Factors Associated with High-Quality/Low-Cost Hospital Performance

H. Joanna Jiang, Bernard Friedman, and James W. Begun

This study explores organizational and market characteristics associated with superior hospital performance in both quality and cost of care, using the Healthcare Cost and Utilization Project State Inpatient Databases for ten states in 1997 and 2001. After controlling for a variety of patient factors, we found that for-profit ownership, hospital competition, and the number of HMOs were positively associated with the likelihood of attaining high-quality/low-cost performance. Furthermore, we examined interactions between organizational and market characteristics and identified a number of significant interactions. For example, the positive likelihood associated with for-profit hospitals diminished in markets with high HMO penetration. Key words: *quality, cost, hospital competition, managed care.*

THE substantial changes occurring in the health care sector for the last 20 years, first sparked by the implementation of the Prospective Payment System and later by the rise of managed care, have drawn mounting attention to the impact of those changes on hospital cost and quality of care. At least a dozen studies have investigated the relationship between hospital competition and quality of care.[1] The effects of hospital competition and HMO penetration on hospital costs is another frequently studied topic.[2] Most studies tend to focus on either quality or cost, and few have attempted to examine these two dimensions of hospital performance jointly.

Policy interventions also usually are designed to address quality and cost separately. Concerned with the limited success of various strategies to control healthcare costs, purchasers are experimenting with the use of quality-based financial incentives.[3] For example, the federal Centers for Medicare and Medicaid Services (CMS) recently

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renamed the Peer Review Organizations (PROs), which traditionally focused on utilization control, as Quality Improvement Organizations (QIOs), which emphasize compliance with evidence-based practices and improving patient outcomes.[4] Additionally, CMS has partnered with Premier, Inc., to work with nearly 300 hospitals on a three-year demonstration project to reward high quality financially.[5]

Some recent pay-for-performance programs are integrating quality and efficiency measures. The Leapfrog Hospital Reward Program, a private-sector initiative, ranks hospitals based on both quality and resource-efficiency and rewards top-cohort hospitals with bonus payments or increased patient share.[6] Hospitals are faced with the challenge of accomplishing both higher quality and greater efficiency in order to compete.

We conducted this study to explore organizational and market characteristics that may be associated with the likelihood of a hospital to achieve high-quality/low-cost performance. Although policy interventions are usually designed to encourage improvements in either quality or cost separately, from the social welfare perspective, attaining high performance in both quality and cost should be the most desirable goal for increasing value and efficiency.[7] Realistic expectations for policy interventions should recognize the market forces and organizational differences that may be conducive or counteractive to reaching the goal.

Conceptual Background

Industrial organization economics and organizational theory provide conceptual guidance in this study to examine the relationship among organizations, their environments, and their performance. According to Porter,[8] organizations can choose one of two generic strategies (*i.e.*, low-cost or differentiation) or a hybrid (*i.e.*, both low-cost and differentiation) to achieve competitive advantage. The quality of the product or service can serve as a basis for distinguishing an organization from its competitors. In this regard, examining hospitals' joint performance of cost and quality of care allows the identification of those market conditions associated with the pursuit of a hybrid strategy. Porter's hypothesis focuses on the role of market factors in strategic choices, whereas the structural contingency theory guides the exploration of an organization's structural attributes in relation to performance. Structural contingency theory suggests that both environment and organizational structure are key determinants of organizational performance.[9] Additionally, interactions between environmental and organizational characteristics can have a significant impact on organizational performance.

We applied these two complementary theories to investigate organizational and market determinants of hospital quality-cost performance. A number of basic organizational characteristics that include size, ownership, teaching status, and system affiliation should be considered. Variation in these characteristics is closely linked to differences in mission, service domain, patient population, and structural dimensions. For instance, for-profit hospitals are more likely to have a relatively limited scope of services than nonprofit or public hospitals. Compared with small hospitals, large hospitals offer more variety of services and are more formalized structurally. Teaching hospitals serve multiple missions and a more diverse patient population. System-affiliated

hospitals may be more centralized in decision making than independent hospitals. Previous studies found that cost and mortality were positively associated with hospital size[10] but negatively with for-profit status.[11] Findings are inconsistent on teaching status and quality;[12] little is known about the effect of system affiliation on quality.

Other organizational characteristics expected to have an impact on hospital performance are nurse staffing, service specialization, patient volume, and payor mix. Higher nurse staffing level and skill mix have been found to be associated with better patient outcomes[13] but higher costs.[14] Service specialization can lower costs and increase quality.[15] Patient volume for specific procedures and conditions is likely to have a positive impact on both cost and quality through economics of scale and potential volume-outcome relationships. Finally, payor mix should also be considered, as recent evidence suggests that inpatient care provided for Medicaid or uninsured patients is much less profitable than it is for privately insured patients or Medicare beneficiaries, and payor generosity has a positive effect on the intensity of care.[16]

Among market conditions, hospital competition and managed care penetration are key sources of environmental turbulence. Hospital competition can stimulate quality improvement and lower cost if having good performance in quality and cost is recognized as a competitive advantage. Empirical evidence shows that hospital competition has a positive impact on cost reduction[17] but either positive or minimal effects on quality.[18] Managed care adds to market uncertainty through selective contracting and use of financial mechanisms such as capitation for risk shifting to providers. The impact of managed care penetration on restraining growth of hospital expenditures is well-supported in empirical studies.[19] Results have been mixed, however, as to the effects of managed care on hospital quality of care.[20]

A number of other market characteristics that can influence hospital quality and cost performance include the supply of physicians, economic wealth, and age composition of the population. These characteristics reflect the availability of resources and demand that are essential to hospital operation. The size and specialty mix of the physician workforce are important factors on cost, accessibility, and quality of care.[21] Economic wealth and the population size in certain age groups (*e.g.*, the elderly) are key determinants of hospital utilization that can affect both the cost and quality of care through a demand for more high-tech services, volume-outcome relationships, and other mechanisms.

Methods

Study Sample

The initial sample consists of 1,456 nonfederal, general acute hospitals in ten states (Arizona, California, Colorado, Florida, Georgia, Illinois, Iowa, New York, Tennessee, and Wisconsin) that contributed complete discharge data to the Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases in both 1997 and 2001. These ten states, in combination, provide a reasonable representation of hospitals in different geographic regions, market conditions, and structural categories (*e.g.*, teaching status, ownership, size). Hospitals merged or closed during the study period as well as those opened in 2001 were excluded from the study. For each year, we dropped from the study sample those hospitals that

were outliers in patient volume (the lowest 5 percent of total patient volume at risk of the mortality indicators), risk-adjusted mortality rate, or severity-adjusted cost. Outliers for risk-adjusted mortality and severity-adjusted cost were defined as four times the inter-quartile range above the median. The final study samples contain 1,369 hospitals in 1997 and 1,351 hospitals in 2001.

Measures and Data Sources

Data for this study derive from multiple sources. We measured quality and cost of hospital care using the HCUP inpatient discharge data; hospital structural characteristics from the American Hospital Association (AHA) Annual Survey; and county-level market characteristics from the Area Resource File (ARF) and InterStudy HMO County Surveyor.

Quality and Cost Measures

Quality of care was defined from an outcome perspective using the AHRQ Inpatient Quality Indicators (IQIs).[22] We selected ten mortality IQIs that cover six common medical conditions (acute myocardial infarction, congestive heart failure, gastrointestinal bleeding, hip fracture, pneumonia, stroke) and four surgical procedures (abdominal aortic aneurysm repair, coronary artery bypass graft, craniotomy, hip replacement). These ten indicators apply to non-maternal adult patients only. For patients who overlap between the medical and surgical indicators (*e.g.*, a heart attack patient receiving bypass surgery), we modified the IQI software to assign those patients to the surgical class only. The IQI software produced risk-adjusted rates for each indicator with APR-DRGs, age, and gender as the risk factors. We then constructed a composite score as the weighted average of all ten indicators, with weights equal to the proportion of patients for each individual condition or procedure. This approach allows control for differences in both case mix and severity of illness across hospitals.

Cost per discharge was estimated by applying the cost-to-charge ratios to the discharge data. The cost-to-charge ratios were developed from hospital-specific accounting data collected and released by the Centers for Medicare and Medicaid Services and tested against state accounting systems.[23] Area wage indices were used to adjust for geographic differences in input price. Severity-adjusted costs were estimated through hospital fixed-effect models controlling for principal diagnosis, age, admission source, APR-DRG severity subclass, and comorbidities. Only those patients at risk of the ten mortality IQIs were included in the cost estimation.

Organizational Characteristics

Hospital characteristics derived from the AHA survey include size (number of beds), ownership (public, nonprofit, and for-profit), location (urban, rural), teaching status, system affiliation, and nurse staffing. To address missing values and potential data errors, teaching status was defined as meeting any two of the following criteria:

1. Membership in the Council of Teaching Hospitals,
2. Residency programs approved by the American Medical Association, and
3. A resident-to-bed ratio greater than 0.25.

For nurse staffing, the AHA survey reports number of full-time equivalents (FTEs)

by registered nurses (RNs) and licensed practical nurses (LPNs). The number of FTEs was converted to hours by multiplying the number by 2,080 hours (a standard year of 52 weeks at 40 hours per week). AHA also provides adjusted patient days (APD) that have taken into account both inpatient and outpatient activities. Based on these data, we developed two measures of nurse staffing—total number of hours by licensed nurses (RN and LPN) per APD and proportion of RNs among licensed nurses—with the former measuring staffing level and the latter indicating skill mix.

Three hospital characteristics were generated from the HCUP inpatient files, based only on non-maternal adult patients. Payor mix was measured by the proportion of Medicaid and uninsured patients. Service specialization was defined as the sum of squares of the proportion of discharges from each service category, $\sum_i (P_i^2)$, which is similar to use of the Herfindahl-Hirschman Index (HHI) for measuring market concentration.[24] To define service category, we grouped the principal diagnoses along organ systems following the established chapters of the ICD-9-CM coding manual. Lastly, patient volume covered by the ten mortality IQIs was calculated as the total number of discharges at risk of any of the mortality indicators divided by number of beds.

Market Characteristics

Hospital competition is a key market structure characteristic. We used actual patient flows to define market area by taking advantage of the patient zipcode information available in the HCUP inpatient files. Only non-maternal adult patients were included. We followed the method developed by Friedman, *et al.*,[25] which includes a number of procedures:

1. Identify leading zip codes that account for 90 percent of the hospital's patient volume as the market area for the hospital;
2. Calculate market shares for the hospital and its competitors;
3. Define as a major competitor any other hospital that captures a market share of at least 10 percent (or at least 5 percent for small hospitals that account for less than 10-percent share of their market);
4. Compute the HHI as the sum of squared market shares including the hospital and its major competitors only.

Overall, the average hospital share of the market was 24 percent, and the number of major competitors identified for every hospital ranged from zero to ten, with an average of 2.8. Because the HHI is a concentration index, we subtracted it from 1 to derive the measure of hospital competition.

Another two key market characteristics are HMO penetration and number of HMOs, provided by the InterStudy HMO County Surveyor. Other county-level characteristics were obtained from ARF, including number of physicians per capita, proportion of specialist physicians, median household income, unemployment rate, and proportion of residents aged 65 years and above. To match the patient population in the quality and cost indicators, pediatricians and obstetric/gynecologic physicians were excluded in the measures of physician supply.

Analytic Approach

The analytic approach addressed two objectives of this study: to classify hospitals based on performance in both quality and cost of care, and to examine organizational and market characteristics that may be associated significantly with the joint quality-cost performance. All of the analyses are cross-sectional. After computing the composite risk-adjusted mortality score and the adjusted cost per discharge, hospitals were grouped into quality and cost categories based on quartiles. High-quality/low-cost performance, the category of our primary interest, was defined as being in the lowest quartiles for both the mortality score and cost. Each hospital was classified first in relation to all other hospitals in the entire sample and then to those within its peer group. Three peer groups were specified based on hospital size: small (<100 beds), medium (100–249 beds), and large (250+ beds). Given that most performance measurement systems compare hospitals with their peers, it is important to test the feasibility of applying the same methodology to classify hospital performance in different peer groups.

We fitted logistic regression to examine the relationship of specific organizational and market variables with a hospital's likelihood of being in the high-quality/low-cost category, using STATA software with standard errors corrected for clustering within state. In the regression for each year, we further tested interactions between key organizational characteristics and key market conditions. The purpose is to investigate whether a particular organizational characteristic significantly moderates the relationship between a certain market condition and the hospital's performance. Key organizational characteristics include teaching status, size, ownership, and system affiliation, and key market conditions include hospital competition, HMO penetration, and number of HMOs. Only those interactions significant at the $p < .05$ level were retained in the final models.

Results

Quality-Cost Performance

Figure 1 presents descriptive statistics for the study variables in both 1997 and 2001. The average composite risk-adjusted mortality rate dropped slightly from 7.42 percent to 6.85 percent, and the average adjusted cost per discharge increased 19 percent, after adjusting for inflation. The average organizational and market characteristics remained relatively stable over the study period.

Figure 2 compares the average mortality rate and cost among hospitals in different quality-cost categories for the entire sample and for each peer group. In each year, the percentage of hospitals attaining high-quality/low-cost performance, being in the lowest quartiles for both mortality and cost, was approximately 8 percent for the entire sample and ranged from 6.6 percent to 8.72 percent across peer groups. The average mortality and cost for the low-mortality, low-cost group of hospitals were about 50 to 60 percent lower than those hospitals located in the highest quartiles for both mortality and cost. If the quality and cost categories were defined using medians, about 25 to 30 percent of the hospitals were below (or above) the medians for both mortality and cost. There are also considerable differences

Figure 1. Descriptive Statistics

Variable	1997 (N = 1369) Mean	1997 (N = 1369) (SD)	2001 (N = 1351) Mean	2001 (N = 1351) (SD)
Performance				
Composite risk-adjusted mortality rate (%)[a]	7.42	(2.13)	6.85	(2.15)
Severity-adjusted cost per discharge [b]	7280.59	(1500.87)	9547.30	(2113.07)
Organizational Characteristics				
Number of beds	192.05	(190.99)	189.92	(188.40)
Not-for-profit hospitals (%)	60.85		63.95	
Public hospitals (%)	20.96		18.95	
For-profit hospitals (%)	18.19		17.10	
Teaching hospitals (%)	8.33		8.59	
Rural hospitals (%)	32.51		32.86	
System hospitals (%)	56.61		56.62	
License nurse (RN+LPN) hours per adjusted patient day	6.32	(2.73)	6.26	(3.23)
Proportion of RNs among licensed nurses (%)	84.241	(10.80)	85.23	(10.40)
Proportion of Medicaid and uninsured patients (%)	15.11	(12.27)	15.55	(13.21)
Service specialization	0.17	(0.04)	0.17	(0.04)
Number of discharges at risk of IQIs per bed[c]	6.16	(2.65)	6.48	(2.82)
Market Characteristics				
Hospital competition (1-HHI)	0.61	(0.21)	0.61	(0.21)
HMO penetration (%)[d]	26.87	(18.67)	28.17	(19.34)
Number of HMOs	11.12	(7.15)	9.00	(5.62)
Number of physicians per 100,000 population[e]	173.52	(124.58)	173.99	(121.99)
Proportion of specialist physicians (%)	57.94	(18.09)	57.60	(17.81)
Median household income[f]	41570.27	(9926.68)	41609.12	(9978.47)
Unemployment rate (%)	5.56	(2.77)	5.11	(2.16)
Proportion of aged 65+ (%)	13.91	(4.35)	13.60	(4.22)

Note: a) The risk-adjusted mortality rate is a weighted composite of 10 mortality IQIs; b) cost per discharge was adjusted for principal diagnosis, severity of illness, and the area wage index; c) the number of discharges at risk of any of the 10 mortality IQIs were summed and divided by the number of beds; d) HMO data are of 1998 and 2001; e) Physician counts exclude pediatricians and OB/GYN physicians; and f) median household income is available only for 1999.

in the average mortality and cost between these two groups of hospitals.

Association with Organizational and Market Characteristics

Figure 3 provides parameter estimates for the likelihood of achieving high-quality/low-cost performance for the entire hospital sample in 1997 and 2001, respectively. A number of organizational and market characteristics consistently showed, in both years, significant and positive associations with the likelihood of attaining high-quality/low-cost performance. These characteristics include for-profit ownership, system affiliation, hospital competition, the number of HMOs, and the percent of elderly population. In addition, the HMO penetration rate and the number of physicians per capita had significant and positive associations with the likelihood of achieving high-quality/low-cost performance in 1997. No such relationships were found in 2001. In contrast, public, teaching, or large non-teaching

Figure 2. Quality-Cost Performance[a] Classification, for All Hospitals and by Peer Group

Category Based on Locations for *Both* Mortality and Cost[b]	1997			2001		
	% Hospitals	Average Mortality (%)	Average Cost ($)	% Hospitals	Average Mortality (%)	Average Cost ($)
All Hospitals	(N = 1369)			(N = 1,351)		
Lowest quartiles	8.04	4.89	5,526.93	8.14	4.26	7,166.77
Below medians	26.81	5.70	6,106.13	25.98	5.12	7,953.98
Above medians	26.81	9.04	8,424.99	25.98	8.50	11,133.33
Highest quartiles	7.60	10.35	9,259.87	6.81	9.69	12,311.25
Small Hospitals (<100 beds)	(N = 515)			(N = 512)		
Lowest quartiles	6.60	4.68	5,559.04	8.01	4.08	6,562.51
Below medians	25.63	5.91	6,142.19	25.59	5.30	7,715.02
Above medians	25.63	9.69	8,511.34	25.59	9.23	1 1,226.92
Highest quartiles	7.00	10.86	9,139.25	6.25	10.62	13,003.25
Medium Hospitals (100–249 beds)	(N = 487)			(N = 478)		
Lowest quartiles	8.01	4.58	5,410.28	7.32	4.23	7,344.15
Below medians	29.57	5.61	6,018.50	27.41	4.99	8,003.75
Above medians	29.36	8.85	8,052.91	27.41	8.22	10,954.29
Highest quartiles	8.21	9.82	8,789.13	8.58	9.19	12,069.70
Large Hospitals (250 + beds)	(N = 367)			(N = 361)		
Lowest quartiles	8.72	5.07	5,687.20	8.03	4.36	7,586.74
Below medians	28.07	5.74	6,282.04	24.93	5.15	8,199.32
Above medians	27.79	8.40	8,788.26	24.93	7.66	11,197.27
Highest quartiles	8.72	9.53	9,866.97	7.76	8.46	12,059.69

Note: a) Quality is measured by the composite risk-adjusted mortality rate and cost is measured by adjusted cost per discharge; b) Hospitals are classified by locations for *both* mortality and cost, for instance, being in the lowest quartiles for *both* mortality and cost or being above the medians for *both* mortality and cost.

hospitals were significantly less likely to have high-quality/low-cost performance in 2001.

Significant interactions were found between key organizational and market characteristics. For example, the positive associations of hospital competition (in 2001) and HMO penetration (in 1997) with high-quality/low-cost performance were greater for public hospitals; for system hospitals, these relationships were negative. HMO penetration was negatively associated with high-quality/low-cost performance among for-profit hospitals in 2001.

For a number of organizational and market characteristics that showed significant results for both years in Figure 3, odds ratios were estimated. In both years, for-profit hospitals were more than twice as likely to be in the high-quality/low-cost category compared with nonprofit hospitals (odds ratio = 2.69 and 2.53 in 1997 and 2001, respectively). The likelihood of attaining high-quality/low-cost performance was twice as high for hospitals with system membership in 1997 but was insignificant in 2001. An increase of 0.1 in the hospital competition index (1-HHI) was associated

Figure 3. Results of Logistic Regression for the Likelihood of Being in the Lowest Quartiles for both Mortality and Cost

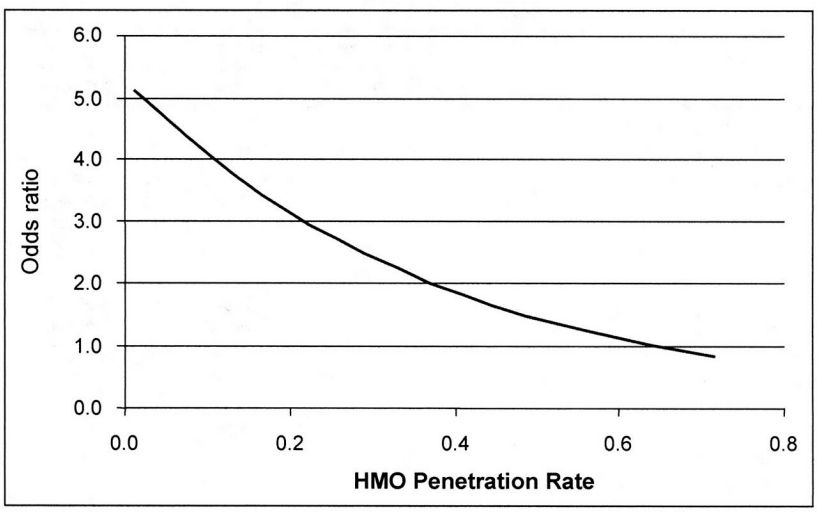
Variable	1997(N = 1369) Coefficient	SE	2001 (N = 1351) Coefficient	SE
Organizational Characteristics				
Non-teaching, medium (100–249 beds)	0.005	0.190	−0.381	0.401
Non-teaching, large (250+ beds)	0.249	0.630	−2.459**	0.529
Teaching	−0.502	0.531	−2.439*	1.185
Public	−0.613	0.528	−2.327**	0.788
For-profit	0.991*	0.434	1.659**	0.296
System	1.247**	0.414	1.471*	0.618
Rural	1.066*	0.521	−0.253	0.354
(RN+LPN) hours per adjusted patient day	−0.061	0.037	0.026	0.017
% RNs	−0.148	1.233	−0.947	1.685
% Medicaid and uninsured patients	0.821	0.490	−0.194	1.681
Service specialization (log)	0.124	0.931	0.884	0.864
# IQI discharges per bed	0.150*	0.060	0.077	0.042
Market Characteristics				
Hospital competition (1-HHI)	1.495**	0.505	1.410**	0.513
HMO penetration	3.696**	1.243	0.708	1.057
#HMOs	0.066**	0.025	0.124**	0.033
#MDs per capita (log)	−0.637*	0.299	−0.229	0.245
% Specialist MDs	2.042	1.177	−0.496	1.074
Median household income (000)	0.010	0.011	−0.002	0.019
% Unemployed (log)	−0.295	0.332	0.039	0.235
% Aged 65+	7.781**	1.220	8.074**	1.398
Interactions of Key Market Conditions with Key Organizational Characteristics				
Hospital competition × Non-teaching, large	−2.697**	0.831		
Hospital competition × Public			4.078**	1.373
Hospital competition × System			−2.319**	0.887
HMO penetration × Non-teaching, large	3.730**	0.512	5.109**	0.763
HMO penetration × Public	1.858*	0.819		
HMO penetration × System	−1.884*	0.758		
HMO penetration × For-profit			−2.598*	1.234
Pseudo *R*-squared	0.179		0.169	
Hosmer-Lemeshow *chi*-squared	4.17(p = 0.842)		11.47(p = 0.177)	
C-statistic: area under ROC curve	0.813		0.798	

** $p < .01$, * $p < .05$. Standard errors (SE) were corrected for clustering by state. Interaction terms were retained only if significant at $p < .05$ level—key market conditions include hospital competition, HMO penetration, and number of HMOs; and key organizational characteristics include size, teaching status, system affiliation, and ownership.

with a 9 to 10 percent higher probability of being in the high-quality/low-cost category, and one additional HMO in the market was associated with a 7 to 13 percent increase in the likelihood of attaining high-quality/low-cost performance.

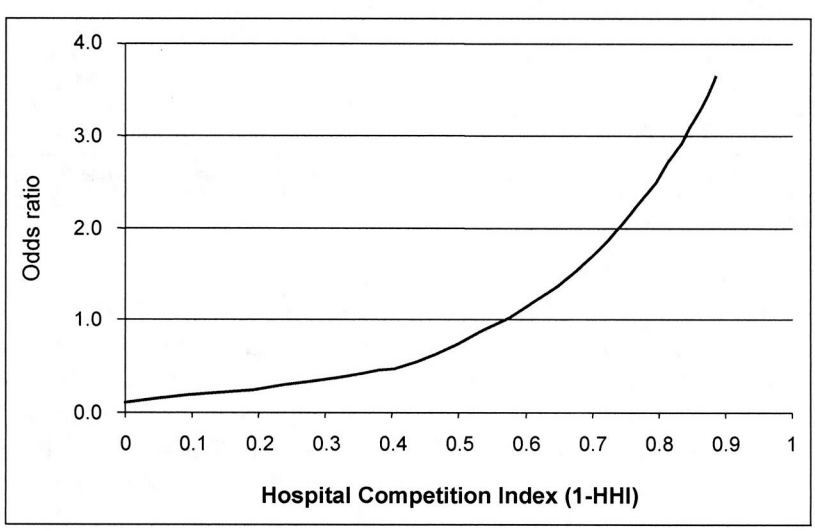
Figures 4 and 5 illustrate selected significant interactions found between key market forces and hospital ownership in 2001. Although for-profit hospitals were generally more likely than nonprofit hospitals to be in the high-quality/low-cost category, this

Figure 4. Achieving High-Quality/Low-Cost Performance: For-Profit vs. Nonprofit Hospitals, 2001



positive likelihood significantly diminished in markets with high HMO penetration (*e.g.*, penetration rate > 0.50). At the average level of hospital competition (1-HHI = .61) there was no significant difference between public and nonprofit hospitals (odds ratio close to 1). Nonetheless, in markets with a high level of hospital competition (*e.g.*,

Figure 5. Achieving High-Quality/Low-Cost Performance: Public vs. Nonprofit Hospitals, 2001



1-HHI > 0.7), public hospitals were more likely than nonprofit hospitals to be in the high-quality/low-cost category.

Discussion

Although a large volume of research has been conducted on the effects of organizational and market changes on hospital cost and quality, few studies have attempted to integrate both aspects in measuring individual hospital performance. In this study, we classified hospitals into performance quartiles for both quality and cost and examined the likelihood of attaining high-quality/low-cost performance in relation to organizational and market characteristics. A number of key findings were produced.

First, organizational characteristics show significant relationships with hospital quality-cost performance. Specifically, the likelihood of achieving high-quality/low-cost performance increased for hospitals with for-profit ownership or system membership. This by no means implies that all for-profit hospitals are efficient in terms of high quality at low cost or that all not-for-profit hospitals are inefficient. Among those hospitals identified with high-quality/low-cost performance, the proportion of nonprofit hospitals was close to that of for-profit hospitals (45% vs. 44% in 1997, and 46% vs. 40% in 2001). One may argue that for-profit hospitals selectively attract low-cost and less-sick patients to achieve better outcomes. Nevertheless, in our analysis we have controlled for a wide range of patient risk factors as well as the hospital's share of Medicaid and uninsured patients. A more limited mission and scope of services at for-profit hospitals as well as better access to capital may be important contributors to their performance. The positive association of system membership with hospital quality-cost performance is an important finding, given that little is known on this subject. System hospitals may be able to achieve lower costs and better quality through sharing knowledge, skills, and resources with other member hospitals. A recent study reveals that system-affiliated and for-profit hospitals are more likely than their counterparts to adopt managerial information systems in support of financial analysis, strategic planning, resource allocation, and quality improvement operations.[26]

Second, competitive market forces have positive relationships with hospital performance. Hospitals in highly competitive markets were more likely to achieve high-quality/low-cost performance. HMO penetration showed a significant relationship with hospital performance only in 1997, whereas the number of HMOs was significantly associated with hospital high-quality/low-cost performance in both years. These results suggest that as managed care spreads across the nation and grows in maturity, the number of HMOs has emerged to be an important market attribute. Recent evidence shows that HMOs focus not only on price but also on non-price attributes that include quality-related proxies.[27] Two other studies also reported that the use of cardiac diagnostic procedures for AMI patients increased with the level of HMO competition, suggesting less restriction on access to care and increased attention to quality of care.[28] Furthermore, despite concerns raised about the resurgence of hospitals' negotiating leverage and a new medical arms race,[29] our findings

indicate that the presence of managed care organizations in local markets does not necessarily diminish quality, and hospitals in those markets with strong competitive dynamics fueled by an increase in the number of HMO plans are more likely to outperform in both quality and cost. This should have significant implications for the current debate among policymakers with regard to the role of market forces in promoting quality care at lower cost.

Third, the results reveal significant interactions between organizational and market characteristics. For 1997, we found that hospitals in markets with higher HMO penetration were more likely to have high-quality/low-cost performance; and, independent of market conditions, for-profit hospitals were more likely than nonprofit hospitals to be high performers. For 2001, the results continue to show a greater likelihood for for-profit hospitals to be in the high-quality/low-cost category; however, this positive likelihood significantly diminished in markets with high HMO penetration. In other words, the differences between nonprofit and for-profit hospitals became smaller under high HMO penetration. This indicates that in markets with high HMO penetration, the competitive pressure generated over time by HMOs' selective contracting may have motivated nonprofit hospitals to achieve higher performance in competing with their for-profit counterparts.

Another significant interaction pertains to hospital competition and public ownership. Compared with nonprofit hospitals, public hospitals were more likely to have high-quality/low-cost performance in markets with a high level of hospital competition. Prior research has found that public hospitals are more likely than any other hospitals to offer relatively unprofitable services,[30] which could make them less competitive in the markets. Nonetheless, our finding suggests that when hospitals in the market are highly competitive with one another, public hospitals are responsive to the market pressures and can outperform nonprofit hospitals in those clinical areas that are common to all hospitals.

Several limitations of this study should be noted. First, the quality measure is limited to in-hospital mortality. But the ten specific conditions and procedures were carefully selected so that mortality in the hospital, risk-adjusted using administrative data, would be a good signal of quality of care.[31] Second, as discussed previously, the organizational characteristics examined are limited to those available in the AHA survey. We likely missed other important characteristics, such as the medical staff composition and the type of clinical information systems. In view of the limited number of measures available for empirical tests, the internal structure and operations of all hospitals found to be high performers deserve further attention. Third, the analyses are cross-sectional. The logical next step is to address how changes in hospital quality and cost over time are related to changes in particular organizational and market characteristics. This is an important topic for designing payment incentives that are aimed to motivate low-performing providers to improve their performance over time.

In summary, the results of this study demonstrate that it is feasible to measure and compare hospital performance in both quality and cost, and that superior hospital performance is associated with particular organizational characteristics and

market forces. If pay-for-performance programs are designed to reward relatively high performance, extra considerations may be important for preserving hospitals that serve broader missions (*e.g.*, public, teaching). For hospitals located in markets with less competitive pressure, multiple policy alternatives should be explored to encourage those hospitals to achieve targets demonstrated elsewhere.

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