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RESEARCH ARTICLE

Impact of Health System Affiliation on Hospital Resource Use Intensity and Quality of Care

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Objective. To assess the impact of hospital affiliation, centralization, and managed care plan ownership on inpatient cost and quality.

Data Sources. Inpatient discharges from 3,957 community hospitals in 44 states and American Hospital Association Annual Survey data from 2010 to 2012.

Study Design. We conducted a retrospective longitudinal regression analysis using hierarchical modeling of discharges clustered within hospitals.

Data Collection. Detailed discharge data including costs, length of stay, and patient characteristics from the Healthcare Cost and Utilization Project State Inpatient Databases were merged with hospital survey data from the American Hospital Association.

Principal Findings. Hospitals affiliated with health systems had a higher cost per discharge and better quality of care compared with independent hospitals. Centralized systems in particular had the highest cost per discharge and longest stays. Independent hospitals with managed care plans had a higher cost per discharge and better quality of care compared with other independent hospitals.

Conclusions. Increasing prevalence of health systems and hospital managed care ownership may lead to higher quality but are unlikely to reduce hospital discharge costs. Encouraging participation in innovative payment and delivery reform models, such as accountable care organizations, may be more powerful options.

Key Words. Centralization, cost, health systems, hospitals, quality indicators

U.S. health care spending topped $3 trillion in 2014 and accounts for 17 percent of the gross domestic product (GDP) (Sisko et al. 2014). The unsustainable increase in health care expenditures slowed following the Great Recession of 2008 but likely will pick up again because of continued enrollment in Medicare and the momentum of historical trends (Sisko et al. 2014). Although quality indicators suggest that hospital performance has improved as spending has risen (Andrews, Russo, and

Pancholi 2006), substantial variation in quality between hospitals persists (Davis et al. 2014). To bend the cost curve and improve quality of care, policy makers have focused on encouraging new ways of organizing and reimbursing care (McClellan 2011).

A focus on system redesign and overhauling reimbursement methods is not new. As early as the 1970s, policy makers encouraged the development of health maintenance organizations (HMOs) and capitated contracting with provider groups. HMO adoption led to some success at containing costs without adversely affecting quality (Miller and Luft 1997; Chernew et al. 1998).

The latest innovation is *accountable care organizations* (ACOs)—networks of providers responsible for defined patient populations that share in savings if they slow the growth of health care spending while maintaining or improving quality of care (Merlis 2010). The Patient Protection and Affordable Care Act (ACA) authorized the use of ACOs to improve the safety and quality of care and reduce health care costs in Medicare. Commercial insurers followed suit. Hospitals are positioning themselves for this ACO-oriented contracting environment by joining or forming health systems (Burns et al. 2015) and preparing for risk-based contracting and population-based payments. Early results on the influence of ACOs on overall cost and quality have been mixed but promising (McWilliams, Landon, and Chernew 2013; Nyweide et al. 2015).

The ACA's focus on cost containment and alternative payment models has encouraged hospital partnerships with providers and generated interest in hospital partnerships with payers. There are increasing numbers of *payer-provider partnerships* in which hospitals or other providers partner with insurers to offer health plans (Van Tol et al. 2015). There also is an anticipated trend toward more *provider-payers*, a model in which hospitals or health systems offer their own managed care plans. Kaiser Permanente, Intermountain Healthcare, and Geisinger Health System are examples of provider-payers. Because it requires significant capital investment, the provider-payer model is likely to grow less rapidly than the payer-partnership (Caramenico 2013). Both models can support infrastructure investments for managing population health (Health Research & Educational Trust 2015), increase revenue, and increase

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diversification to help hospitals financially survive the shift from volume-based to value-based payment (Caramenico 2013). These benefits may entice health systems dissatisfied with the ACO model to diversify to insurance products, particularly because they offer more financial predictability and protections for taking on capitated payments.

Whether an increase in health systems and hospital involvement in managed care plans will affect inpatient cost and quality is not known. The literature suggests that health systems, particularly those that are organized centrally, may be positioned to provide better quality (Madison 2004; Chukmaitov et al. 2009, 2015). Health systems that take on risk for a population of patients via managed care contracts also may be poised to provide care at lower cost. In this study, we investigated whether three aspects of hospital organization affect resource use and quality outcomes: health system affiliation, health system centralization, and managed care ownership.

Hospitals Organized as Health Systems

Growth in hospitals organized as health systems accelerated with mergers and consolidations and the rapid rise of managed care during the 1990s (Lesser and Ginsburg 2000; Cuellar and Gertler 2003). Many mergers led to the development of health systems. Over half of community hospitals are members of health systems (Cutler and Morton 2013).

System hospitals may outperform independent hospitals because of economies of scale that allow them to operate more efficiently (Menke 1997; Madison 2004; Büchner, Hinz, and Schreyögg 2016). With access to cheaper resources than independent hospitals, system hospitals are better positioned to invest in infrastructure, technology, staff, and care management systems, which enable them to direct patient flow more effectively, share and transfer information, coordinate care between hospitals and across care settings, and comply with evidence-based clinical protocols (Madison 2004; Chukmaitov et al. 2009). Ingrained, system-wide care delivery processes that facilitate expeditious treatment and release of patients may result in shorter stays. However, system hospitals may not be as responsive to local needs or as quick to implement change as independent hospitals.

Centralization of Health Systems

Centralization refers to the extent to which organizations make decisions and offer services at the system level rather than locally. Some health systems

centralize all decision making, including decisions pertaining to contracting, technology adoption, and service delivery. These systems often directly employ—rather than contract with—all health care professional staff. Hospitals in noncentralized health systems have contractual relationships with each other but make decisions locally. Centralized health systems appear to have better quality and financial outcomes than noncentralized systems (Bazzoli et al. 2000; Chukmaitov et al. 2009, 2015). They have a more global view of operations and a systematic, data-driven approach to identifying quality issues and implementing solutions.

Ownership of Managed Care Plans

Managed care became popular in the late 1980s through the 1990s as a way for payers to use provider networks, utilization review, and prior authorization to rein in health care costs. Despite prevailing skepticism, managed care plans appeared to succeed in reducing costs without adversely affecting quality (Miller and Luft 1997).

A more direct relationship between insurance administration and providers (Enthoven 2009) allows an evolved managed care plan to offer hospitals greater ability to invest in, and sustain, innovative care management models (Evans 2015; Global Credit Research 2015). Managed care also has the potential to reduce duplication of services and enhance data collection and integration, utilization review, and cost-control capacity (Enthoven 2009).

Accountability for the cost and quality of care for a defined population should provide hospitals linked to insurance products with a strong incentive to provide care more efficiently without skimping on quality. Indeed, strong results in terms of health care value have been observed for Intermountain Healthcare and Kaiser Permanente (Feachem, Sekhri, and White 2002; Shih et al. 2009).

In the present study, we tested (1) whether health system affiliation is associated with resource use and quality, as gauged by average cost and length of stay per discharge and select patient quality indicators, respectively; (2) whether hospital affiliation with a centralized health system reduces cost and improves quality; and (3) whether managed care ownership reduces cost and length of stay and improves quality. We examined results for different combinations of hospital characteristics, anticipating that centralized health systems that own managed care products would have the most favorable outcomes.

METHODS

Data Sources

Data were drawn primarily from the 2010 through 2012 HCUP State Inpatient Databases (SID) (Agency of Healthcare Research and Quality [AHRQ], 2010b). HCUP databases bring together data collection efforts of state data organizations, hospital associations, private data organizations, and the federal government to create a national information resource of patient-level health care data. HCUP has the largest collection of longitudinal, all-payer, encounter-level hospital care data in the United States, including demographic, clinical, and billing information. The HCUP SID contain the universe of inpatient discharge abstracts from participating states, translated into a uniform format. All investigators signed a Data Use Agreement. Because HCUP does not involve human subjects, institutional review board approval was not required for this study. We extracted hospital health system affiliation and other characteristics from the American Hospital Association (AHA) Annual Survey of Hospitals and price index inflation data from the Bureau of Economic Analysis (BEA).

Study Population

The population of interest included all discharges from U.S. community, nonrehabilitation hospitals between 2010 and 2012. We excluded 258 long-term acute care hospitals and all children's hospitals because their patient mixes were substantially different in terms of age and length of stay. We also excluded 336 hospitals in states that did not contribute data to HCUP during the study period, 501 hospitals without 3 years of data in states that did contribute data to HCUP, 60 hospitals that did not have length of stay or charge information on discharge abstracts, and 22 hospitals with fewer than 30 discharges in any year. After these exclusions, our study sample consisted of 3,957 unique hospitals and approximately 99 million total discharges from 44 states.

Variables

We examined resource use and quality outcomes. Our first measure of resource use was hospital cost for an inpatient stay. Our aim is to study hospital resource use, and so we use a measure of cost that reflects the hospital's cost

of providing care, as opposed to any direct measure of expenditure by the patient and insurer. The SID contain data on total charges billed for each discharge; to estimate the actual costs of care, we converted charges to costs using the HCUP cost-to-charge ratio (CCR) files. The CCRs are all-payer, hospital-specific cost-to-charge ratios based on hospital accounting reports from the Centers for Medicare & Medicaid Services (CMS) (AHRQ 2010a). The derivation of cost-to-charge ratios applicable to HCUP hospitals is publicly available (AHRQ 2010a). We inflation-adjusted our cost estimates to 2012 dollars using the GDP Price Index from BEA (U.S. Department of Commerce, n.d.). We also measured length of stay per discharge, another measure of resource use.

For the quality dimension, we examined five Inpatient Quality Indicators (IQIs) (AHRQ n.d.): in-hospital mortality following admission for acute myocardial infarction (AMI), heart failure, acute stroke, and pneumonia, and uncomplicated cesarean delivery rate (Chukmaitov et al. 2009). We chose these five quality measures because they have high volume across hospitals, are almost always present on admission (some states cannot provide data on diagnoses accrued after admission), and have well-established clinical significance. In sensitivity analyses, we also examined mortality for gastrointestinal hemorrhage, hip fracture, percutaneous coronary intervention (PCI), carotid endarterectomy, and craniotomy. We opted not to include prevention quality indicators and patient safety indicators, because the former are sensitive to ambulatory care quality and the latter represent rare events and are not present on admission. For the quality regressions, we included only discharges identified with the relevant condition, resulting in a significantly smaller sample than that used for the cost-per-discharge and length of stay regressions.

The two health system classification schemes that we used were based on responses to AHA Annual Survey of Hospitals' questions related to health system membership, and degree of centralization in hospital services, physician arrangements, and insurance product development derived from responses to other AHA survey questions. The first specification employed a binary variable for system membership, a binary variable for HMO or PPO insurance products provided by the health system, and an interaction of the two. We also included a binary physician arrangement variable indicating hospitals with employment arrangements rather than contractual arrangements. The second specification relied on the AHA system cluster variable, which uses multiple AHA survey responses and factor analysis to classify hospitals into an organized grouping of systems on the basis of differentiation, centralization, and integration (Bazzoli et al. 1999). The system classification variable

from the AHA survey data defines five kinds of health systems: (1) centralized, (2) centralized physician/insurance, (3) moderately centralized, (4) decentralized, and (5) independent. A sixth value is reserved for hospitals that are part of systems but cannot be assigned to one of the five explicitly defined categories. This cluster system is well established in the literature (Bazzoli et al. 2000; Dubbs et al. 2004; Chukmaitov et al. 2009). We reclassified the six clusters used by AHA into three groups: (1) clusters 1–2 for health systems with highly centralized physician arrangements and insurance product development, (2) clusters 3–6 for other noncentralized health systems, and (3) independent hospitals not part of a system.

We obtained additional hospital characteristics from AHA survey data including teaching status, ownership, urban or rural location, region, bed size, number of hospitals in system, and technology status. Following previous work (Zuckerman, Hadley, and Iezzoni 1994; Rosko and Mutter 2008; Valdmanis, Rosko, and Mutter 2008), we defined high-technology hospitals as those offering at least six of eight high-technology services. We included an indicator for whether the hospital was affiliated with an ACO. Finally, we included the Herfindahl–Hirschman Index (HHI) as a measure of hospital market competition from the 2012 HCUP Hospital Market Structure (HMS) file (AHRQ 2014b). HHI is the sum of squared market shares for all of the hospitals in the market and has been linked to resource use and quality (Zwanziger and Melnick 1988; Gaynor, Ho, and Town 2014). We used the HHI patient flow definition of a hospital's market that is based on the collection of ZIP codes from which a nontrivial number of patients are sent to the hospital (Wong, Zhan, and Mutter 2005).

To control for the influence of patient mix and condition severity on resource use and quality outcomes, we measured patient age, sex, primary expected payer, and median household income of the patient's ZIP code. Uninsured populations had an expected payment source of *self-pay* or *no charge*. For our cost and length of stay models, we controlled for clinical condition and severity with a full set of categorical variables for major diagnostic categories (MDCs). We used relevant All Patient Refined Diagnosis Related Groups (APR-DRGs) with corresponding severity codes in our quality measure estimates (Averill et al. 2003). In addition, we included Elixhauser comorbidity measures (Elixhauser et al. 1998) identified on the discharge abstract in the form of an index (van Walraven et al. 2009). We included three additional patient factors that may influence resource intensity: admission from the hospital's emergency department, transfer from another facility, and

the HCUP Surgery Flag (AHRQ 2014a) for narrowly defined therapeutic invasive surgeries.

Statistical Approach

Given the multilevel nature of the data, we adopted a hierarchical modeling approach to model discharges clustered within hospitals using *SAS 9.3* (SAS Institute Inc., Cary, NC). These models allow intercepts to vary by hospital with all other predictors fixed. We included indicator variables for each year to account for changes in costs over time common to all hospitals. We specified the cost models with the Gaussian distribution, identity link, and variance components covariance structure using the PROC MIXED procedure.

We modeled length of stay using the PROC GLIMMIX procedure, specifying the Poisson distribution with a log link function and an unstructured covariance matrix. For the quality models, the dependent variables were dichotomous indicators reflecting whether that patient had died during hospitalization for AMI, heart failure, stroke, or pneumonia. For uncomplicated cesarean delivery rate, the dependent variable was an indicator for whether the patient had a cesarean section. Because the quality outcomes were binary, our models used the logit link and binomial distribution, with an unstructured covariance matrix.

We conducted several sensitivity analyses. First, to ensure that joint determination of health system affiliation and insurance ownership did not bias parameter estimates, we excluded the insurance ownership variables because they were derived from questions that also were used to categorize health systems into clusters. Second, we included a full set of APR-DRG severity indicator variables to enhance our discharge-level clinical severity adjustment for the cost-per-discharge regressions. Third, we estimated cost-per-discharge models with these iterations: (1) including hospitals that did not meet our eligibility criteria because they lacked all 3 years of data or were a children's hospital, (2) excluding public hospitals, (3) including an interaction between for-profit status and system, and (4) including an interaction between HHI and system. Finally, we estimated our models with four additional IQIs.

RESULTS

Our study sample included 3,957 community nonrehabilitation hospitals, of which 58 percent were part of systems (Table 1). System hospitals and

Table 1: Characteristics of Hospitals in Sample

Variable	*All Hospitals*	*Independent Hospitals*	*System Hospitals*	*System Hospital—Centralized*	*System Hospital—Noncentralized*
N	3,957	1,679	2,278	457	1,821
Percentage of all hospitals	100	42	58	12	46
Patient Characteristics					
Patient mean age (years)	49	49	49	49	49
Female patients (%)	58	58	58	58	58
Medicare (%)	38	39	38	38	38
Medicaid (%)	21	22	20	18	21
Private insurance (%)	32	30	33	36	32
Self-pay (%)	5	5	5	5	5
No charge (%)	2	3	1	1	1
Primary payer other (%)	3	4	3	3	4
Patients from 1st quartile median household income (%)	30	32	29	25	31
2nd quartile median household income (%)	26	26	25	24	26
3rd quartile median household income (%)	24	22	24	26	24
4th quartile median household income (%)	21	20	21	26	20
Transfer from emergency department (%)	49	50	49	47	50
Hospital Characteristics					
Northeast region (%)	14	16	11	18	10
Midwest region (%)	31	34	29	33	29
South region (%)	36	31	40	36	41
West region (%)	19	18	20	13	21
Public, nonfederal (%)	21	36	10	7	10
Private, not-for-profit hospital (%)	62	55	68	91	62
Private, for-profit hospital (%)	17	9	23	2	28
Small bed size (%)	39	47	34	36	33
Medium bed size (%)	25	23	27	24	27
Large bed size (%)	35	30	39	40	39
Teaching hospital (%)	19	15	22	32	19
Urban location (%)	59	48	67	76	65
ACO established (%)†	5	2	7	20	4
Ratio of OP revenue to IP revenue (mean)	0.9	1.0	0.8	0.8	0.8

continued

Table 1: *Continued*

Variable	*All Hospitals*	*Independent Hospitals*	*System Hospitals*	*System Hospital—Centralized*	*System Hospital—Noncentralized*
Patient flow HHI 0-1 (mean)	0.28	0.29	0.28	0.28	0.28
Number of hospitals in system	17	1	29	7	35
Number of high-tech services (mean)	2	2	3	3	2
EMR/EHR (% fully implemented)	20	19	20	25	19
Ownership stake in HMO or PPO (%)	17	12	21	48	14
Outcome Measures					
Cost per discharge ($)	9,430	9,326	9,479	10,166	9,227
Length of stay (days)	4.50	4.48	4.51	4.66	4.45
AMI mortality (%)	6.0	6.6	5.8	5.7	5.9
Heart failure mortality (%)	3.2	3.4	3.2	3.2	3.1
Pneumonia mortality (%)	3.8	3.9	3.7	3.7	3.7
Stroke mortality (%)	9.1	9.1	9.1	9.3	9.0
Cesarean section probability (%)	30.1	29.7	30.2	30.1	30.3

[†]ACO statistics from 2011 AHA data because the measure was not tracked before then.
ACO, accountable care organization; EHR, electronic health records; EMR, electronic medical records; HHI, Herfindahl–Hirschman Index; HMO, health maintenance organization; IP, inpatient; OP, outpatient; PPO, preferred provider organization.
Source. Analysis of American Hospital Association (AHA) data, 2010.

independent hospitals had a similar mix of patients in terms of age, sex, primary payer, comorbidities, and MDCs. Independent hospitals were more likely than system hospitals to be public (36 vs. 10 percent), small (47 vs. 34 percent), and non-urban (52 vs. 33 percent), and to have a higher ratio of outpatient-to-inpatient revenue.

Centralized systems constituted 12 percent of hospitals in the sample. They treated a higher proportion of patients with private insurance (36 vs. 32 percent) and patients who resided in the highest income ZIP codes (26 vs. 20 percent) than did noncentralized system hospitals. They also were more likely to be private not-for-profit (91 vs. 62 percent) and teaching (32 vs. 19 percent), with a higher average technology index score (3 vs. 2 on a scale from 0 to 6).

Nearly half of centralized system hospitals had an ownership stake in managed care plans—in contrast, only 14 percent of noncentralized system

hospitals and only 12 percent of independent hospitals owned managed care plans. Although 2010 data are shown, these percentages generally were consistent across study years.

Table 2 provides a summary of results. Tables S1–S7 provide full regression results from our cost, length of stay, and quality models on which Table 2 estimates are based. The predictions are generated by setting each continuous covariate to its overall mean, and each categorical indicator other than those associated with system affiliation to $1/k_i$, where k_i represents the number of different categories for characteristic i. Tables S8–S12 provide regression results from the additional quality metrics examined as sensitivity analyses. Each appendix table shows the results from the two modeling specifications. Specification 1 was used to test predictions regarding the performance of health systems versus independent hospitals. Specification 2 was used to test predictions regarding the performance of hospitals that owned and did not own managed care plans and were and were not part of centralized hospitalized systems. As a sensitivity analysis, we also tested predictions regarding the performance of health systems versus independent hospitals without inclusion of variables for insurance products provided by or physician ownership arrangements of the hospital. These results were nearly identical to those from Specification 1, alleviating concerns about these decisions being made endogenously as a function of system affiliation.

Health System Affiliation

We found that system hospitals had a higher cost per discharge than independent hospitals, controlling for hospital and patient characteristics ($11,332 vs. $11,207, $p < .01$). There was no difference in length of stay. Across the five quality indicators, system hospitals performed significantly better than independent hospitals. Patients at system hospitals had a 2.19 percent AMI mortality rate compared with 2.55 percent for patients at independent hospitals ($p < .01$). Patients at system hospitals had a 1.71 percent heart failure mortality rate compared with 1.90 percent for patients at independent hospitals ($p < .01$). Stroke and pneumonia mortality rates were 4.05 and 1.78 percent, respectively, at system hospitals compared with 4.32 and 2.03 percent at independent hospitals ($p < .01$ for both outcomes). However, patients at system hospitals were more likely than patients at independent hospitals to have a cesarean section (29.86 vs. 29.31 percent, $p = .01$).

Table 2: Impact of Health Care Systems, Managed Care Ownership, and Central Decision Making on Cost, Length of Stay, and Quality

Variable	*Health System*	*Independent Hospital*	*Health System—Centralized*	*Health System—Noncentralized*	*Hospital with HMO or PPO*	*Hospital without HMO or PPO*
Cost per discharge ($)						
Predicted mean	11,332	11,207	11,416	11,314	11,343	11,186
p value	<.01		<.01		<.01	
Length of stay (days)						
Predicted mean	4.08	4.08	4.09	4.08	4.08	4.09
p value	0.82		<.01		<.01	
AMI mortality (%)						
Predicted mean	2.19	2.55	2.13	2.21	2.15	2.33
p value	<.01		.03		<.01	
Heart failure mortality (%)						
Predicted mean	1.71	1.90	1.73	1.70	1.74	1.77
p value	<.01		.16		.24	
Pneumonia mortality (%)						
Predicted mean	1.78	2.03	1.74	1.77	1.79	1.88
p value	<.01		.32		<.01	
Stroke mortality (%)						
Predicted mean	4.05	4.32	4.17	4.01	4.29	4.07
p value	<.01		.01		<.01	
Cesarean section probability (%)						
Predicted mean	29.86	29.31	30.21	29.60	28.72	30.09
p value	.01		<.01		<.01	

Notes. Predicted values from hierarchical linear models (discharges nested within hospitals) measure the relationship between key hospital characteristics (health system affiliation, health maintenance organization [HMO]/preferred provider organization [PPO] ownership, centralization) and outcomes. Predicted means were calculated as though categorical regressor distributions were balanced across the population. Regression models were measured for each outcome and included year dummies, hospital covariates (hospital ownership type, size, teaching status, patient flow Herfindahl–Hirschman Index, urban, region) and patient covariates (payer, median income quartile of residence, emergency department transfer, comorbidity index, major diagnostic category, surgery flag, sex, age group, and transfer status). Regression models for each of the quality measures included All Patient Refined Diagnosis Related Groups (APR-DRG) with corresponding severity codes.

AMI, acute myocardial infarction.

Source. Healthcare Cost and Utilization Project State Inpatient Databases data, 2010–2012, linked with American Hospital Association survey data.

Health System Centralization

After controlling for hospital and patient characteristics, centralized system hospitals had a slightly higher cost per discharge ($11,416 vs. $11,314, $p < .01$) and a slightly longer length of stay (4.09 days vs. 4.08 days, $p < .01$). Quality results were mixed—centralized system hospitals had lower AMI mortality,

higher stroke mortality, and higher cesarean section probability compared with noncentralized system hospitals. Centralized and noncentralized system hospitals had similar heart failure mortality and pneumonia mortality.

Hospital Ownership of Managed Care Plans

Hospitals with an ownership interest in managed care plans had a higher average cost per discharge ($11,343 vs. $11,186, $p < .01$) and a slightly shorter average length of stay (4.08 vs. 4.09 days, $p < .01$) than other hospitals, controlling for hospital and patient characteristics. Hospitals with managed care plans performed better than hospitals without managed care plans on AMI mortality (2.15 vs. 2.33 percent, $p < .01$), pneumonia mortality (1.79 vs. 1.88 percent, $p < .01$), and cesarean section (28.72 vs. 30.09 percent, $p < .01$). Hospitals with managed care plans performed worse on stroke mortality (4.29 vs. 4.07 percent, $p < .01$) and were no different on heart failure mortality.

Differential Impacts of Hospital Characteristics

Table 3 contains results for each combination of health system type and outcome. System type had a more pronounced impact on cost per discharge for hospitals with no ownership stake in a managed care product. For hospitals without managed care ownership, predicted cost per discharge was $11,442 ($p < .01$) for centralized system hospitals, $11,281 ($p < .01$) for noncentralized system hospitals, and $11,070 for independent hospitals (reference category). In contrast, predicted cost per discharge for hospitals that owned a managed care product, regardless of system type, were very similar, ranging from $11,344 to $11,389 ($p = .05$). We also found that the relationship between system characteristics and length of stay depended on managed care ownership, but absolute differences in length of stay across all combinations were minimal—none exceeded 0.02 days.

Health systems had differing influences on quality outcomes by managed care ownership. System type had a more pronounced positive impact on quality across hospitals that did not have an ownership stake in managed care. The only quality indicator with a different trend was cesarean section—the probability was higher for system hospitals than for independent hospitals regardless of managed care ownership, except for noncentralized systems with managed care, which had the lowest cesarean rate.

Table 3: Predicted Outcomes by Health System Type and Insurance Product Ownership

	Own HMO or PPO: Yes			*Own HMO or PPO: No*		
Variable	*Health System—Centralized*	*Health System—Noncentralized*	*Independent Hospital (Reference)*	*Health System—Centralized*	*Health System—Noncentralized*	*Independent Hospital (Reference)*
Cost per discharge ($)						
Predicted mean	11,389	11,347	11,344	11,442	11,281	11,070
p value	.05	.87		.01	.01	
Length of stay (days)						
Predicted mean	4.09	4.08	4.07	4.08	4.08	4.10
p value	<.01	<.01		<.01	<.01	
AMI mortality (%)						
Predicted mean	2.13	2.08	2.29	2.12	2.25	2.63
p value	.04	<.01		<.01	<.01	
Heart failure mortality (%)						
Predicted mean	1.82	1.67	1.74	1.66	1.70	1.94
p value	.23	.19		<.01	<.01	
Pneumonia mortality (%)						
Predicted mean	1.84	1.69	1.84	1.64	1.79	2.07
p value	.98	<.01		<.01	<.01	
Stroke mortality (%)						
Predicted mean	4.24	4.30	4.34	4.12	3.94	4.32
p value	.44	.77		.03	<.01	
Cesarean section probability (%)						
Predicted mean	29.25	27.94	28.35	31.13	30.00	29.59
p value	<.01	.04		<.01	.01	

Notes. Predicted values from hierarchical linear models (discharges nested within hospitals) measure the relationship between key hospital characteristics (health system affiliation, health maintenance organization [HMO]/preferred provider organization [PPO] ownership, centralization) and outcomes. Predicted means were calculated as though categorical regressor distributions were balanced across the population. Within each level of *Own HMO or PPO*, *p* values associated with *Health System—Centralized,* and *Health System—Noncentralized* test for significant differences in predicted means against *independent hospital.* Regression models were measured for each outcome and included year dummies, hospital covariates (hospital ownership type, size, teaching status, patient flow Herfindahl–Hirschman Index, urban, region) and patient covariates (payer, median income quartile of residence, emergency department transfer, comorbidity index, major diagnostic category, surgery flag, sex, age group, and transfer status). Regression models for each of the quality measures included All Patient Refined Diagnosis Related Groups (APR-DRG) with corresponding severity codes.
Source. Healthcare Cost and Utilization Project State Inpatient Databases data, 2010–2012, linked with American Hospital Association survey data, 2010–2012.

Sensitivity Analyses

Sensitivity analyses provided evidence that our results were robust to choice of quality metrics and choice of modeling framework. Results from the four additional quality metrics (Tables S8–S13) were in the same direction, but fewer reached statistical significance. This is likely because admissions for these conditions occurred less frequently, and, thus, our samples were smaller. We estimated models without managed care ownership variables to determine whether this omission changed the main effect of health system type (centralized vs. noncentralized) on the outcomes. It did not. We included a full set of APR-DRG severity indicator variables in our models to increase the robustness of case-mix adjustment. This also did not alter our findings. Therefore, we focused on the more parsimonious models without the full set of APR-DRG severity indicators. We estimated additional cost models including models relaxing hospital exclusion criteria to include those without 3 years of data, models including children's hospitals, models excluding public hospitals, and models including an interaction between system membership and ownership type. All were consistent with our primary results.

DISCUSSION

We found that system hospitals have a higher cost per discharge, similar length of stay, and better quality compared with independent hospitals. Centralized system hospitals have a higher cost per discharge, slightly longer length of stay, and similar quality compared with noncentralized system hospitals. Hospitals with managed care ownership have higher cost per discharge, slightly shorter length of stay, and mixed quality results compared with hospitals without managed care ownership.

We found that independent hospitals had lower costs than system hospitals. This result may be attributable to system hospitals' investment in infrastructure, technology, and clinical staff, as suggested by our analysis of the AHA data, which revealed that system hospitals invest more in high-technology services and have a higher rate of electronic health record adoption. This explanation is consistent with research that found a relationship between quality improvement efforts, better infrastructure, and higher quality of care (Chernew et al. 1998; Buntin et al. 2011). Any long-term cost savings may not have been detectable during our study period. Our finding that system hospitals provide higher quality of care than independent hospitals on most quality

measures is consistent with the literature (Madison 2004; Chukmaitov et al. 2009; Carretta et al. 2013).

We found noncentralized system hospitals had lower costs and shorter stays compared with centralized system hospitals, contrary to previous research (Bazzoli et al. 2000). Greater infrastructure investment and focus on patient management may explain the higher costs for centralized systems. Our results may differ from those of previous studies because we used more recent data, analyzed discharge-level, all-payer data, and included patients from all payers. Certain centralized systems, such as those that are small and that have a hub-and-spoke structure, may be more cost efficient than others (Burns et al. 2015).

We found hospitals that owned managed care products had higher costs per discharge, despite their incentives to reduce the cost of care. Because managed care products may account for only a small portion of these hospitals' revenues, they may not have a significant impact on decisions that affect costs. These hospitals also may focus on improving access to outpatient care and preventing inpatient admissions rather than on reducing resource intensity in the inpatient setting. To attract patients and meet contract obligations regarding quality, they may make investments in infrastructure, technology, and clinical staff that allow them to provide higher quality care. Hospitals with managed care ownership have higher rates of electronic health record adoption and offer more high-technology services compared with hospitals with no managed care ownership. These investments are consistent with the notion that hospitals use capitated payments as an opportunity to make infrastructure investments, which may reduce cost per discharge in the long run.

When we examined combinations of health system characteristics, we found that no particular structure was dominant, with respect to minimizing mortality probability and resource use simultaneously. Independent hospitals without managed care ownership had the lowest cost per discharge; independent hospitals with managed care ownership had the shortest stays; and system hospitals had the best quality. Hence, there may not be a single best organizational structure for achieving superior results on all outcomes.

We found that the influence of system type on outcomes depended on managed care ownership. Across several outcomes, independent hospitals with managed care were similar to system hospitals. Independent hospitals without managed care were quite different from all other types of hospitals—with lower cost, longer stays, and lower quality. Perhaps independent hospitals

with managed care have greater access to data and focus more on quality and efficiency than independent hospitals without managed care. The generally positive influence of managed care ownership on quality can be attributed to a systematic approach to quality improvement used by organizations affiliated with managed care products that include standard sets of performance measures and performance tracking.

Limitations

There were several limitations to our analysis. First, the observational, short-panel study design that we used to examine the association between hospital type and outcomes is subject to endogeneity concerns because we could not account for the possibility that unobserved, time-varying hospital characteristics (such as management quality) may have influenced selection into systems and outcomes. Previous research examining the relationship between multihospital membership and similar outcomes found that selection did not influence results (Madison 2004). Another limitation is that cost per discharge is influenced by utilization and cost per service. We included MDCs and APR-DRGs in regression models, but empirical analysis cannot fully control for utilization. Further, we calculated our cost measures from hospital reported charges multiplied by a hospital-specific, cost-to-charge ratio derived from hospital cost reports, which may be inaccurate at the discharge level. Costs for not-for-profit hospitals also will include reinvested profits.

No tractable health system classification scheme, including that used in this study, can accommodate the complexity and variety of U.S. health systems. Some hospitals assigned to the noncentralized system category operate with some degree of centralization. Similarly, some hospitals without managed care ownership may be affiliated with insurers that provide the same exposure. Hospitals may have more or less exposure to managed care contracts. We did not differentiate between systems that are limited to inpatient services and those that provide a continuum of care, which may have more incentives and levers to control hospital costs.

Finally, we examined only inpatient care. Health systems may benefit patients and payers by improving the management of the care continuum, which we could not observe by focusing on inpatient costs and quality. However, because hospital care accounts for nearly 36 percent of total national health expenditures (Martin et al. 2014), it often is considered the setting with the greatest potential for savings.

Strengths

Our study has several strengths. We used 3 years of national, all-payer data that provided discharge-level clinical and demographic detail about each patient to enhance risk adjustment. The 2010–2012 timeframe presents a more recent look at the association between hospital type and outcomes compared with other studies in this area. We also examined multiple outcomes—cost, length of stay, and several quality indicators—whereas other studies have focused exclusively on financial outcomes or quality outcomes. Our use of CCRs to estimate cost per discharge afforded us direct cost estimates, averting the need to rely on reimbursements or charges as proxies. Our measure of health system centralization built on a peer-reviewed, widely accepted algorithm developed by Bazzoli et al. (1999) that has been used in multiple other studies (Bazzoli et al. 1999, 2000; Chukmaitov et al. 2009, 2015). Finally, our sensitivity analyses ensured that our results were robust to various modeling frameworks.

Policy Implications

The relationship between hospital structure and hospital outcome measures can inform policy decisions pertinent to the new health care marketplace, where hospitals are joining together (Cutler and Morton 2013) and taking on risk for populations of patients via ACO and/or managed care contracts. Centralized management and accountability for cost and quality are hypothesized to be key drivers of change among ACOs.

Policy makers envision that ACOs will assume increasing financial risk and ultimately may accept a global payment for aligned beneficiaries, putting them at risk for the entire cost of care. The CMS Next Generation ACO model, for example, has similarities to fully capitated Medicare Advantage plans, with a key difference being that Medicare beneficiaries retain choice of provider. If our results generalize, we would expect hospitals affiliated with ACOs that take on financial risk to have superior inpatient quality results but not necessarily lower costs. However, other aspects of the ACO model, such as the uncertainty that accompanies the retrospective determination of savings or losses compared with benchmarks, may provide a more powerful incentive to reduce costs than those provided by the managed care model in which financial performance is determined more simply by comparing spending to the preset capitation rate.

Our results have implications for hospital mergers. This is a particularly relevant topic given the recent wave of consolidations in the hospital industry (Cutler and Morton 2013), which some researchers have suggested may lead to higher prices and harm consumers (McDermott 2009). Contrary to previous studies of the effect of consolidation on hospital costs (Dranove and Lindrooth 2003; Harrison 2011; Büchner, Hinz, and Schreyögg 2016), our results suggest that system hospitals incur higher costs per discharge than do independent hospitals, regardless of whether they own an insurance product. We also find that system hospitals provide superior quality of care compared with independent hospitals. Research examining the relative merits of joining a system with high market share in one community versus a system with lower market share across many communities is needed to illuminate potential antitrust concerns associated with these findings.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.

Table S1: Estimates from Regression Models Measuring the Relationship between Hospital System Type, Managed Care Ownership, and Cost of Stay.

Table S2: Estimates from Regression Models Measuring the Relationship between Hospital System Type, Managed Care Ownership, and Length of Stay.

Table S3: Estimates from Regression Models Measuring the Relationship between Hospital System Type, Managed Care Ownership, and Acute Myocardial Infarction (AMI) Mortality.

Table S4: Estimates from Regression Models Measuring the Relationship between Hospital System Type, Managed Care Ownership, and Heart Failure Mortality.

Table S5: Estimates from Regression Models Measuring the Relationship between Hospital System Type, Managed Care Ownership, and Pneumonia Mortality.

Table S6: Estimates from Regression Models Measuring the Relationship between Hospital System Type, Managed Care Ownership, and Acute Stroke Mortality.

Table S7: Estimates from Regression Models Measuring the Relationship between Hospital System Type, Managed Care Ownership, and Cesarean Delivery Rate, Uncomplicated.

Table S8: Estimates from Regression Models Measuring the Relationship between Hospital System Type, Managed Care Ownership, and Gastrointestinal Hemorrhage Mortality.

Table S9: Estimates from Regression Models Measuring the Relationship between Hospital System Type, Managed Care Ownership, and Hip Fracture Mortality.

Table S10: Estimates from Regression Models Measuring the Relationship between Hospital System Type, Managed Care Ownership, and Percutaneous Coronary Intervention (PCI) Mortality.

Table S11: Estimates from Regression Models Measuring the Relationship between Hospital System Type, Managed Care Ownership, and Carotid Endarterectomy Mortality.

Table S12: Estimates from Regression Models Measuring the Relationship between Hospital System Type, Managed Care Ownership, and Craniotomy Mortality.

Table S13: Impact of Health Care Systems, Managed Care Ownership, and Central Decision Making on Additional Quality Metrics.

Table S14: Predicted Outcomes by Health System Type and Insurance Product Ownership.