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Assessing variation in utilization for acute myocardial infarction in New York State ☆

William B. Borden [a,*], Allison F. Marier [b,1], Thomas H. Dennison [c,2], Deborah A. Freund [d,3], Kevin Cook [e,4], Alvin I. Mushlin [a,5]

[a] Department of Public Health, Weill Cornell Medical College, Cornell University, 402 East 67th Street, New York, NY 10065, United States
[b] Abt Associates, 55 Wheeler Street, Cambridge, MA 02139, United States
[c] Maxwell School, Syracuse University, 426 Eggers Hall, Syracuse, NY 13244, United States
[d] Claremont Graduate University, Harper Hall 100, 150 East Tenth Street, Claremont, CA 91711-6160, United States
[e] SUNY Upstate Medical University, 750 East Adams Street, Syracuse, NY 13210, United States

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ABSTRACT

Background: Wide variations exist in healthcare expenditures, though most prior studies have assessed aggregate utilization. We sought to examine healthcare utilization variation in New York State by assessing hospitals in peer groups of similar capabilities.
Methods: Using charge data in New York State from the 2008 Statewide Planning and Research Cooperative System (SPARCS) and cost-to-charge ratios at the cost-center level drawn from Institutional Cost Reports, we calculated total, routine, and ancillary costs for patients discharged with an acute myocardial infarction (AMI) diagnosis in 2008. We assessed the correlation of these cost data to Hospital Referral Region (HRR) Medicare reimbursement data from the 2007 Dartmouth Atlas of Health Care. After describing hospital level cost variability, we examined characteristics associated with higher costs within peer groups of similar cardiac care capabilities.
Results: We found greater costs in hospitals providing the highest level of cardiovascular services, with cardiac surgery capable hospitals and non-invasive hospitals having total costs of $21,166 and $9268 per AMI discharge, and ancillary costs of $12,006 and $4167 per AMI discharge, respectively. Substantial variability in utilization existed in all levels of hospitals and across individual departmental cost centers. The two factors most frequently associated with higher total and ancillary costs across peer groups were patient case mix index and major or minor teaching status.
Conclusions: Significant variation in cost per AMI discharge exists even within peer groups of hospitals with similar cardiac care capabilities.
Implications: These findings support measurement and analysis at the hospital level to further understand the reasons for variation in utilization.

1. Introduction

In the quest to control healthcare costs, the ultimate goal is to provide the information and environment that facilitates value-based care at the local level. Studies examining healthcare utilization have demonstrated wide variations at the regional level.[1–3] While most prior studies have examined Medicare reimbursements, such analyses were made problematic by the inclusion of "public policy payments" – disproportionate share, graduate medical education, and outlier payments. By performing our analysis using SPARCS cost data, which do not include public policy payments, we are able to examine the utilization directly associated with AMI admissions. In order to support the use of hospital cost data for this purpose and to relate our findings to the question of regional variations in care, we sought first to assess whether hospital costs correlated with Medicare reimbursements, both at the regional level. Then we sought to describe the distribution of these costs at the department level within hospital peer-group categories. Lastly, we examined whether any correlation existed

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* Corresponding author. Tel.: +1 646 962 8009; fax: +1 646 962 0281.
E-mail address: wbb2001@med.cornell.edu (W.B. Borden).
[1] Tel.: +1 617 520 2732; fax: +1 617 386 8449.
[2] Tel.: +1 315 443 9060; fax: +1 315 443 1081.
[3] Tel.: +1 909 607 3305; fax: +1 909 607 9103.
[4] Tel.: +1 315 464 4325; fax: +1 315 464 4318.
[5] Tel.: +1 646 962 8009; fax: +1 646 962 0281.

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between the costs per discharge and hospital characteristics for AMI patients.

2. Materials and methods

We analyzed hospital discharges for AMI in New York State in 2008 in the SPARCS database[4] that contains patient level data on demographics, diagnoses, procedures, days of care, and charges for every hospital discharge, ambulatory surgery patient and emergency discharge admission in New York State. The reasons for specifically studying AMI were that clear treatment guidelines exist, it is a common hospital admission, the costs are distributed across multiple departments (cost centers), and national variation in costs has been demonstrated.

The SPARCS data contain charges for both routine and ancillary services at the Medicare-defined cost center level. 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 such as operating room time or x-rays, for which a separate fee is charged.

To estimate actual costs of care for specific diagnosis-related groups (DRGs) at each hospital at the cost center level, we used information from each hospital's Institutional Cost Reports[5] to obtain the hospital and cost center specific costs-to-charges ratio. For each hospital, total departmental charges were calculated from the SPARCS data and then compared to the corresponding departmental costs reported on the Institutional Cost Report. A cost-to-charge ratio was calculated using the departmental costs as reported on the Institutional Cost Report.

Because labor costs can vary substantially and are beyond the control of individual hospitals, we used the Bureau of Labor Statistics (BLS) estimates of average wages among health care support workers as defined by Standard Occupational Classification to wage-adjust the proportion of each cost centers' expenditures that are associated with wages and salaries. This yielded a wage-adjusted measure of cost for each cost center in each hospital. We then computed a regional wage index by dividing each region's 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. Hospital inpatient sector Medicare reimbursements per enrollee were obtained from the Dartmouth Atlas of Health Care[6] to allow comparisons between those reimbursements and AMI costs from SPARCS both at the geographic regional level.

2.1. Peer groupings

Since both cost and patient co-morbidities directly relate to the level of advanced care provided in a particular hospital, we performed the analysis comparing hospitals within peer groups based on the highest level of cardiac care provided by that hospital. The peer groups were non-invasive care, diagnostic-only catheterization, interventional cardiology, and cardiac surgery capable hospitals. Our assumption was that the hospitals capable of providing higher-level cardiac care would also be capable of performing the lower level functions. Thus, in comparing cardiac surgery hospitals, we would be comparing hospitals that offered the full range of cardiac services.

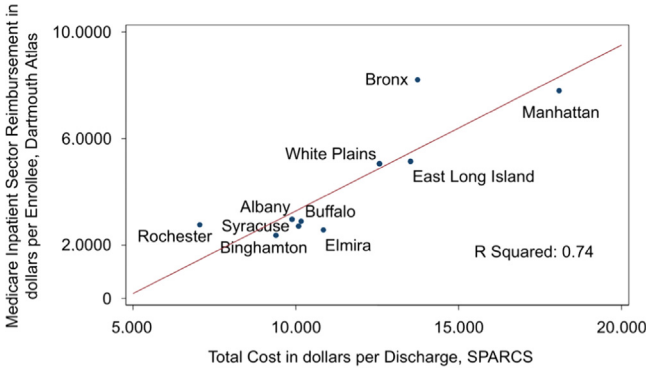
2.2. Analysis

We first compared Medicare expenditures and hospitals' costs by regressing the average logged Medicare inpatient sector reimbursements per enrollee within each Hospital Referral Region (HRR) to the total costs per AMI discharge in the HRRs using SPARCS and cost report data. We calculated the total, routine, and ancillary costs for each AMI discharge by cardiac peer group hospitals, with mean, standard deviation, and the calculated coefficient of variation. Within these cardiac peer groups, we also examined the variation in ancillary costs per AMI discharge. We highlight the cardiology, operating room, and medical/surgical supplies ancillary costs as these cost centers have the greatest likelihood to vary for AMI patients between hospitals. Lastly, using generalized linear models, we performed regressions of total and ancillary costs per AMI discharge on patient characteristics (age, race, gender), hospital characteristics (teaching status of the hospital, case mix index at the patient level), and regional characteristics (county fixed effects, HRR fixed effects) for each hospital peer group of cardiac care capabilities. The regressions treated each patient discharge as an observation, effectively allowing for a hospital's costs to be correlated with the hospital's number of AMI discharges. For patients with multiple admissions, each discharge was treated individually since the data were not linked longitudinally. We adjusted the standard errors at the hospital level using Huber-White clustering, which takes into account the potential correlation of patient outcomes in each hospital, and adjusts the standard errors upward as a result. Thus, the corrected standard errors lead to conservative inferences. A $p < 0.05$ was defined as the level of significance for all analyses. Analyses were performed using Stata, version 12.1.

3. Results

We analyzed data that represented 56,000 AMI cases in 150 hospitals. We found a strong correlation (R^2 0.74) between the average Medicare inpatient sector reimbursements per enrollee and the total costs per AMI discharge using SPARCS data for all hospitals within each HRR (Fig. 1). The patient and hospital characteristics of each peer group are listed in Table 1. In examining the individual costs by hospitals' cardiac care capability, the average total costs per AMI discharge were higher for cardiac surgery capable hospitals ($21,166) than for interventional cardiology capable hospitals ($13,760), diagnostic-only catheterization capable hospitals ($12,685), and non-invasive capable hospitals ($9268). Ancillary rather than routine costs drove the total costs in cardiac surgery hospitals, while routine costs contributed more to total costs in the other cardiac peer group hospitals (Table 2).

There was a three-fold difference in ancillary costs per AMI discharge between hospitals capable of cardiac surgery and those with only non-invasive capabilities. All peer groups demonstrated variation in routine, ancillary, and total costs. This pattern of increased costs at higher capability hospitals extended across the cost centers, though with less variation at higher capability



AMI = Acute myocardial infarction

Fig. 1. Correlation between Medicare Reimbursements from the Dartmouth Atlas and Total Costs from SPARCS per AMI Discharge by Hospital Referral Regions.

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hospitals (Table 3). When a multivariate regression was performed of total and ancillary costs on hospital and patient characteristics for each cardiac peer-group, we found that the main factors associated with higher total and ancillary costs were the patient case mix index and teaching status of hospitals (Tables 4 and 5). In these tables, the coefficient for each variable in the regression represents the change in cost per AMI patient for that variable. For example, Major Teaching Hospital status was associated with an increase of $4117 in total costs and $2690 in ancillary costs per AMI patient.

4. Discussion

With much of the prior research examining utilization variations at the HRR level, such analyses do not provide sufficient granularity to understand differences in practice at an individual hospital level. As the United States struggles with growing health care costs and considers strategies to control those costs, questions about the factors related to cost variation are paramount. We sought to shed light on such questions by first determining whether such an analysis of variations in costs at the hospital level is justifiable. We assessed whether hospital costs in an HRR generally correlate with the HRR's Medicare reimbursements, which have been the focus of the major concerns about variations in the use of medical services in the US. We found a strong correlation between regional Medicare reimbursements for HRRs in New York State and HRR hospital costs, supporting the use of these costs to examine the reasons for regional variations.

Second, our examination of total, routine, and ancillary costs revealed significant variation. While routine costs mostly reflect length of stay, ancillary costs reflect the discretionary utilization of specific services for each AMI admission that may or may not contribute to the quality of care. Cardiac surgery capable hospitals had higher ancillary costs, with somewhat lower but yet substantial cost variability compared to hospitals that did not provide invasive services, demonstrating that such variability was not limited to one type of hospital. That pattern of sizable variability and higher costs in higher capability hospitals extended throughout the various cost centers that compose the ancillary costs. It is not surprising that more advanced medical centers had higher utilization since, compared to non-invasive capable hospitals, cardiac surgery capable hospitals care for more complex patients and can provide more intensive services. The finding that ancillary costs drive total costs in cardiac surgery capable hospitals is also expected, given that elements such as operating room costs play a large role. What is revealing is that the substantial variation across peer-grouped hospitals extended from total costs all the way down to individual cost centers. Data at this detailed level could provide hospitals with information to improve quality and efficiency. This is the first study to our knowledge demonstrating that this variation amongst peer-grouped hospitals extended down to the individual cost centers. These hospitals provided similar levels of services yet, in fact, had widely varying costs.

We found a statistically significant correlation between total and ancillary hospital costs per AMI discharge and patient case mix index for all hospitals together and for each of the individual peer groups. The other main factor associated with higher total and ancillary costs was major or minor teaching status, though this was not consistent across all peer groups. These results are not surprising in that even within peer groups more complex and ill patients would have longer lengths of stay driving higher routine costs, and would require more involved care driving higher ancillary costs. Though less strongly correlated, teaching hospitals also had higher costs, which would be expected given their additional and important mission of education and training.

4.1. Limitations

Our findings should be interpreted in the context of several limitations. Firstly, using the cost-to-charge ratio to determine costs may have two sources of error: how hospitals set charges, which is unique to each hospital, and how the hospitals account for costs to establish the cost-to-charge ratio, which can be variable based on the hospitals' accuracy in accounting. Secondly, the total costs included capital costs, such as facility amortization, rent, facility maintenance, as well as labor and administrative costs.[7,8] We attempted to account for regional variation in costs by adjusting labor by local wage indices and including spatial fixed effects into the regressions. Additionally, capital costs would not explain the variation in ancillary costs, which are directly related to utilization during the hospitalization. Thirdly, the costs in New York State may not be generalizable to the rest of the United States. While the absolute costs may be greater due to higher fixed costs, the findings of variations within peer groups and down to the cost center level should still be relevant since the reasons for higher fixed costs in New York State should not influence such variation.

Table 1
Patient populations and characteristics of hospitals by cardiac care capability.

	Non-invasive ($n=111$)		Diagnostic catheterization ($n=25$)		Interventional catheterization ($n=15$)		Cardiac surgery ($n=39$)	
	Mean (%)	SD (%)	Mean (%)	SD (%)	Mean (%)	SD (%)	Mean (%)	SD (%)
Caucasian	81.2	39.1	68.2	46.6	68.8	46.3	74.5	43.6
Black	8.1	27.2	15.4	36.1	13.7	34.4	8.4	27.8
Asian	1.4	11.5	0.8	9.1	3.0	17.0	1.6	12.6
Hispanic	4.5	20.6	11.7	32.2	9.4	29.1	6.1	23.9
Female	54.5	49.8	52.9	49.9	54.1	49.8	47.8	50.0
Major Teaching	23.6	42.5	51.3	50.0	40.0	49.0	74.5	43.6
Minor Teaching	6.7	25.0	3.7	19.0	32.4	46.8	18.5	38.9

SD = Standard deviation.

Table 2
Mean routine, ancillary, and total costs per AMI discharge by cardiac care capability.

	N	Routine costs			Ancillary costs			Total costs		
		Mean	SD	COV	Mean	SD	COV	Mean	SD	COV
Non-invasive	145	$5101	$4607	0.903	$4167	$2756	0.661	$9268	$2511	0.182
Diagnostic Catheterization	82	$7581	$5601	0.739	$5104	$2548	0.499	$12,685	$5386	0.604
Interventional Catheterization	51	$7308	$2688	0.368	$6452	$1732	0.268	$13,760	$6552	0.517
Cardiac surgery	39	$9160	$4650	0.508	$12,006	$4301	0.358	$21,166	$6223	0.294

AMI = Acute Myocardial Infarction; SD = Standard Deviation; COV = Coefficient of Variation.

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Table 3
Ancillary departmental costs per AMI discharge by cardiac care program capability.

	Cost department								
	Cardiology costs			Medical/surgical supplies costs			Operating room costs		
	Mean	SD	COV	Mean	SD	COV	Mean	SD	COV
Non-Invasive	$570	$543	0.953	$325	$621	1.911	$62	$163	2.629
Diagnostic Catheterization	$872	$666	0.764	$484	$1035	2.138	$89	$152	1.708
Interventional Catheterization	$1731	$927	0.536	$1317	$1103	0.838	$242	$245	1.012
Cardiac Surgery	$3309	$1891	0.571	$2971	$1737	0.585	$1107	$900	0.813

AMI=Acute Myocardial Infarction; SD=Standard Deviation; COV=Coefficient of Variation.

Table 4
Regression of hospital characteristics on total costs per AMI discharge per cardiac care capability.

	All hospitals		Non-invasive		Diagnostic catheterization		Interventional catheterization		Cardiac surgery	
	Total costs per discharge	SE[a]	Total costs per discharge	SE[a]	Total costs per discharge	[a]SE	Total costs per discharge	SE[a]	Total costs per discharge	SE[a]
Patient Case mix Index	10,369[†]	850.6	10,295[†]	1096	10,323[†]	1075	10,523[†]	1127	10,720[†]	1259
Age 45–54	1719	2050	2112	1229	1675	2465	2087	2730	2951	3354
Age 55–64	2713	1774	2762	1699	2705	2135	3151	2325	3942	2869
Age 65+	2376	1615	3305	1759	2180	1887	2342	2024	2980	2521
Caucasian	401.8	615.1	350.5	850.8	625.9	756.0	899.1	819.5	1157	1054
African-American	−1044	1012	−3053	1568	−275.5	1176	−447.5	1272	423.7	1820
Hispanic	−755.4	652.0	−1220	1044	−374.4	804.3	−342.2	971.8	−1511	1211
Female	478.7	311.3	255.0	253.1	574.4	415.4	628.1	478.9	890.2	572.8
Major Teaching Hospital	4117[†]	1096	809.3	957.9	7055[†]	1815	3530	1919	8324[†]	2414
Minor Teaching Hospital	−680.4	894.2	12531;[‡]	611.1	1578	1525	−1567	1796	3336[†]	207.8
Constant	−11,211[†]	3684	−9923[†]	2407	−13,533[†]	4042	−11,0441;[‡]	4544	−17,201[†]	4880
Observations	17,628		4480		13,148		11,531		9427	
R^2	0.673		0.754		0.642		0.648		0.647	

AMI=Acute Myocardial Infarction; SE=Standard Error.
[†] $p < 0.01$.
[‡] $p < 0.05$.
[a] Robust standard errors, clustered by hospital.

Table 5
Regression of hospital characteristics on ancillary costs per AMI discharge per cardiac care capability.

	All Hospitals		Non-Invasive		Diagnostic Catheterization		Interventional Catheterization		Cardiac Surgery	
	Total costs per discharge	SE[a]	Total costs per discharge	SE[a]	Total costs per discharge	SE[a]	Total costs per discharge	SE[a]	Total costs per discharge	SE[a]
Patient Case mix Index	5228[†]	459.6	4707[†]	388.7	5044[†]	571.3	5079[†]	589.3	5237[†]	626.0
Age 45–54	683.9	1088	1110	817.9	822.9	1287	1124	1418	1603	1747
Age 55–64	679.1	968.4	466.7	657.4	1047	1163	1338	1271	1878	1582
Age 65+	−12.82	876.7	448.0	623.0	248.4	1034	389.8	1111	787.7	1397
Caucasian	588.5	647.5	353.6	499.7	824.4	720.6	1178	787.2	881.0	616.5
African-American	671.6	829.9	342.0	739.0	929.9	985.1	930.9	1067	1495	1554
Hispanic	409.3	699.1	−188.4	538.7	984.4	811.2	822.9	800.1	−40.06	726.2
Female	−422.7[†]	146.1	−267.7	267.3	−471.4[†]	173.2	−541.3[†]	193.1	−441.81;[‡]	215.8
Major Teaching Hospital	2690[†]	913.6	−18551;[‡]	846.1	6292[†]	1220	3871[†]	1384	4862[†]	1617
Minor Teaching Hospital	459.7	785.4	288.5	438.8	3379[†]	1161	1118	1413	2549[†]	101.8
Constant	−3372	2091	−3833[†]	495.8	−6232[†]	2214	−4149	2555	−62911;[‡]	2515
Observations	17,628		4480		13,148		11,531		9427	
R-squared	0.664		0.791		0.640		0.632		0.643	

AMI=Acute Myocardial Infarction; SD=Standard Error.
[†] $p < 0.01$.
[‡] $p < 0.05$.
[a] Robust standard errors, clustered by hospital.

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4.2. Implications

Our study suggests that cost analyses at the individual hospital level are valid ways to evaluate regional variations, and that substantial variation exists even within peer groups of hospitals with similar cardiac capabilities. Across these peer groups, the complexity and illness of patients was the leading cause of variability in utilization, suggesting that even though analyses at the HRR level are intended to account for differences in patient acuity by having large geographic areas, that such differences in patient factors still influence variations in utilization. Moreover, adjusting for other factors, teaching hospitals have greater costs on a per-patient basis, supporting federal government payments for teaching activities. While regional analyses have played an important role in highlighting the presence of cost variations, local analyses may provide information to improve health care. The more local that health care analyses can get to the patient, provider, and hospital, the more likely that such data will inform and drive true quality and efficiency improvements.

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Disclosures

Dr. Borden also serves as a medical officer at the Agency for Healthcare Research and Quality (AHRQ), although his work on this study was not related to AHRQ and the views expressed are his own.

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