Hospital Competition and Surgical Length of Stay

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The hypothesis that competitive pressures encourage hospitals to accommodate patient and physician preferences for longer lengths of stay was tested. Seven hundred forty-seven nonfederal short-term hospitals were divided in terms of the number of neighboring hospitals within a 24-km radius, and this measure of hospital concentration and competition was measured against length of stay for ten surgical procedures, using 1982 data on 498454 patient discharges. Patient, physician, and hospital characteristics associated with length of stay were controlled for. Competition-related percentage increases in length of stay were identified for all procedures, including total hip replacement (14.8%), transurethral prostatectomy (13.9%), intestinal operations (14.0%), stomach operations (14.7%), hysterectomy (6.9%), cholecystectomy (9.1%), hernia repair (10.5%), appendectomy (8.4%), cardiac catheterization (22.9%), and coronary artery bypass graft surgery (21.2%). It was concluded that there is a strong association between the number of hospital competitors in the local market and the average length of stay in US hospitals.

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SUBSTANTIAL differences exist among individual hospitals and among geographic areas in average lengths of hospital stay for patients undergoing similar surgical procedures. While presumably due in part to differences in case-mix severity, these length of stay differences are probably also due to differences in physician practice styles and hospital discharge protocols. A number of major policy initiatives, including Medicare's prospective payment system, have targeted long lengths of stay that are not explainable by case-mix severity as part of a larger effort to reduce the rate of health care cost inflation. Little is known, however, about the factors that influence patient length of stay; it is therefore difficult to predict the long-term effects of financing incentives that penalize those hospitals that keep their patients longer than do other institutions.

We analyzed the effect of competition among hospitals in local geographic areas on the length of stay for ten surgical procedures, controlling for a number of measures of case-mix severity. Hospital and surgeon volumes for each procedure were also controlled for, given the growing literature suggesting that low-volume hospitals and surgeons may have significantly worse outcomes than otherwise comparable hospitals and surgeons performing high volumes of particular surgical procedures.[1-6] Data were obtained on 498454 surgical discharges from 747 hospitals in 1982, the year immediately before the introduction of Medicare's prospective payment system. We also examined average length of stay for all discharges from our sample of hospitals, controlling for the distribution of patients across 23 broad treatment categories.

The guiding hypothesis in this study was that, at least until 1982, hospitals in areas with other nearby hospitals competed intensely with one another, but on a nonprice rather than price basis. Hospitals in competitive local markets were under especially strong pressure to develop clinical services and administrative procedures designed to attract physician affiliations and patient admissions. Patients generally prefer longer to shorter postoperative lengths of stay to reduce the subsequent burden of nursing on themselves and family members at home. Surgeons are typically paid one fee that covers postoperative care in addition to the actual surgical procedure; hence, they face no direct economic incentives to extend lengths of stay. However, a reduction in preoperative stay may reduce the surgeon's confidence that the patient has been adequately monitored and prepared, while shorter postoperative stays reduce the certainty that the patient is fully recovered before discharge. Much postoperative inpatient care is given by the original referring physician, however, who is typically reimbursed for each visit. Both surgeons and internists are likely to resent pressures to shorten lengths of stay for economic reasons alone.

A number of studies have documented the effects of nonprice competition in hospital markets. Markets with many hospitals have been found to ex-

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hibit duplication of clinical services[7,8] and high average costs per admission.[9] Using 1972 data on average length of stay for all admissions, two of us (J.C.R. and H.S.L.)[10] found longer stays in competitive markets, that is, ones with many neighboring hospitals, than in noncompetitive local markets. Sloan and Valvona[11] examined year-to-year changes in average lengths of stay for ten medical and surgical procedures. Their finding of no consistent effects attributable to competititon may be due to their measure of competition that was based on the metropolitan area. The present study improves on earlier methodologies by combining procedure-specific lengths of stay, an enlarged set of controls for case-mix severity, and more precise measures of local market competition. The following question was under consideration: Are procedure-specific lengths of stay longer in more competitive than in less competitive local markets, controlling for patient case mix, hospital procedure-specific volume, and other previously identified influences?

PATIENTS AND METHODS

The data used in this study were assembled from four sources. Procedure-specific average lengths of patient stay were obtained from patient record data collected by the Commission on Professional and Hospital Activities. The commission provided case-mix measures, including patient age, sex, and secondary diagnoses and procedures. Procedure-specific rates of patient transfer into and out of each hospital and the distribution of total hospital volume for each procedure across the surgeons performing those procedures were also obtained from the commission. Measures of competition were calculated by the authors using latitude and longitude coordinates for each of the nation's hospitals, as discussed below. Demographic data on the local population were taken from 1982 Area Resource File. Information on hospital role in medical education and ownership status was obtained from the 1982 Annual Survey of Hospitals, conducted by the American Hospital Association (AHA).

Patient Abstract Data

Hospitals were included in the sample if they participated in the Professional Activities Study of the Commission on Professional and Hospital Activities, if they admitted at least one patient during 1982 for any of the ten procedures studied, and if they responded to the 1983 Survey of Specialized Clinical Services, a survey designed by the authors and conducted under the auspices of the AHA. This survey has been described elsewhere.[12] Long-term and federal (Veterans Administration) hospitals were excluded from the analysis. The 747 hospitals in the sample were slightly larger, somewhat more likely to be private nonprofit, and more often affiliated with a medical school than the population of short-term general hospitals in the country. Individual patient records were excluded if data were missing on age, sex, discharge status, or length of stay. To maintain confidentiality, all patient records were aggregated to the hospital level by the commission before we received the data. Risk factor measures for each hospital and procedure were developed using mortality rates and patient characteristics, including age category, sex, type of procedure, and secondary diagnoses and procedures. Each hospital was assigned a risk factor measure for each procedure based on the characteristics of that hospital's procedure-specific population and the association between these characteristics and procedure-specific mortality rates for all hospitals in the sample. The number of classification cells in the matrices ranged from nine for stomach operations, which was categorized by age and admission diagnosis (a 3×3 matrix), to 48 for cholecystectomy, which was a subset by age, sex, type of procedure, and single/multiple diagnoses (a $3\times2\times4\times2$ matrix).

Additional case-mix measures were constructed for nine of the ten procedures based on the proportion of each hospital's patients undergoing the procedure that had a particular secondary diagnosis or procedure. The number of measures that were included ranged from one for appendectomy (proportion of patients with normal tissue at the time of pathologic study) up to eight for stomach operation (proportions of patients with a secondary diagnosis of [1] diabetes, [2] anemias or hemorrhage, and/or secondary procedures of [3] partial gastrectomy, [4] vagotomy, [5] pyloroplasty, [6] suture of ulcer, [7] total gastrectomy, and [8] esophagectomy or gastrectomy). These secondary diagnosis and procedure measures could not be included in the risk factor matrices because dividing the matrices into too many cells reduces the stability of the cell-specific rates. No secondary diagnoses or procedures of relevance could be obtained from the data available on total hip replacement.

To control for the effects of procedure volume on outcome and, hence (potentially), on length of stay, we included in the analysis the annual volume of each procedure performed in each hospital and a measure of the distribution of procedures among surgeons performing the procedure. The surgeon-volume variable was calculated as the proportion of patients undergoing each procedure that was treated by surgeons whose annual volume was less than the median for that procedure among all surgeons in the sample. This measure, which has been described in detail elsewhere,[4] was constructed in such a manner as to capture the influence of having a significant fraction of all procedures performed by especially low-volume surgeons.

The proportion of patients with each procedure who were transferred into a hospital was included to control for the especially severe patient case mix faced by hospitals that attract a disproportionate share of complicated cases from other institutions. The proportion of patients for each procedure who were transferred out of the hospital was also controlled for, since hospitals with high transfer-out rates should report shorter average lengths of stay.

Measurement of Market Competition

The number of competing hospitals in each local market was measured according to the latitude and longitude coordinates for each of the nation's approximately 6000 nonfederal, short-term general hospitals. For each of the 747 hospitals providing patient discharge data, we used a computer algorithm to search for all the neighboring institutions within a 24-km radius (1800 km^2). Straight-line distances between hospitals were calculated from latitude and longitude coordinates using the Pythagorean theorem adjusted for the curvature of the earth. Markets were defined according to whether they included 0, 1 through 4, 5 through 10, or more than 10 neighboring hospitals within a 24-km radius. While procedure-specific patient abstract data were only available for 747 hospitals, as discussed above, the market measures were calculated using the full set of almost 6000 nonfederal, short-term hospitals in the continental United States, as obtained from the 1982 AHA survey. This method of measuring hospital market competition has been discussed at length elsewhere.[13]

This measure of competition assumes that the size of the relevant market does not vary by type of surgical procedure. The 24-km radius was chosen with the hypothesis that this was the maximum distance a physician would be willing to travel among hospitals regularly to conduct rounds. For some procedures, however, surgeons in some areas are willing to travel considerable distances, workhibit duplication of clinical services[7,8] and high average costs per admission.[9] Using 1972 data on average length of stay for all admissions, two of us (J.C.R. and H.S.L.)[10] found longer stays in competitive markets, that is, ones with many neighboring hospitals, than in noncompetitive local markets. Sloan and Valvona[11] examined year-to-year changes in average lengths of stay for ten medical and surgical procedures. Their finding of no consistent effects attributable to competititon may be due to their measure of competition that was based on the metropolitan area. The present study improves on earlier methodologies by combining procedure-specific lengths of stay, an enlarged set of controls for case-mix severity, and more precise measures of local market competition. The following question was under consideration: Are procedure-specific lengths of stay longer in more competitive than in less competitive local markets, controlling for patient case mix, hospital procedure-specific volume, and other previously identified influences?

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Table 1.—Hospital and Patient Statistics for Ten Surgical Procedures and for All Discharges

	No. of Hospitals	No. of Patients	Average Length of Stay, d	*ICD9-CM* Code*
Total hip replacement	500	13656	18.5	81.5
Transurethral prostatectomy	629	41211	10.1	60.2
Intestinal operations	706	28162	19.7	45.71-45.79, 45.8, 45.92-45.94, 46.10-46.14, and 46.20-46.24
Stomach operations	654	9231	18.7	43.6, 43.7, 43.9, 44.0-44.03, 44.2, and 44.41-44.42
Hysterectomy	734	104999	7.9	68.3-68.7
Cholecystectomy	740	79782	10.6	51.21-51.22
Hernia repair	740	77633	4.5	53.00-53.05 and 53.10-53.17
Appendectomy	739	39029	5.5	47.0
Cardiac catheterization	297	75740	6.1	37.2-37.23 and 85.50-88.58
Coronary artery bypass graft	120	29011	15.3	36.10-36.19
All discharges	747	6143237	7.7	...

**ICD9-CM* indicates *International Classification of Diseases, Ninth Revision–Clinical Modification.*

Table 2.—Adjusted Average Length of Stay in Days, by Number of Neighboring Hospitals Within 24-km Radius*

	Length of Stay, d			
	No Neighbors	1-4 Neighbors	5-10 Neighbors	≥11 Neighbors
Total hip replacement	17.11	17.59	18.39†	19.64‡
Transurethral prostatectomy	9.43	9.63	10.28§	10.74‡
Intestinal operations	18.47	18.73	19.92§	21.05‡
Stomach operations	17.08	18.27†	18.95§	19.59‡
Hysterectomy	7.64	7.73	7.93†	8.17‡
Cholecystectomy	10.17	10.32	10.71§	11.10‡
Hernia repair	4.19	4.34§	4.50‡	4.63‡
Appendectomy	5.36	5.37	5.55	5.81‡
Cardiac catheterization	4.98	5.95	6.13	6.12
Coronary artery bypass graft	13.13	14.13	14.93	15.91
All discharges	7.04	7.37	7.79‡	8.23‡

**P* values given in footnotes below relate to the test of the null hypothesis that average length of stay in hospitals with 1 through 4, 5 through 10, or 11 or more neighbors is identical to average length of stay in hospitals with no neighbors.
†$P<.10$.
‡$P<.01$.
§$P<.05$.

ing in geographically quite distant institutions on different days of the week. Long-distance travel of this type occurs most frequently in less densely populated areas. As a partial adjustment for these differences in the market area, we included as explanatory variables in the regressions both the total population residing in the county where the hospital was located and the population per square mile in the county. These data were based on US Bureau of the Census records and compiled by the Bureau of Health Professions, US Department of Health and Human Services, in the 1982 Area Resource File. Nevertheless, it was to be expected that our measure of market structure provided a more precise index of the true degree of competition for routine surgical procedures, such as appendectomy and hysterectomy, than for more specialized procedures, such as coronary artery bypass graft surgery.

Hospital Characteristics

The 1982 AHA Annual Survey of Hospitals provided information on hospital ownership status (public, private nonprofit, or private for profit) and role in medical education (whether or not the institution was a member of the Council of Teaching Hospitals). The region of the nation (Northeast, Midwest, Southeast, or West) was also used to control for the well-known, though poorly understood, geographic differences in average length of patient stay. Average length of stay for all patients, admitted over the course of 1982, was also derived from the AHA survey. To control for broad differences in patient mix when using this measure, we used the AHA data to calculate the percentage of all inpatient days over the course of 1982 that were accounted for by each of 23 broad diagnostic categories. These 23 categories included five forms of acute care (adult medical and surgical, pediatric, obstetric, psychiatric, and other acute), eight forms of intensive care (general medical and surgical intensive, cardiac intensive, neonatal intensive, neonatal intermediate, pediatric intensive, burn, psychiatric intensive, and other special), five forms of subacute care (nursery long term, psychiatric long term, other long term, self-care, and other subacute), and five miscellaneous forms of care (rehabilitation, respiratory disease, hospice, alcoholism, and other). These 23 categories assumed the role in the analysis of the overall length of stay played by the procedure-specific case mix and secondary diagnosis and procedure measures in the analysis of the ten procedure-specific average lengths of stay.

Analytic Techniques

We used linear multiple regression analysis (weighted least squares) to explain the cross-hospital variation in average length of stay for each of the ten surgical procedures and for all discharges.

To prevent hospitals with small procedure volumes from dominating the statistical results, we weighted each hospital observation by the square root of its volume of patients. For the ten surgical procedures, procedure-specific volumes were used as the basis for the weights. For length of stay for all discharges, the total number of discharges was used.

Each regression used a common set of independent variables plus a unique set of variables tailored to that particular procedure. Variables used in all regressions included the market competition measures, county population, county population density, region of the nation, ownership type, and whether or not the institution was a member of the Council of Teaching Hospitals. Procedure-specific variables for each of the ten forms of surgery included hospital volume for that procedure, our measure of surgeon volume for that procedure, the case-mix measures, the secondary diagnosis and procedure measures, the proportion of cases transferred into the hospital, and the proportion of cases transferred out of the hospital. The overall length of stay regression used annual discharges as its measure of volume and the 23 diagnostic categories as its measure of patient case mix, in addition to the common set of explanatory variables.

Adjusted lengths of stay for each surgical procedure and for all discharges were calculated based on these regressions. An adjusted mean was an estimate based on the hypothetical situation that all hospital groups had the same (sample mean) values on each of the independent variables that were entered into the regression equation. The adjusted mean lengths of stay were calculated for hospitals in each type of local market, ie, those with no neighboring institution within 24 km, those with one through four neighbors, those with five through ten neighbors, and those with more than ten neighbors.

RESULTS

Table 1 presents descriptive statistics on each of the ten surgical procedures and for all discharges. Sample sizes for the procedures varied according to their degree of complexity and, hence, the proportion of hospitals within which each was performed. Of the 747 hospitals in the sample, only 120 had patients undergoing coronary artery bypass graft surgery in 1982, and only 297 had patients undergoing cardiac catheterization. Over two thirds of the hospitals reported total hip replacement, transurethral prostatectomy, and stomach operations. Almost all reported intestinal operations, hysterectomy, cholecystectomy, hernia repair, and appendectomy. Relatively long average lengths of stay were reported for coronary bypass surgery, total hip replacement, stomach operations, and intestinal operations.

Table 2 presents adjusted average lengths of stay for each of the ten surgical procedures and for all discharges, according to the number of neighboring hospitals within a 24-km radius. These data control for the following: differences among markets in terms of population and population density; differences among major regions of the country; differences among hospitals in ownership status, teaching role, hospital and surgeon volumes, and percentage of patients transferred in and out; and differences in patient case mix in terms of expected inhospital mortality rate and presence of secondary diagnoses and procedures.

The differences in length of stay associated with increasing numbers of neighboring hospitals in the local market were striking. For each of the ten surgical procedures and for all hospital discharges, average length of stay increased with the number of competitors. The size of the market-related differences varied considerably among the procedures, but these differences were consistently associated with differences in average length of stay for each procedure among all hospitals in the sample. In percentage terms, market-related length of stay differences were fairly similar among procedures.

Compared with hospitals with no neighbors within 24 km, hospitals in the most competitive markets reported average lengths of stay that were 14.8% higher for total hip replacement ($P<.01$), 13.9% higher for transurethral prostatectomy ($P<.0001$), 14.0% higher for intestinal operations ($P<.0001$), 14.7% higher for stomach operations ($P<.001$), 6.9% higher for hysterectomy ($P<.01$), 9.1% higher for cholecystectomy ($P<.0001$), 10.5% higher for hernia repair ($P<.001$), 8.4% higher for appendectomy ($P<.01$), 22.9% higher for cardiac catheterization ($P>.05$), and 21.2% higher for coronary artery bypass graft surgery ($P>.05$). The market-related differences for cardiac catheterization and bypass surgery, while large in size, were not statistically significant due to the relatively small sample sizes available for these complex procedures. The explanatory power of the linear regressions underlying these market-related differences was high, with adjusted multiple correlation coefficients ranging from a low of .31 for stomach operations to a high of .48 for cardiac catheterization.

The last row of Table 2 presents adjusted length of stay data for all hospital discharges according to the number of neighboring hospitals in the local market. Hospitals in the most competitive markets reported average lengths of patient stay 16.9% higher ($P<.0001$) than comparable hospitals that had no nearby neighbors. The adjusted multiple correlation coefficient on this regression was .58.

COMMENT

This study documented the strong association between the number of hospital competitors in the local market and average length of stay in US hospitals in 1982. For each of the ten surgical procedures examined, and for the sum of all discharges, hospitals in markets with more neighbors reported substantially longer lengths of stay than otherwise similar hospitals without nearby neighbors. These market-related differences were especially remarkable since they were based on statistical analyses that controlled for total population and population density in the market. As these population measures were both positively associated with average length of stay in their own right and with the number of competing hospitals in the market, the hospital-based measures of market competition understated the full association between average length of stay and the number of neighboring hospitals.

These findings are consistent with the hypothesis that patients and physicians tend to prefer longer over shorter lengths of stay for surgical procedures and that hospitals under competitive pressure are more likely to accommodate those desires than hospitals not under such pressures. These findings are particularly striking since they concern surgical procedures. Given their global-fee method of reimbursement, surgeons do not face economic incentives to lengthen patient stays. The fee covers follow-up visits and, thus, provides some incentives to reduce stays, but this appears to be weak relative to the increased uncertainties associated with shorter stays. Attending physicians for patients undergoing medical treatments tend to be reimbursed for each visit. Competition-related length of stay differences may be greater for some medical admissions than for the surgical procedures reported here.

An additional and complementary explanation for these findings can be derived from economic theories of hospital decisions concerning bed capacity utilization. Harris[14] and Joskow[15] have argued that physicians prefer hospitals to maintain excess bed capacity so as to be able to accommodate unscheduled admissions without delays. This desire for excess capacity is particularly acute where hospital beds are assigned to particular services, such as orthopedic surgery, and cannot be easily switched to another service when an unexpected increase in admissions is experienced. Hospitals facing competitive pressures are more susceptible to physician demands for the maintenance of this excess capacity.[15] Once the excess bed capacity is in place, hospital administrators can be more generous in allowing long lengths of stay during periods when admission rates are not exceptionally high. Pressure can be placed on staff physicians to shorten lengths of stay, thereby freeing up bed capacity, during the rare periods of peak admission rates.

To test the Harris-Joskow hypothesis[14,15] concerning competitive influences on hospital bed utilization, we initially analyzed the influence of local market competition on bed occupancy