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Variable surgical outcomes after hospital consolidation: Implications for local health care delivery

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Abstract

Background—With more hospital consolidations as an inevitable part of our future health care ecosystem, we investigated the relationship between hospital consolidations and operative outcomes.

Methods—Using the Health Care Cost and Utilization Project State Inpatient Database (Florida and California), the American Hospital Association Annual Survey Database, and Medicare's Case Mix Index data, we identified 19 hospitals that consolidated between 2007 and 2013 and propensity matched them with 19 independent hospitals, using patient and hospital characteristics. One year before consolidation and again 1 year after, we used difference-in-differences analysis to compare changes in the risk-adjusted complication rate of 7 elective operations performed in the consolidated hospitals and in the matched control group.

Results—Of the 7 procedures studied, 2 procedures saw a decrease in complication rate (lumbar and lumbosacral fusion of the posterior column posterior technique, difference-in-differences = -0.6% , $P < .01$; total hip replacement, difference-in-differences = -0.6% , $P < .01$); 3 procedures saw an increase in complication rate (transurethral prostatectomy, difference-in-differences = 4.1% , $P < .01$; cervical fusion of the anterior column anterior technique, difference-in-differences = 1.5% , $P < .01$; total knee replacement, difference-in-differences = 0.3% , $P < .01$); and 2 procedures saw no change in complication rate (laparoscopic cholecystectomy, lumbar and lumbosacral fusion of the anterior column posterior technique, both $P > .05$) after hospital consolidation.

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Conclusion—Arguments have been made that consolidated health care systems can share high-performing clinical services and infrastructure resources, such as electronic medical records, to improve quality. Our results indicate that hospital consolidation does not uniformly improve postoperative complication rates.

Hospital consolidations have been increasing in recent years, with potential implications to health care delivery. Since 2010, there have been more than 90 hospital consolidations each year in the United States; this represents a steep increase from 2005 when only 50 consolidations occurred.¹ According to a recent report by Xu et al,² approximately 20% of all US hospitals will seek a merger in the next 5 years. Based on these data, more than 1,000 hospitals across the country may pursue consolidation in the near future.

Hospital leaders in favor of mergers have claimed hospital consolidations benefit both the finances of the health system as well as patient care by decreasing costs while improving quality.³ There is only a paucity of data, however, in the current literature to support this claim. To date, the majority of hospital quality studies have demonstrated that competition, not consolidation, improves the quality of health care. Researchers at the Robert Wood Johnson Foundation showed that of the 9 studies that examined competition and quality in US hospitals, 8 found a direct correlation between increased competition and a decrease in mortality across multiple conditions.⁴⁻¹³ The caveat is that of the 9 studies, only 2 examined the relationship in operations, and none of the studies examined specifically the relationship between hospital consolidation and operations.

Bridging this gap in the literature may have important implications for how surgery is practiced in the near future. Many leaders in surgery have long advocated for a volume-based distribution of selected operative procedures, restricting the performance of procedures at hospitals that do not meet minimum volume thresholds on both clinical and economic grounds.^{14,15} Hospital consolidation is one mechanism through which access to high-volume centers could be achieved. Currently, however, federal regulators seem to be limiting consolidation and potentially obstructing the redistribution of patients to high-volume centers. With centralizing care to high-volume centers and maintaining competition in the health care market currently hanging in the balance, this study investigates the effect consolidations have the outcomes of select representative operations.

Methods

Patient-level data were queried from the Health Care Cost and Utilization Project State Inpatient Database (HCUP SID). Patients who underwent 1 of 7 elective operations 1 year prior to consolidation and 1 year after consolidation were included in our study. The 7 elective operations included laparoscopic cholecystectomy, transurethral prostatectomy, cervical fusion of the anterior column (anterior technique), lumbar and lumbosacral fusion of the anterior/posterior column (posterior technique), total hip replacement, and total knee replacement. The associated International Classification of Diseases 9th Revision, Clinical Modification (ICD-9-CM) diagnosis codes are shown in Supplementary Table I (online only).¹⁵ The primary outcome of study was the incidence of any one of the following postoperative complications: pulmonary failure, myocardial infarction, acute renal failure,

pneumonia, deep vein thrombosis, pulmonary embolism, surgical site infection, hemorrhage, and gastrointestinal bleed (Supplementary Table II, online only). This composite endpoint was chosen to ensure an adequate number of events to provide appropriate statistical power for the chosen analytic technique.

Hospital-level data were abstracted from the American Hospital Association Annual Survey Database (AHA ASD) and merged with the patient-level data. Hospital consolidations for the states of California and Florida between 2007–2013 were identified using the AHA ASD health care system identification (SYSID) variable, a variable that identifies hospitals in systems, as demonstrated previously by Dranove and Lindrooth.¹⁶ This method yielded 19 hospital consolidations in the 2 states during the study period. These 19 hospitals were propensity score-matched in a 1:1 fashion with 19 independent, control hospitals. Matching was performed by year and by patient (sex, race, age, Charlson comorbidity index score, and income) and hospital characteristics (HOSPBD, MAPP1, MAPP3, MAPP5, FTERN, SUROPIP, ADJADC). Figure 1 illustrates the inclusion and exclusion criteria of our study population.

Difference-in-differences (DID) analysis was used to compare the change in the complication rate of 7 elective operations 1 year prior to consolidation (preconsolidation) and the year after consolidation (postconsolidation) between the consolidated hospitals and the matched control group. The use of DID eliminates background changes in outcomes that may occur during consolidation years. The DID study design used a comparison group that experienced the same temporal variations without undergoing the change being studied. By using a DID analysis, we eliminated background changes in outcomes that may occur during consolidation years.¹⁷ The equation used for our DID analysis is shown below:

$$DID = (x_{T1} - x_{C1}) - (x_{T2} - x_{C2})$$

Where: x = risk-adjusted complication rate; T = consolidated hospitals; C = propensity-matched hospitals; 1 = 1 year prior to consolidation; 2 = year of consolidation.

At the hospital level, the complication rate for each procedure was risk adjusted using the following equation:

$$\text{risk-adjusted complication rate} = (\text{observed complication rate} / \text{predicted complication rate}) \times \text{overall complication rate}$$

The predicted complication rates were generated using multilevel, mixed-effects, logistic regression models. The models controlled for patient demographic characteristics (age, sex, race, income) and the Elixhauser comorbidity variables.¹⁸ The overall complication rates were determined using the average complication rate of our 38 hospitals (19 consolidated hospitals and 19 control hospitals).

Statistical analysis was performed using Stata 13 MP (StataCorp; College Station, TX). This study was deemed exempt from institutional review board approval, given the use of deidentified patient records.

Results

Baseline patient and hospital characteristics during the preconsolidation and postconsolidation periods and after propensity score matching are demonstrated in Tables I and II. There were no statistically significant variations in the matched variables. Stratifying the top 10 comorbidities for our patient populations, we found that rates of fluid and electrolyte disorder comorbidities for patients of consolidated hospitals were greater both pre- and postconsolidation ($P = .012$ and $P = .018$, respectively). The comorbidity rate of obesity for patients of consolidated hospitals was also greater postconsolidation ($P = .043$).

For 2 of the 7 procedures included in this study, somewhat improved complication rates were seen with hospital consolidation (Table III and Fig 2). For lumbar/lumbosacral fusion of the posterior column, the risk-adjusted complication rates the year prior to consolidation were 1.2% and 1.0% compared with 0.9% and 1.3% after consolidation, for consolidated and control hospitals, respectively. DID analysis demonstrated that hospital consolidation resulted in a small 0.6% improvement in the risk-adjusted complication rate ($P < .01$). Similarly, risk-adjusted complication rates for total hip replacement prior to consolidation were 3.5% and 2.6% compared with 2.9% and 2.6% after consolidation, for consolidated and control hospitals, respectively. DID analysis again demonstrated that hospital consolidation resulted in a small 0.6% improvement in the risk-adjusted complication rate ($P < .01$).

For 3 procedures studied, the risk-adjusted complication rate increased after hospital consolidation. For patients undergoing transurethral prostatectomy (TURP), cervical fusion, and total knee replacements, complication rates increased at consolidated hospitals. The risk-adjusted complication rates for TURP changed from preconsolidation rates of 7.6% and 6.5% to postconsolidation rates of 8.3% and 3.1% for consolidation and control hospitals, respectively. Risk-adjusted complication rates for cervical fusion changed preconsolidation from 1.5% and 2.3% to 1.5% and 0.8% for consolidated and control hospitals, respectively. Risk-adjusted complication rates for total knee replacement changed somewhat from preconsolidation rates of 2.1% and 2.3% to 3.3% and 2.2%, for consolidated and control hospitals, respectively. DID analysis demonstrated worsening of risk-adjusted complication rates for TURP (4.1%, $P < .01$), cervical fusion (1.5%, $P < .01$), and total knee replacement (0.3%, $P < .01$).

Two procedures—laparoscopic cholecystectomy and lumbar/lumbosacral fusion of the anterior column—demonstrated no change in risk-adjusted complication rates after consolidation. For both procedures, improvements in the risk-adjusted complication rates were seen in the consolidated and control hospitals over time. Risk-adjusted complication rates for laparoscopic cholecystectomy changed from preconsolidation rates of 4.2% and 4.4% to postconsolidation rates 3.2% and 2.9% for consolidated and control hospitals, respectively. Risk-adjusted complication rates for lumbar/lumbosacral fusion of the anterior

column changed from preconsolidation rates of 2.5% and 2.0% to postconsolidation rates 2.3% and 1.8% for consolidated and control hospitals, respectively. DID analysis demonstrated stable, risk-adjusted complication rates for laparoscopic cholecystectomy (0.5%, $P = .14$) and lumbar/lumbosacral fusion of the anterior column ($<0.1\%$, $P = .99$).

Discussion

The effect of hospital consolidation on postoperative complication rates does not seem to have an overall net positive or negative effect. After controlling for patient and hospital factors, DID analysis comparing adjusted complication rates for 7 common operative procedures demonstrated possibly improved complication rates although quite small ($<1\%$) for 2 procedures; no change in complication rates for 2 procedures; and worse outcomes for 3 procedures. To our knowledge, this is the first study investigating directly the effect of hospital consolidation on surgical outcomes.

Looking at the hospitals that underwent consolidation, it is interesting to see somewhat greater baseline risk-adjusted complication rates for 5 of the 7 procedures studied when compared with the matched control hospitals. It is possible that the lesser performing hospitals are more inclined to consolidate through a merger or acquisition. Past studies have shown that mergers allow for cost savings, and by increasing market power and economy of scale, the lesser performing hospitals may decrease focus on quality care improvement if financial solvency can otherwise be obtained.^{16,19}

It is also notable that the DID changes in risk-adjusted complication rates were not due solely to improved or worsened complication rates at the consolidated hospitals. For 5 procedures, the risk-adjusted complication rates of the control hospitals decreased somewhat during the study period. While a determination cannot be made from the present data, 1 well-documented hypothesis is that increased competition improves quality of care. In particular, consolidations may alter the competitive dynamic of local health care markets and pressure peer hospitals to improve their quality of care to increase their competitive advantage against growing hospital systems. Two prior studies have focused on the relationship between competition and the quality of surgical care. Cutler et al¹² found that the repealing of the Pennsylvania legislation led to increased competition in the market for cardiac surgery with a resultant redistribution of patients in need of coronary artery bypass graft to higher-quality cardiac surgeons. In another study, Howard et al¹³ demonstrated that surgical demand is directly associated with outcomes. In their study, transplant centers that had an increase of one-standard deviation in kidney transplant graft-failure rate saw an associated 6% decline in patient registrations. With the demand for surgery being sensitive to quality, this study supports the idea that nonconsolidating hospitals in the same markets as consolidating hospitals may be pressured to provide higher-quality care to increase their demand and retain their bargaining power with insurance companies.

This study uses a retrospective review of administrative data and as such is subject to the associated limitations. As an administrative dataset, HCUP SID is reliant on accurate coding at the source. But given its inclusion of all payers, comprehensive inpatient discharges, and capacity for longitudinal analysis, HCUP SID has been used frequently in past studies of a

similar scope.²⁰⁻²² Our analysis also was limited by the number of consolidations that took place during the time period of the study. To maximize the sample size, we were required to restrict our comparison to 1-year prior to consolidation and the year of consolidation. The effects of a hospital consolidation may take more than a year to manifest, a time frame our study was unable to capture. Additional studies with a greater duration of longitudinal analysis to assess the intermediate and long-term effects of hospital consolidation on patient care are warranted. One important concept our data did not allow us to measure was whether the results of consolidation differ on a hospital-by-hospital basis. Specifically, we were unable to discern whether a high-performing hospital can bolster the performance of a lesser-performing hospital during a consolidation (or vice versa). Understanding the local dynamics of a consolidation may explain the differential impact on outcomes noted in this study. Furthermore, this study only looked at hospital consolidations in 2 states and may not be generalizable to a national population; however, the states included in this analysis are large states with a diverse population base and large urban and small rural hospitals.

Hospital consolidation does not uniformly improve postoperative complication rates. While arguments have been made that consolidated health care systems can share high-performing clinical services and infrastructure resources to improve quality of care, a decrease in competition may result ultimately in the opposite effect. Undoubtedly, surgical outcomes after consolidation are affected by many factors, such as surgeon experience, surgical volume, hospital perioperative resources, leadership, and local hospital market dynamics. Further exploration to determine the effect hospital consolidations have on surrounding peer hospitals and the hospital characteristics associated with hospital consolidations will allow for better understanding of this growing trend.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Fig 1.
The inclusion and exclusion criteria for the study sample.

A Procedures in which consolidated hospitals saw a decrease in complication rates. **B** Procedures in which consolidated hospitals saw an increase in complication rates. **C** Procedures in which consolidated hospitals saw no change in complication rates. **Fig 2.**

Risk-adjusted surgical complication rates before and after hospital consolidation. (A) Lumbar and lumbosacral fusion of the posterior column posterior technique (DID = -0.6% , $P < .01$) and total hip replacement (DID = -0.6% , $P < .01$) had a somewhat decreased risk-adjusted complication rate after hospital consolidation. (B) Transurethral prostatectomy (DID = 4.1% , $P < .01$), cervical fusion of the anterior column anterior technique (DID = 1.5% , $P < .01$), and total knee replacement (DID = 0.3% , $P < .01$) had a somewhat increased risk-adjusted complication rate after hospital consolidation. (C) Laparoscopic cholecystectomy (DID = 0.5% , $P = .14$) and lumbar and lumbosacral fusion of the anterior column posterior technique (DID = $<0.1\%$, $P = .99$) had no change in risk-adjusted complication rates after a hospital consolidation.

Table 1
Patient characteristics for consolidation and control hospitals pre- and postconsolidation

Patient characteristics	Preconsolidation			Postconsolidation		
	Consolidated hospitals (N = 19)	Control hospitals (N = 19)	P value	Consolidated hospitals (N = 19)	Control hospitals (N = 19)	P value
Mean age (SD) *	57.9 (7.475)	57.8 (6.830)	.953	57.3 (8.67)	56.4 (5.96)	.758
Mean % female (SD) *	55.0 (11.87)	59.6 (6.855)	.156	56.9 (12.8)	55.1 (11.3)	.661
Mean % lowest income quartile (SD) *	40.4 (28.38)	34.9 (22.61)	.519	40.6 (28.6)	38.0 (22.3)	.777
Mean Medicare case mix index (SD)	1.37 (0.2618)	1.40 (0.2166)	.700	1.37 (0.289)	1.41 (0.201)	.649
Mean Charlson comorbidity index (SD) *	0.958 (0.3016)	0.856 (0.2195)	.242	0.982 (0.320)	0.817 (0.233)	.104
Race						
White	53.7 (28.1)	52.1 (29.2)	.871	53.1 (28.0)	53.6 (31.1)	.957
Hispanic	23.5 (27.0)	30.9 (28.3)	.412	24.4 (27.1)	31.3 (30.9)	.495
Black	12.7 (8.44)	6.97 (8.44)	.0629	12.7 (9.72)	7.68 (9.08)	.135
Top 10 comorbidities, %						
Hypertension (SD)	47.9 (11.6)	46.1 (13.0)	.649	49.1 (13.4)	44.6 (11.5)	.306
Fluid and electrolyte disorders (SD)	22.6 (6.48)	17.3 (5.94)	.0122	24.9 (8.62)	18.0 (7.15)	.018
Diabetes (SD)	19.4 (5.03)	16.6 (7.19)	.166	19.7 (6.86)	16.1 (7.40)	.129
Deficiency anemias (SD)	18.8 (5.45)	18.0 (8.27)	.732	20.5 (6.19)	16.7 (6.79)	.090
Chronic pulmonary disease (SD)	17.9 (5.95)	17.6 (5.03)	.875	18.3 (6.32)	16.8 (4.46)	.439
Renal failure (SD)	9.71 (4.18)	10.9 (6.10)	.492	10.5 (4.35)	10.2 (6.11)	.867
Hypothyroidism (SD)	9.64 (3.42)	9.84 (3.95)	.866	9.89 (3.97)	9.34 (3.16)	.672
Obesity (SD)	9.87 (4.19)	9.67 (5.35)	.898	12.3 (5.10)	8.77 (4.47)	.043
Depression (SD)	8.70 (4.73)	8.11 (4.46)	.691	9.11 (4.93)	7.40 (4.02)	.286
Neurologic disorder (SD)	7.88 (2.96)	7.66 (3.07)	.822	8.49 (3.53)	7.96 (2.75)	.638

* Variable was used for propensity score-matching consolidated hospitals with independent control hospitals.

Table II
Hospital characteristics for consolidated and control hospitals pre- and postconsolidation

Hospital characteristics	Preconsolidation			Postconsolidation		
	Consolidated hospitals (N = 19)	Control hospitals (N = 19)	P value	Consolidated hospitals (N = 19)	Control hospitals (N = 19)	P value
No. of hospitals accredited by the Joint Commission (%) *	14 (73.68)	14 (73.68)	1.00	14 (73.68)	14 (73.68)	1.00
No. of hospitals accredited by ACGME (%) *	3 (15.79)	2 (10.53)	.642	3 (15.79)	2 (10.53)	.642
No. of hospitals with a medical school affiliation (%) *	3 (15.79)	2 (10.53)	.642	3 (15.79)	2 (10.53)	.642
Mean total hospital beds (SD) *	192.5 (146.1)	188 (134.6)	.922	187.9 (144.3)	198 (136.9)	.824
Mean total facility Medicare discharges (SD)	3,912 (3092)	4,620 (4,083)	.551	4,068 (3,140)	4,420 (3,911)	.767
Mean inpatient surgical operations (SD) *	2,114 (1787)	2,135 (1,971)	.973	2,201 (1,937)	2,345 (1,989)	.827
Mean outpatient surgical operations (SD)	3,136 (1700)	2,769 (2,015)	.548	2,982 (1,284)	2,821 (2,122)	.782
Mean adjusted average daily census (SD)	216.3 (153.7)	200.9 (130.8)	.741	230.5 (152.6)	201.9 (138.3)	.562
Mean FTE registered nurses (SD) *	276.5 (186.4)	252.6 (202.4)	.708	278.2 (179.4)	273.5 (207.2)	.708
Core-based statistical area type						
No. of hospitals in metro area (%)	8 (42.10)	8 (42.10)	1.00	8 (42.10)	8 (42.10)	1.00
No. of hospitals in micro area (%)	9 (47.37)	9 (47.37)	1.00	9 (47.37)	9 (47.37)	1.00
No. of hospitals in division/rural area (%)	2 (10.53)	2 (10.53)	1.00	2 (10.53)	2 (10.53)	1.00

* Variable was used for propensity score-matching consolidated hospitals with independent control hospitals.

ACGME, Accreditation Council for Graduate Medical Education; FTE, full time equivalent; SD, standard mean of deviation.

Table III

DID for risk-adjusted complication rates

Procedure	Preconsolidation		Postconsolidation		DID	
	Consolidated hospitals (%)	Control (%)	Consolidated hospitals (%)	Control (%)	Independent effect of hospital consolidation (%)	P value
Laparoscopic cholecystectomy	4.2	4.4	3.2	2.9	0.5	.14
Transurethral prostatectomy	7.6	6.5	8.3	3.1	4.1	<.01
Cervical fusion of the anterior column, anterior technique	1.5	2.3	1.5	0.8	1.5	<.01
Lumbar and lumbosacral fusion of the posterior column, posterior technique	1.2	1.0	0.9	1.3	-0.6	<.01
Lumbar and lumbosacral fusion of the anterior column, posterior technique	2.5	2.0	2.3	1.8	<0.1	.99
Total hip replacement	3.5	2.6	2.9	2.6	-0.6	<.01
Total knee replacement	3.1	2.3	3.3	2.2	0.3	<.01