Medicare and Commercial Inpatient Resource Use: Impact of Hospital Competition

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Objectives: To examine the influence of hospital competition on small-area inpatient resource use by payer.

Methods: We measured hospital competition and inpatient resource use using data from the 2008 Healthcare Cost and Utilization Project State Inpatient Databases. Generalized linear models adjusted for patient, population, and market characteristics were used to assess the relationship between inpatient resource use and hospital competition.

Results: Hospital competition had a similar influence on inpatient resource intensity for Medicare and privately insured patients. Hospitals in more competitive markets had significantly lower costs per discharge for both Medicare and privately insured patients. Hospital competition was not significantly associated with length of stay per discharge for either payer.

Conclusion: Findings suggest that policies or incentives that promote or encourage competition in less competitive markets may reduce variation in resource use for both Medicare and private payers.

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Small-area variation in healthcare utilization and intensity has been well documented.[1-3] Determining the factors associated with this variation is critical to identifying whether the variation in healthcare utilization is appropriate (eg, because of differences in population needs) or whether it represents excessiveness due to exogenous factors. Identifying the sources of the variation can help identify potential policy levers to reduce costs and improve care.

Medicare fee-for-service data are often used to study small-area variations because of their availability and comprehensiveness. The few studies examining data from multiple payers have found that the pattern of variation differs by payer after controlling for population differences.[4-6] Market characteristics are a possible source of the observed payer-specific variation in small areas as market factors may impact patient care differently for each payer.

In this study, we examined whether the intensity of competition among hospitals in an area had a differential effect on inpatient resource use for Medicare and privately insured patients. We hypothesized that public payers are less vulnerable to provider market power because they use administrative pricing strategies that are not directly influenced by provider negotiation. Thus, we expected that measures of hospital competition would have more influence on resource use for private payers than would be true for Medicare. This study contributes to the literature by testing this hypothesis using comprehensive inpatient data that capture all discharges at community hospitals in the majority of states in the United States.

METHODS

We analyzed data from the Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases (SID)[7] supplemented with other national data to determine the influence of hospital competition on inpatient resource intensity by payer, controlling for patient, population, and market factors. We estimated models for 2 outcomes: length of stay per discharge and cost per discharge.

Data and Time Frame

We created an analytic file that included all inpatient stays at community, nonrehabilitation hospitals from the 42 states that contributed data to the HCUP

In this article
Take-Away Points / e239
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SID in 2008. These states were Arizona, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Hawaii, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, Nevada, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, and Wyoming.

Take-Away Points

Small areas with more competitive hospital markets tend to have lower facility costs per discharge for both Medicare and privately insured patients.

- By using comprehensive data that capture all patients and payers in 43 states, our results add to the evidence that market factors influence small-area healthcare resource use.
- Results do not support the hypothesis that payer-specific patterns of healthcare resource variation are a product of differences in how payers determine prices.

Small areas were defined by Core Based Statistical Areas (CBSA) boundaries in this study. We used patient zip code to identify the CBSA associated with each discharge. The CBSAs represent the universe of metropolitan and micropolitan areas in the United States.[8] Each CBSA includes a core area with a substantial population that together with the adjacent communities contain a high degree of economic and social integration. Core Based Statistical Areas have been used in previous studies to examine geographic variation[2,6,9,10] and are desirable because population and market characteristics can be readily measured at the CBSA level using national data sets such as the Area Resource File.[11] We included only those CBSAs for which 99% or more of the population reside in 1 of the states that contributed HCUP data.

We used the HCUP SID data to measure patient characteristics and used the 2 measures of inpatient resource use as outcomes in this study. We linked HCUP SID data with data from the Area Resource File, the American Community Survey, the American Hospital Association Annual Survey, the Centers for Medicare & Medicaid Services Hospital Compare, and the Medicaid Statistical Information System at the CBSA level to measure population and market characteristics. We used the HCUP Hospital Market Structure file[7] to measure the degree of hospital competition in each area.

Population

The Medicare sample consisted of inpatient stays among patients more than 65 years old, with Medicare assigned as the primary expected payer. This group included patients enrolled in Medicare fee-for-service and Medicare Advantage. Ideally, we would have examined these 2 groups separately, but the data did not allow us to distinguish between them. The private insurance sample consisted of inpatient stays among patients between 40 and 65 years old, with private insurance as the primary expected payer. A limitation of the analysis is that, by definition, the Medicare sample was older than the private insurance sample; thus, age could confound the results. To make the private insurance sample more clinically comparable to the Medicare sample, we excluded patients less than 40 years old and maternity stays.

Measures

We examined 2 dimensions of inpatient resource intensity as outcomes. First, we measured length of stay (LOS) per discharge. LOS was determined for each discharge by subtracting the admission date from the discharge date. Second, we measured cost per discharge. Cost was derived from total charges using the Cost-to-Charge Ratios (CCRs) developed for HCUP[12] adjusted for area wage index. It is important to underscore that this study examines cost to the facility (resource use) rather than cost to the payer (price).

We measured hospital competition using the Herfindahl-Hirschman Index (HHI). The Herfindahl-Hirschman Index is the sum of the squares of market shares for all of the hospitals in the CBSA. A hospital's market share is calculated as the number of discharges from that hospital divided by the total number of discharges from all hospitals in the market. More competitive markets have lower HHI values; less competitive markets have higher HHI values. The HHI is the standard measure of hospital competition used by the Department of Justice for antitrust enforcement[13] analysis and has been validated through comparison of other competition indicators.[14]

We measured several patient characteristics to control for the influence of patient mix on resource intensity. Characteristics included patient age, sex, race/ethnicity, and an individual indicator for each of 18 comorbid conditions: addictive disorders, diabetes, general blood disorders, cancer, arthritis, congestive heart failure, chronic obstructive pulmonary disease, hypertension, hypothyroidism, liver disease, fluid and electrolyte disorders, other neurologic disorders, obesity, paralysis, renal failure, solid tumor without metastasis, valvular disease, and weight loss. We measured patient severity using the All-Payer Severity-adjusted diagnostic related group (APS-DRG) system, which is appropriate for both private payer and Medicare populations and all medical/surgical conditions.[15] The APS-DRG system includes LOS and charge weights that measure the predicted LOS and predicted cost of each discharge using diagnoses, procedures, discharge status, age, and LOS as inputs.

We measured population characteristics that may influence resource intensity. These measures included the percentage of adults with a bachelor's degree or more education, the percentage of households with income below the federal poverty level, average income, income disparity (Gini coefficient), the percentage of persons 16 years or older who were unemployed, the total population of the CBSA, population density (population per square mile), and race/ethnicity (percent white, percent black, percent Hispanic, percent other).

We measured CBSA market characteristics in addition to HHI, which also may influence the area's inpatient resource intensity. These measures included the number of acute care beds per capita, the number of long-term care beds per capita, the number of rehabilitation beds per capita, the number of primary care physicians per capita, the number of emergency department visits per capita (a proxy for primary care access), the number of physician assistants per capita, the number of specialists per capita, the percentage of acute care beds in high-technology hospitals, and the percentage of discharges from outside the hospital's CBSA. Following previous work,[16-18] we defined high-technology hospitals as those that reported having at least 6 of 8 high-technology services as reported in the American Hospital Association Survey. Finally, we included the state average Medicaid payment per beneficiary as a proxy for Medicaid payment generosity. We obtained this data from the Medicaid Statistical Information System state summary data set.

Quality of care may have a positive or negative association with inpatient resource intensity. We included 3 measures of inpatient quality from the 2008 Centers for Medicare & Medicaid Services Hospital Compare data set aggregated to the CBSA level: heart attack composite, heart failure composite, and pneumonia composite. All quality-of-care, population, and market characteristics were associated with discharges based on patient zip code.

Analysis

We examined the means and distributions of each patient, population, and market characteristic at the CBSA level. We also examined the variation in inpatient resource intensity (cost per discharge and LOS per discharge) and patient characteristics by payer.

To measure the association between hospital competition and inpatient resource intensity, we estimated generalized linear models for both outcomes (LOS per discharge, cost per discharge), including hospital competition and all patient, population, and market variables. Core Based Statistical Areas were the units of analysis. We estimated models that included both populations (Medicare and private insurance) and models that were stratified by payer (Medicare and private). The fit of the models with both payers combined was measured via the Chow's F ratio test.[19] The Chow test result for both the LOS and cost per discharge models was significant (P <.01), suggesting that estimating a separate model for each payer was more appropriate. Thus, we focused our results on the payer-specific models.

To more precisely account for patient differences across CBSAs, we re-estimated the models using a 2-level hierarchical linear specification with random intercepts (SAS GLIMMIX procedure; SAS Institute Inc, Cary, North Carolina). The first and second levels of the models were discharges and CBSAs, respectively. Models included hospital competition and all patient, population, and market variables, and were also stratified by payer. The results from these models were essentially the same, so we present the more simplified generalized linear models in this study. The results from the hierarchical models are shown in **Appendix A** and **Appendix B**.

RESULTS

The HCUP SID contained comprehensive discharge data for 834 of 944 CBSAs in 2008. All patient, population, market, and quality characteristics were available for 742 of 834 CBSAs. Our sample comprised these 742 CBSAs.

Table 1 describes the population and market characteristics of the sample. The CBSAs had an average HHI of 68.2 on a scale from 1 (highly competitive hospital market) to 100 (highly concentrated hospital market). The CBSA inpatient capacity included an average of 1.8 acute hospital beds, 0.3 long-term care beds, and 0.1 rehabilitation beds per 1000 population. The CBSA physician capacity included an average of 56.3 primary care physicians, 23.1 physician assistants, and 98.3 specialists per 1000 population. The CBSA average quality composite scores were more than 90% for the 3 clinical composites: heart attack, heart failure, and pneumonia.

The average CBSA population was 340,800 with 152.4 persons per square mile. The CBSAs had an average of 20.9% population with a bachelor's degree or higher education, 10.8% of families below the poverty line, 6.5% unemployment rate, and a mean household income of $58,265. The average Gini coefficient was 43.6 on a 0 to 100 scale where 0 represents total equality and 100 represents maximal inequality. On average, CBSAs were 78.1% white, 8.5% black, and 9.4% Hispanic.

Table 2 provides the distribution and variation of inpatient LOS per discharge and cost per discharge across CBSAs included in the study. Average LOS per discharge was greater for Medicare than private insurance (4.09 vs 5.28; P <.01). Average cost per discharge was greater for private insurance

Table 1. CBSA Population and Market Characteristics[a]

CBSAs (N = 742)	Mean	SD	Minimum	Maximum
Market characteristics				
Hospital competition: Herfindahl-Hirschman Index (0-100)	68.2	31.3	1.1	100.0
Medicaid payment per beneficiary	$5103	$1326	$2996	$8840
Percent inflows	15.1	11.0	1.3	89.6
Acute hospital beds per 1000 capita	1.8	0.8	0.1	6.9
Long-term care beds per 1000 capita	0.3	0.8	0.0	8.6
Rehabilitation beds per 1000 capita	0.1	0.2	0.0	1.0
Primary care physicians per 100,000 capita (2007)	56.3	19.6	11.7	182.7
Physician assistants per 100,000 capita	23.1	15.7	0.0	99.1
Specialists per 100,000 capita (2007)	98.3	73.0	5.5	903.5
Emergency department visits per capita (2006)	0.5	0.2	0.1	1.3
Percent acute care beds in high-technology hospitals	15.2	28.6	0.0	100.0
Quality of care: heart attack composite	94.6	8.5	0.0	100.0
Quality of care: heart failure	91.1	6.7	54.0	100.0
Quality of care: pneumonia	92.6	4.4	62.4	99.7
Population characteristics				
Total population in 1000s	340.8	1118.0	20.2	18,968.5
Population density per square mile	152.4	196.0	2.3	2240.0
Percent with bachelor's degree or above	20.9	7.8	6.2	55.9
Percent households below federal poverty level	10.8	4.3	3.1	33.8
Mean household income	$58,265	$10,936	$36,577	$135,894
Percent unemployed	6.5	2.0	1.7	16.2
Gini coefficient (0-100)	43.6	3.0	34.8	54.2
Percent white	78.1	17.4	2.2	98.2
Percent black or African American	8.5	10.9	0.1	61.5
Percent Hispanic	9.4	14.1	0.6	97.2

CBSA indicates Core Based Statistical Area; SD, standard deviation.
[a]Sample was limited to patients aged more than 40 years and those with nonmaternal stays.
Source: Authors' analysis of 2008 Healthcare Cost and Utilization Project State Inpatient Databases linked with 2008 American Hospital Association survey data, 2006 to 2008 data from the Area Resource File, 2008 data from the Medicaid Statistical Information System, and 2008 Centers for Medicare & Medicaid Services Hospital Compare data. Data are from 2008 unless noted otherwise.

than for Medicare ($11,908 vs $11,548; $P < .01$). The variation across CBSAs as measured by the coefficient of variation was similar for both resource measures and for both payers.

We compared the Medicare sample with the private insurance sample (results not shown) at the CBSA level. Compared with private insurance discharges, Medicare discharges were older by definition (mean age 78 years vs 53 years); more likely to be female (57% vs 53%); and more likely to be complex/severe cases with a greater average APR-DRG LOS weight (1.24 vs 1.05). Unexpectedly, Medicare discharges and private discharges had similar APR-DRG charge weights (1.32 vs 1.30). Compared with privately insured discharged patients, a greater percentage of discharged Medicare patients had each comorbid condition studied, with a few exceptions. Compared with discharged Medicare patients, a greater percentage of privately insured discharge patients had addictive disorders, had liver disease, and were obese.

Table 3 shows the results of the general linear model that estimated the association between hospital competition and average cost per discharge, controlling for patient, population, and market characteristics. Findings indicate that greater hospital market competition (HHI) predicted lower costs per discharge for both payers. A 1-unit increase in HHI was significantly associated with an $11.05 increase in average cost per discharge for Medicare patients. For privately insured patients, every 1-unit increase in HHI was significantly associated with a $7.47 increase in average cost per discharge.

Table 2. Variation in Resource Use by Payer[a]

	Private			Medicare		
CBSAs (N = 742)	Mean	SD	Coefficient of Variation	Mean	SD	Coefficient of Variation
LOS per discharge	4.09	0.4	0.10	5.28	0.66	0.12
Cost per discharge	$11,908	$1546	0.13	$11,548	$1487	0.13

CBSA indicates Core Based Statistical Area; LOS, length of stay; SD, standard deviation.
[a]Sample was limited to patients aged more than 40 years and those with nonmaternal stays.
Source: Authors' analysis of 2008 Healthcare Cost and Utilization Project State Inpatient Databases.

Table 3. Association Between Hospital Competition and Cost per Discharge by Payer, 2008[a]

	Private			Medicare		
Characteristics	Coefficient	SE	*P*	Coefficient	SE	*P*
Intercept	–8368.21	6207.16	.18	22,816.85	7877.92	.00
Herfindahl-Hirschman Index (0-100)	7.47	1.99	.00	11.05	2.06	<.01
Other market characteristics						
Acute hospital beds per 1000 capita	97.36	82.20	.24	150.23	86.35	.08
Long-term care beds per 1000 capita	58.65	66.98	.38	155.17	69.00	.02
Rehabilitation beds per 1000 capita	–429.45	358.60	.23	–73.83	378.27	.85
Primary care physicians per 100,000 capita (2007)	1.65	4.07	.68	2.33	4.19	.58
Specialists per 100,000 capita (2007)	–0.52	1.25	.68	–1.61	1.28	.21
Physician assistants per 100,000 capita	–2.80	3.89	.47	–2.45	3.99	.54
Emergency department visits per capita (2006)	406.16	348.62	.24	287.51	365.30	.43
Percent acute care beds in high-technology hospitals	–2.55	2.01	.20	–0.17	2.09	.94
Medicaid payment per beneficiary	–0.13	0.04	.00	–0.09	0.05	.06
Percent discharges from a different CBSA	–0.63	5.28	.91	–0.05	5.46	.99
Quality of care: heart attack composite	15.88	6.59	.02	11.79	6.85	.09
Quality of care: heart failure	–13.63	10.01	.17	–11.94	10.51	.26
Quality of care: pneumonia	25.05	15.02	.10	10.94	15.63	.48
Population characteristics						
Percent with bachelor's degree or above	33.00	11.76	.01	28.58	12.52	.02
Percent households below federal poverty level	8.12	27.28	.77	7.83	28.72	.79
Mean household income	0.00	0.01	.99	0.01	0.01	.22
Gini coefficient	–17.00	26.49	.52	–31.66	27.02	.24
Percent unemployed	–106.75	32.29	.00	–78.91	33.40	.02
Total population	0.07	0.07	.29	0.04	0.07	.57
Population density per square mile	–1.22	0.46	.01	–0.52	0.49	.29
Percent white	–7.68	13.11	.56	–15.34	13.48	.26
Percent black or African American	17.07	13.54	.21	–4.84	14.20	.73
Percent Hispanic	–0.43	13.36	.97	3.26	13.83	.81

APS-DRG indicates All-Payer Severity-adjusted diagnostic related group; CBSA, Core Based Statistical Area; SE, standard error.
[a]General linear model at the CBSA level with average cost per discharge as the outcome. Models also included patient characteristics (age, sex, race/ethnicity, severity [APS-DRG charge weight], and presence of comorbid conditions) to adjust for case mix. Sample was limited to patients aged more than 40 years and those with nonmaternal stays. CBSAs that had missing data or could not be measured on all covariates were excluded.
Source: Authors' analysis of 2008 Healthcare Cost and Utilization Project State Inpatient Databases linked with 2008 American Hospital Association survey data, 2006 to 2008 data from the Area Resource File, 2008 data from the Medicaid Statistical Information System, and 2008 Centers for Medicare & Medicaid Services Hospital Compare data. Data are from 2008 unless noted otherwise.

The only other market characteristics that predicted higher cost per discharge for Medicare was more long-term care beds per capita. For privately insured patients, other market characteristics that predicted higher cost per discharge were lower Medicaid payment per beneficiary and higher quality score on the heart attack composite.

Among the population characteristics studied, the percentage of patients with a college degree and the percentage of unemployed patients were significantly associated with cost per discharge for both Medicare and privately insured populations. Population density was associated with lower cost per discharge for privately insured patients. Patient characteristics including age, sex, APS-DRG, and presence of comorbid conditions were included in the models displayed in Table 3 but were not shown due to space limitations. Parameter estimates for these characteristics are available upon request. All patient characteristics were significant, most notably patient severity, and explained the observed variation in average cost per discharge.

Table 4 provides the results of the general linear model that estimated the association between hospital competition and average LOS per discharge, controlling for patient, population, and other market characteristics. Findings indicate that hospital market competition did not predict LOS for either Medicare or privately insured patients. Market characteristics that did significantly predict longer average LOS for Medicare were more rehabilitation beds per capita, fewer primary care physicians per capita, a higher percentage of acute care beds in high-technology hospitals, and greater Medicaid payment per beneficiary. For private insurance, fewer primary care physicians per capita, more physician assistants per capita, a higher percentage of acute care beds in high-technology hospitals, and greater Medicaid payment per beneficiary predicted longer average LOS. A higher percentage of patients from outside a CBSA predicted shorter average LOS.

Among the population characteristics studied, income inequality predicted longer average LOS for both the Medicare and privately insured populations. A higher percentage of black patients predicted longer average LOS for private insurance but not for Medicare. Of the patient characteristics, patient severity measured by APS-DRG LOS weight was the most important predictor of average LOS per discharge (not shown).

DISCUSSION

Findings from this study suggest that observed payer-specific patterns of inpatient healthcare resource intensity[4-6] are not a response to differences in private payer vulnerability to hospital market power. If this were the case, we would have observed an association between hospital competition and inpatient resources for private payers but not for Medicare. However, for both Medicare and private payers, hospital competition was associated with a similar decrease in inpatient cost per discharge. We found no association between hospital competition and LOS per discharge for either payer.

One interpretation of our results is that hospitals in highly competitive areas have moderated costs in response to weaker negotiating positions with private payers. Cost moderation could have been achieved by adopting resource efficiencies, reducing the cost of medical devices, or reducing overhead expenses. These efficiencies have translated to the care of Medicare beneficiaries. Hospitals in competitive markets must find ways to moderate their costs or else face shrinking profit margins.[20] Another interpretation is that hospitals in highly competitive areas perceive a greater necessity to profit by keeping facility costs below Medicare payment rates since they have a slimmer margin from private payers.[21]

Our finding that hospital competition is associated with reduced inpatient resource intensity is consistent with a study by Robinson[22] that examined this association for private payers in 61 hospitals spanning 8 states. Robinson found that hospital competition predicted reduced payment for privately insured patients admitted for 6 high-volume procedures. A study by Chang and colleagues[23] found no relationship between hospital competition and hospital costs in 2003 using HCUP Nationwide Inpatient Sample data. In contrast to our study, Chang and colleagues examined all payer groups together (including Medicaid and the uninsured) and focused on 5 standardized surgical procedures: appendectomy, carotid endarterectomy, bariatric surgery, radical prostatectomy, and pyloromyotomy. The costs for standardized procedures where there is little room for variation may be similar in areas that are more competitive and areas that are less competitive.

The relationship between hospital competition and cost has changed over time due to the implementation of the Prospective Payment System by Medicare in 1984. Studies examining data from the 1970s and early 1980s found hospitals in competitive environments had higher costs.[24,25] However, hospitals in more competitive environments had significantly slower cost growth before and after Prospective Payment System implementation compared with hospitals in less competitive environments.[21,26]

Under the Medicare Prospective Payment System, Medicare does not reimburse hospitals for costs. Rather, Medicare reimburses hospitals at a set rate based on patient diagnosis and adjusted for the area wage index. Hospitals that care for a high percentage of low-income patients and approved teaching facilities receive a percentage add-on payment for each case. In addition, the payment is increased for particular cases that are unusually costly. As a result of this payment structure, the relationship between hospital competition and actual

Table 4. Association Between Hospital Competition and Length of Stay per Discharge by Payer, 2008[a]

	Private			Medicare		
Characteristics	**Coefficient**	**SE**	***P***	**Coefficient**	**SE**	***P***
Intercept	–1.34	1.32	.31	–3.57	2.37	.13
Herfindahl-Hirschman Index (0-100)	0.00	0.00	.22	0.00	0.00	.08
Other market characteristics						
Acute hospital beds per 1000 capita	0.02	0.02	.17	0.05	0.03	.08
Long-term care beds per 1000 capita	0.00	0.01	.73	0.00	0.02	.89
Rehabilitation beds per 1000 capita	0.10	0.08	.17	0.36	0.13	.01
Primary care physicians per 100,000 capita (2007)	0.00	0.00	.03	0.00	0.00	.00
Specialists per 100,000 capita (2007)	0.00	0.00	.64	0.00	0.00	.69
Physician assistants per 100,000 capita	0.00	0.00	.04	0.00	0.00	.07
Emergency department visits per capita (2006)	–0.05	0.07	.50	0.00	0.12	.98
Percent acute care beds in high-technology hospitals	0.00	0.00	.00	0.00	0.00	.00
Medicaid payment per beneficiary	0.00	0.00	.01	0.00	0.00	<.01
Percent discharges from a different CBSA	0.00	0.00	.01	0.00	0.00	.10
Quality of care: heart attack composite	0.00	0.00	.35	0.00	0.00	.45
Quality of care: heart failure	0.00	0.00	.84	0.00	0.00	.92
Quality of care: pneumonia	0.00	0.00	.30	0.00	0.01	.53
Population characteristics						
Percent with bachelor's degree or above	0.00	0.00	.66	–0.01	0.00	.06
Percent households below federal poverty level	0.00	0.01	.60	–0.01	0.01	.18
Mean household income	0.00	0.00	.67	0.00	0.00	.96
Gini coefficient	0.02	0.01	.01	0.03	0.01	.00
Percent unemployed	–0.01	0.01	.09	–0.02	0.01	.06
Total population	0.00	0.00	.11	0.00	0.00	.09
Population density per square mile	0.00	0.00	.17	0.00	0.00	.06
Percent white	0.00	0.00	.86	–0.01	0.00	.13
Percent black or African American	0.01	0.00	.02	0.01	0.00	.10
Percent Hispanic	0.00	0.00	.29	0.00	0.00	.41

APS-DRG indicates All-Payer Severity-adjusted diagnostic related group; CBSA, Core Based Statistical Area; SE, standard error.
[a]General linear model at the CBSA level with average length of stay as the outcome. Models also included patient characteristics (age, sex, race/ethnicity, severity [APS-DRG length-of-stay weight], and presence of comorbid conditions) to adjust for case mix. Sample was limited to patients aged more than 40 years and those with nonmaternal stays. CBSAs that had missing data or could not be measured on all covariates were excluded.
Source: Authors' analysis of 2008 Healthcare Cost and Utilization Project State Inpatient Databases linked with 2008 American Hospital Association survey data, 2006 to 2008 data from the Area Resource File, 2008 data from the Medicaid Statistical Information System, and 2008 Centers for Medicare & Medicaid Services Hospital Compare data. Data are from 2008 unless noted otherwise.

reimbursement for Medicare may be different from the relationship between hospital competition and incurred costs for Medicare patients. However, because costs more closely track with actual resource use than with reimbursement, studying the relationship between competition and costs can shed light on whether resource efficiencies (or inefficiencies) driven by hospital competition are payer specific.

The confidential nature of private insurance reimbursement data prevents the creation of a nationally comprehensive database with detailed private insurance reimbursement information. Therefore, for our study to be geographically comprehensive and include data from multiple payers, we opted to use 2008 HCUP SID, which contain hospital charges rather than claims payments. We derived cost from charges using a hospital-specific CCR. The CCR is constructed using all-payer inpatient cost and charge information reported annually in the Medicare Cost Report. The hospitalwide CCRs represent the sum of the inpatient costs divided by the sum of

the inpatient charges at each hospital as reported in the Medicare Cost Report for that particular year. The CCRs have a known bias that tends to overestimate costs for patients with a relatively high proportion of ancillary unit services. Estimates of this bias by diagnostic categories are typically less than 10%.[27] Another limitation of the CCR is that payer-specific differences in the markup of charges are not captured. Markups are likely to be higher in less competitive areas. Therefore, the relationship between competition and costs for private payers across CBSAs is likely to be a conservative substitute for variation in reimbursement. Researchers are currently developing a method to estimate prices from discharge records using detailed hospital financial data available in selected states. Once available, these price estimates could be used to test the sensitivity of our findings.

We did not see a relationship between hospital competition and average LOS per discharge for either Medicare or private insurance. This could be because this outcome is a more blunt measure of resource intensity than cost per discharge. The decision to keep a patient for an additional night is a significant one, possibly driven more by unobservable disease severity/characteristics and patient social characteristics (eg, having an available caretaker and necessary accommodations) than by inefficiencies. Length of stay is also known to be influenced by the use of hospitalists and the complexity of discharge planning required for the patient,[28] 2 variables we were not able to measure. Of the measured characteristics, LOS per discharge appears to be influenced more by the availability of primary care physicians and income inequality than by cost per discharge.

Small-area variation studies using Medicare fee-for-service data often use the hospital referral region as the geographic unit of analysis. We defined small areas using CBSA boundaries in this study because hospital referral region–level analyses may not be appropriate to study the non-Medicare population due to the fact that hospital referral region boundaries were determined based on Medicare fee-for-service healthcare utilization patterns for major cardiovascular surgical procedures and for neurosurgery, and may not be appropriate for other populations.

In summary, this study sheds light on whether competition may affect resource use intensity and whether this effect differs by payer. We used a nationwide sample from 742 CBSAs and controlled for a number of patient, population, and market characteristics. There are important implications for policy makers regarding the finding that hospital competition contributed to variation in cost per discharge. This finding suggests that policies or incentives that promote or encourage competition in less competitive markets may reduce unnecessary variation in resource use for both Medicare and private payers. The Patient Protection and Affordable Care Act encourages hospitals and physicians to create accountable care organizations capable of managing the continuum of care and bearing joint risk. This type of coordination may strengthen the negotiating power of providers in competitive areas and blunt the potential influence of competition on reducing costs. Thus, there is a possibility that competitive areas that become more concentrated as hospitals merge and consolidate in preparation for becoming an accountable care organization may experience a greater increase in costs than comparable less competitive areas, perhaps exacerbated by the anticipated slowdown in Medicare reimbursement rates. However, as provider partnerships progress to the mature accountable care organizations envisioned by experts, with global population-based reimbursement structures,[29] such a trend would be tempered by strengthened primary care and reductions in the provision of unnecessary, duplicative, and ambulatory-sensitive care.

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■ **Appendix A.** Association Between Hospital Competition and Cost per Discharge by Payer, 2008, With a Hierarchical Linear Model Specification[a]

	Private			Medicare		
Characteristics	**Coefficient**	**SE**	***P***	**Coefficient**	**SE**	***P***
Intercept	15,913.00	144.82	<.01	16,878.00	94.34	<.01
Herfindahl-Hirschman Index (0-100)	8.47	2.19	<.01	13.00	2.32	<.01
Other market characteristics						
Acute hospital beds per 1000 capita	75.06	92.41	.42	206.03	96.64	.03
Long-term care beds per 1000 capita	–33.23	78.22	.67	0.56	81.85	.99
Rehabilitation beds per 1000 capita	–766.60	394.44	.05	–496.44	416.11	.23
Primary care physicians per 100,000 capita (2007)	7.97	4.49	.08	6.14	4.67	.19
Specialists per 100,000 capita (2007)	–2.92	1.48	.05	–2.93	1.51	.05
Physician assistants per 100,000 capita	2.49	4.26	.56	5.86	4.48	.19
Emergency department visits per capita (2006)	729.30	392.88	.06	851.70	411.79	.04
Percent acute care beds in high-technology hospitals	–105.64	221.14	.63	–185.79	234.53	.43
Medicaid payment per beneficiary	–124.76	48.46	.01	–43.61	50.77	.39
Percent discharges from a different CBSA	–3.27	5.51	.55	–9.28	6.33	.14
Quality of care: heart attack composite	13.23	7.47	.08	7.34	7.75	.34
Quality of care: heart failure	–3.94	11.22	.73	–15.37	11.78	.19
Quality of care: pneumonia	17.84	16.93	.29	18.17	17.72	.31
Population characteristics						
Percent with bachelor's degree or above	46.35	12.74	<.01	25.96	13.37	.05
Percent households below federal poverty level	4.64	29.64	.88	3.70	31.21	.91
Mean household income	–3.59	10.49	.73	12.29	11.15	.27
Gini coefficient	–15.56	28.40	.58	–14.06	30.00	.64
Percent unemployed	–58.87	34.70	.09	–88.71	36.57	.02
Total population	0.06	0.07	.38	0.06	0.08	.47
Population density per square mile	–1.01	0.48	.04	–0.80	0.52	.12
Percent white	5.68	14.07	.69	–5.48	14.94	.71
Percent black or African American	21.14	14.21	.14	13.78	15.11	.36
Percent Hispanic	8.24	14.31	.56	8.89	15.21	.56

APS-DRG indicates All-Payer Severity-adjusted diagnostic related group; CBSA, Core Based Statistical Area; SE, standard error.
[a]Hierarchical linear model with patient discharge cost (adjusted for area wage index) as the outcome. Models also included patient characteristics (age, sex, race/ethnicity, severity [APS-DRG charge weight], and presence of comorbid conditions) to adjust for case mix. Cost was estimated from charge using the Cost-to-Charge Ratio. Sample was limited to patients aged more than 40 years and those with nonmaternal stays. CBSAs that had missing data or could not be measured on all covariates were excluded.
Source: Authors' analysis of 2008 Healthcare Cost and Utilization Project State Inpatient Databases linked with 2008 American Hospital Association survey data, 2006 to 2008 data from the Area Resource File, 2008 data from the Medicaid Statistical Information System, and 2008 Centers for Medicare & Medicaid Services Hospital Compare data. Data are from 2008 unless noted otherwise.

Appendix B. Association Between Hospital Competition and Length of Stay per Discharge by Payer, 2008, With a Hierarchical Linear Model Specification[a]

	Private			Medicare		
Characteristics	**Coefficient**	**SE**	***P***	**Coefficient**	**SE**	***P***
Intercept	10.21	0.06	<.01	7.70	0.05	<.01
Herfindahl-Hirschman Index (0-100)	0.00	0.00	.41	0.00	0.00	.20
Other market characteristics						
Acute hospital beds per 1000 capita	0.02	0.02	.30	0.11	0.03	<.01
Long-term care beds per 1000 capita	0.01	0.02	.60	0.02	0.03	.51
Rehabilitation beds per 1000 capita	0.02	0.09	.87	0.13	0.15	.39
Primary care physicians per 100,000 capita (2007)	0.00	0.00	.25	0.00	0.00	.06
Specialists per 100,000 capita (2007)	0.00	0.00	.39	0.00	0.00	.71
Physician assistants per 100,000 capita	0.00	0.00	<.99	0.00	0.00	.71
Emergency department visits per capita (2006)	0.08	0.09	.37	0.14	0.15	.33
Percent acute care beds in high-technology hospitals	0.07	0.05	.14	0.08	0.08	.30
Medicaid payment per beneficiary	0.05	0.01	<.01	0.11	0.02	<.01
Percent discharges from a different CBSA	0.00	0.00	.04	–0.01	0.00	<.01
Quality of care: heart attack composite	0.00	0.00	.18	0.00	0.00	.60
Quality of care: heart failure	0.00	0.00	.62	0.00	0.00	.65
Quality of care: pneumonia	0.00	0.00	.41	0.00	0.01	.47
Population characteristics						
Percent with bachelor's degree or above	0.00	0.00	.24	–0.01	0.00	.02
Percent households below federal poverty level	0.00	0.01	.62	–0.01	0.01	.30
Mean household income	0.00	0.00	.79	0.00	0.00	.96
Gini coefficient	0.02	0.01	.01	0.03	0.01	<.01
Percent unemployed	0.00	0.01	.75	–0.01	0.01	.25
Total population	0.00	0.00	.43	0.00	0.00	.42
Population density per square mile	0.00	0.00	.16	0.00	0.00	.15
Percent white	0.00	0.00	.85	0.00	0.01	.92
Percent black or African American	0.01	0.00	.06	0.01	0.01	.02
Percent Hispanic	0.00	0.00	.17	0.01	0.01	.12

APS-DRG indicates All-Payer Severity-adjusted diagnostic related group; CBSA, Core Based Statistical Area; SE, standard error.
[a]Hierarchical linear model with patient length of stay as the outcome. Models also included patient characteristics (age, sex, race/ethnicity, severity [APS-DRG length-of-stay weight], and presence of comorbid conditions) to adjust for case mix. Sample was limited to patients aged more than 40 years and those with nonmaternal stays. CBSAs that had missing data or could not be measured on all covariates were excluded.
Source: Authors' analysis of 2008 Healthcare Cost and Utilization Project State Inpatient Databases linked with 2008 American Hospital Association survey data, 2006 to 2008 data from the Area Resource File, 2008 data from the Medicaid Statistical Information System, and 2008 Centers for Medicare & Medicaid Services Hospital Compare data. Data are from 2008 unless noted otherwise.