Medical Care Research and Review
2020, Vol. 77(6) 538–548

DOI: 10.1177/1077558719828938
journals.sagepub.com/home/mcr


Weighing the Effects of Vertical Integration Versus Market Concentration on Hospital Quality

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Abstract

Provider organizations are increasing in complexity, as hospitals acquire physician practices and physician organizations grow in size. At the same time, hospitals are merging with each other to improve bargaining power with insurers. We analyze 29 quality measures reported to the Center for Medicare and Medicaid Services' Hospital Compare database for 2008 to 2015 to test whether vertical integration between hospitals and physicians or increases in hospital market concentration influence patient outcomes. Vertical integration has a limited effect on a small subset of quality measures. Yet increased market concentration is strongly associated with reduced quality across all 10 patient satisfaction measures at the 95% confidence level ($p < .05$) and 6 of the 10 patient satisfaction measures remain statistically significant with a Bonferroni corrected p value ($p < .005$). Regulators should continue to focus scrutiny on proposed hospital mergers, take steps to maintain competition, and reduce counterproductive barriers to entry.

Keywords

integrated health care, market competition, physician–hospital relations, quality of care, economic analysis

Introduction

Current health care policies and changing economic conditions have promoted an increase in physician–hospital integration. Hospitals are increasingly becoming employers of not only hospitalists but also primary and specialty care doctors (Cantlupe, 2010; Kane, 2015). From 2012 to 2016, the percentage of hospital-employed physicians increased by more than 63%, and as of July 2016, 42% of physicians were employed by hospitals (Physicians Advocacy Institute & Avalere Health, 2012). At the same time, hospitals are merging with each other to improve bargaining power with insurers (Berenson, Ginsburg, & Kemper, 2010). Greater integration has the potential to increase care coordination and limit redundancies, which could improve patient outcomes. However, larger organizations could instead feel less incentive to compete on the basis of quality.

Recently, Scott, Orav, Cutler, and Jha (2017) published a nationwide analysis which found no association between integrating to an employment model and mortality, readmissions, length of stay, or patients' overall satisfaction. Previous studies of physician–hospital integration vary substantially in terms of sample composition and analysis methods employed (Post, Buchmueller, & Ryan, 2017). Many prior studies focus only on select state groups, hospital systems, or insurers and used data from the 1990s (Berenson et al., 2010; Chukmaitov, Harless, Bazzoli, Carretta, & Siangphoe, 2015; Ciliberto & Dranove, 2006; Cuellar & Gertler, 2006; Goes & Zhan, 1995; Madison, 2004; Stensland & Stinson, 2002). Consequently, their conclusions conflict on whether physician–hospital integration improves the quality of care. With a wide variety of theories suggesting both positive and negative results of physician–hospital integration, integration must be studied empirically to discover its true implications and form evidence-based management and policy recommendations.

Conceptual Framework

The Affordable Care Act and increasingly more payers are requiring that providers report on quality measures.

This article, submitted to *Medical Care Research and Review* on April 4, 2018, was revised and accepted for publication on January 15, 2019.

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Components of the legislation, including accountable care organization shared savings programs and bundled payments, encourage providers to improve the quality of care provided while controlling costs. In addition, increased availability of hospital quality data to consumers may prod hospitals to improve quality in order to attract more customers. For this study, we hypothesize that decreased fragmentation, which improves care coordination between hospitals and physicians, could improve patient care (Flores, 2012). Care coordination requires careful quality monitoring by hospitals of physicians (Burns, Goldsmith, & Sen, 2013; Summer, 2010). Hospitals may feel that physicians can be more effectively monitored if they are employed. In addition, as payers shift to pay-for-performance, hospitals may view performance incentives folded into salaried contracts as the most effective means for inducing employed physicians to meet quality goals. Any analysis of the determinants of hospital quality must also account for the potential association between increased market concentration and reduced quality (Kessler & McClellan, 2000).

New Contributions

There has been little research specifically on the implications of varying degrees of physician–hospital integration on quality, very little of which included nationwide analysis (Post et al., 2017). Our analysis builds on previous literature using the American Hospital Association's (AHA) detailed measures of integration while adjusting for market competition, with more recent nationwide data and a broader set of quality measures to advance our knowledge of the effects of physician–hospital integration (Baker, Bundorf, & Kessler, 2014; Ciliberto & Dranove, 2006; Cuellar & Gertler, 2006). The adjustment for market competition is an important inclusion in the analysis since previous literature demonstrates competition's potential to improve quality of care (Kessler & McClellan, 2000).

We investigate whether increases in physician–hospital integration and/or market competitiveness lead to better adherence to standardized processes of care for conditions such as acute myocardial infarction (AMI) and heart failure, where response time is critical. We also analyze whether increases in physician–hospital integration and/or market competitiveness affect readmissions for select conditions.

Measuring quality based on patient perception is becoming more important, as consumers increase their use of online physician ratings to choose providers (Hanauer, Zheng, Singer, Gebremariam, & Davis, 2014; Nuance, 2015). Therefore, we examine the effects of physician–hospital integration and market competitiveness on quality defined by clinical measures and patient satisfaction.

Method

Measuring Hospital Quality

We compiled hospital-level data for 4,438 hospitals from the Medicare Hospital Compare website including the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey, Hospital Inpatient Quality Reporting (IQR) and Outpatient Quality Reporting (OQR) programs. Processes of care data are from the years 2008 to 2014. Readmissions data are from 2009 to 2015. Patient satisfaction data are from 2008 to 2015. Hospital Compare data were selected for its availability of yearly standardized quality measures from a large number of Medicare-certified hospitals nationwide; these measures are regularly vetted for usefulness based on scientific evidence and the availability of better indicators of quality (Audet & Sinha, 2011).

The IQR and OQR programs are intended to encourage hospitals to improve the quality of care and provide consumers with the proper information to make better health care decisions (QualityNet, n.d.-a). The reported measures have high impact on quality and efficiency for Medicare patients and relate to national priorities (QualityNet, n.d.-b). Each of these "process of care" measures represents the percentage of hospital patients who receive treatments that yield the best results for certain common, serious medical conditions or surgical procedures. The measures may indicate how quickly patients with certain emergencies receive treatment or how well hospitals provide preventive services. Each process measure only applies to patients for whom the recommended treatment is appropriate, and therefore do not require risk adjustment for patient mix (Medicare.gov, n.d.). Processes included in the analysis were reported in at least 5 adjacent years and included data more recent than 2012. Sample sizes for the processes of care ranged from 4,420 to 16,224 hospital-year observations.

We also examined 30 day readmission rates found in the Hospital Compare data for AMI, heart failure, and pneumonia. The readmissions data are not adjusted for patient mix because of recent concerns that hospitals increased their coding severity in response to CMS' Hospital Readmissions Reduction Program (Ibrahim et al., 2018). Readmission sample sizes ranged from 14,074 to 24,168 hospital-year observations.

The HCAHPS surveys a random sample of adults after discharge. It aims to incentivize hospitals to improve their quality and increase accountability through public reporting of data for consumers to compare providers. It focuses on patient perspective of care including communication with doctors, nurses, and staff; hospital staff responsiveness; hospital cleanliness and quietness; pain management; and overall rating. Additional screener questions and demographics are collected to adjust the data for patient mix before it is released to the public (Centers for Medicare & Medicaid Services, 2014). Each satisfaction measure was defined as always/usually receiving the level of care expected. Sample sizes for the satisfaction measures ranged from 22,886 to 22,997 hospital-year observations.

Measuring Vertical Integration

Based on previous literature, the quality data were merged with the AHA annual survey to designate four forms of integration, from loosest to tightest: independent practice

associations, open physician–hospital organizations (OPHO), closed physician–hospital organizations (CPHO; also including the highly similar management services organizations), and fully integrated organizations (FIO; including integrated salary model and foundation hospitals; Baker et al., 2014; Ciliberto & Dranove, 2006; Cuellar & Gertler, 2006). If a hospital claims more than one integration type, they are classified using the most integrated form reported (Baker et al., 2014). Our reference group for analysis purposes includes hospitals without any of these four forms of integration. Across the sample period there were 2,017 changes in integration level. These occurred at 1,579 hospitals, meaning that some hospitals change integration level more than once. Only 1,081 out of the 4,438 hospitals in our sample have no form of integration in any year.

In independent practice associations, the hospital primarily assists physicians in contracting with managed care plans (Cuellar & Gertler, 2006). This loose affiliation may boost demand for the hospital, increasing its market power. OPHOs allow any physician in the market to join a management organization which contracts with managed care plans and provides administrative services to member physicians; this form of integration has equal capitalization and ownership between medical staff and the hospital (Cuellar & Gertler, 2006). CPHOs are similar, except they select physicians on the basis of cost, quality, or both (Brown, 1996). Physicians in CPHOs generally do not enter into similar agreements with other hospitals, although they may maintain admitting privileges at other hospitals (Baker et al., 2014). FIOs hire physicians as salaried employees and own the practice (Baker et al., 2014).

Measuring Market Concentration

To measure hospital market concentration, the Herfindahl–Hirschman index (HHI) was calculated by hospital referral region (HRR) based on the number of hospital admissions reported in the AHA annual survey. HHI values may range from 1 to 10,000 where a low value indicates low market concentration/high market competition, between 1,500 and 2,500 is moderately concentrated, and above 2,500 is highly concentrated. The HHI is commonly used to measure market competition and has been used in previous studies of integration (Baker et al., 2014; Ghiasi, Zengul, Ozaydin, Oner, & Breland, 2017; Kessler & McClellan, 2000; Neprash, Chernew, Hicks, Gibson, & McWilliams, 2015). One advantage of using HHI over other possible measures of market concentration is its ability to reflect both the number of hospitals and the market shares across hospitals. From a policy perspective, HHI is an important measure, given that it is used by the Department of Justice to evaluate potential mergers (U.S. Department of Justice & the Federal Trade Commission, 2010). Some recent articles have used a geographic-based IV to develop a "fixed-travel-time HHI," which requires using a patient's location in relation to the hospital (Dauda, 2018; Dunn & Shapiro, 2014). But since Hospital Compare only provides quality measures aggregated at the hospital level, we are unable to utilize this method. Instead, HRR was selected as the market level because its definition considers not only the geographic or population factors which define a market but also the observed patient flows to hospitals in each region. In addition, an evaluation of hospital admissions comparing hospital services areas (HSAs), HRRs, and counties found that for 45% of HSAs less than 50% of the patients were admitted to hospitals in their HSA of residence (Kilaru et al., 2015). By using HRRs, which are composed of many HSAs, the HHI accounts for the fact that competition extends beyond the boundaries of a county or HSA.

Other Variables

Hospital-level indicators were derived from the AHA annual survey to identify the presence of costly hospital services which could potentially improve outcomes. These include whether a hospital has a CT scanner, electron beam computed tomography, MRI, multislice spiral computed tomography, or positron emission tomography. About 50% of the hospitals in our sample experience a change in one or more of these variables at some point during our sample period. In addition, the nurse-to-patient ratio was included to account for the fact that ratios have been shown to influence patients outcomes and satisfaction (Driscoll et al., 2018; Press Ganey, 2015). Variables were also created to define the quartiles of total admissions for hospitals.

Statistical Analysis

Analyses included a separate fractional probit regression for each quality measure with primary interest on the sign and magnitude of the integration and market concentration coefficients (Stata, n.d.). The fractional probit is applied in cases where the dependent variable lies between 0 and 1. All other variables aforementioned were included as control variables. Following previous literature, all regressions included hospital fixed effects to control for fixed, unobservable differences across hospitals (Ciliberto & Dranove, 2006; Cuellar & Gertler, 2006; Madison, 2004; Stensland & Stinson, 2002). Year fixed effects were utilized to control for potential changes in quality that may have coincided with changes in integration. With the inclusion of fixed effects, the integration variables measure the association between within-hospital changes in integration with physicians and quality. All standard errors are robust and clustered at the provider level.

Analyses were performed using StataMP, version 15 (StataCorp LLC), to compute average marginal effects. Two-tailed p values less than .05 were considered significant. We reevaluated the significance of the regression results using Bonferroni corrections at the .05 significance level to reduce the heightened probability of Type I errors which results

Table 1. Summary Statistics by Year.

	All integration levels and years				2008				2015			
	M	*SD*	Min	Max	*M*	*SD*	Min	Max	*M*	*SD*	Min	Max
Market concentration												
Herfindahl–Hirschman index	1523.7940	1235.6270	162	9,084	1426.2390	1146.4390	182	8,816	1612.0120	1301.9760	165	8,898
Integration level												
None	0.3328	0.4712	0	1	0.3250	0.4684	0	1	0.3265	0.4690	0	1
Independent Physician Assoc.	0.0396	0.1951	0	1	0.0545	0.2270	0	1	0.0313	0.1741	0	1
Open Physician Hospital Org.	0.0659	0.2481	0	1	0.0863	0.2809	0	1	0.0617	0.2407	0	1
Closed Physician Hospital Org.	0.0614	0.2400	0	1	0.0877	0.2829	0	1	0.0433	0.2036	0	1
Full Integrated Org.	0.5003	0.5000	0	1	0.4465	0.4972	0	1	0.5372	0.4987	0	1

from multiple comparisons. For this reevaluation, processes of care were grouped by patient type (i.e., surgical, outpatient, AMI, etc.), and readmission and patient satisfaction measures were evaluated as two separate but complete groups.

Results

Across the sample period, the percentage of hospitals in FIOs increased, while the percentage in the other levels of integration decreased (Table 1). The average HHI was also higher in 2015 than in 2008. Our average HHI calculated by HRR of 1,524 corresponds to similar HHIs by HRR published in other research (Cutler & Scott Morton, 2013; NCCI Insights, 2018), but it is much lower than the HHI by metropolitan statistical area reported by a recent policy paper due to the fact that HRRs cover a larger geographic area than metropolitan statistical areas (Fulton, 2017). Process adherence and patient satisfaction were higher in the final year than in the first, while readmissions were lower in the final year than the first, suggesting that quality improved over the sample period (see Tables, Supplemental Digital Content 1 [available online], which contains descriptive statistics for all quality measures by year, level of integration, and market competition). Process adherence, readmissions rates, and patient satisfaction mean values tend to be similar across the different levels of integration. Process adherence measures tend to be 90% or higher and are also similar across the quartiles of market competition. Yet as market concentration increases the mean readmission rate slightly decreases and the majority of patient satisfaction measures tend to increase slightly. Full regression results are in the supplement, which is available online.

While 8 out of 29 quality measures have results which suggest that integration may be significantly associated with quality at the 95% confidence interval (CI) level, coefficients for only two quality measures remain significant with the Bonferroni correction (Tables 2-4). For processes of care, FIOs have on average 1.38 percentage points (95% CI [0.00415, 0.0234]; $p < .008$ for surgical patients) better adherence to the continuation of beta blockers than nonintegrated hospitals (Table 2). For pneumonia, CPHOs and FIOs have readmission rates on average 0.19 (95% CI [−0.00336, −0.000453]; $p < .017$) and 0.12 percentage points (95% CI [−0.00203, −0.000321]; $p < .017$) lower than nonintegrated hospitals, respectively (Table 3).

There are no significant differences in readmission rates associated with market concentration and only a single coefficient statistically significant at the 95% CI level for the processes of care of remaining on beta blockers (Tables 2 and 3). But increased market concentration is significantly associated with lower patient satisfaction across the board (Table 4). The coefficients for market concentration range from −0.00000177 for doctors communicating well up to −0.00000801 for patients receiving help as soon as they want it. To interpret these coefficients, assume a simplified example where two hospitals merge in a market with four equally sized hospitals. The HHI would increase from 2,500 ($HHI = 25^2 + 25^2 + 25^2 + 25^2 = 2{,}500$) to 3,750 ($HHI = 25^2 + 25^2 + 50^2 = 3{,}750$). This change would translate to an estimated decrease in satisfaction ranging on average from 0.22 percentage points ($[3750 - 2500] \times [-0.00000177] \times 100 = -0.22$) for doctors communicating well up to 1.00 percentage points ($[3750 - 2500] \times [-0.00000801] \times 100 = -1.00$) for patients receiving help as soon as they want it. Using the Bonferroni correction, 6 of the 10 market concentration coefficients remain statistically significant ($p < .005$).

Regression results for the control variables may be found in the supplemental materials available online (see Tables, Supplemental Digital Content 2, which contains regression results of control variables for all quality measures).

Similar to other recent studies examining the quality or price effects associated with vertical integration of physicians and hospitals, our regression analyses do not account for potential endogeneity; which physicians may prefer to

Table 2. Adjusted Effect of Market Concentration and Integration on Process of Care Adherence.

	Surgical patients						Outpatients			Heart attack (AMI) patients		Heart failure patients			Pneumonia patients	
	Received preventative antibiotics 1 hour before incision	Received the appropriate preventative antibiotic(s) for their surgery	Preventative antibiotic(s) are stopped within 24 hours after surgery	Doctors ordered treatments to prevent blood clots for certain surgeries	Received treatment to prevent blood clots within 24 hours before or after selected to prevent blood clots	Taking beta blockers before coming to the hospital were kept on beta before and after surgery	Chest pain or possible heart attack treated with aspirin within 24 hours of arrival	Having surgery and got antibiotic at the right time within 1 hour before surgery	Having surgery and got the right kind of antibiotic	Given aspirin at discharge	Given PCI within 90 minutes of arrival	Given discharge instructions	Given an evaluation of left ventricular systolic function	Given ACE inhibitor or ARB for left ventricular systolic dysfunction	Initial emergency room blood culture performed prior to first hospital dose of antibiotics	Given most appropriate initial antibiotic(s)
Market concentration																
HHI	−6.75E-06 [−0.0000176, 0.00000408]	−4.23E-06 [−0.0000125, 0.00000408]	−0.0000136 [−0.0000302, 0.00000294]	−5.01E-06 [−0.0000278, 0.0000178]	−4.12E-06 [−0.0000246, 0.0000164]	0.00000978* [−0.0000187, 0.0000382]	−2.01E-06 [−0.0000106, 0.0000066]	2.26E-06 [−0.00000689, 0.0000114]	−2.75E-06 [−0.00000988, 0.00000439]	1.86E-06 [−0.00000239, 0.00000611]	−0.0000105 [−0.0000262, 0.00000527]	−5.33E-06 [−0.0000213, 0.0000107]	6.04E-07 [−0.00000646, 0.00000767]	2.71E-06 [−0.00000788, 0.0000133]	−3.53E-06 [−0.0000104, 0.00000338]	−1.56E-06 [−0.0000106, 0.00000749]
Integration level																
Independent Physician Assoc.	0.00369 [−0.00550, 0.0129]	0.000878 [−0.0136, 0.0153]	−0.000786 [−0.0214, 0.0198]	−0.0296* [−0.0578, −0.00133]	−0.0338* [−0.0647, −0.00297]	−0.0496 [−0.0993, 0.000156]	−0.000877 [−0.0152, 0.0134]	0.009 [−0.00375, 0.0218]	−0.00281 [−0.0104, 0.00474]	−0.00277 [−0.00869, 0.00314]	0.00376 [−0.0211, 0.0287]	0.000328 [−0.0211, 0.0218]	−0.00485 [−0.0127, 0.00304]	−0.000922 [−0.0117, 0.00984]	−0.00831 [−0.0176, 0.000974]	−0.00895 [−0.0194, 0.00152]
Open Physician Hospital Org.	0.00114 [−0.00959, 0.0119]	0.00623 [−0.00179, 0.0142]	0.00606 [−0.00646, 0.0186]	−0.00197 [−0.0188, 0.0149]	−0.00103 [−0.0144, 0.0124]	0.0204* [0.000365, 0.0405]	0.00808 [−0.00137, 0.0175]	−0.00342 [−0.0129, 0.00604]	−0.00292 [−0.00976, 0.00392]	−0.0032 [−0.00864, 0.00224]	0.00268 [−0.0157, 0.0210]	−0.00494 [−0.0207, 0.0108]	−0.00477 [−0.0128, 0.00322]	−0.00255 [−0.0125, 0.00738]	−0.00623 [−0.0132, 0.000697]	0.00201 [−0.00605, 0.0101]
Closed Physician Hospital Org.	−0.00663 [−0.0190, 0.00579]	0.00473 [−0.00260, 0.0120]	0.0000342 [−0.0121, 0.0121]	−0.00424 [−0.02460, 0.0161]	−0.00468 [−0.0219, 0.0125]	0.0108 [−0.00649, 0.0280]	0.00937* [0.00119, 0.0175]	0.00872* [0.00165, 0.0158]	0.0011 [−0.00524, 0.00744]	−0.00201 [−0.00617, 0.00216]	0.00731 [−0.0104, 0.0250]	0.00872 [−0.00430, 0.0217]	−0.000573 [−0.00704, 0.00589]	0.00306* [−0.00583, 0.0120]	−0.00102 [−0.00733, 0.00529]	0.00486 [−0.00218, 0.0119]
Fully Integrated Org.	−0.00126 [−0.00705, 0.00454]	0.000619 [−0.00409, 0.00533]	0.00653 [−0.00170, 0.0148]	0.00645 [−0.00414, 0.0170]	0.00375 [−0.00486, 0.0123]	0.0138**[a] [0.00415, 0.0234]	0.00528* [0.000372, 0.0102]	0.00341 [−0.00220, 0.00903]	−0.00284 [−0.00730, 0.00162]	−0.000698 [−0.00327, 0.00188]	−0.00529 −0.0173, 0.00677]	−0.000056 [−0.00931, 0.00920]	−0.00295 [−0.00675, 0.000856]	0.00158 [−0.00401, 0.00716]	−0.0000537 [−0.00395, 0.00384]	−0.000507 [−0.00549, 0.00448]
N	7,075	7,067	7,021	5,695	6,997	4,420	6,958	11,337	11,370	9,643	5,371	14,995	16,224	10,741	12,391	14,661
Number of providers	1,834	1,831	1,825	1,711	1,852	1,432	2,076	2,746	2,752	2,031	1,299	3,158	3,391	2,376	2,975	3,268

Note. PCI = percutaneous coronary intervention; AMI = acute myocardial infarction; HHI = Herfindahl–Hirschman index; ACE = Angiotensin-converting enzyme; ARB = Angiotensin II receptor blockers. Year and hospital fixed effects also included in regression. 95% Confidence interval in brackets.

[a]Bonferroni correction statistically significant.

*$p < .05$. **$p < .01$. ***$p < .001$.

Table 3. Adjusted Effect of Market Concentration and Integration on Readmission Rates.

	Heart attack (AMI)	Heart failure	Pneumonia
Market concentration			
HHI	−1.41E-07	−3.36E-07	4.76E-07
	[−0.00000212, 0.00000183]	[−0.00000189, 0.00000122]	[−0.000000725, 0.00000168]
Integration level			
Independent Physician Assoc.	0.000717	−0.00167	−0.000311
	[−0.00127, 0.00270]	[−0.00382, 0.000489]	[−0.00196, 0.00133]
Open Physician Hospital Org.	−0.000889	0.00115	−0.000601
	[−0.00269, 0.000909]	[−0.000929, 0.00322]	[−0.00222, 0.00102]
Closed Physician Hospital Org.	−0.000642	0.00117	−0.00191*[a]
	[−0.00220, 0.000913]	[−0.000642, 0.00298]	[−0.00336, −0.000453]
Fully Integrated Org.	−0.000838	0.000215	−0.00118**[a]
	[−0.00182, 0.000142]	[−0.000841, 0.00127]	[−0.00203, −0.000321]
N	14,074	22,998	24,168
Number of providers	2,544	4,021	4,182

Note. AMI = acute myocardial infarction; HHI = Herfindahl–Hirschman index. Year and hospital fixed effects also included in regression. 95% Confidence interval in brackets.
[a]Bonferroni Correction statistically significant.
*$p < .05$. **$p < .01$. ***$p < .001$.

vertically integrate with higher quality hospitals (Baker, Bundorf, & Kessler, 2016; Carlin, Feldman, & Dowd, 2017; Scott et al., 2017). Capps, Dranove, and Ody (2018) address endogeneity by specifying vertical integration status for the patient's physician in the first year of the sample as an instrumental variable for vertical integration in all periods. However, the authors acknowledge that this approach requires relatively strong assumptions about the relationship between vertical integration and physician spending that could be violated in a number of ways. The potential for physicians to choose higher quality hospitals to vertically integrate is less of a concern for us, because we find little evidence of an association between vertical integration and hospital quality.

Nevertheless, we follow the approach of Baker et al. (2016) and tested whether integration 1 year ahead predicted quality in the current year. Precisely measured coefficients on vertical integration dummy variables would suggest that future integration is determined by current quality. Of the 29 quality measures and 116 coefficients on vertical integration examined in this study, only 5 coefficients on the 1-year lead of integration had a p value less than or equal to .05. In addition, only one of these coefficients remained significant after applying a Bonferroni correction. Therefore, it is unlikely that endogeneity of vertical integration and quality biases our estimates.

Sensitivity Analyses

Sensitivity analyses were performed using an alternative classification of integration. In this secondary analysis, if a hospital claims more than one integration type, they were classified using the least integrated form reported instead of the most integrated form. The coefficients for integration variables tend to be significant less often, and the magnitude of the coefficients for market concentration tend to be slightly higher than in our original estimates. Therefore, the results affirm our conclusions.

Results were also similar when a fractional logit regression was used instead of probit. Another sensitivity analysis was performed removing the variables for costly services and all results remained the same. Analysis was also performed including an additional variable indicating the number of years since the initial integration change. The new variable was only significant in 3 of the 29 regressions. Only one integration coefficient changed significance, but there were no changes in the results for market concentration.

Sensitivity analysis were also performed using HHI calculated by core-based statistical areas (CBSAs) and health service areas. The overall results remained largely the same for both CBSA-level and health service area-level HHIs for the readmission and process of care regressions. Using a health service area-level HHI, 6 of the 10 patient satisfaction HHI coefficients were statistically significant at the $p < .05$ level, none of which remain significant with the Bonferroni correction. Using the CBSA-level HHI indicates that only one patient satisfaction HHI coefficient is statistically significant at the $p < .05$ level, and it does not remain significant with the Bonferroni correction.

Finally, sensitivity analyses were performed adding the quadratic term HHI^2 to allow for a nonlinear effect of market concentration on quality. The coefficient for HHI^2 is statistically significant in only 6 of the 29 quality regressions. For readmissions, the HHI and HHI^2 coefficients are both

Table 4. Adjusted Effect of Market Concentration and Integration on Patient Satisfaction.

	Hospital clean	Nurse communicated well	Doctor communicated well	Patient received help as soon as wanted	Pain well controlled	Staff explained medicines	Hospital quiet at night	Staff provided home care instructions (Y/N)	Probably/ definitely recommend hospital (Y/N)	Hospital rating 7-10
Market concentration										
HHI	−3.91E-06* [−0.0000069, −0.000000922]	−2.81E–06**[a] [−0.00000454, −0.00000109]	−1.77E-06* [−0.0000033, −0.000000232]	−8.01E–06***[a] [−0.000011, −0.00000499]	−4.49E-06***[a] [−0.00000657, −0.0000024]	−6.27E-06**[a] [−0.00000998, −0.00000257]	−3.53E-06* [−0.00000682, −0.000000238]	−3.48E-06* [−0.00000659, −0.000000372]	−4.02E-06***[a] [−0.00000594, −0.00000209]	−4.57E-06**[a] [−0.00000748, −0.00000167]
Integration level										
Independent Physician Assoc.	0.00105 [−0.00209, 0.00419]	0.000296 [−0.00161, 0.00221]	−0.000139 [−0.00188, 0.00160]	0.00100 [−0.00257, 0.00457]	0.00142 [−0.00121, 0.00404]	0.00436 [−0.000186, 0.00890]	0.00174 [−0.00186, 0.00535]	0.00139 [−0.00290, 0.00568]	0.000640 [−0.00169, 0.00297]	0.000451 [−0.00300, 0.00390]
Open Physician Hospital Org.	−0.000812 [−0.00377, 0.00214]	−0.000495 [−0.00209, 0.00110]	−0.000710 [−0.00222, 0.000797]	−0.00219 [−0.00499, 0.000606]	−0.000726 [−0.00267, 0.00122]	−0.000239 [−0.00348, 0.00300]	−0.000202 [−0.00350, 0.00309]	−0.00288 [−0.00601, 0.000254]	−0.000401 [−0.00234, 0.00154]	−0.00128 [−0.00405, 0.00148]
Closed Physician Hospital Org.	0.00132 [−0.00110, 0.00374]	−0.00130 [−0.00289, 0.000281]	−0.00112 [−0.00261, 0.000371]	−0.00175 [−0.00437, 0.000871]	−0.000401 [−0.00232, 0.00152]	−0.000273 [−0.00352, 0.00297]	−0.000769 [−0.00370, 0.00216]	−0.00378* [−0.00704, −0.000527]	−0.000922 [−0.00274, 0.000892]	−0.00351* [−0.00617, −0.000851]
Fully Integrated Org.	−0.000303 [−0.00195, 0.00134]	−0.0000335 −0.00100, 0.000935]	−0.0000877 [−0.000976, 0.000800]	−0.000388 [−0.00206, 0.00128]	−0.000397 [−0.00161, 0.000815]	0.000639 [−0.00147, 0.00275]	0.000193 [−0.00163, 0.00202]	−0.000277 [−0.00216, 0.00160]	−0.0000879 [−0.00124, 0.00106]	−0.00110 [−0.00277, 0.000564]
N	22,886	22,886	22,886	22,886	22,886	22,886	22,886	22,886	22,997	22,886
Number of providers	3,839	3,839	3,839	3,839	3,839	3,839	3,839	3,839	3,914	3,839

Note. HHI = Herfindahl–Hirschman index. Year and hospital fixed effects also included in regression. 95% Confidence interval in brackets.

[a]Bonferroni Correction statistically significant.

*$p < .05$. **$p < .01$. ***$p < .001$.

statistically significant for pneumonia where they were not before. The coefficient for HHI^2 is statistically significant in 5 of the 10 satisfaction regressions: nurses communicating well, receiving help as soon as wanted, pain well controlled, staff explaining medicines, and staff providing home care instructions. In addition, the average marginal effects of a change in HHI on patient satisfaction were calculated to be roughly twice the magnitude of those in the main analyses, suggesting that the effect of market concentration on patient satisfaction is being underreported. In addition, with the sensitivity analyses seven coefficients remain significant at the Bonferroni level as compared with only six in the main analysis; this again suggests that the reported results may be conservative.

Discussion

Descriptive summaries of the data revealed high adherence to the processes of care in all levels of integration and market competition. Our results suggest that vertical integration may significantly improve quality for only a limited set of processes such as continuation of beta blockers for surgical patients. The potential for hospitals to better monitor integrated physicians cited in previous literature is evident in the coefficients of only 1 of 17 processes of care (Burns et al., 2013; Summer, 2010).

The process of care measures analyzed from the Hospital Compare data are regularly reviewed and reflect accepted standards of care based on current scientific evidence (Medicare.gov, n.d.). Therefore, processes may be so widely accepted that there is little variation in these measures; regardless of integration level, physicians want the best outcomes for patients and may adhere to common processes with or without hospital oversight. Although economic theory would suggest that increased competition would increase quality, we find that increased market concentration tends to improve adherence to one process measure for heart failure patients—evaluation of left ventricular systolic function.

Previous descriptive analysis indicates that readmissions began to drop soon after the Hospital Readmissions Reduction Program was enacted, suggesting that hospitals enacted changes to reduce readmissions in an effort to avoid penalties in future years (Boccuti & Casillas, 2015). Similar to previous literature, we found little evidence that any of this reduction may be attributed to changes in physician–hospital integration for AMI or heart failure, but changes in integration level may be a method hospitals can consider to reach readmission reduction goals for pneumonia (Scott et al., 2017). Reduced readmissions may be a result of factors such as better coordination of care or simply fewer complications.

Our analysis also focused on results from the HCAHPS survey which is specifically "designed to produce comparable data on patients' perspectives of care that allows objective and meaningful comparisons among hospitals on topics that are important to consumers" (Centers for Medicare & Medicaid Services, 2014). A previous study using only the HCAHPS overall hospital rating did not find a significant association between integration and patient satisfaction (Scott et al., 2017). Our analysis includes all of the survey's satisfaction measures. Although the coefficients were no longer significant with the Bonferroni correction, for a select set of satisfaction measures CPHOs may decrease satisfaction. In CPHOs, hospitals select physicians on the basis of cost and/or quality; perhaps the criteria hospitals use to select physicians is not aligned with the criteria that consumers value. For example, hospitals may value efficient clinical care, while consumers may value providers taking extra time to explain their treatment.

More striking is the statistically strong association between market concentration and patient satisfaction for 6 of the 10 patient satisfaction scores examined, revealing the decreases in satisfaction as market concentration increases and in turn lowers market competition. With fewer competitors it seems that there is less incentive to keep patients content. Given the nature of some satisfaction measures, such as explaining medications and communicating well with patients, overall clinical quality could suffer if patients do not properly understand care recommendations during their hospital stay or postdischarge.

Although better patient experience may not always correlate with higher clinical quality, measuring quality based on patient perception is increasingly important as more consumers use online physician ratings and reviews of patient experience to select providers. In one U.S. study, 59% of survey respondents stated that physician ratings are "somewhat" or "very important" in their choice of physician, and consumers aged 18 to 24 years are more likely to use online health information and physician ratings for provider selection than the general population (Hanauer et al., 2014; Nuance, 2015). As this young cohort becomes a larger consumer of health care, we expect this increase to continue. Research using HCAHPS data suggests that patients consistently choose their health care based on higher scores for patient experience (Faber, Bosch, Wollersheim, Leatherman, & Grol, 2009). There is also evidence that a patient's selection of plan and provider may be better predicted by patient experience measures than clinical quality measures (Schultz, Call, Feldman, & Christianson, 2001). Survey data suggests that consumers have difficulty finding what they consider trustworthy provider data and therefore tend to focus more on doctor–patient interactions rather than effectiveness of care (Associated Press-NORC Center for Public Affairs Research, 2014). Yet previous research has found that HCAHPS measures are associated with processes of care and complications (Isaac, Zaslavsky, Cleary, & Landon, 2010). Further research is needed on the ability of patient satisfaction to accurately reflect clinical quality of care. If patient satisfaction does not reflect clinical quality well, better measures should be developed and provided to patients in terms that laypersons can understand and utilize.

This study expands on the mixed results of previous literature examining the association between physician–hospital integration and quality of care. A study of three states suggested that fully integrated, large teaching hospitals seem to have higher quality (Cuellar & Gertler, 2006). A study of three hospital systems in a single metropolitan area found limited increases in quality of care as a result of vertical integration (Carlin, Dowd, & Feldman, 2015). Another study found no effect of the physician–hospital affiliations of cardiologists on mortality for cardiac Medicare beneficiaries (Madison, 2004). An analysis of Floridian patients linked tighter integration to increased mortality (Chukmaitov et al., 2015). There are studies which examine the differences in hospital versus physician-owned practices which may be relevant to this work. One found that hospital-owned practices had worse screening and quality measures than physician-owned (Kralewski, Dowd, Knutson, Tong, & Savage, 2015), but others found that groups affiliated with hospitals were significantly better at care management (Bishop, Shortell, Ramsay, Copeland, & Casalino, 2016; Shortell et al., 2005). These studies were based on limited data and did not differentiate between integration levels.

Inclusion of the HHI with integration levels poses the potential for multicollinearity. A higher HHI indicates high concentration in the market, which could be correlated with areas of more tightly integrated hospitals. However, it is difficult to determine causality. Physician–hospital integration is not necessary to gain higher market share, but a more competitive market may encourage integration in order to achieve larger market share. Therefore, before analyses, we examined the correlations between the AHA integration and HHI and found no evidence of multicollinearity.

Similar to Scott et al. (2017), our findings do not uphold the hypothesis that increased integration may result in better care, likely because structural integration (e.g., human resource management, financial management, etc.) through physician employment does not necessarily lead to clinical integration (e.g., coordinated patient services among providers or site, monitoring of "best practices," etc.; AHA, 2010). Our results indicate that vertical integration improves quality for only a limited set of process of care and patient satisfaction measures. But increased hospital market concentration is strongly associated with reduced quality across multiple measures. With this result in mind, regulators should continue to focus scrutiny on proposed hospital mergers, take steps to maintain competition, and reduce counterproductive barriers to entry (Gaynor, Mostashari, & Ginsburg, 2017).

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Agency for Healthcare Research and Quality grant number R01HS024727

Supplemental Material

Supplemental material for this article is available online.

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