 (-11.57 to -4.97)	-15.13 (-20.15 to -9.79)	0.492 (0.455 to 0.532)
Diagnostic cardiac catheterization; coronary arteriography	-2.08 (-4.69 to +0.60)	+3.05 (+0.20 to +5.97)	+5.87 (+1.92 to +10.08)	0.371 (0.341 to 0.403)
Diagnoses, n	+2.43 (+2.22 to +2.63)	+1.61 (+1.41 to +1.82)	+1.41 (+1.01 to +1.92)	0.975 (0.969 to 0.980)
Procedures, n	+12.86 (+12.52 to +13.31)	+19.48 (+18.77 to +20.20)	+20.32 (+19.48 to +21.05)	1.209 (1.201 to 1.217)

CABG indicates coronary artery bypass grafting; CT, computer tomography; LOS, length of stay; N/A, not applicable; OR, operating room; VAD, ventricular assist device.