E C O N O M I C S B U L L E T I N

Correlates of hospital quality: a preliminary study

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Abstract

The research uses three indicators of quality suggested by the Center for Medicare and Medicaid Services to examine factors leading to differentials in quality of hospital care. We find that hospital quality can be explained by the number of beds, the number of employees per bed, hospital financial performance, and whether the hospital is urban or rural. However, these variables are significant for only one measure of quality, procedures implemented in case of heart attack.

None.
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1. Introduction

An issue of concern to Americans is quality of hospital care. With risk of over simplifying, researchers on hospital quality have approached the subject from two broad perspectives.

The medical profession has for the main part concerned itself with studying the efficacy of using various metrics in a hospital setting. Challiner, Watson, Julious, and Philip (2004) study hospital quality using questionnaire data, while Normand and Zou (2002) examine the relationship between sample size and the study of health care quality. Obstetric trauma indicators as measures of hospital quality are studied by Grobman, Feinglass, and Murthy (2005). The work of Graaff, Foody, Galusha et al. (2004) centers in on the bias introduced into hospital quality measures when patients transfer between hospitals. Milne and Clarke (1990), Ashton, del Junco, Souchek et al. (1997), and Kossovsky, Sarasin, Perneger et al. (2000) all address the issue of whether hospital quality is reflected in data on hospital readmissions.

A second strand of research deals with factors associated with hospital quality. Hanson, McPake, Nakamba, and Archard (2004), for instance, find that thoroughness of medical examination is the hospital quality attribute in highest demand. Beita (2003) analyzes the link between quality provided by a hospital and the market structure in which it operates. The researcher finds that in terms of total surplus monopoly and duopoly are equally efficient at providing quality when the level of quality is not verifiable. Cutler and Horwitz (1998), Sloan (1998), and Sloan, Picone, Taylor, and Chou (2001) find that hospital quality is on average invariant with respect to ownership structure. Li (1997), Li and Benton (2003), and Gowen, McFadden, Hoobler, and Tallon (2005) demonstrate that hospital quality can be improved through the use of hospital quality initiatives and other managerial workforce decisions, while the link between hospital quality and hospital costs is studied by Carey and Burgets (1999) and Deily and McKay (2006).

Given this background, the purpose of the paper is twofold. First, we find empirical evidence linking hospital quality and hospital performance. With the exception of a recent article by Shen (2003), showing that hospital quality is negatively related to financial pressure from the Prospective Payment System for inpatient care, the link between hospital quality and performance has not been studied extensively. In our study we will also introduce some hospital characteristics not used in previous empirical work. In particular, quality will be measured by the indicators suggested by the Center for Medicare and Medicaid Services. The advantages of using these measures are discussed below.

2. Quality Measure and Data Set

A widely used measure of hospital quality is the inpatient morbidity rate or mortality rate, with a lower rate signifying greater hospital quality. The studies by Dubois, Brook, and Rogers (1987), Brook (1992), McGarvey and Harper (1993), Shen (2003), Tourangeau and Tu (2003), and Dimick, Staiger, and Birkmeyer (2006) all measure hospital quality using this type of metric. The problem with this type of measure, as Gowrisankaran and Town (1999) argue, is that hospital morbidity and mortality rates are biased measures of quality, since sicker people entering hospitals as inpatients are more likely to die. The same criticism holds for most outcome-based measures of hospital quality.

To circumvent this problem, we use the quality indicators suggested by the Center for Medicare and Medicaid Services. These indicators consist of a group of agreed upon procedures that a hospital can administer to a newly admitted patient. The present study uses procedures associated with a patient being admitted with one or more of three conditions, acute myocardial infarction, congestive heart failure, and pneumonia. The specific suggested procedures appear in Appendix A.

Our measure of quality for each hospital is the fraction of the admissions on which a given procedure was performed. These scores were averaged to obtain the overall quality score for that condition for the hospital under consideration. These quality measures were obtained for a sample of 89 hospitals in Alabama from the quality reports submitted to the American Hospital Directory.

Let Q_{ij} be the average quality measure for hospital i and condition j. The determinants of hospital quality were examined using the regression equations

$$Q_{ij} = \alpha + \beta_{i1} Beds_i + \beta_2 \frac{Employees_i}{Beds_i} + \beta_3 Performance_i + \beta_4 Urban_i + \varepsilon_i .$$

The independent variables are listed in Appendix B. The first two independent variables are used to measure the relationship between hospital characteristics and hospital quality. These measures have not been used in previous studies of hospital quality. The coefficient on the number of hospital beads is used to measure the relationship between hospital size and quality. If there are scale economies in the production of hospital care, larger hospitals will be less strapped for hospital resources, and able to devote more resources to administering recommended procedures to newly admitted patients. The sign on β_1 is therefore expected to be positive. Implementation of the various recommended procedures to newly admitted patients with the conditions in Appendix A is a labor intensive endeavor. We therefore expect hospitals with large staffs relative to the number of beds to perform the procedures more often. The coefficient β_2 is expected to be positive.

We consider three performance measures, total revenue per employee, operating income per employee, and operating margin, defined as operating income relative to total revenue. Scaling for the first two performance measures is relative to the number of employees rather than the number of beds. This is done to minimize correlation between the performance measures and the employee per bed variable. All three performance measures are expected to be positively related to quality. There are two interpretations of this expected sign. First, β_3 will be positive if hospitals that perform more of the recommended procedures or perform the recommended procedures on a greater percentage of inpatients will have reputations for higher quality service and therefore be able to generate more revenue and operating income. Second, β_3 will be positive if hospitals that generate more revenue and operating income, or have higher operating margins can afford to devote more resources to quality, as measured by the frequency with which the recommended procedures are performed on newly admitted inpatients.

The final independent variable is a dummy variable coded to 1 if the hospital is listed as urban in the American Hospital Directory and 0 if the hospital is designated as rural. The popular notion is that small rural hospitals are understaffed and provide low levels of service. The expected sign of β_4 is therefore positive.

3. Results

Summary statistics for the variables used in the study are displayed in Table 1. The average quality rating for heart attack procedures was the lowest, scoring 0.60, while the pneumonia quality rating averaged at .75. The range was largest for the quality rating for heart failure. The range indicated that some hospitals reported performing neither of the prescribed procedures for heart failure, while at least one hospital performed both procedures on all incoming patients with congestive heart failure.

The sample included a wide range of hospital sizes, ranging from a minimum of 20 beds to a maximum of 847 beds. The mean hospital size was approximately 152 beds. Employees per bed ranged from 0 to 8, with a mean of 3.75. The mean revenue per employee was $392,450, and ranged from slightly over $100,000 to a maximum of $2.3 million. On average, hospital operating income was negative. Similarly, the mean operating margin for our sample of hospitals was -2.6%. This does not mean that hospitals were on average operating at a loss, since most hospitals generate income through auxiliary services such as food services and gift shops. Such income is not counted as part of operating income.

The regression results are displayed in Tables 2 through 4. Table 2 shows the regressions for quality as measured by heart attack procedures for the three performance measures. All three performance measures display similar results. The F statistics indicate that the as a group the independent variables significantly explain the variation in the quality measures across our sample of hospitals. The R squares show that at least 45% of the variation in quality as measured is explained by the independent variables used.

In all three equations the coefficient on the number of beds is positive and significant at the 1% level. This means that larger hospitals performed the suggested procedures for incoming patients with heart attacks more often. The employee per bed coefficient was also positive across all performance measures and significant at a minimum level of 2%. This suggests that hospitals with larger staffs relative to facilities were able to perform the procedures more often. The coefficient on the urban rural dummy variable was also significant and positive, supporting the notion that urban hospitals on average provide higher quality service than rural hospitals.

The coefficient on two of the performance measures, revenue per employee and operating income per employee, are positive and significant. This suggests that hospitals that provide higher quality service generate more revenue and revenue relative to operating expenses. However, although positive, the coefficient on the operating margin is not significant. There are two explanations for this. First, since both revenues and operating income are correlated with higher quality, the ratio of operating income to revenue may not vary enough across hospitals to result in a significant effect on the heart attack quality measure. The economic explanation is that perceived higher quality mainly results in horizontal shifts in demand for a hospital's services, but does not allow the hospital to increase price enough to increase the operating margin. This is consistent with hospitals receiving compensation at fixed prices by third parties.

The regression results for the quality measures for procedures to be implemented in case of congestive heart failure appear in Table 3. These results are much less significant than those for heart attack. None of the F statistics indicates a significant

regression. Moreover, the adjusted R squares are low. However, the coefficient for the variable indicating number of beds is positive and significant at the 6% level in equations in which the hospital financial performance measure is operating income and operating margin. This is similar to the situation in which the quality measure is the fraction of times a hospital implements recommended procedures in case of heart attack.

Why are the results less significant when quality is measured by procedures implemented for heart attack patients and patients with heart failure? We offer two explanations. First, only four procedures are recommended in the case of heart failure. This may not be enough options to capture differences in responses of hospitals. Second, three of the four procedures recommended for heart attack are instructional, the only procedure involving medication being the administering of ACE Inhibitor or ARB for Left Ventricular Systolic Dysfunction. If the hospitals in our sample, in general, concentrated on treatment of patients rather than instruction, any quality differences among hospitals would not be captured by the heart failure measure.

The findings for quality as measured by treatment of patients with pneumonia are displayed in Table 4. These results are similar to the results for the heart failure measure, with insignificant F statistics and low adjusted R squares. Moreover, none of the independent variables is significant.

The most likely explanation for these results is that the prescribed procedures for patients with pneumonia are relatively routine and implemented by all hospitals. If this were so, there would be insufficient variation among hospitals in the average quality score for the pneumonia procedures for the scores to be explained by the independent variables in the model. What gives credence to this explanation is the low coefficient of variation for the quality score associated with the pneumonia procedure. Table 1 reveals that the coefficient of variation for the pneumonia procedure score is (.11/.75) = .15. This is approximately equal to one half of the coefficient of variation for the quality score associated with the heart attack procedures, (.18/.61) = .30.

4. Conclusion

This paper has used three indicators of quality suggested by the Center for Medicare and Medicaid Services to examine factors leading to differentials in quality of hospital care. We found that we could explain hospital quality by the number of beds, the number of employees per bed, hospital financial performance, and whether the hospital was urban or rural. However, these variables were significant for only one measure of quality, procedures implemented in case of heart attack.

Although interesting, our results suggest more research is needed concerning the determinants of hospital quality. Two ways of expanding our model come to mind. First, additional independent variables, including the cost of providing hospital services should be added to the model. Second, the sample size should be increased. In lieu of this, we hope that the present research has stimulated the reader's interest in the subject.

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Table 1: Summary Statistics

Variable	No. Obs	Mean	Std. Dev.	Min	Max
Rate1	89.00	0.61	0.18	0.13	0.95
Rate2	89.00	0.71	0.18	0.00	1.00
Rate3	89.00	0.75	0.11	0.31	0.94
Beds	89.00	151.93	149.60	20.00	847.00
EmpB	89.00	3.75	1.54	0.00	8.00
Revemp	88.00	392449.40	287660.80	105763.80	2229976.00
Incemp	88.00	-4956.88	19792.44	-95584.77	36525.08
Margin	89.00	-0.03	0.09	-0.77	0.11

Table 2: Regressions for Heart Attack Procedures

Performance Measure Revemp

F(4, 83) = 21.03
Prob > F = 0.0000
Adj R squared = 0.4794

	Coef.	Std. Err.	t	P> t
Beds	0.0004012	0.0001098	3.654	0
EmpB	0.0336348	0.0104411	3.221	0.002
Revemp	1.36E-07	5.52E-08	2.462	0.016
Urb	0.0838231	0.0328227	2.554	0.012
Constant	0.315236	0.046747	6.743	0

Performance Measure Incemp

F(4, 83) = 19.77
Prob > F = 0.0000
Adj R squared = 0.4633

	Coef.	Std. Err.	t	P> t
Beds	0.0004782	0.0001072	4.462	0
EmpB	0.0230696	0.0098793	2.335	0.022
Incemp	1.30E-06	7.09E-07	1.837	0.07
Urb	0.1033999	0.0322146	3.21	0.002
Constant	0.3916861	0.0395039	9.915	0

Performance Measure Margin

F(4, 84) = 19.08
Prob > F = 0.0000
Adj R squared = 0.4512

	Coef.	Std. Err.	t	P> t
Beds	0.0004699	0.0001085	4.33	0
EmpB	0.0238103	0.0096842	2.459	0.016
Margin	0.1235175	0.1496651	0.825	0.412
Urb	0.1050027	0.0324983	3.231	0.002
Constant	0.3863961	0.0379344	10.186	0

Table 3: Regressions for Congestive Heart Failure Procedures

Performance Measure Revemp

F(4, 83) = 1.58
Prob > F = 0.1871
Adj R-squared = 0.0260

	Coef.	Std. Err.	t	P> t
Beds	0.0002278	0.0001496	1.523	0.132
EmpB	0.0074493	0.0142265	0.524	0.602
Revemp	8.98E-08	7.52E-08	1.194	0.236
Urb	-0.01607	-0.0447223	0.359	0.72
Constant	0.6170259	0.0636948	9.687	0

Performance Measure Incemp

F(4, 83) = 1.26
Prob > F = 0.2906
Adj R-squared = 0.0120

	Coef.	Std. Err.	t	P> t
Beds	0.000276	0.0001448	1.906	0.06
EmpB	0.0016002	0.0133512	0.12	0.905
Incemp	-4.61E-07	-9.58E-07	0.481	0.632
Urb	-0.0019014	-0.0435359	0.044	0.965
Constant	0.656398	0.053387	2.295	0

Performance Measure Margin

F(4, 84) = 1.27
Prob > F = 0.2878
Adj R-squared = 0.0122

	Coef.	Std. Err.	t	P> t
Beds	0.0002815	0.0001443	1.951	0.054
EmpB	0.0008591	0.012879	0.067	0.947
Margin	-0.0853153	-0.1990392	0.429	0.669
Urb	-0.0031385	-0.0432195	0.073	0.942
Constant	0.6592252	0.0504488	3.067	0

Table 4: Regressions for Pneumonia Procedures

Performance Measure Revemp

F(4, 83) = 0.93
Prob > F = 0.4524
Adj Rsquared = 0.0034

	Coef.	Std. Err.	t	P> t
Beds	0.0000426	0.0000947	0.449	0.654
EmpB	0.0104676	0.009009	1.162	0.249
Revemp	2.78E-08	4.76E-08	0.584	0.56
Urb	0.0118149	0.0283207	0.417	0.678
Constant	0.6878263	0.0403352	17.053	0

Performance Measure Incemp

F(4, 83) = 0.84
Prob > F = 0.5041
Adj Rsquared = 0.0074

	Coef.	Std. Err.	t	P> t
Beds	0.0000577	0.0000913	0.632	0.529
EmpB	0.0085677	0.0084117	1.019	0.311
Incemp	4.08E-08	6.04E-07	0.068	0.946
Urb	0.0161106	0.027429	0.587	0.559
Constant	0.7008871	0.0336355	20.838	0

Performance Measure Margin

F(4, 84) = 0.86
Prob > F = 0.4918
Adj Rsquared = 0.0064

	Coef.	Std. Err.	t	P> t
Beds	0.0000546	0.0000911	0.6	0.55
EmpB	0.006785	0.0081272	0.835	0.406
Margin	0.1048813	0.125602	0.835	0.406
Urb	0.0151392	0.0272733	0.555	0.58
Constant	0.7128617	0.0318353	22.392	0

Procedures Used in Defining Quality

Measure: Heart Attack

Condition
Patients Given Aspirin at Arrival
Patients Given Aspirin at Discharge
Patients Given ACE Inhibitor or ARB for Left Ventricular Systolic Dysfunction (LVSD)
Patients Given Beta Blocker at Discharge
Patients Given Beta Blocker at Arrival
Patients Given Smoking Cessation Advice/Counseling
Patients Given Thrombolytic Medication Within 30 Minutes Of Arrival
Patients Given PCI Within 120 Minutes Of Arrival

Measure: Heart Failure

Condition
Patients Given Assessment of Left Ventricular Function (LVF)
Patients Given ACE Inhibitor or ARB for Left Ventricular Systolic Dysfunction (LVSD)
Patients Given Discharge Instructions
Patients Given Smoking Cessation Advice/Counseling

Measure: Pneumonia

Condition
Patients Given Oxygenation Assessment
Patients Assessed and Given Pneumococcal Vaccination
Patients Given Initial Antibiotic(s) within 4 Hours After Arrival
Patients Having a Blood Culture Performed Prior to First Antibiotic Received in Hospital
Patients Given Smoking Cessation Advice/Counseling
Patients Given the Most Appropriate Initial Antibiotic(s)

Appendix B
Variables

Rate1 = average quality rating for heart attack procedures

Rate2 = average quality rating for heart failure procedure

Rate3 = average quality rating for pneumonia procedure

Beds = total facility beds

Emp = total facility employees

EmpB = Emp/Beds

Revenue = total facility revenue

Revemp = Revenue/Emp

Inc = patient operating income

Incemp = Inc/Emp

Margin = Inc/Revenue

UR = 1 if urban, 0 if rural