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Spending more, doing more, or both? An alternative method for quantifying utilization during hospitalizations

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Abstract

Background—Because Relative Value Unit (RVU)-based costs vary across hospitals, it is difficult to use them to compare hospital utilization.

Objective—To compare estimates of hospital utilization using RVU-based costs and standardized costs.

Design—Retrospective cohort

Setting and Patients—2009–2010 heart failure hospitalizations in a large, detailed hospital billing database that contains an itemized log of costs incurred during hospitalization.

Intervention—We assigned every item in the database with a standardized cost that was consistent for that item across all hospitals.

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Measurements—Standardized costs of hospitalization vs. RVU-based costs of hospitalization.

Results—We identified 234 hospitals with 165,647 heart failure hospitalizations. We observed variation in the RVU-based cost for a uniform “basket of goods” (10th percentile cost \$1,552; 90th percentile cost of \$3,967). The interquartile ratio (Q75/Q25) of the RVU-based costs of a hospitalization was 1.35 but fell to 1.26 after costs were standardized, suggesting that the use of standardized costs can reduce the “noise” due to differences in overhead and other fixed costs. Forty-six (20%) hospitals had reported costs of hospitalizations exceeding standardized costs (indicating that reported costs inflated apparent utilization); 42 hospitals (17%) had reported costs that were less than standardized costs (indicating that reported costs underestimated utilization).

Conclusions—Standardized costs are a novel method for comparing utilization across hospitals and reduce variation observed with RVU-based costs. They have the potential to help hospitals understand how they use resources compared to their peers and will facilitate research comparing the effectiveness of higher and lower utilization.

Keywords

methodology; health sciences research; billing and compliance

INTRODUCTION

Health care spending exceeded \$2.5 trillion in 2007, and payments to hospitals represented the largest portion of this spending (more than 30%), equaling the combined cost of physician services and prescription drugs.^{1,2} Researchers and policymakers have emphasized the need to improve the value of hospital care in the United States, but this has been challenging, in part because of the difficulty in identifying hospitals that have high resource utilization relative to their peers.^{3–11}

Most hospitals calculate their costs using internal accounting systems that determine resource utilization via “Relative Value Units” (RVUs).^{7,8} RVU-derived costs, also known as “hospital reported costs,” have proven to be an excellent method for quantifying what it costs a given hospital to provide a treatment, test, or procedure. However, RVU-based costs are less useful for comparing resource utilization across hospitals because the cost to provide a treatment or service varies widely across hospitals. The cost of an item calculated using RVUs includes not just the item itself, but also a portion of the fixed costs of the hospital (overhead, labor, and infrastructure investments such as electronic records, new buildings, or expensive radiological or surgical equipment).¹² These costs vary by institution, patient population, region of the country, teaching status, and many other variables, making it difficult to identify resource utilization across hospitals.^{13,14}

Recently, a few claims-based multi-institutional datasets have begun incorporating item-level RVU-based costs derived directly from the cost accounting systems of participating institutions.¹⁵ Such datasets allow researchers to compare reported costs of care from hospital to hospital, but because of the limitations we described above, they still cannot be used to answer the question: Which hospitals with higher costs of care are actually providing more treatments and services to patients?

In order to better facilitate the comparison of resource utilization patterns across hospitals, we standardized the unit costs of all treatments and services across hospitals by applying a single “cost” to every item across hospitals. This standardized cost allowed us to compare utilization of that item (and the 15,000 other items in the database) across hospitals. We then compared estimates of resource utilization as measured by the two approaches: standardized and RVU-based costs.

METHODS

Ethics Statement

All data were de-identified, by Premier, Inc., at both the hospital and patient level in accordance with the Health Insurance Portability and Accountability Act. The Yale University Human Investigation Committee reviewed the protocol for this study and determined that it is not considered to be Human Subjects Research as defined by the Office of Human Research Protections.

Data Source

We conducted a cross-sectional study using data from hospitals that participated in the database maintained by Premier Healthcare Informatics, Charlotte, NC, in the years 2009–2010. The Premier database is a voluntary, fee-supported database created to measure quality and health care utilization.^{3,16–18} In 2010, it included detailed billing data from 500 hospitals in the United States, with more than 130 million cumulative hospital discharges. The detailed billing data includes all elements found in hospital claims derived from the uniform billing 04 (UB-04) form, as well as an itemized, date-stamped log of all items and services charged to the patient or insurer, such as medications, laboratory tests, and diagnostic and therapeutic services. The database includes approximately 15% of all US hospitalizations. Participating hospitals are similar to the composition of acute care hospitals nationwide. They represent all regions of the United States, and represent predominantly small- to mid-sized non-teaching facilities that serve a largely urban population. The database also contains hospital reported costs at the item level as well as the total cost of the hospitalization. Approximately 75% of hospitals that participate submit RVU-based costs taken from internal cost accounting systems. Because of our focus on comparing standardized costs to reported costs, we included only data from hospitals that use RVU-based costs in this study.

Study Subjects

We included adult patients with a hospitalization recorded in the Premier database between January 1, 2009 and December 31, 2010 and a principal discharge diagnosis of heart failure (HF) (International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes: 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428.xx). We excluded transfers, patients assigned a pediatrician as the attending of record, and those who received a heart transplant or ventricular assist device during their stay. Because cost data are prone to extreme outliers, we excluded hospitalizations that were in the top 0.1% of length of stay, number of billing records, quantity of items billed, or total standardized cost. We also excluded hospitals that admitted fewer than 25 HF patients

during the study period in order to reduce the possibility that a single high-cost patient affected the hospital's cost profile.

Hospital Information

For each hospital included in the study, we recorded number of beds, teaching status, geographic region, and whether it served an urban or rural population.

Assignment of Standardized Costs

We defined reported cost as the RVU-based cost per item in the database. We then calculated the median across hospitals for each item in the database and set this as the "standardized" unit cost of that item at every hospital (Figure 1). Once standardized costs were assigned at the item level, we summed the costs of all items assigned to each patient and calculated the standardized cost of a hospitalization per patient at each hospital.

Examination of Cost Variation

We compared the standardized and reported costs of hospitalizations using medians, interquartile ranges, and interquartile ratios (Q75/Q25). To examine whether standardized costs can reduce the "noise" due to differences in overhead and other fixed costs, we calculated, for each hospital, the coefficients of variation (CV) for per-day reported and standardized costs and per-hospitalization reported and standardized costs. We used the Fligner-Killeen test to determine whether the variance of CVs was different for reported and standardized costs.¹⁹

Creation of "Basket of Goods"

Because there can be differences in the costs of items, the number and types of items administered during hospitalizations, two hospitals with similar reported costs for a hospitalization might deliver different quantities and combinations of treatments (Figure 1). We wished to demonstrate that there is variation in reported costs of items when the quantity and type of item is held constant, so we created a "basket" of items. We chose items that are commonly administered to patients with heart failure, but could have chosen any combination of items. The basket included a day of medical room and board, a day of ICU room and board, a single dose of beta blocker, a single dose of angiotensin-converting enzyme inhibitor, complete blood count, a B-natriuretic peptide level, a chest radiograph, a chest CT, and an echocardiogram. We then examined the range of hospitals' reported costs for this basket of goods using percentiles, medians, and interquartile ranges.

Reported to Standardized Cost Ratio

Next, we calculated standardized costs of hospitalizations for included hospitals and examined the relationship between hospitals' mean reported costs and mean standardized costs. This ratio could help diagnose the mechanism of high reported costs for a hospital, because high reported costs with low utilization would indicate high fixed costs, while high reported costs with high utilization would indicate greater use of tests and treatments. We assigned hospitals to strata based on reported costs greater than standardized costs by more than 25%; reported costs within 25% of standardized costs; and reported costs less than

standardized costs by more than 25%. We examined the association between hospital characteristics and strata using a Chi-square test. All analyses were carried out using SAS version 9.3 (SAS Institute Inc., Cary, NC).

RESULTS

The 234 hospitals included in the analysis contributed a total of 165,647 hospitalizations, with the number of hospitalizations ranging from 33 to 2,772 hospitalizations per hospital (eTable 1). Most were located in urban areas (84%) and many were in the southern United States (42%). The median hospital reported cost per hospitalization was \$6,535, with an interquartile range of \$5,541 to \$7,454. The median standardized cost per hospitalization was \$6,602 with a range of \$5,866 to \$7,386. The interquartile ratio (Q75/Q25) of the reported costs of a hospitalization was 1.35. After costs were standardized, the interquartile ratio fell to 1.26, indicating that variation decreased. We found that the median hospital reported cost per day was \$1,651 with an IQR of \$1,400 to \$1,933 (ratio 1.38) while the median standardized cost per day was \$1,640 with an IQR of \$1,511 to \$1,812 (ratio 1.20).

There were more than 15,000 items (e.g., treatments, tests, and supplies) that received a standardized charge code in our cohort. These were divided into 11 summary departments and 40 standard departments (eTable 2). We observed a high level of variation in the reported costs of individual items: the reported costs of a day of room and board in an ICU ranged from \$773 at hospitals at the 10th percentile to \$2,471 at the 90th percentile (Table 1a). The standardized cost of a day of ICU room and board was \$1,577. We also observed variation in the reported costs of items across item categories. While a day of medical room and board showed a three-fold difference between the 10th and 90th percentile, we observed a more than ten-fold difference in the reported cost of an echocardiogram, from \$31 at the 10th percentile to \$356 at the 90th percentile. After examining the hospital-level cost for a “basket of goods,” we found variation in the reported costs for these items across hospitals, with a 10th percentile cost of \$1,552 and a 90th percentile cost of \$3,967.

We found that 46 (20%) hospitals had reported costs of hospitalizations that were 25% greater than standardized costs (Figure 2). This group of hospitals had reported costs overestimated apparent utilization; 146 (62%) had reported costs within 25% of standardized costs; and 42 (17%) had reported costs that were 25% less than standardized costs (indicating that reported costs underestimated utilization). We examined the relationship between hospital characteristics and strata and found no significant association between the reported to standardized cost ratio and number of beds, teaching status, or urban location (Table 1b). Hospitals in the Midwest and South were more likely to have a lower reported cost of hospitalizations, while hospitals in the West were more likely to have higher reported costs ($p < 0.001$). When using the CV to compare reported costs to standardized costs, we found that per-day standardized costs showed reduced variance ($p = 0.0238$), but there was no significant difference in variance of the reported and standardized costs when examining the entire hospitalization ($p = 0.1423$). At the level of the hospitalization, the Spearman correlation coefficient between reported and standardized cost was 0.89.

To better understand how hospitals can achieve high reported costs through different mechanisms, we more closely examined three hospitals with similar reported costs (Figure 3). These hospitals represented low, average, and high utilization according to their standardized costs, but had similar average per-hospitalization reported costs: \$11,643, \$11,787, and \$11,892, respectively. The corresponding standardized costs were \$8,757, \$11,169, and \$15,978. The hospital with high utilization (\$15,978 in standardized costs) was accounted for by increased use of supplies and “other” services. In contrast, the low- and average-utilization hospitals had proportionally lower standardized costs across categories, with the greatest percentage of spending going towards room and board (which includes nursing).

DISCUSSION

In a large national sample of hospitals, we observed variation in the reported costs for a uniform basket of goods, with a more than two-fold difference in cost between the 10th and 90th percentile hospitals. These findings suggest that reported costs have limited ability to reliably describe differences in utilization across hospitals. In contrast, when we applied standardized costs, the variance of per-day costs decreased significantly and the interquartile ratio of per-day and hospitalization costs decreased as well, suggesting less variation in utilization across hospitals than would have been inferred from a comparison of reported costs. Applying a single, standard cost to all items can facilitate comparisons of utilization between hospitals (Figure 1). Standardized costs will give hospitals the potential to compare their utilization to their competitors’ and will facilitate research that examines the comparative effectiveness of high and low utilization in the management of medical and surgical conditions.

The reported to standardized cost ratio is another useful tool. It indicates whether the hospital’s reported costs exaggerate its utilization relative to other hospitals. In this study, we found that a significant proportion of hospitals (20%) had reported costs that exceeded standardized costs by more than 25%. These hospitals have higher infrastructure, labor, or acquisition costs relative to their peers. To the extent that these hospitals might wish to lower the cost of care at their institution, they could focus on renegotiating purchasing or labor contracts, identifying areas where they may be “overstaffed,” or holding off on future infrastructure investments (Table 1c).¹⁴ In contrast, 17% of hospitals had reported costs that were 25% less than standardized costs. High-cost hospitals in this group are therefore providing more treatments and testing to patients relative to their peers and could focus cost-control efforts on reducing unnecessary utilization and duplicative testing.²⁰ Our examination of the hospital with high reported costs and very high utilization revealed a high percentage of supplies and “other” items, which is a category used primarily for nursing expenditures (Figure 3). Because the use of nursing services is directly related to days spent in the hospital, this hospital may wish to more closely examine specific strategies for reducing length of stay.

We did not find a consistent association between the reported to standardized cost ratio and hospital characteristics. This is an important finding that contradicts prior work examining associations between hospital characteristics and costs for heart failure patients,²¹ further

indicating the complexity of the relationship between fixed costs and variable costs and the difficulty in adjusting reported costs to calculate utilization. For example, small hospitals may have higher acquisition costs and more supply chain difficulties, but they may also have less technology, lower overhead costs, and fewer specialists to order tests and procedures. Hospital characteristics such as urban location and teaching status are commonly used as adjusters in cost studies because hospitals in urban areas with teaching missions (which often provide care to low income populations) are assumed to have higher fixed costs,³⁻⁶ but the lack of a consistent relationship between these characteristics and the standardized cost ratio may indicate that using these factors as adjusters for cost may not be effective and could even obscure differences in utilization between hospitals. Notably, we did find an association between hospital region and the reported to standardized cost ratio, but we hesitate to draw conclusions from this finding because the Premier database is imbalanced in terms of is regional representation, with fewer hospitals in the Midwest and West and a bulk of the hospitals in the South.

Although standardized costs have great potential, this method has limitations as well. Standardized costs can only be applied when detailed billing data with item-level costs are available. This is because calculation of standardized costs requires taking the median of item costs and applying the median cost across the database, maintaining the integrity of the relative cost of items to one another. The relative cost of items is preserved (i.e., an MRI still costs more than an aspirin), which maintains the general scheme of RVU-based costs while removing the “noise” of varying RVU-based costs across hospitals.⁷ Application of an arbitrary item cost would result in the loss of this relative cost difference. Because item costs are not available in traditional administrative datasets, these datasets would not be amenable to this method. However, highly detailed billing data are now being shared by hundreds of hospitals in the Premier network and the University Health System Consortium. These data are widely available to investigators, meaning that the generalizability of this method will only improve over time. It was also a limitation of the study that we chose a limited “basket” of items common to patients with heart failure in order to describe the range of reported costs and to provide a standardized snapshot by which to compare hospitals. Because we only included a few items, we may have overestimated or underestimated the range of reported costs for such a basket.

Standardized costs are a novel method for comparing utilization across hospitals. Used properly, they will help identify high and low intensity providers of hospital care.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.
Standardized costs allow comparison of utilization across hospitals

Figure 2.
Hospital average reported vs. standardized cost

Figure 3.

Average per-hospitalization standardized cost for three hospitals with reported costs of approximately \$12,000

a) Reported costs of a basket of items commonly used in patients with HF; b) Standardized vs. reported costs of total hospitalizations at 234 hospitals, by hospital characteristics (using all items); c) Characteristics of hospitals with various combinations of reported and standardized costs

Table 1

a)						
Item	Reported Costs	10 th Percentile	25 th Percentile	75 th Percentile	90 th Percentile	Median (standardized cost)
Day of Medical		490.03	586.41	889.95	1121.2	722.59
Day of ICU		773.01	1275.84	1994.81	2471.75	1577.93
Complete Blood Count		6.87	9.34	18.34	23.46	13.07
B-Natriuretic Peptide		12.13	19.22	44.19	60.56	28.23
Metoprolol		0.2	0.68	2.67	3.74	1.66
Lisinopril		0.28	1.02	2.79	4.06	1.72
Spirinolactone		0.22	0.53	2.68	3.83	1.63
Furosemide		1.267	2.45	5.73	8.12	3.82
Chest X-ray		43.88	51.54	89.96	117.16	67.45
Echocardiogram		31.53	98.63	244.63	356.5	159.07
Chest CT (w & w/o Contrast)		65.17	83.99	157.23	239.27	110.76
Non-invasive Positive		126.23	127.25	370.44	514.67	177.24
Pressure Ventilation Electrocardiogram		12.08	18.77	42.74	64.94	29.78
Total "Basket"		1552.5	2157.85	3417.34	3967.78	2710.49
b)						
	Reported >Standardized by >25% n (%)	Reported within 25% (two-tailed) of Standardized n (%)	Reported <Standardized by >25% n (%)	p for Chi-square Test		
Total	46 (19.7)	146 (62.4)	42 (17.0)	0.2313		
Number of Beds						
<200	19 (41.3)	40 (27.4)	12 (28.6)			
200-400	14 (30.4)	67 (45.9)	15 (35.7)			
>400	13 (28.3)	39 (26.7)	15 (35.7)			
Teaching				0.8278		
Yes	13 (28.3)	45 (30.8)	11 (26.2)			
No	33 (71.7)	101 (69.2)	31 (73.8)			
Region				<0.0001		

b)

	Reported >Standardized by >25% n (%)	Reported within 25% (two-tailed) of Standardized n (%)	Reported <Standardized by >25% n (%)	p for Chi-square Test
Midwest	7 (15.2)	43 (29.5)	19 (45.2)	
Northeast	6 (13.0)	18 (12.3)	3 (7.1)	
South	14 (30.4)	64 (43.8)	20 (47.6)	
West	19 (41.3)	21 (14.4)	0 (0)	
Urban (vs. Rural)	36 (78.3)	128 (87.7)	33 (78.6)	0.1703

c)

	High Reported Costs High Standardized Costs	High Reported Costs Low Standardized Costs	Low Reported Costs High Standardized Costs	Low Reported Costs Low Standardized Costs
Utilization	High	Low	High	Low
Severity of illness	Likely to be higher	Likely to be lower	Likely to be higher	Likely to be lower
Practice style	Likely to be more intense	Likely to be less intense	Likely to be more intense	Likely to be less intense
Fixed costs	High or Average	High	Low	Low
Infrastructure costs	Likely to be higher	Likely to be higher	Likely to be lower	Likely to be lower
Labor costs	Likely to be higher	Likely to be higher	Likely to be lower	Likely to be lower
Reported-to-standardized cost ratio	Close to 1	>1	<1	Close to 1
Causes of high costs	High utilization, high fixed costs, or both	High acquisition costs, high labor costs, or expensive infrastructure	High utilization	-
Interventions to reduce costs	Work with clinicians to alter practice style; consider renegotiating cost of acquisitions; hold off on new infrastructure investments	Consider renegotiating cost of acquisitions; hold off on new infrastructure investments; consider reducing size of labor force	Work with clinicians to alter practice style	-
Usefulness of reported-to-standardized cost ratio	Less useful	More useful	More useful	Less useful