Beyond the Dartmouth Atlas of Health Care: Exploring Variations in Inpatient Hospital Costs in New York State—the Cases of Acute Myocardial Infarction (AMI) and Congestive Heart Failure (CHF)

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Executive Summary

Variations in patterns of health care in the United States and their associated costs have been widely debated. The Dartmouth Atlas of Health Care (DA) project is a repository of aggregate Medicare data compiled by John Wennberg and colleagues that has been used to measure, delineate, and plot health care use and expenditures in small market areas across patients with selected chronic conditions and hospitals in the United States. The DA project and others have documented variations at the national level quite extensively.

This work extends the literature on variations by focusing specifically on New York State, with a particular emphasis on two expensive conditions, acute myocardial infarction (AMI) and congestive heart failure (CHF). These two conditions combined represented nearly 75,000 admissions statewide among the Medicare population in 2008. This report delves more deeply into the pattern of hospital costs to explore the underlying components of costs and the variations generated by them and is intended to inform a discussion in which reasons behind the variations observed might be discerned and interventions at the hospital level identified in the hopes of mitigating the variations.

This report begins with a display and analysis of data and methodology drawn from the portion of the DA project that focuses on New York. There are, however, three characteristics of the DA methodology that limit its utility. First, the DA organizes hospitals into hospital referral regions that are not comparable because they are made up of different combinations of hospital types, or peer groups. Second, instead of using individual hospital spending the DA uses Medicare payments as its measure of costs and Medicare payments also include public policy expenditures such as graduate medical education payments and disproportionate share payments. Third, the DA aggregates several terminal conditions that are not clinically consistent and for which quality measures are not available. As a result, the DA does not support analysis to define actionable interventions at the hospital level.

Therefore, we used data from the New York State Department of Health Statewide Planning and Research Cooperative System (SPARCS) combined with Medicare cost reports. The SPARCS database, which was established by the New York State Legislature in 1979 to collect information on discharges from hospitals, currently collects patient level detail on patient characteristics, diagnoses and procedures, days of care, and charges for every hospital discharge, ambulatory surgery patient, and emergency department admission in New York State. Each hospital discharge is maintained as a separate record and can be sorted by diagnosis related group code. The data contain charges for both routine and ancillary services at the Medicare-defined cost center level. (Routine costs are the regular room and board costs of care that for which a separate charge is not customarily made and ancillary costs are for services specific to a particular patient care plan for which a separate fee is generally charged.) By combining the

SPARCS data with information from Medicare cost reports, we can construct estimates of the cost at each hospital at the cost center level using the ratio of costs to charges (RCC) methodology*.* This permits us to analyze the actual costs of care for specific DRGs with a high level of detail. Use of this dataset also allows us to control for regional wage differences.

Analysis using SPARCS is consistent with DA analysis. Hospital inpatient reimbursements from the DA for the larger group of chronic conditions are correlated (R-squared of .55) to combined AMI and CHF costs within HRRs, despite the presence of public policy payments in the DA data. The differences observed, therefore, are seen in the underlying costs of the peer groups of hospitals we employed.

This paper describes and graphically charts the patterns of costs and variations of costs for AMI and CHF discharges. In addition, the report relates the costs to days of care, case mix index (CMI), and hospital reported quality measures.

While there is variation in total cost between and within hospital peer groups for primary AMI discharges, it is not fully explained by the hospital characteristics we were able to analyze. Length of stay varies between hospital peer groups but explains only roughly a quarter of the difference of total cost. Case mix index does not contribute much to understanding of the differences in cost, and there is no apparent relationship between total cost and CMS quality score. However, when routine costs for AMI discharges are examined separately, we find that days of care explain more, nearly one-half, of the variation in cost. When ancillary costs were segregated and analyzed, we find that rather than length of stay, case mix index is the characteristic that explains a substantial portion (nearly 60%) of the variation. When costs are studied by segregating hospitals into more refined peer groupings that account for the type of cardiac program (hospitals with non-invasive cardiology, hospitals with diagnostic cardiac catheterization, hospitals offering diagnostic catheterization and angioplasty and those hospitals offering a full range of cardiac care, including surgery), the variation between and within these hospital peer groupings is, as would be expected, substantial.

While the patterns of cost are similar in the CHF discharge population to the AMI population, the variation in total cost between and within hospital peer groups for primary CHF discharges is somewhat smaller than we found with primary AMI discharges. However, the characteristics we were able to analyze contributed little to our understanding of variation. Specifically, length of stay and case mix explained little of the variation and, as was observed with AMI, there is no apparent relationship between total cost and CMS quality score. When routine costs are examined separately, the findings are similar except days of care explain some (approximately 38%) of the variation in routine cost. When ancillary costs were segregated and analyzed and the findings are similar to the total cost except rather than length of stay (which explained none of the difference), case mix index is the characteristic that explains a substantial portion (nearly half) of the variation.

There is variation between the hospital and peer groups in costs at every level for both AMI and CHF discharges. Routine costs tend to be explained somewhat by length of stay and ancillary costs are partially explained by case mix index. Quality scores do not appear to be related to cost at any level.

Our data are consistent with nationwide findings from the Dartmouth Atlas Project; variations in costs are present across peer groupings and across New York State. However, using the more detailed SPARCS data enables us to identify specific areas where costs vary, which makes it possible to identify actions to reduce unnecessary variations. These data are the framework within which individual hospitals can begin to understand their unique cost profile.

In order to explore and understand the reasons behind the variation in cost that was observed, we undertook a qualitative study that involved site visits to hospitals to conduct interviews with key leadership. The objective of the site visits was to identify some of the reasons behind variation and to determine if there are actions that might be taken by the hospitals to reduce unnecessary variation and the associated cost. Overall, our findings are consistent with earlier research that showed that the resources used in the care of chronically ill patients varies widely and that the reasons behind this variation is not easily or crisply explained.

After performing the six interviews and reviewing the discussions, our research team came to the conclusion that the unique geographic, marketplace, workforce, culture and general characteristics of each hospital limit finding a common thread to explain either quality of care or resource utilization performance.

Background

Since 1973 John Wennberg and colleagues at Dartmouth College have focused research efforts on the study of healthcare variation. Specifically, Wennberg and his colleagues focused on studying small area variation of health care utilization. Their work initially was directed at observing variation at the state level, in places like Vermont, the broader New England region. Over time however, Wennberg's team began to focus on variation nation-wide, which lead to the creation of the Dartmouth Atlas of Healthcare. This work helped to launch many other studies on healthcare variation across the United States.

Using such studies as ammunition, Atul Gawande (*The New Yorker*, June 1, 2009) explored why health care in one Texas community grew exponentially more expensive over the last 15 years compared to another similar Texas community with similar patients and similar health conditions. A month later he and three other researchers convened the 'How Do They Do That?' conference in Washington DC, and invited physicians, hospital executives and local leaders from 10 hospital referral regions (HRRs) around the country that they called "positive outliers…regions with per capita Medicare costs that are low or markedly declining in rank and where federal measures of quality are above average." They found that these positive outlier HRRs had fewer medical and surgical discharges, and inpatient days, more primary care visits, fewer specialty visits, and less use of imaging technology.

Different HRRs achieved these results through different mechanisms, including the use of electronic health records, removing incentives to over utilize by placing physicians on salary (a practice of not only HMOs but the Mayo and Cleveland Clinics), collaboration in viewing metrics of quality and jointly taking action, and merging hospitals (Gawande, Berwick, Fisher, and McClellan (*New York Times*, August 13, 2009).

Currently, the importance of variations research has reached the national level. Former Congressional Budget Office Director Peter Orszag highlighted Wennberg and his colleagues' findings in a 2008 presentation to the National Academy of Social Insurance and endorsed their estimate that

> [N]early 30 percent of Medicare's costs could be saved without negatively affecting health outcomes if spending in high- and medium-cost areas could be reduced to the level in low-cost areas—and those estimates could probably be extrapolated to the health care system as a whole. (p. 4)

Orszag believes that reducing variations is a key to funding health care reform, a finding echoed in speeches by President Obama.

Project Overview

The purpose of this project is to study variations of health expenditures in New York State using two synergistic approaches: quantitative and qualitative. The quantitative study uses data from the Dartmouth Atlas Project and the New York State Department of

Health Statewide Planning and Research Cooperative System (SPARCS) as well as Medicare hospital cost report data to measure the degree of variation of health expenditures in New York State. Specifically, we focused on patterns of cost at the hospital level in order to inform a discussion at the hospital level about variation in these costs. The objective of this discussion is to identify some of the reasons behind variation and to determine if there are actions that might be taken by the hospitals to reduce unnecessary variation and the associated cost.

Methods

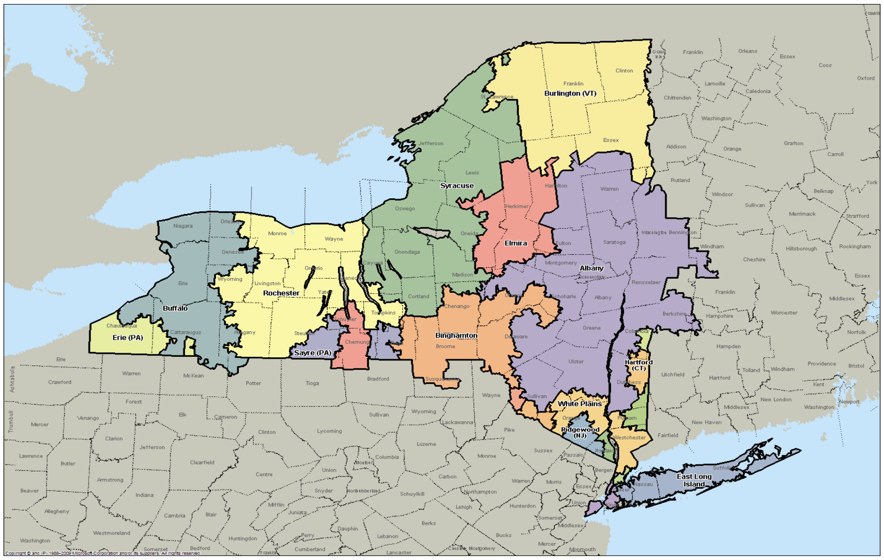
The quantitative study included two analyses; one employed data from the Dartmouth Atlas of Health and the other utilized the New York State Planning and Resource Cooperative System (SPARCS) combined with Medicare cost reports.

The initial data analysis was conducted using Dartmouth Atlas data, specifically the Medicare database which captures spending during an individual's last two years of life. This data, which observed variation at the ***Hospital Referral Region (HRRs; see glossary)***, found that variation in New York State was present. However, a number of concerns regarding use of Dartmouth Atlas data began to arise after a closer inspection.

Concerns with the Dartmouth Atlas of Health Data

The Dartmouth Atlas data views variation within and between HRRs. The HRRs employed by the Dartmouth Atlas in New York State are displayed in Figure 1.

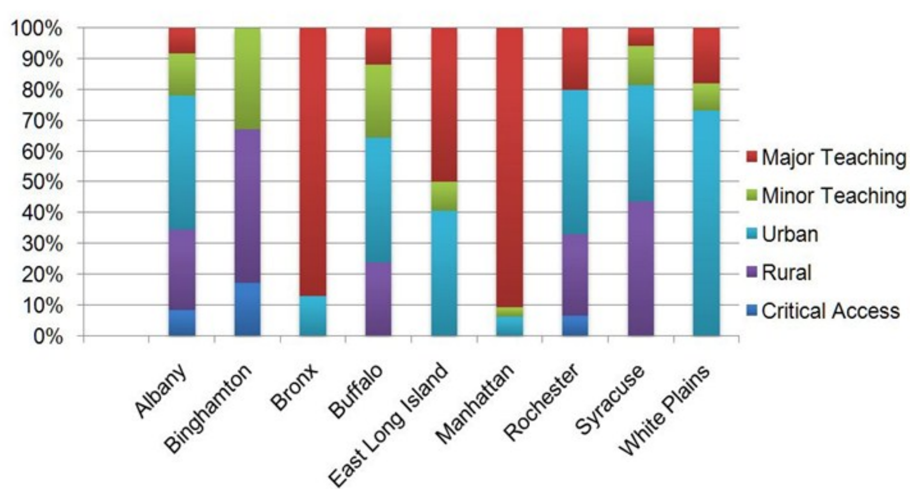
Figure 1 – New York State Hospital Referral Regions



Source: United Hospital Fund and IPRO.org

These hospital referral regions were analyzed by distributing the hospitals in the regions into **peer groups (see glossary).** We found, as can be seen in Figure 2, that certain HRRs have a much higher proportion of teaching hospitals represented by the red bars,

Figure 2 – Distribution of Hospitals by Peer Group by HRR



notably Manhattan, Bronx and East Long Island. It is these HRRs that show much higher Medicare reimbursement.

The HRRs are not reasonably comparable because they are composed of different combinations of hospital types, or **peer groups (see glossary)**, which is akin to comparing apples and oranges. For that reason, analysis of HRR's was abandoned, and analysis at a statewide peer group level was adopted.

Further, the Dartmouth Atlas reports Medicare reimbursement rather than cost. In many cases, these reimbursements include "public policy payments" which increase the rate of reimbursement and tend to be directed at teaching institutions. These public policy payments include ***Disproportionate Share (DSH; see glossary)*** hospital payments, ***Graduate Medical Education (GME; see glossary)*** payments, and ***Outlier (see glossary)*** payments. As a result teaching institutions may appear to be more costly than their non-teaching counterparts.

In addition, the DA data uses a grouping of chronic conditions that cover a broad spectrum of services and providers, drawn from Iezzoni et al. (1994). The Iezzoni study examined the risk of in-hospital death due to a pre-existing chronic condition. Iezzoni and her colleagues selected 14 chronic conditions that were likely to cause complications after a hospital admission. They showed that in-hospital death rates also needed to take into account factors such as underlying chronic conditions in order to reasonably compare quality across hospitals. Since then, Iezzoni has suggested that using this method would be impractical today as many of the clinical procedures for treatment have changed over time. The sub-set of conditions defined by Iezzoni employed by Dartmouth Atlas is displayed in Table 1.

Table 1. Dartmouth Atlas Conditions
Malignant Cancer/Leukemia
Chronic Pulmonary Disease
Coronary Artery Disease
Congestive Heart Failure
Peripheral Vascular Disease
Severe Chronic Liver Disease
Diabetes with end organ damage
Chronic renal failure
Dementia

Given these concerns with the DA data, an alternative data source was sought that could support analysis of differences in cost, not reimbursement, between comparable hospitals. In addition, we looked for data that could be disaggregated by payer for groupings of patients or conditions for which a quality measure could be collected and also for which some hospital level intervention may be able to impact utilization and, therefore, cost. We identified a set of data that met these criteria.

SPARCS and Medicare Hospital Cost Report Data

The New York State Department of Health Statewide Planning and Research Cooperative System (SPARCS) system data is useful for analysis at the hospital level. In the SPARCS database, each hospital discharge is maintained as a separate record and can be sorted by diagnostically related group (DRG) codes. The data contains charges for routine services and ancillary services at the departmental level. Combining the SPARCS data with information from Medicare cost reports to construct estimates of the cost at each hospital at the departmental level using the ***ratio of costs to charges (RCC) methodology (see glossary)*** allows an analysis of the actual costs of care for specific DRGs at a high level of detail. Use of this dataset also allows for ***wage adjustment (see glossary)*** to control for regional differences.

The SPARCS data permit analysis inpatient sector costs at both the routine and ancillary cost perspectives in a number of ways, including in the context of days of care and case mix index.

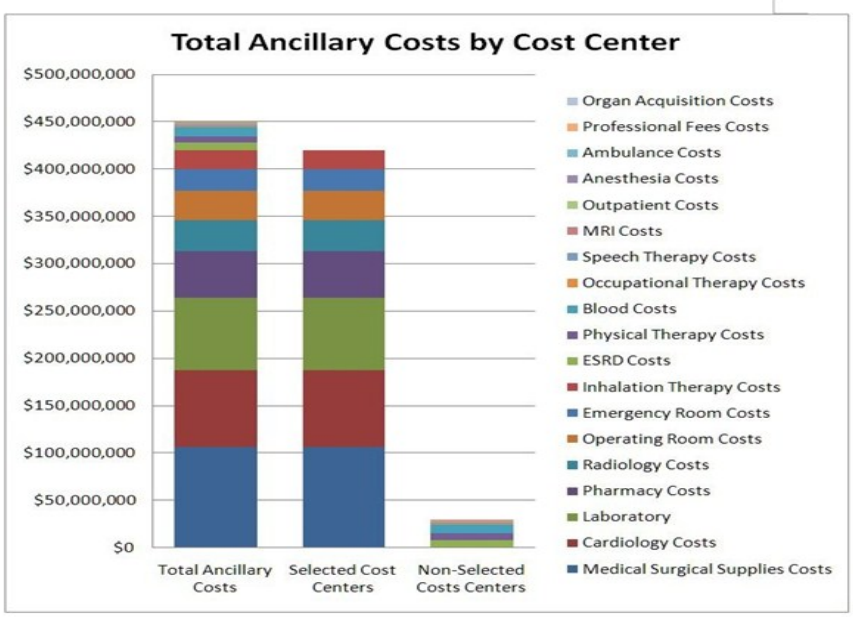
Clinical Conditions - AMI and CHF

Since the focus of our study is the specific variation in cost associated with individual inpatient hospitalizations, we chose to examine conditions that met the following criteria: a) prevalent inpatient diagnoses representing a large portion of health care expenditures, b) diseases managed by both specialists and generalist in nearly every full-service hospital, c) conditions with established treatment guidelines and associated performance measures. Accordingly, we selected acute myocardial infarction (AMI) and congestive heart failure (CHF) which met all of the above criteria. Therefore, hospital discharges covered by Medicare with a primary diagnosis of either AMI or CHF were chosen. Data for 2008 was available and was employed in this analysis.

We chose to analyze these diagnoses separately for several reasons. First, the goal of the project is to identify and understand variation in cost that might be moderated by some administrative or clinical intervention; the interventions at the hospital level may be different for different populations of patients. Second, hospital structural characteristics (such as the presence or absence of a cardiac surgery program) might impact one of the patient populations more than another. And finally, the pattern of utilization of days of care and ancillary services may be materially different between patients discharged with AMI versus CHF.

The highly detailed nature of the SPARCS database also allows for an in depth analysis of ancillary cost centers. For AMI and CHF, SPARCS identifies 23 different cost centers. However, 93% of the total ancillary costs are captured in 8 cost centers as demonstrated in Figure 3 below (cardiology, laboratory, medical/surgical

Figure 3 – Total Ancillary Costs by Cost Center



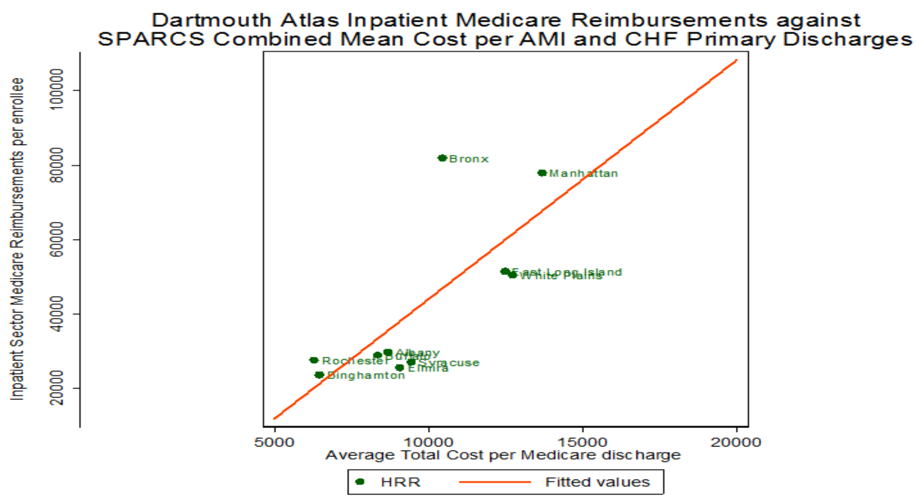
supplies, pharmacy, radiology, operating room, emergency room and inhalation therapy). For that reason, the ensuing analysis of AMI and CHF will focus on those eight cost centers.

Relationship between DA Findings and SPARCS Findings

We analyzed findings between the DA methodology for the larger grouping of chronic conditions during the last two years of life and the approach using SPARCS database linked to cost reports for hospitalizations for the two conditions (AMI and CHF) on an HRR basis to test the validity of using the SPARCS data.

Analysis using SPARCS is consistent with DA analysis. Hospital inpatient reimbursements from the DA for the larger group of chronic conditions are correlated to combined AMI and CHF spending within HRRs. This relationship is shown in Figure 4.

Figure 4 – Correlation of Inpatient Reimbursements and Costs per AMI and CHF



Therefore, the relationship between the DA methodology and the SPARCS database is fairly strong (55% of variation accounted for).

Acute Myocardial Infarction (AMI)

This section of the study examines patterns of cost for patients discharged with a primary diagnosis of acute myocardial infarction. There are over 21,000 cases in the population studied.

Summary of AMI Findings

While there is variation in total cost between and within hospital peer groups for primary AMI discharges, it is not fully explained by the characteristics we were able to analyze. Specifically:

- Length of stay varies between hospital peer groups but explains only roughly a quarter of the difference;
- Case mix index does not contribute much to understanding of the difference; and
- There is no apparent relationship between total cost and CMS quality score.

When routine costs are examined separately, the findings are similar except days of care explain more, nearly one-half, of the variation in cost.

Ancillary costs were segregated and analyzed and the findings are similar to the total cost except rather than length of stay, case mix index is the characteristic that accounts for a substantial portion of the variation (59%).

When costs are studied by segregating hospitals into more refined peer groupings that account for the type of cardiac program (hospitals with non-invasive cardiology, hospitals with diagnostic cardiac catheterization, hospitals offering diagnostic catheterization and angioplasty and those hospitals offering a full range of cardiac care, including surgery), the variation between and within these hospital peer groupings is, as would be expected, substantial.

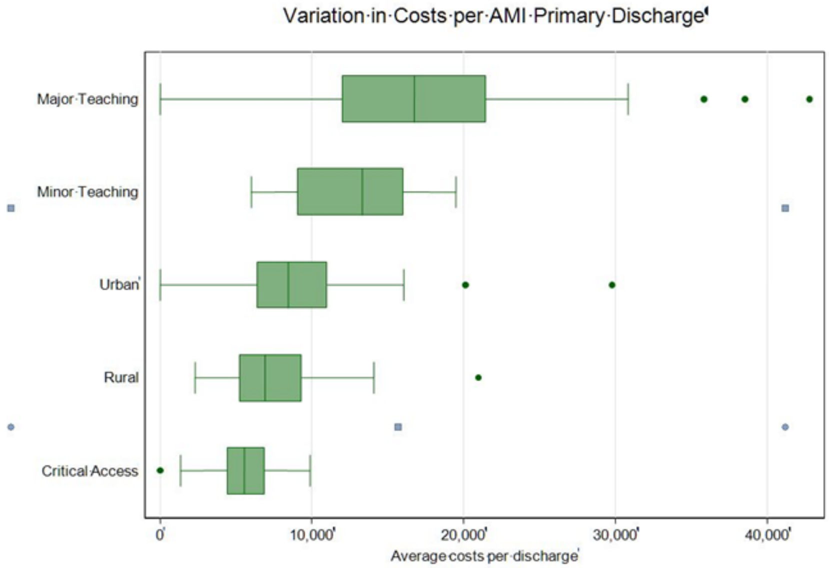
Table 2 shows mean costs for discharge by peer group. As can be seen there is a substantial difference between peer groups and variation within peer groups, as reflected in the coefficients of variation.

Table 2. Mean Costs for Discharges by Peer Group: AMI

Peer Group	Mean Costs	Standard Deviation	Coefficient of Variation
Major Teaching	$17,835	$8,004	0.449
Minor Teaching	$12,771	$4,022	0.315
Urban	$9,079	$4,290	0.473
Rural	$7,798	$3,967	0.509
Critical Access	$5,361	$3,282	0.612
Total	$12,339	$7,352	0.596

Figure 5 displays the variation in costs by peer group for AMI graphically. The boxes represent the 25^{th} percentile to the 75^{th} percentile of cost. The line represents the mean (the arithmetic average) and between the “whiskers” 90% of values in the sample is included and outliers are represented as individual points.

Figure 5 – Variation in Costs per Primary Discharge: AMI



There does appear to be a clear pattern of average lengths of stay for AMI patients by peer group, as shown in Figure 6.

Figure 6 – Average Length of Stay for Discharges by Peer Group: AMI

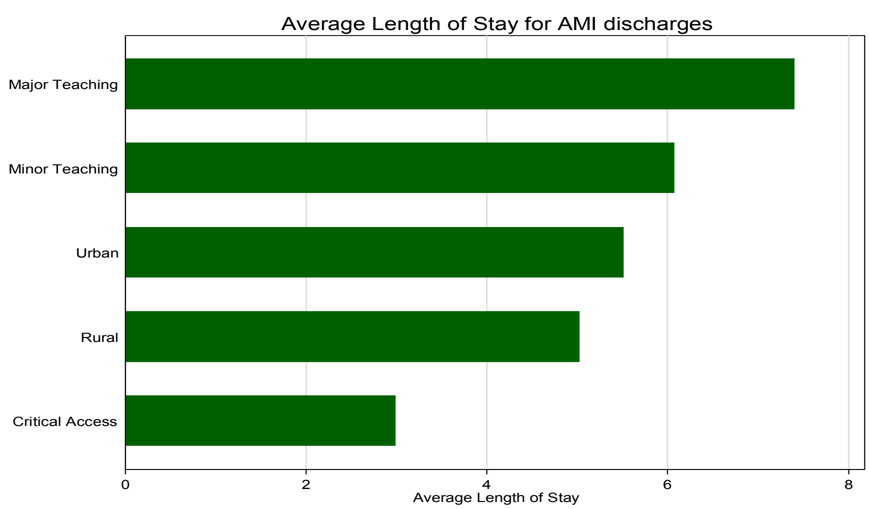
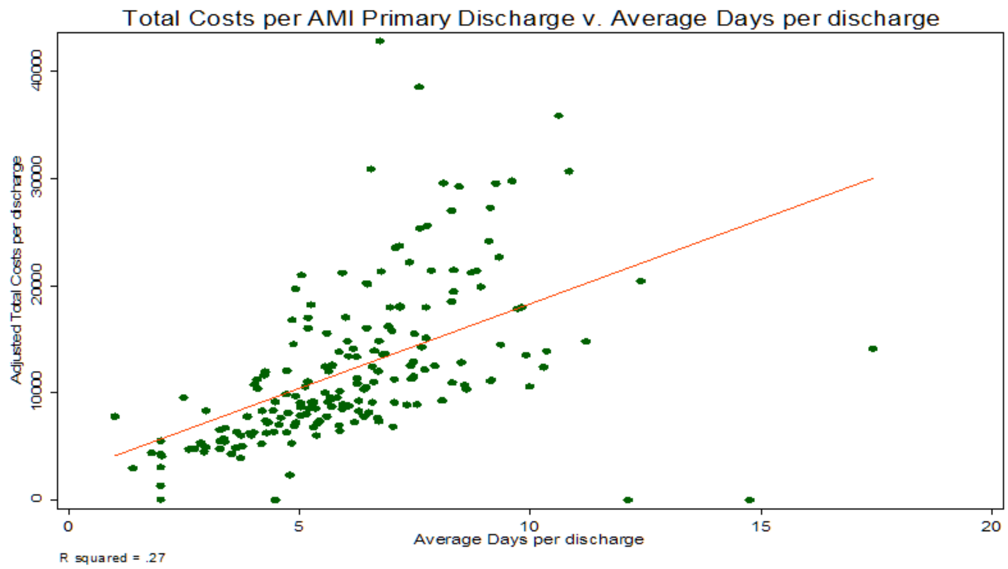


Figure 7 shows the relationship between AMI inpatient discharge costs to average days of care. An R-squared of .27 suggests that days explain about 27% of the relationship.

Figure 7 – Correlation of Total Discharge Costs and Average Days per Discharge: AMI



However, it does not appear that Medicare case mix explains much of the difference in length of stay, as displayed in Figure 8.

Figure 8 – Correlation of Medicare Case Mix Index and Average Length of Stay: AMI

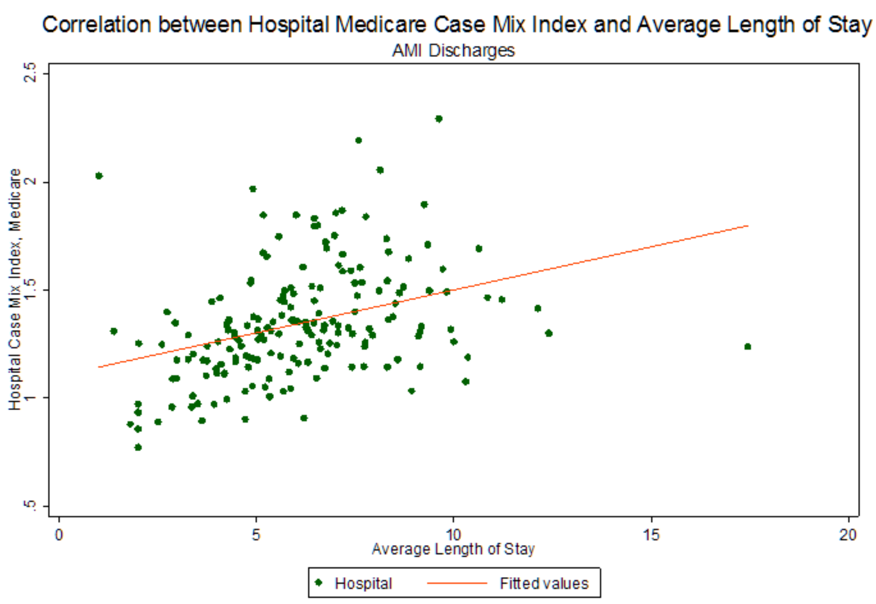
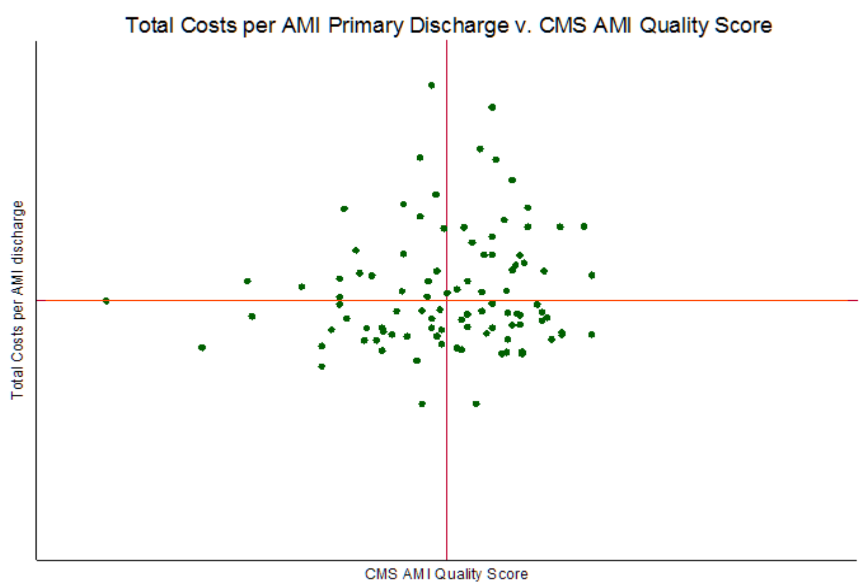


Figure 9 demonstrates the relationship between mean costs per discharge and the mean quality score reported to the CMS. The intersection of the vertical and horizontal lines represents the mean quality score and mean cost per discharge in the data; the distribution of the data suggests virtually no relationship between the quality and cost per discharge.

Figure 9 – Correlation of Routine Costs and CMS Quality Score: AMI



Total inpatient costs for AMI are not explained well by days of care or by case mix index. And, there appears to be little relationship between total inpatient costs and quality.

The next set of analyses disaggregate inpatient costs by routine and ancillary costs (and further disaggregate ancillary costs into departments) to better understand the patterns of cost.

Routine AMI Costs

As noted in the glossary, routine costs are “the regular room, dietary and nursing services, minor medical and surgical supplies, and the use of equipment for which a separate charge is not customarily made.”

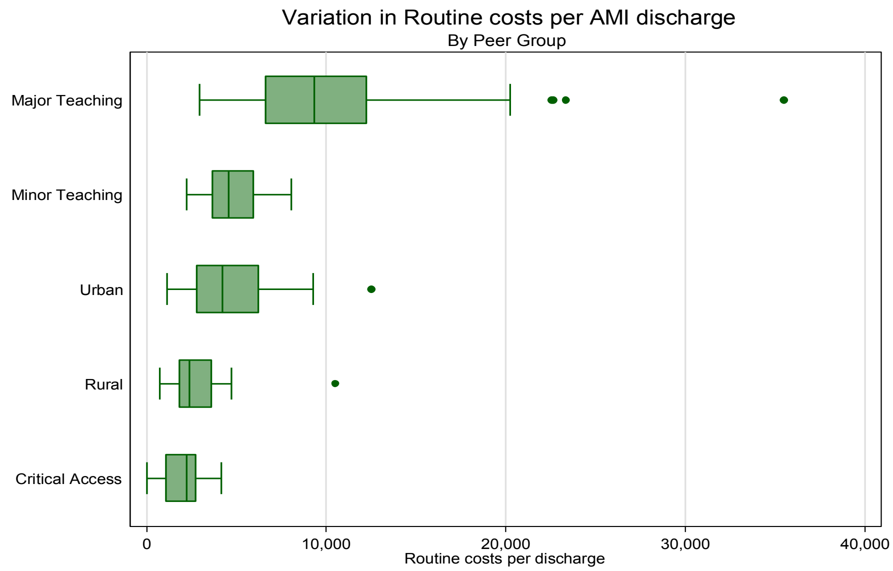
There is a striking difference in mean routine costs for AMI discharges between major teaching hospitals, with costs double any other peer group. As shown in Table 3, the coefficient of variation for routine AMI costs reflects a high degree of variation within and between the peer groups and is highest in the rural and critical access hospitals.

Table 3. Mean Routine Costs for Discharges by Peer Group: AMI

Peer Group	Mean Routine Costs	Standard Deviation	Coefficient of Variation
Major Teaching	$10,399	$5,607	0.539
Minor Teaching	$4,805	$1,601	0.333
Urban	$4,605	$2,258	0.490
Rural	$2,902	$1,929	0.678
Critical Access	$2,120	$1,392	0.657
Total	$6,415	$4,891	0.759

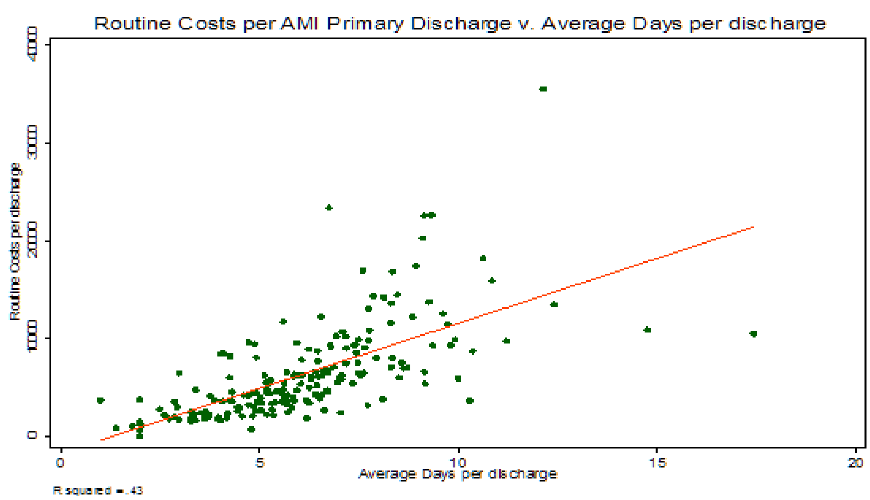
The pattern of cost and variation for routine costs for AMI discharges is shown graphically in Figure 10. Again, the boxes represent the 25^{th} percentile to the 75^{th} percentile of cost. The line represents the mean (the arithmetic average) and between the “whiskers” 90% of values in the sample is included and outliers are represented as individual points.

Figure 10 – Variation of Routine Costs per Discharge: AMI



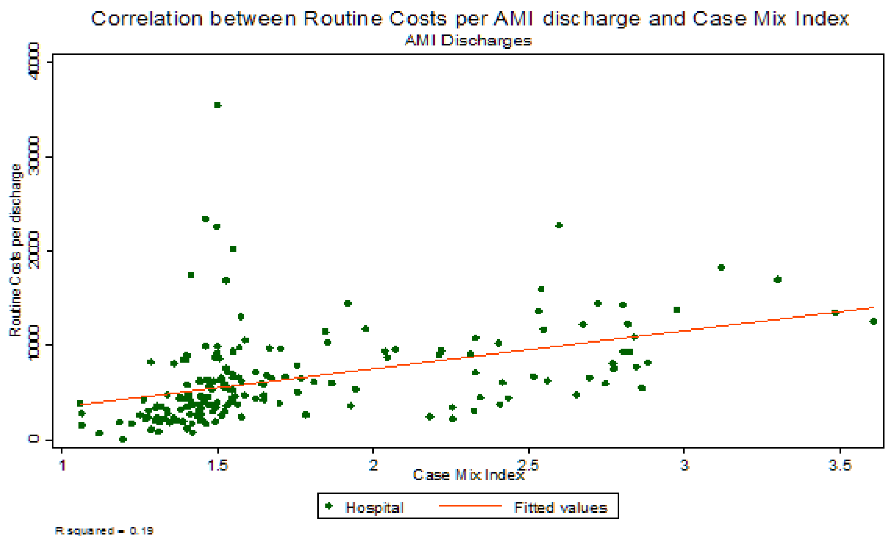
Average days of care account for nearly half of the routine costs, (43%) as seen in Figure 11.

Figure 11 – Correlation of Routine AMI Discharge Costs and Average Days per Discharge



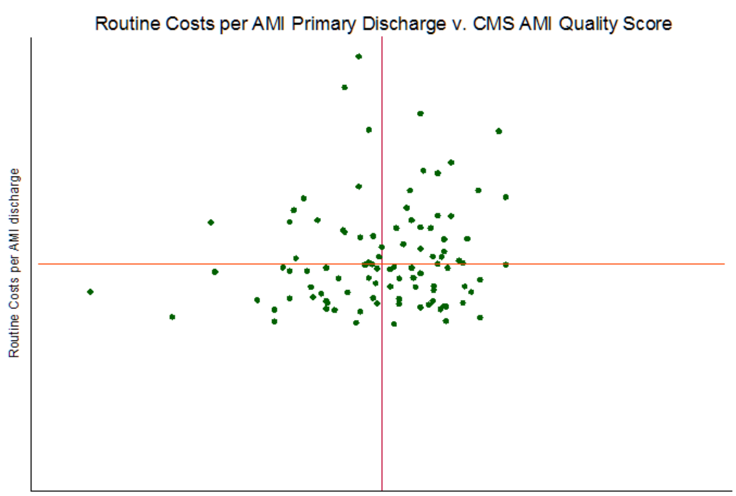
Case mix, however, only accounts for a small portion of the variation in routine costs, (19%) as seen in Figure 12.

Figure 12– Correlation of Routine Costs per AMI Discharge and Medicare Case Mix Index



As was the case with total inpatient costs, routine costs do not appear to be related to quality score for AMI discharges. Figure 13 plots routine costs against the AMI quality score as reported by

Figure 13 – Routine Costs per AMI Discharge v. Quality Score



CMS. As with total inpatient costs, higher routine costs do not appear to be related to quality scores.

Higher routine costs do, however, appear to be explained to a small extent by case mix but, as would be expected, by a higher number of days of care. The degree of variation in length of stay by peer group, which tend to have more consistent case mix indices, suggests that length of stay for AMI patients should be explored as one of the factors driving cost and variation in cost.

Ancillary AMI Costs

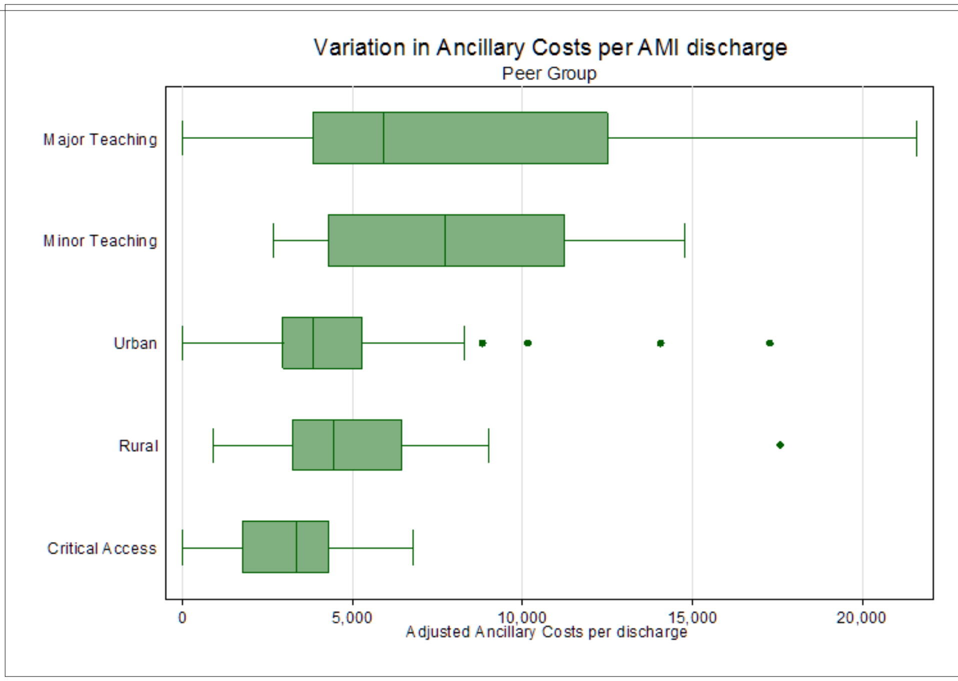
Ancillary costs include services such as surgery or x-rays, for which a separate fee is charged. Table 4 shows the mean ancillary costs and measures of dispersion for AMI discharges. Again, there are material differences between and within peer groups.

Table 4. Mean Ancillary Costs for Discharges by Peer Group: AMI

Peer Group	Mean Ancillary Costs	Standard Deviation	Coefficient of Variation
Major Teaching	$7,951	5,272	0.663
Minor Teaching	$7,966	3,809	0.478
Urban	$4,516	2,764	0.612
Rural	$4,868	3,211	0.672
Critical Access	$3,241	2,202	0.680
Total	$6,101	4,335	0.710

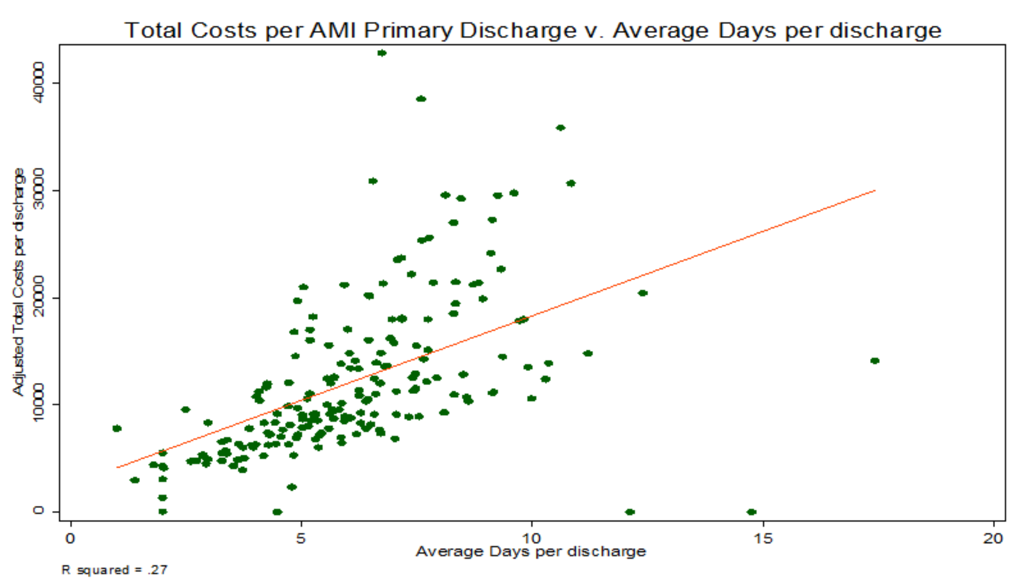
The distribution of ancillary costs for AMI discharges by peer group are displayed graphically in Figure 14.

Figure 14 – Variation of Ancillary Costs per Discharge: AMI



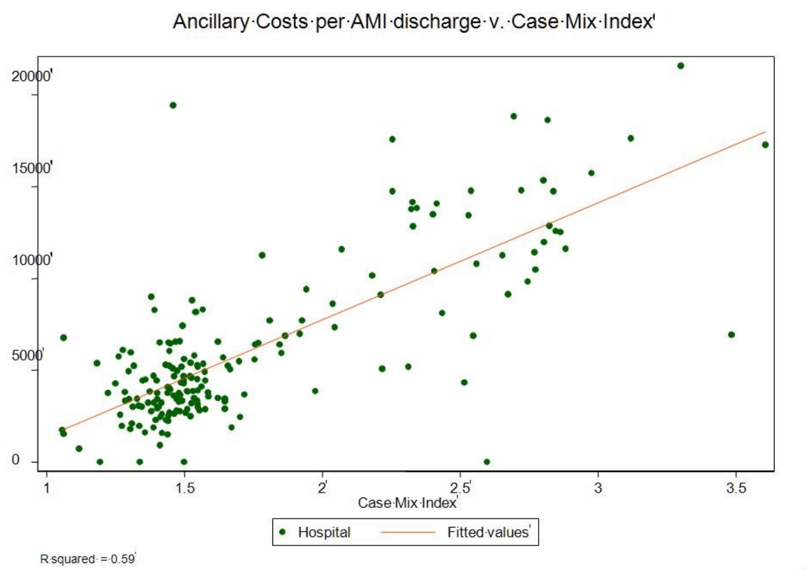
Days of care do not explain much of the ancillary cost. The relationship between days of care and ancillary costs is displayed in Figure 15.

Figure 15 — Correlation of AMI Ancillary Cost and LOS



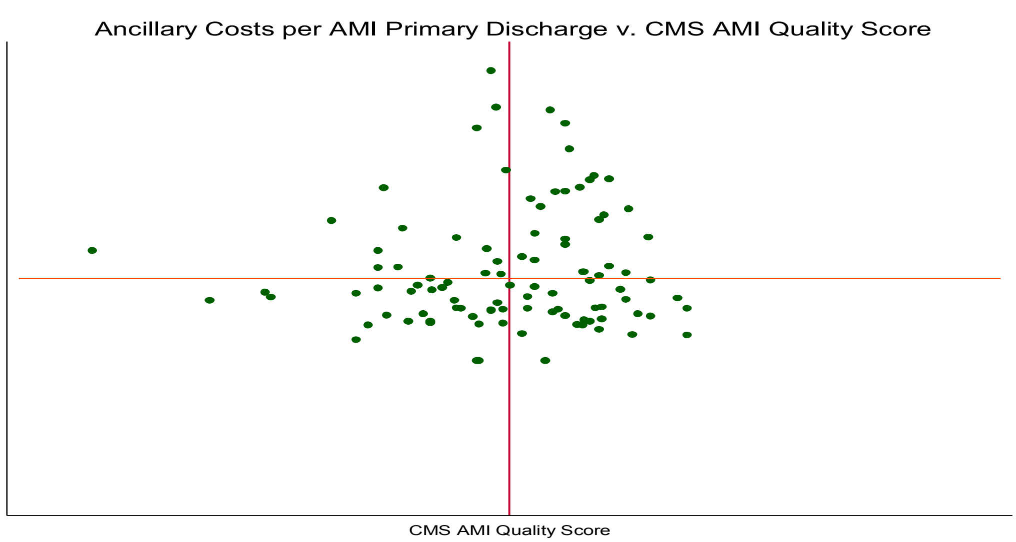
However, there does appear to be a strong relationship between AMI ancillary costs and case mix index. With an R-squared of .59, case mix index explains nearly 60% of the ancillary costs (Figure 16).

Figure 16 – Correlation of Ancillary Discharge Costs and Case Mix Index: AMI



But, as with routine costs, ancillary costs do not appear to be related to quality scores (Figure 17).

Figure 17 – Ancillary Costs per AMI Discharge vs. Quality Score



The ancillary cost centers that showed the highest variation within and peer groups are cardiology, operating room and medical/surgical supplies, as shown in Table 5.

Table 5. Mean of Selected AMI Ancillary Cost Centers			
Cost Center	**Mean**	**Standard Deviation**	**Coefficient of Variation**
Emergency Room	$359	$246	0.685
Radiology	$500	$364	0.728
Laboratory	$1,199	$812	0.677
Cardiology	$1,281	$1,494	1.166
Operating Room	$300	$606	2.02
Inhalation Therapy	$269	$276	1.026
Medical/Surgical Supplies	$984	$1,484	1.508
Pharmacy	$789	$556	0.705

AMI Costs, by Type of Cardiac Program

The modalities employed to treat patients with acute myocardial infarction range from medical management to interventional diagnostic and therapeutic services. Costs vary for the different levels of intervention. In order to isolate the variation in cost within the different levels of inpatient cardiac programs, the hospitals were sorted into four groups: hospitals with non-invasive cardiology, hospitals with diagnostic cardiac catheterization, hospitals offering diagnostic catheterization and angioplasty and those hospitals offering a full range of cardiac care, including surgery. Length of stay, the driver of routine cost, as well as those ancillary costs that would likely be impacted by program type (operating room costs, cardiology costs and medical/surgical supplies) and which also showed high coefficients of variation were analyzed.

The variation in length of stay viewed in the context of the different types of cardiac programs offered suggest that the type of cardiac program does not vary materially (Table 6).

Table 6. Types of Hospital Cardiac Programs and Length of Stay: AMI

Program Type	Number of Hospitals	Length of Stay
Cardiac Surgery (Inclusive)	39	7.16
Diagnostic Catheterization and Angioplasty	51	7.16
Diagnostic Cardiac Catheterization	82	6.91
Non-Invasive Cardiology	145	5.51

However, even though length of stay is quite similar, routine costs vary between program types, with hospitals offering cardiac surgery having costs twice those that offer non-invasive programs. The variation, however, is greater within the category of hospitals offering non-invasive programs. These data are shown in Table 7.

Table 7. Mean Routine Cost per AMI Discharge by Cardiac Program

Cardiac Program	Mean	Standard Deviation	Coefficient of Variation
Cardiac Surgery	$9,160	$4,650	0.508
PCI Angioplasty	$7,308	$2,688	0.368
Catheterization	$7,581	$5,601	0.739
Non-Invasive	$5,101	$4,607	0.903
Total	$6,457	$4,900	0.759

Figure 18 displays the level of variation graphically in routine costs for hospitals offering different kinds of cardiac programs. As can be seen in this data, there is a fair amount of variation in routine costs.

Figure 18 – Variation of Routine Costs per Discharge by Cardiac Program

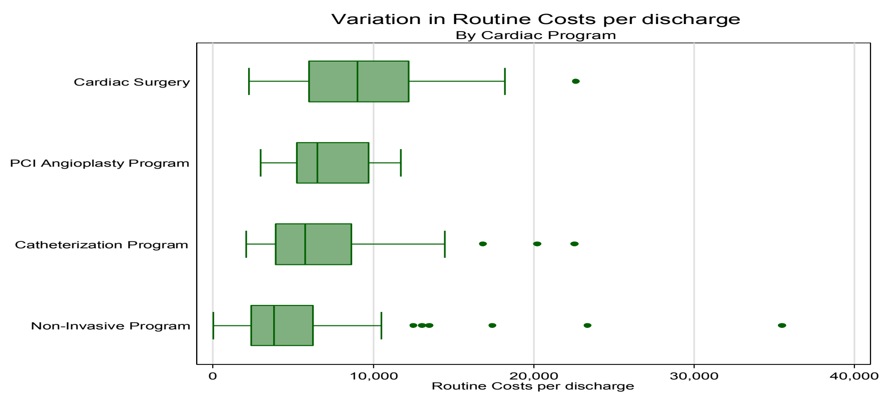


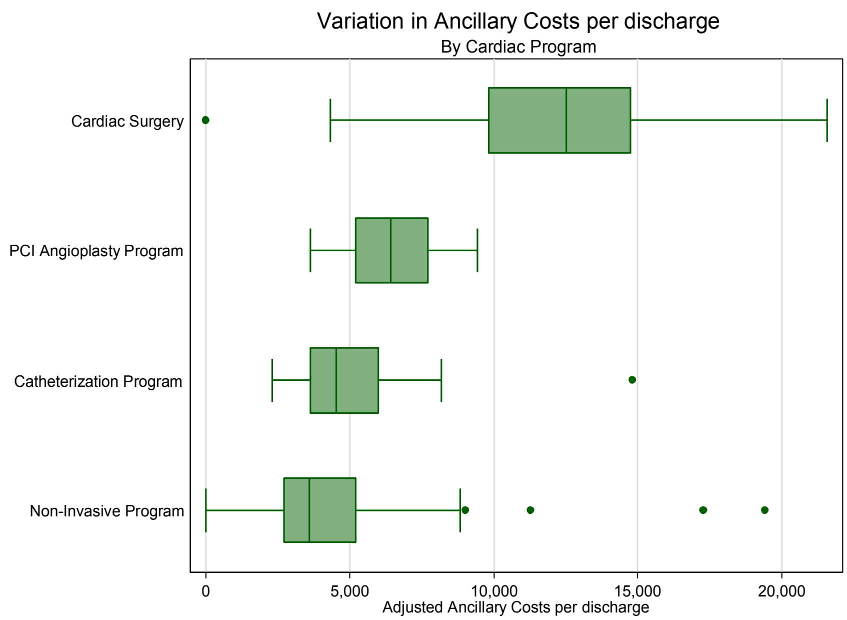
Table 8 displays the mean ancillary cost per discharge for AMI patients, by type of cardiac program. There is a three-fold difference in cost between hospitals with cardiac surgery versus those with no invasive program.

Table 8. Mean Ancillary Cost per AMI Discharge by Cardiac Program

Cardiac Program	Mean	Standard Deviation	Coefficient of Variation
Cardiac Surgery	$12,006	$4,301	0.358
PCI Angioplasty	$6,452	$1,732	0.268
Catheterization	$5,104	$2,548	0.499
Non-Invasive	$4,167	$2,756	0.661
Total	$6,126	$4,352	0.710

Figure 19 shows the degree of variation in these costs. As in the case of routine costs, there is fairly significant variation in total ancillary costs.

Figure 19 – Variation of Total Ancillary Costs per Discharge by Cardiac Program



The three cost centers that would likely vary the most between hospitals with different levels of cardiac program (cardiology, operating room and medical/surgical supplies) were analyzed separately and average cost by are displayed in Tables 9 through 11. As expected, there is a high degree of variation both between and within the four different programs.

Table 9. Cardiac Program Cardiology Costs, Standard Deviation and COV			
Cardiac Program	**Mean**	**Standard Deviation**	**Coefficient of Variation**
Cardiac Surgery	$3,309	$1,891	0.571
PCI Angioplasty	$1,731	$927	0.536
Catheterization	$872	$666	0.764
Non-Invasive	$570	$543	0.953
Total	$1,281	$1,494	1.166

Table 10. Cardiac Program Operating Room Costs, Standard Deviation and COV			
Cardiac Program	**Mean**	**Standard Deviation**	**Coefficient of Variation**
Cardiac Surgery	$1,107	$900	0.813
PCI Angioplasty	$242	$245	1.012
Catheterization	$89	$152	1.708
Non-Invasive	$62	$163	2.629
Total	$300	$606	2.02

Table 11. Cardiac Program Med/Surg Supplies Costs, Standard Deviation, and COV			
Cardiac Program	**Mean**	**Standard Deviation**	**Coefficient of Variation**
Cardiac Surgery	$2,971	$1,737	0.585
PCI Angioplasty	$1,317	$1,103	0.838
Catheterization	$484	$1,035	2.138
Non-Invasive	$325	$621	1.911
Total	$984	$1,484	1.508

Summary – Acute Myocardial Infarction

There is variation between the hospital and peer groups in costs at every level. Routine costs tend to be explained somewhat by length of stay and ancillary costs are partially explained by case mix index. Quality scores are not related to cost at any level. Some of this variation is explained by the type of cardiac program —the costs and variation between different types of cardiac programs are even greater than between peer groups. Comparisons of hospitals must take into consideration both peer group and type of cardiac program.

Congestive Heart Failure (CHF)

This section of the study examines patterns of cost for patients discharged with a primary diagnosis of congestive heart failure. There are over 49,294 cases in the population studied.

While the patterns of cost are similar in the CHF discharge population to the AMI population, the variation in total cost between and within hospital peer groups for primary CHF discharges is somewhat smaller than we found with primary AMI discharges. However, the characteristics we were able to analyze contributed little to our understanding of variation. Specifically:

- Length of stay and case mix explained little of the variation; and

- As was observed with AMI, there is no apparent relationship between total cost and CMS quality score.

When routine costs are examined separately, the findings are similar. Days of care explain a little more (R-squared of .38), of the variation in cost.

Ancillary costs were segregated and analyzed and the findings are similar to the total cost except rather than length of stay (which explained none of the difference), case mix index is the characteristic that explains a substantial portion of the variation (R-squared of .48).

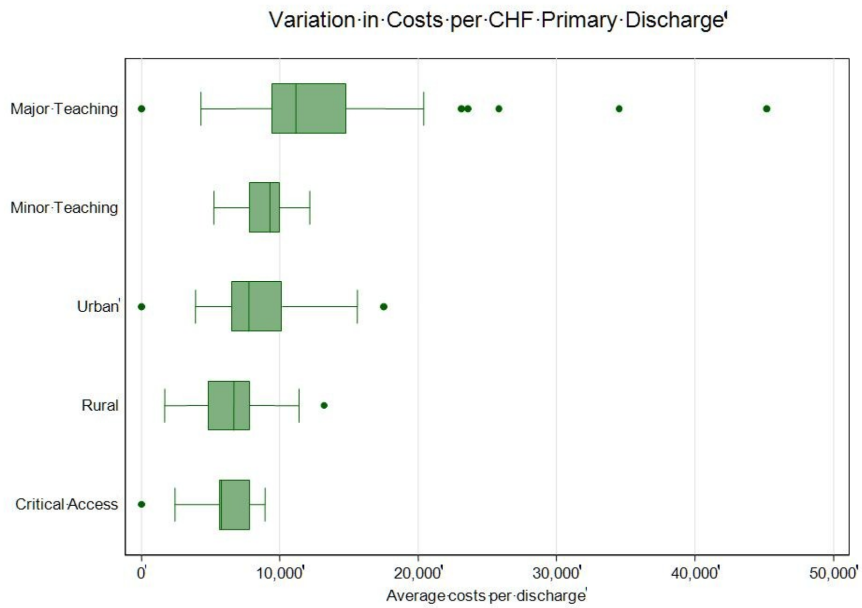
Mean inpatient costs per CHF discharge show a variation in cost between in peer group hospitals (Table 12).

Table 12. Mean Inpatient Costs per Discharge: CHF

Peer Group	Mean	Standard Deviation	Coefficient of Variation
Major Teaching	$12,640	$6,529	0.517
Minor Teaching	$9,019	$1,632	0.181
Urban	$8,382	$2,877	0.343
Rural	$6,724	$2,737	0.407
Critical Access	$5,787	$2,904	0.502
Total	$9,662	$5,108	0.529

Figure 20 displays the variation in total costs by peer group for CHF. Again, the boxes represent the 25th percentile to the 75th percentile of cost. The line represents the mean (the arithmetic average) and between the "whiskers" 90% of values in the sample is included and outliers are represented as individual points. While the patterns are similar as observed with AMI, there is less varia-

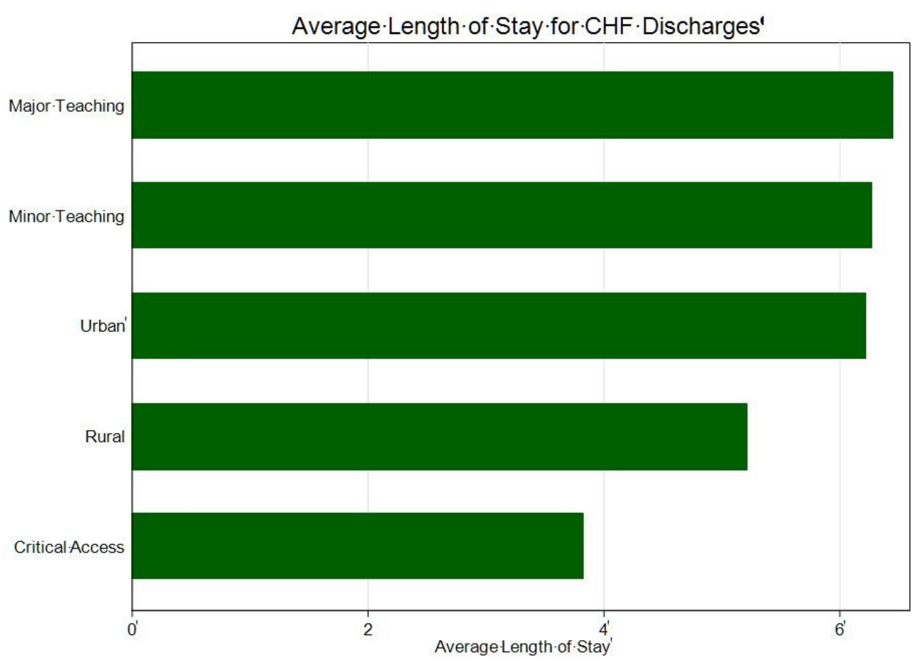
Figure 20 – Variation in Costs per Primary Discharge: CHF



tion in all groups, particularly with regard to minor teaching hospitals, than with AMI discharges.

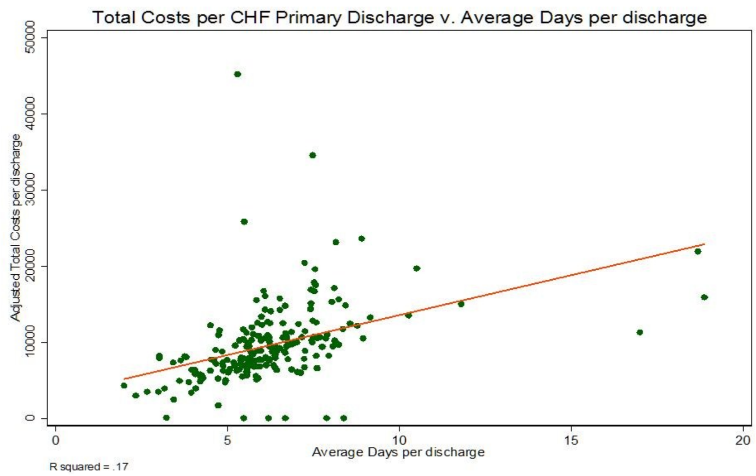
Average length of stay for CHF discharges, displayed in Figure 21, does not show substantial differences, particularly for patients in the two teaching and urban hospital peer groups.

Figure 21 – Average Length of Stay for Discharges by Peer Group: CHF



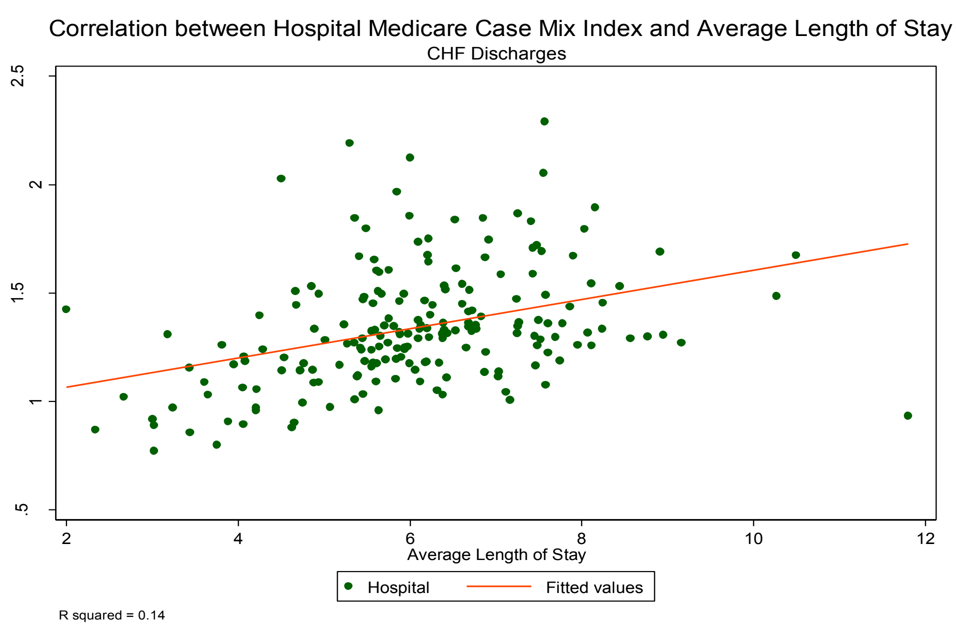
Average days of care explain only a small portion of total cost, as displayed in Figure 22 (17%).

Figure 22 – Correlation of Total Discharge Costs and Average Days per Discharge: CHF



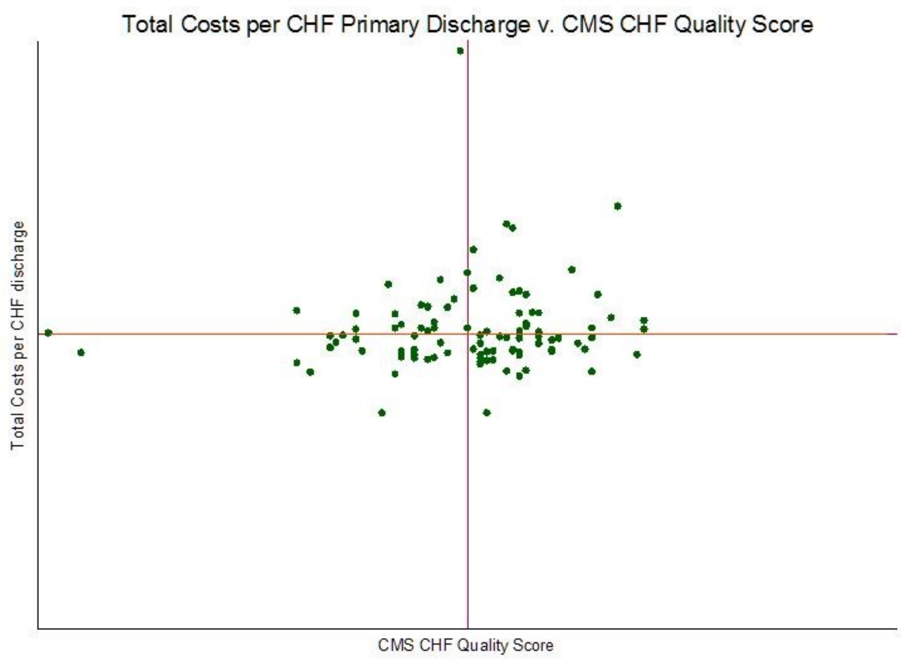
The Medicare case mix index contributes only a small part of the explanation in difference in length of stay, as shown in Figure 23 (14%).

Figure 23 – Correlation of Medicare Case Mix Index and Average Length of Stay: CHF



There does not appear to be any relationship between cost and quality for CHF for those hospitals which submitted a quality score to CMS. Figure 24 demonstrates the relationship between mean costs per discharge and the mean quality score reported to the CMS. The intersection of the vertical and horizontal lines represents the mean quality score and mean cost per discharge; the distribution of the data suggests virtually no relationship between the quality and cost per discharge, consistent with the finding for AMI.

Figure 24 – Total Inpatient Costs per Discharge vs. Quality Score: CHF



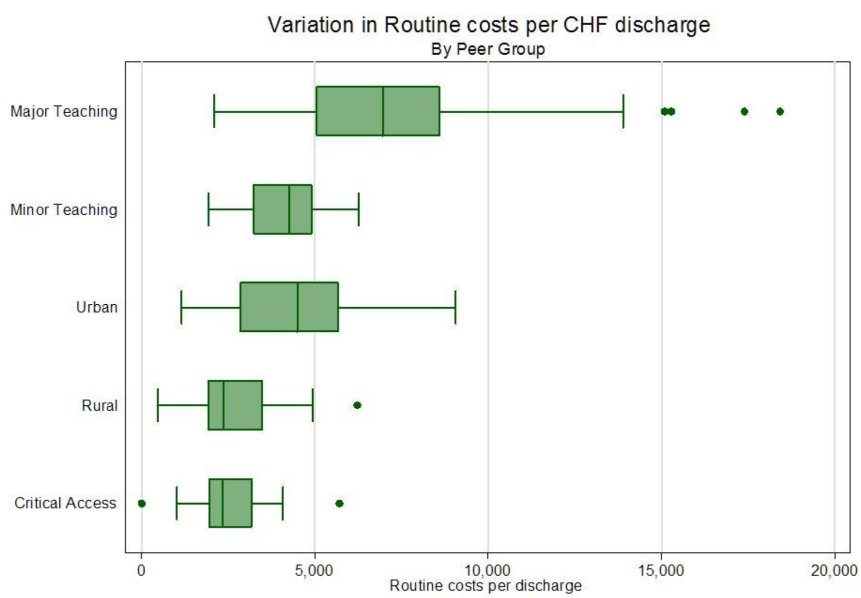
Routine CHF Costs

Average routine costs for teaching hospitals are nearly triple that of rural and critical access hospitals and minor teaching and urban routine costs are nearly double the cost of the two least costly peer groups, as shown in Table 13.

Table 13. Mean Costs for Routine Discharges by Peer Group: CHF			
Peer Group	Mean Routine Costs	Standard Deviation	Coefficient of Variation
Major Teaching	$7,546	3,372	0.447
Minor Teaching	$4,175	1,234	0.296
Urban	$4,483	1,749	0.390
Rural	$2,751	1,293	0.470
Critical Access	$2,533	1,665	0.657
Total	$5,237	3,044	0.581

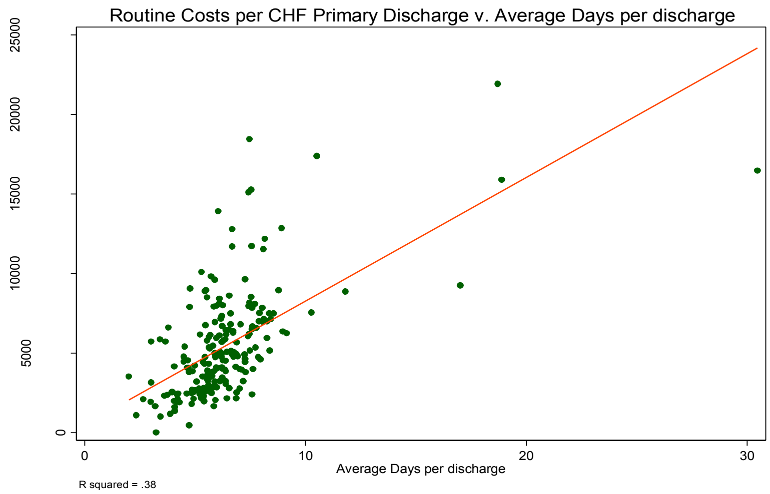
As Figure 25 shows, there is some variation in routine costs within and between peer groups with the largest variation in the major teaching and urban per groups.

Figure 25 – Variation of Routine Costs per CHF Discharge



There is some correlation between routine costs and days of care (38% of variation accounted for), as shown in Figure 26. It is

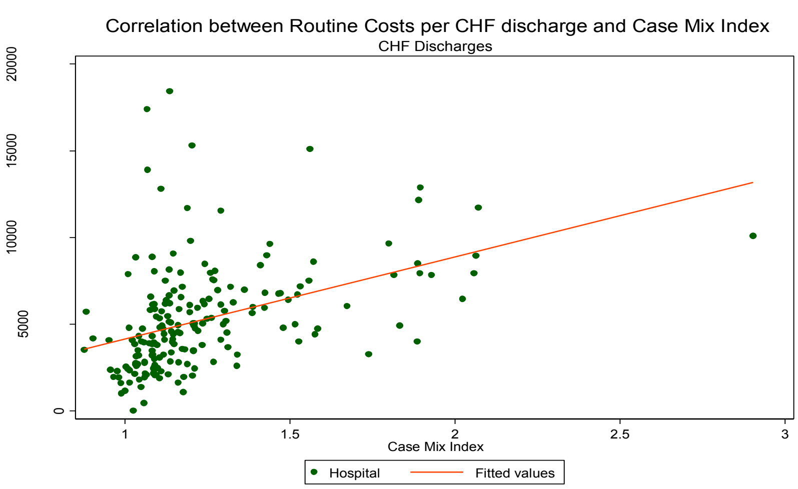
Figure 26 – Correlation of Routine CHF Discharge Costs and Average Days per Discharge



logical that there would be a relationship between routine costs and days because days consumed drives attribution of routine costs.

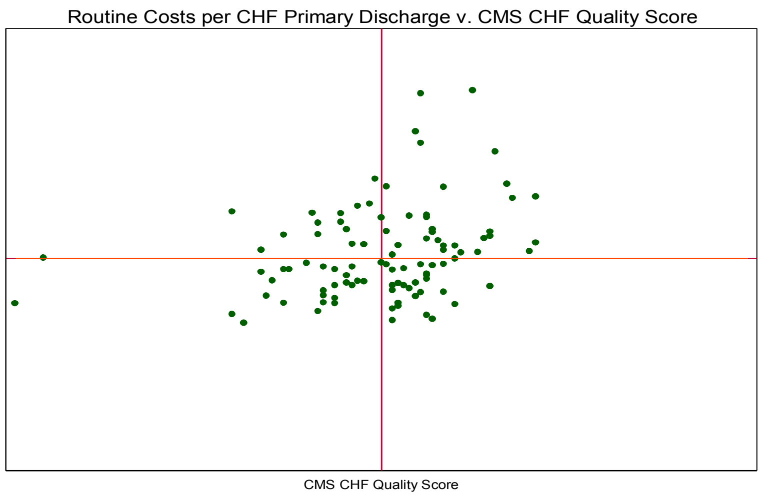
There is only a small relationship between routine cost per CHF discharge and Medicare case mix index, as shown in Figure 27 (18%).

Figure 27 - Correlation of Routine Costs per CHF Discharge and Medicare Case Mix Index



As in the case of the AMI patients studied, there appears to be no relationship, as shown in Figure 28, between average routine cost and quality score.

Figure 28 – Routine Costs per CHF Discharge vs. Quality Score



Ancillary CHF Costs

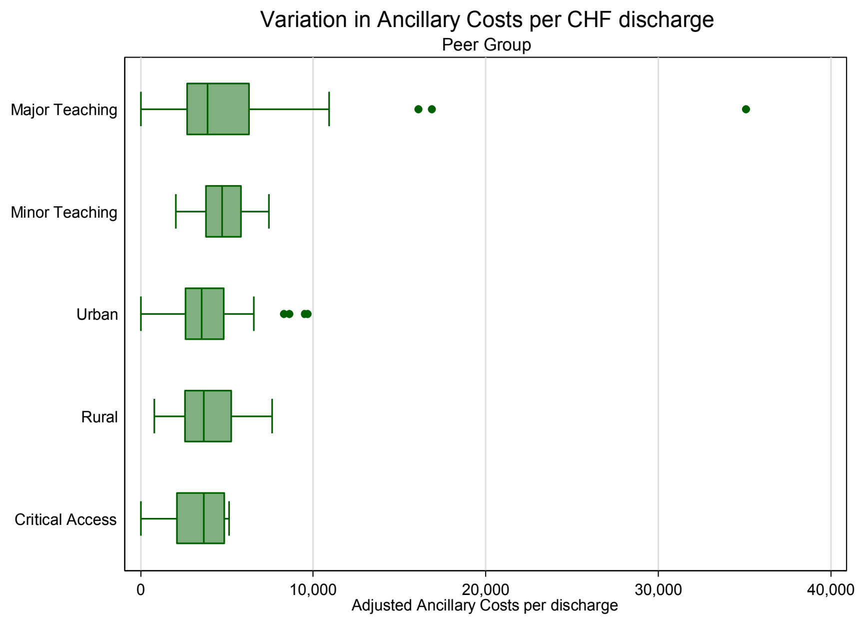
Mean ancillary costs for CHF patients do not vary greatly between the peer groups, as shown in Table 14.

Table 14. Mean Costs for Ancillary Discharges by Peer Group: CHF

Peer Group	Mean Ancillary Costs	Standard Deviation	Coefficient of Variation
Major Teaching	$5,269	$4,789	0.909
Minor Teaching	$4,843	$1,497	0.309
Urban	$3,937	$1,833	0.466
Rural	$3,978	$1,908	0.490
Critical Access	$3,254	$1,760	0.541
Total	$4,488	$3,297	0.736

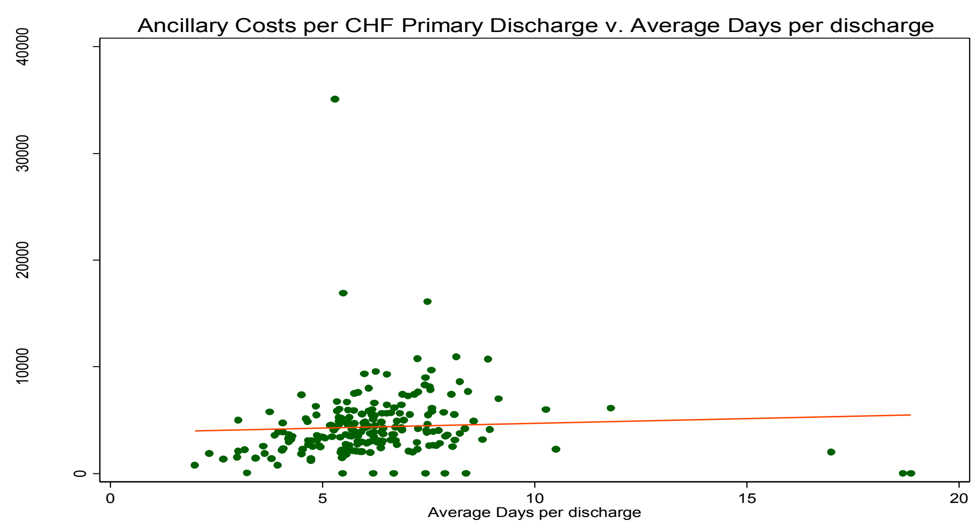
However, the variation in ancillary costs is much higher in the major teaching peer group, compared to the others, as shown in Figure 29.

Figure 29 – Variation in Ancillary Costs per CHF Discharge



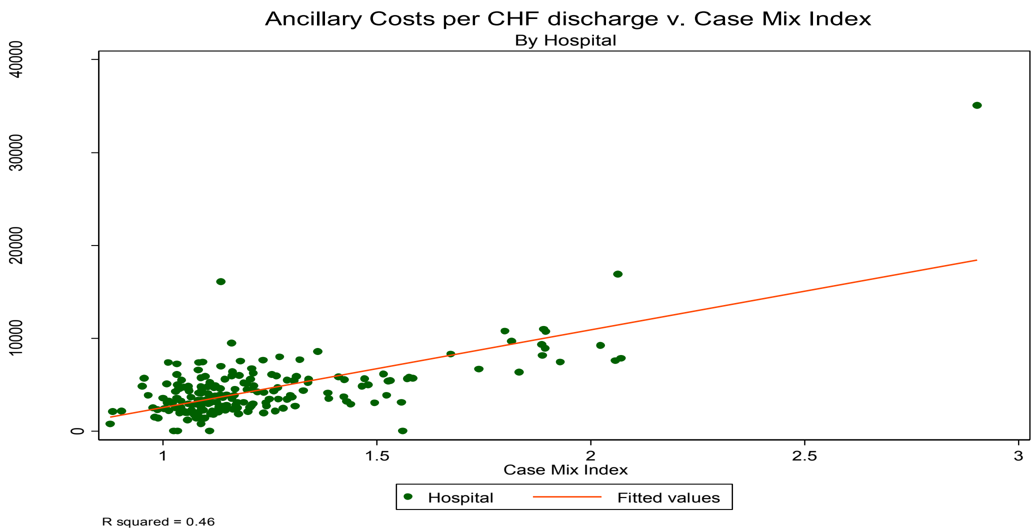
Days of care explain none of the relationship between ancillary costs for CHF discharges, as is shown in Figure 30.

Figure 30 – Correlation of Ancillary CHF Discharge Costs and Average Days per Discharge



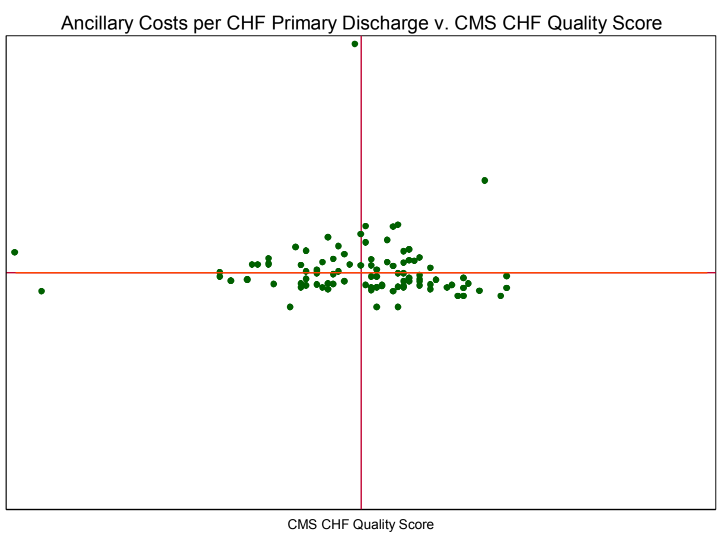
However, Medicare case mix is fairly strongly correlated to average ancillary cost for primary CHF discharges, (46% of variation accounted for), as shown in Figure 31.

Figure 31 – Correlation of Ancillary CHF Discharge Costs and Case Mix Index



As in all of the earlier analyses, quality score is not associated with average ancillary costs, shown in Figure 32.

Figure 32 – Ancillary Costs per CHF Discharge vs. Quality Score



To gain a fuller understanding of some of the factors behind ancillary cost patterns, a more detailed analysis of ancillary cost centers was developed. Table 15 separates the average ancillary costs into their respective cost centers and shows the variation within these cost centers. Coefficients of variation confirm that the level of variation in some of these cost centers is significant,

Table 15. Mean of Selected Ancillary Cost Centers: CHF

Cost Center	Mean	Standard Deviation	Coefficient of Variation
Emergency Room	$327	$211	.645
Radiology	$405	$243	.600
Laboratory	$984	$621	.631
Cardiology	$597	$1,075	1.800
Operating Room	$184	$565	3.070
Inhalation Therapy	$264	$232	.879
Medical/Surgical Supplies	$787	$1,582	2.010
Pharmacy	$567	$434	.765

Summary – Congestive Heart Failure

There is variation between the hospital and peer groups in costs at every level. Routine costs tend to be explained somewhat by length of stay and ancillary costs are partially explained by case mix index. Quality scores are not related to cost at any level.

Qualitative Study

In order to explore and understand the reasons behind the variation in cost that was observed, we undertook a qualitative study that involved site visits to hospitals to conduct interviews with key leadership, both clinicians and administrators. The objective of the site visits was to identify some of the reasons behind variation and to determine if there are actions that might be taken by the hospitals to reduce unnecessary variation and the associated cost.

Methods

A convenience sample of hospitals was selected for a site visit. The criteria for the selection included classification of either a major or minor teaching hospital, location in upstate New York and offering a full spectrum of cardiology services as well as agreeing to participate in the study. A total of six hospitals were included in the study.

A monograph that detailed and graphically displayed the patterns of costs for AMI and CHF discharges and, in addition to showing the cost and variation for these conditions, relates the cost to days of care, case mix index (CMI), and hospital reported quality measures for each hospital was prepared.

A multivariate regression analysis on the costs per discharge was performed. The purpose of the analysis was to control for the variables outside of hospital characteristics. The dependent variables were total, routine, total ancillary as well as each of the eight ancillary cost centers which represent the bulk of ancillary cost per discharge. The independent variables were percentage female Medicare discharges, percentage black Medicare discharges, total hospital discharges, patient age group, Medicare case mix index, average total hospital Medicare case mix index, city status (whether in New York City), peer group indicators (for CHF) or cardiac program indicators (for AMI).[1] In this manner, we were able to calculate a 'predicted' cost for individual hospital.

Using a structured protocol, interviews were conducted with hospital leadership. A team of researchers, including a health administrator, economist and a physician, met with hospital leadership. The hospital leadership represented executive management, clinical, nursing and medical leadership as well as medical staff members practicing cardiovascular medicine.

Findings

The interview protocol began with a formal power point of study methodology and the findings specific to the individual hospital. Anonymity was assured.

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1. The linear regression formula is as follows:

$$Cost\ per\ discharge_j = \boldsymbol{X}_j{}'\ \ \boldsymbol{\beta} - \boldsymbol{Z}_j{}'\gamma - \epsilon_j$$

X is a vector of patient characteristics, while **Z** is a vector of average hospital characteristics. β is the idiosyncratic hospital error term. The coefficients beta and gamma were estimated through an ordinary least squares regression analysis, and predicted values for each hospital were obtained by storing the coefficients and inserting the hospital specific numbers into the formula.

Shafrin, Jason. "Operating on Commission: Analyzing How Physician Financial Incentives Affect Surgery Rates" *Health Economics* 19: 562-580 (2010).

Data was gathered relative to such structural characteristics as the presence or absence of an electronic medical record, computerized physician order entry, clinical order sets and hospital owned or affiliated home care and nursing home resources. The structure of the medical staff was explored. The role of the medical director (chief medical officer) relative to clinical and administrative management was discussed. The role of hospitalists in the care of inpatients was reviewed. The relationships between primary care and specialist physicians and the hospital were discussed to determine if referring and admitting physicians were employees or independent attendings. Finally, the relationship between invasive cardiologists and cardiovascular surgeons and the hospital was explored to determine extent to which financial incentives were present.

The clinical process of care for patients with diagnoses of both acute myocardial infarction and congestive heart failure was explored from presentation to the emergency department or referral by the primary care physician through discharge.

We were not able to categorize hospitals into any sort of typology that was predictive of a particular cost or quality pattern. All the hospitals scored well on the CMS quality indicators but the costs for both CMI and CHF at the total, routine and ancillary levels (actual compared to peers and predicted) had no consistent relationship to any of the hospital characteristics discussed above. The reasons for high or low costs were particular to individual hospitals. Length of stay consistently related to routine costs but the reason for higher or lower length of stay was not explained by any characteristic, structural or process, that we could identify.

We hypothesized that fee for service payment patterns for invasive cardiologists and cardiovascular surgeons would be related to high cardiology costs but found no consistent relationship (Shafrin, 2010). Our data, however, does not offer a window on the impact on the number of cases or procedures but the average cost for a patient served by the physician.

Nearly without exception, the hospitals said that the data we provided in the monograph provided a very useful framework for them to think through their individual cost profile. One hospital, publicly sponsored, understood that their costs were systematically higher because of the costs of public employment but identified an ancillary cost center where costs might be moderated by introducing a more focused approach to supervising resident physician's ordering patterns. Another hospital indicated that they were going to re-examine the case management and discharge planning processes to see how length of stay might be decreased to decrease routine costs. And another hospital planned to analyze their cost allocation processes to determine if their relatively higher medical/surgical supply cost and lower routine costs is a result of cost finding or whether there were interventions that could be employed to reduce supply costs.

Overall, our findings are consistent with earlier research that showed that the resources used in the care of chronically ill patients varies widely and that the reasons behind this variation is not easily or crisply explained (Baker et al, 2008). In fact, after performing the six interviews and reviewing the discussions, our research team came to the conclusion that the unique geographic, marketplace, workforce, culture and general characteristics of each hospital limit finding a common thread to explain either quality of care or resource utilization performance. A recent qualitative study did find that a quality improvement organizational culture was found in higher hospitals with lower AMI mortality rates; however, our study added in the dimension of resource utilization and was not able to find any common theme with both high and low performers advocating improvement efforts (Curry et al. (2011). We agree that hospital culture plays a critical role and we anecdotally noted different degrees of openness to unfavorable data from the various hospital leadership teams, ranging from viewing the data as a springboard for improvement, to highly critically dismissal of the data. These cultural differences were difficult to measure in our study, but did seem to be a factor in hospital performance.

Summary

What we were left with at the end of this analysis was that each hospital has a unique environment and requires a unique approach to improving the value of their healthcare. All of these approaches can be aided by data. Our findings and the dissemination of our findings to individual hospitals did show that when hospitals have comparative data within which to view their own cost patterns, they are able and willing to identify strategies that might lead to higher value healthcare with better quality and lower utilization. Quality improvement should be done on an individual hospital level, guided by the best available data, and performed in the context strong leadership support.

Glossary

Coefficient of Variation (COV) is a mathematical term that is used to describe variation. The COV is a unitless measure of dispersion from the mean. The formula for the COV is the standard deviation divided by the mean. A coefficient of variation with a value of 2 indicates that the average distance of a point in the data is twice the value of the mean of the data. Similarly, a COV of zero would indicate that all of the points in the data are the mean value itself (no variation).

Cost Centers: The cost centers that we chose to study were the eight highest cost centers. These cost centers comprised 93 percent of all ancillary costs. The cost centers are defined as follows:

Emergency Room costs include, but are not limited to: EM/EMTALA; ER/Beyond EMTALA; Urgent Care; other emergency costs.

Radiology costs include, but are not limited to: angiocardiography; arthrography; arteriography; chest x-ray; radiation therapy; Diagnostic Radiopharms; Therapeutic Radiopharms; CT Scan (Head and Body); Diagnostic Mammography; Ultrasound; Screening Mammography; PET scan; Magnetic Resonance Imaging; and other diagnostic imaging.

Cardiology costs include, but are not limited to: angiocardiography; cardiac catheter lab; stress test; echocardiology; EKG/ ECG; Holter monitor; telemetry; EEG; Cardiac rehab; and other cardiology services.

Operating Room costs include, but are not limited to: operating room services; minor surgery; organ transplant (including kidney); ambulatory surgery; and electroshock therapy.

Inhalation Therapy costs include, but are not limited to: inhalation services; hyperbaric oxygen therapy; and other respiratory services.

Medical/Surgical Supplies costs include, but are not limited to: non-sterile supplies; sterile supplies; take home supplies; prosthetic/orthotic devices; pacemakers; intraocular lens; other implants; other supplies/devices.

Pharmacy costs include, but are not limited to: generics; non-generics; experimental drugs; non-prescriptions; IV solutions and other pharmaceutical services.

Laboratory costs include, but are not limited to: Diagnostic chemistry; immunology; non-routine dialysis, home dialysis; hematology; bacteriology/microbiology; urology; cytology; histology; biopsy; pap smear; allergy test; pregnancy test; and other laboratory services.

Data Inflation: Data from St. Louis Federal Reserve/FRED was downloaded including CPI for years 1947-2010 as a monthly time series. The CPI for the midpoint year of the DA data (2003) was selected as the base year. CPI monthly values were averaged to yield an annual CPI. The ratio of 2003 data divided by its index value to 2008 divided by its index value provided the value at which to adjust DA data. In this case, the DA data was inflated 1.16 times its 2003 value.

Diagnosis-related group (DRG) is a system to classify hospital cases into one of approximately 500 groups, also referred to as DRGs, expected to have similar hospital resource use, developed for Medicare as part of the prospective payment system. DRGs are assigned by a "grouper" program based on ICD diagnoses, procedures, age, sex, discharge status, and the presence of complications or comorbidities. DRGs have been used in the

US since 1983 to determine how much Medicare pays the hospital, since patients within each category are similar clinically and are expected to use the same level of hospital resources.

The **Disproportionate Share (DSH)** adjustment provision was part of the Consolidated Omnibus Budget Reconciliation Act (COBRA) of 1985 and payments took effect May 1, 1986. The primary purpose of DSH is to assist hospitals that provide a large amount of charity care or use Medicare/Medicaid services. DSH payments are determined in one of two ways. The first is a formula that calculates the DSH patient percentage. Hospitals that exceed 15 percent for the DSH Patient Percentage are eligible for a DSH payment that is derived using another formula that takes into account various location factors. The second way to qualify for DSH payments is through a special exception for large urban hospitals that can prove that over 30 percent of their net total inpatient care revenues come from state and local governments for providing indigent care.

Graduate Medical Education (GME) payments are also part of COBRA 1985 and were established to help teaching facilities pay for the high costs of training residents. Like DSH, GME payments are calculated through a series of formulas that take into account the cost of training residents in teaching facilities. The hospital may in some cases include training costs in a non-hospital setting if the hospital incurs all or nearly all of the costs of that training. Additionally the hospital must have a written agreement with that non-hospital setting.

Hospital referral regions (HRRs) are regional market areas for tertiary medical care. Each HRR contains at least one hospital that performs major cardiovascular procedures and neurosurgery. (DartmouthAtlas.org)

Hospital service areas (HSAs) are local health care markets for hospital care. HSAs are comprised of those zip codes from which each hospital in a state draws its patients. HRRs include one or more HSAs that include the hospital or hospitals most often used by residents of the region for both major cardiovascular surgeries and neurosurgeries. (DartmouthAtlas.org)

Metropolitan and Micropolitan Statistical Areas are defined by the United States Office of Management and Budget (OMB). A metropolitan statistical area consists of at least one urbanized area of 50,000 or more inhabitants, while a micropolitan statistical area consists of at least on urban cluster of at least 10,000 inhabitants but fewer than 50,000. A **Core Based Statistical Area (CBSA)** is an aggregation of both micropolitan and metropolitan areas; counties are included in the CBSA if at least fifty percent of the population of the county resides within the urban area. A complete list of metropolitan, micropolitan, and CBSAs can be found on the census website (Census.gov).

Outlier payments, also established by COBRA 1985, are made to Medicare participating hospitals that incur extraordinarily high costs for a given case. To qualify for an outlier payment, a case must have costs above a fixed-loss cost threshold amount (a dollar amount by which the costs of a case must exceed payments in order to qualify for outliers). For Federal fiscal year 2005, the existing fixed-loss outlier threshold was $25,800.

Peer Group Definitions	
Major Teaching	Greater than 100 Residents or Intern-Residents to Bed Ratio > .25
Minor Teaching	Between 10 and 100 Residents or Intern-Residents to Bed Ratio Between .05 and .25
Urban	CBSA Designated Urban Area (see glossary)
Rural	CBSA Designated Rural Area
Critical Access	Provides no more than 25 inpatient beds that can be used for either inpatient or swing bed services, has an annual length of stay greater than 96 hours and is located more than 35 miles from the nearest hospital

Peer groups used in this study—major teaching, minor teaching, urban, rural, and critical access—were originally derived from CMS definitions, and were later modified by the Hospital Association of New York State (HANYS). The split between major teaching institutions versus minor teaching institutions was done to ensure that hospitals downstate would continue to be compared to hospitals in other major cities as opposed to institutions in smaller areas. For the purposes of this analysis, specialty hospitals (children’s hospitals, rehabilitation facilities and psychiatric hospitals) were excluded.

Ratio of Costs to Charges: for each facility, total departmental charges are calculated from the SPARCS data and then compared to the corresponding departmental charges reported on the Medicare Cost Report (HCRIS). If the departmental charges from both sources are within a reasonable corridor of confidence, a cost-to-charge ratio is calculated using the departmental costs as reported on the Medicare cost report. When the deviation in total charges between the two sources is too great, overall ancillary and routine cost-to-charge ratios are calculated using the reported ancillary and routine charges and costs on the Medicare cost report. A table of facility/departmental specific cost-to-charge ratios will then be prepared and, for each record on the SPARCS database, costs calculated by applying the appropriate cost-to-charge ratio to the record level departmental charges.

Routine services are defined as "the regular room, dietary and nursing services, minor medical and surgical supplies, and the use of equipment for which a separate charge is not customarily made”. **Ancillary services** are items as operating room time or x-rays, for which a separate fee is charged. **Ancillary cost centers** include: Medical Surgical Supplies, Laboratory, Cardiology, Pharmacy, Radiology, Operating Room, Emergency Room, Inhalation Therapy, Other, Physical Therapy, Professional Services, Organ Acquisition, ESRD, Blood, Occupational Therapy, MRI, Anesthesia, Speech Pathology, Outpatient Services, Clinic Visits, and Ambulance.

Hospital Compare Summary Quality Scores. The Dartmouth Atlas uses the Center for Medicare and Medicaid Services (CMS) Hospital Compare Summary Quality Scores, which are relatively simple to compute. The **Composite Quality Score** is composed of two distinct elements: the composite process score and the composite outcome score. The composite process score is composed of a process rate and a weight determined by the CMS, while the composite outcome score is derived by comparing the ratio of deceased to the predicted deceased for each hospital and then multiplied by the weight assigned by the CMS. In the AMI case, the survival index receives a weight of 1/9 and the process score receives a weight of 8/9. That is, the process score counts as 88.9% of a hospital's AMI quality score; the survival index accounts for the last 11% of the hospital's score. Both conditions (CHF and AMI) studied are assigned a short list of treatments for patients upon arrival and discharge that represent hospital optimal behavior. These treatments are assigned equal weight for the patient and are treated as binary actions for the individual. For example, if an AMI patient enters the hospital and is both eligible for and given aspirin at arrival, the hospital receives a 1 out of 1 score for the patient for that treatment. If the patient is not given aspirin but is eligible, the hospital receives a 0 out of 1 for this treatment and this patient. Each patient receives an amount of treatment that may or may not be optimal and is assigned a score. The numerators and denominators are then added for all patients. This is called the composite process rate. This rate is multiplied by 100 and the pre-assigned weight for the composite process score. A hospital composite quality score is computed by computing a hospital-specific risk-adjusted mortality rate. A pre-existing probability of death for a condition is specified by The Joint Commission. The probability of death for each patient is computed by adding the probability of death for each condition that the patient exhibits. The patient probabilities are averaged to create a hospital specific risk adjusted mortality rate.

Wage Adjustment: To wage-adjust the cost center data, the proportion of each cost center's expenditures that are associated with wages and salaries was calculated. These proportions were calculated from data in the Medicare cost reports. A wage index to the salary costs in each cost center was applied and these adjusted costs were added to the unadjusted non-salary costs for each department. This yielded a wage adjusted measure of ancillary cost for each cost center in each hospital. The Bureau of Labor Statistics (BLS) estimates of average wages among health care support workers as defined by Standard Occupational Classification (OCC Code 31-0000) were compiled. The BLS calculated the average wage estimates using data from the National Compensation Survey, the

Occupational Employment Statistics Survey, and the Current Population Survey. Separate estimates of average wages were available for a set of 14 metropolitan and 3 non-metropolitan regions in New York State. The regions are the Core Based Statistical Areas (CBSA) defined by the Office of Management and Budget. A cross-walk of counties to CBSA regions that was available on the BLS website was used. To facilitate the analysis of hospital costs, we computed a regional wage index by dividing each regions average hourly wage for health care support workers by the average hourly wage for health care support workers in New York City. Thus the wage costs are adjusted relative to New York City wage levels.

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