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Association between organizational factors and quality of care: an examination of hospital performance indicators

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ASSOCIATION BETWEEN ORGANIZATIONAL FACTORS AND QUALITY OF CARE: AN EXAMINATION OF HOSPITAL PERFORMANCE INDICATORS

by

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An Abstract

Of a thesis submitted in partial fulfillment of the
requirements for the Doctor of Philosophy degree
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Thesis Supervisor: Professor Marcia M Ward

ABSTRACT

The recent reports by Institute of Medicine, 'To Err is Human' and 'Crossing Quality Chasm', revealed a large prevalence of medical errors and substandard care in US hospitals. Since then there has been a substantial increase in the efforts to measure and improve quality of care. The objective of this study was to compare the quality of care across hospitals using available performance indicators and examine the association between organizational factors and hospital performance. The main focus of this study was on important structural attributes of hospitals, namely – teaching status, location and market competition.

The Nationwide Inpatient Sample for years 2003 and 2005, and the State Inpatient Database for years 2004 to 2006 were used for analyses. Two types of hospital performance indicators were examined to compare quality of care - Patient safety indicators developed by Agency for Healthcare Research and Quality, and process of care indicators developed by Centers for Medicare and Medicaid services. Multivariable regression analyses were performed using generalized estimating equations and random effects regression models. Several organizational factors as well as patient characteristics were included in the multivariable models as control variables.

Overall, the results from this study showed an inconsistent relationship between teaching status, location of hospitals or market competition and quality of care in hospitals. In addition, the results demonstrated that isolating potential effects of hospital structure on outcomes requires controlling for the variation in patient characteristics, such as age and comorbidities, which increase patients' risk for incurring patient safety events. The findings from this study provide useful insight into the areas where the patient safety and quality initiatives should be focused. Moreover, the results identified the organizational factors that are relevant to certain types of hospitals and which should be considered before evaluating quality of care and enacting any policies about publicly reporting of performance or payment initiatives that are relevant to these hospitals.

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CERTIFICATE OF APPROVAL

PH. D. THESIS

This is to certify that the Ph. D. thesis of

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has been approved by the Examining Committee for the thesis requirement for the Doctor of Philosophy degree in Health Services and Policy at the December 2010 graduation.

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To
Aai, Baba, Avadhoot and Sanavi

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Assessing hospital performance has become increasingly important in response to growing demands from purchasers, providers, clinicians and the public. In the last 10 years, there has been a substantial increase in the projects and programs to assess performance of providers, especially hospital performance, and public reporting of it. The final goals of comparing hospitals and public reporting of their performances are to improve the quality of health care, as well as to benchmark it both internally and externally. Studies have shown that the quality of health care is variable and often inadequate.[1-4] Initiatives to measure quality are an important focus for policymakers who believe that measurement can drive quality-improvement programs and guide the choice of provider by consumers and payers.

There is a considerable interest among researchers to identify ways to improve care at the system level by improving the organizations that provide this care. Healthcare organizations are very complex organizations. In addition to their complex social structures and external interdependencies, they also coordinate the activities of a diverse workforce and many are in fact uniquely positioned to implement solutions that might lead to better care. It is important to understand the relationship between these organizational characteristics and provision of care to effectively modify these organizations to improve care. Literature has shown that organizational structure and processes surrounding clinical care delivery interact with clinical treatments to influence patient outcomes.[5] Understanding this interaction between organizational and clinical variables would allow designing care delivery systems that maximize positive patient outcomes. Despite the considerable literature on the relationship between organizational characteristics and quality of care, there are inconsistent results, making management and policy decisions a difficult endeavor.

Overview of literature on association between organizational characteristics and quality of care

The quality of care can be viewed from the perspectives of the structure of the health care delivery system, the operating processes within the system, and the outcomes of care.[6] In addition to IOM's definition of quality[3], quality of care is also defined as "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge".[7] This definition encompasses both clinical processes (e.g., provision of recommended services) as well as clinical outcomes of care (e.g., mortality, morbidity). Various measures such as mortality outcomes, adverse event rates, adherence to processes of care, volume threshold, performance indicators, and cost are used to measure quality. Evidence linking organizational characteristics to quality of care is ambiguous and still emerging.

One recent review compiled eighty-two studies that examined the association between organizational characteristics and quality of care.[8] The articles focused only on hospitals, the level of analysis was at the organizational level and the researchers used a broad conception of quality as the outcome variable. The results of this review indicated that many studies were predominantly focused on the organizational structure–quality outcome relationship. It also concluded that the association between organizational structural characteristics and quality of care showed mixed results.

In general, the existing literature shows that quality of care is consistently associated with structural variables like hospital size[9-12] and nurse staffing[13] whereas it is inconsistently associated with other structural variables like hospital teaching status[9,11,14-16], hospital ownership[10-12] and hospital location.[11,17]

Ayanian and colleagues compared quality of care for three common conditions – acute myocardial infarction, congestive heart failure and pneumonia at teaching and non-teaching hospitals using Medicare patient data for four states. When they examined the implicit and explicit scores of quality across these hospitals, they found that teaching hospitals provided overall better quality of care for CHF and pneumonia.[14] On the other hand, when Elixhauser and colleagues studied the relationship between volume, mortality, and associated hospital characteristics of ten complex procedures they found that teaching status of the hospital had no effect on mortality at these hospitals.[11]

In another study, researchers examined hospital mortality as a function of hospital characteristics, such as size, specialization, service intensity, teaching status, and ownership. The dependent variable was Health Care Financing Administration's mortality rate data for 1996. The results showed a spurious relationship between size, specialization and hospital mortality after controlling for organizational and county-level factors.[9] Additionally, it showed that higher utilization of hospital services is positively associated with mortality.

Joanna Jiang and colleagues examined the effect of hospital and market factors on hospital performance. The hospital performance was measured by ten mortality indicators from the AHRQ Inpatient Quality Indicators (IQIs). They constructed a composite score as the weighted average of all ten indicators, with weights equal to the proportion of patients for each individual condition or procedures thus controlling for differences in both case mix and severity of illness across hospitals. Market structure characteristics such as hospital competition and managed care penetration were included in the analysis along with a number of hospital structural variables, including size, ownership, location, teaching status, and system affiliation. The result from this study showed that the likelihood of being persistently in the low-mortality/low-cost quadrant was positively associated with the number of HMOs in the market, the percentage of Medicare patients, and patient volume but was negatively associated with the nurse staffing level.[18] Moreover, investor-owned hospitals or hospitals with system membership were more likely to be persistently in the low-mortality/low-cost quadrant over time. They found no significant market forces associated with performance improvement

In summary, examination of the literature suggests gaps in understanding the organizational contributions to hospital quality. In addition, the conceptual problems in the hospital level analysis of quality of care are related to the difficulty of identifying domains of hospital performance.

Overview of literature on association between organizational characteristics and patient safety

Patient safety is one of the six domains of quality. The recent publications by the Institute of Medicine (IOM), ‘To Err is Human’[19] and ‘Crossing the Quality Chasm’[3] have highlighted the importance of the organizational factors to address medical errors and patient safety. Non-mortality outcomes such as adverse or patient safety events are more directly related to hospital quality than mortality rates, in that they reflect the ability of physicians and support staff in providing care. There are two review articles which tried to address the linkage between organizational factors and patient safety.[20, 21]

In one of the reviews, researchers examined forty-two studies that studied organizational factors and patient safety.[21] They found that the most common dependent variable was teams and only four out of forty-two studies under consideration focused on structural factors. The results of this review concluded that there is little evidence for asserting the importance of any individual, group, or structural variable in error prevention or enhanced patient safety at the present time.

Another review that looked at eighty-one studies examined the relation among organizational structures or processes and mortality and adverse outcomes.[20] Even though the review examined mortality and adverse events as a function of organizational structural characteristics, the majority of studies were focused on adverse events. The review showed that organizational structural variables like size, ownership, location, teaching status, and staffing ratio had no consistent relation to mortality. Adverse events such as falls, medication errors, failure to rescue, and deficiency indices also showed a highly mixed relation when reported in multivariate analyses of structural characteristics of hospitals.[20]

Both the reviews concluded that organizational characteristics of hospitals affect patient safety; however, the current evidence is ambiguous on the relationship between particular hospital characteristics and patient safety. For example, patient safety is somewhat consistently related to nurse staffing.[13,22], but it is less consistently related to hospital size.[23] The same is true for volume[11,24], and teaching status.[25-27]

Hospital size is often used as a proxy for other hospital structural characteristics. The type and volume of services offered by the hospital, personnel availability, and presence of tertiary services differ by size. Different types of services contribute to different types of patient safety problems, thus adverse events likely vary by size. However, hospital size has shown inconsistent relationships to adverse event rates. One study showed that hospital size is directly proportional to adverse event rates - larger hospitals have higher adverse event rates whereas smaller hospitals have lower adverse event rates.[23] However other studies showed that hospital size has an opposite effect or no effect at all on adverse event rates.[28, 29] Another structural variable that directly affects patient outcomes but has shown an inconsistent relationship with patient outcomes is nurse staffing. Evidence shows that higher nurse staffing is often associated with fewer adverse events and lower mortality[13] but one study found a weak relationship between staffing and mortality.[30]

Other features that are frequently studied in relation to adverse event rates or patient safety events are hospital location and teaching status. A recent study by Rivard et al examined the impact of teaching status and location of the hospital on multiple patient safety outcomes while adjusting for patient characteristics such as age, presence of comorbidities, elective admissions and surgical DRGs. The results from this study showed that the presence of teaching programs, larger bed-size, and higher nurse staffing usually but not always had a positive association with patient safety indicators, signifying worse outcomes.[31]

However, five other studies that have examined patient safety or preventable adverse events as non-mortality outcomes in teaching and non-teaching hospitals found inconsistent results. Brennan and colleagues found that after adjusting for patients' age, race, severity of illness, hospital's location, and ownership, patients in major teaching hospitals were more likely to experience adverse events than those in non-teaching hospitals.[32] When Thomas and colleagues compared 15,000 hospital discharges to determine the association between preventable adverse events and hospital ownership they found lower rates of preventable adverse events in government-owned major teaching hospitals compared with minor or non-teaching government hospitals but the overall results were not statistically different.[33] In the third study, Romano and his colleagues reported US hospital trends for patient safety outcomes. Out of 20 provider level patient safety indicators, some were lower and some were at higher levels in urban teaching hospitals than urban or rural non-teaching hospitals, but no statistical analysis was performed for the results.[34]

In another study, using data from the 1990-1996 NIS, the results showed that major teaching hospitals have significantly lower rates for one but higher rates for two post-operative adverse events than other teaching and non-teaching hospitals.[35] The multivariable regression analysis was adjusted for hospital bed size, location, ownership, nurse staffing levels, primary payer for the patients and geographic region. A recent study that compared five AHRQ PSIs across different hospital types found that rates of post-operative hematoma/hemorrhage were higher for investor owned rural hospitals when compared with private rural hospitals. It also reported that hospital ownership, teaching status and location did not make any difference for post-operative respiratory failure after adjusting for hospital size, region and their interactions.[36] Thus out of five studies, one study favored teaching hospitals[32], two showed no significant difference[33,35], and two showed a mix of higher and lower patient safety indicators.[34, 36]

The same studies that compared patient safety outcomes across hospital teaching status examined the impact of hospital location on patient safety outcomes. Brennan and colleagues reviewed medical records to examine rates of adverse events in New York State hospitals. After controlling for patient age and severity of illness the researchers concluded that rural hospitals in upstate New York had significantly fewer adverse events than urban hospitals.[32] Romano and colleagues used risk-adjusted rates for 19 Patient Safety Indicators (PSIs) to compare urban and rural hospitals. They found that rural hospitals had the lowest overall PSI rates, while urban teaching hospitals had the highest rates, and nonteaching urban hospitals were in the middle.[36] Although these previous studies found lower adverse event rates in rural hospitals, their comparisons of hospitals relied on both location (urban/rural) and teaching status. They did not examine how patient safety varies among urban and rural hospitals based exclusively on location of hospitals.

In conclusion, the relationship between organizational characteristics and patient safety is still ambiguous. The findings from literature showed discrepancies involved in how organizational variables, when used as independent variables, are defined and operationalized across different studies. Furthermore, all these studies differed in their risk adjustment approaches, and had different variables controlled in multivariable analyses, and also had different structural units of analysis (units, departments or hospital) which may have resulted in these mixed results. At the end the researchers concluded that variations in mortality and complications are influenced by patient variables more than by organizational variables. Many of them agreed that isolating potential effects of structure on outcomes required controlling for variation in patient characteristics, such as age and comorbidities, which increase patients' risk for incurring mortality or complications.[31,36] Additionally, they suggested that adverse events may be a more sensitive marker of differences in organizational quality and safety in acute care hospitals. Clarifying the relationship between patient safety, quality and organizational characteristics could help improve patient safety and quality research as well as highlight organizational characteristics that are important and should be controlled for when comparing quality across these institutions. Additionally it will help to identify the types of facilities that are more likely to deliver safer care.

Study objectives

The literature has shown that there are theoretical and empirical reasons to believe that the relationship between organizational characteristics and quality of care differs across health care settings.[20,21] However the findings from previous studies suggest that despite recognition of the importance of organizations and the increase in research on the relationship between organizational characteristics and patient safety and quality of care, there is no clear conclusion. An exclusive focus on hospitals can control for these differences. Hence this dissertation will focus only on acute care hospitals and all analyses will be done at the organizational level.

The goal of this dissertation is to explore patient, organizational and market characteristics associated with superior hospital performance in terms of both patient safety and quality of care. It will explore the underlying mechanism for better patient safety outcomes as well as quality of care at these hospitals. Understanding the exact mechanism for better outcomes will help recognize the factors that differ between comparable acute care hospitals while developing hospital-relevant patient safety interventions at these hospitals. Additionally, it will help to identify quality improvement objectives that can be achieved by market approaches.

In order to realize this goal, this dissertation has following objectives that have not been adequately examined in the previous studies.

a. To examine the relationship between teaching status of hospitals and post-operative patient safety outcomes.
b. To examine the relationship between rural/urban location of hospitals and a number of patient safety outcomes that are relevant to all hospitals.
c. To explore the relationship between market competition and hospital structural factors on hospital process of care performance.

Selection of dependent measures

Quality and patient safety indicators that are based on existing data sources are one way to measure healthcare quality. They provide qualitative or quantitative information about the quality, patient safety and appropriateness of healthcare delivery. They can be used as a basis for self-improvement in quality improvement cycles, to inform policy and strategy making, to monitor performance of services, to empower consumers to help make decisions about their choice of health services, and also to identify poor performers.[37] Increasingly, they are providing the basis for financial incentives related to select health service parameters.

Patient safety indicators

Preventable adverse events are often preferred as outcome measures because they are more directly related to hospital quality than mortality. The Patient Safety Indicators (PSI) developed by the Agency for Healthcare Research and Quality (AHRQ) are such indicators of preventable adverse events.[38] These PSIs are a set of indicators providing information on potential in-hospital complications and adverse events following admissions, surgeries, procedures, and childbirth. The PSIs were developed after a comprehensive literature review, analysis of ICD-9-CM codes, review by a clinician panel, implementation of risk adjustment, and empirical analyses. The PSI software is designed to identify potential in-hospital patient safety problems using hospital discharge summaries. Specifically, PSIs screen for problems that patients experience as a result of exposure to the healthcare system and that are likely amenable to prevention by changes at the system or provider level. Each of the 20 -level provider PSIs indicates the rate of occurrence of a specific category of complications or adverse events. PSIs provide an overall measure of quality though it may be a less reliable measure of quality.

Centers for Medicare and Medicaid's (CMS) process of care measures

The CMS process measures will be used as a second set of measures to examine the association between organizational factors and quality of care. These process measures can be easily measured and are actionable to enhance hospital performance. CMS "core" measures show how often hospitals give recommended treatments to patients with certain medical conditions or surgical procedures. These core measures focus on all patients who have one of three important conditions (myocardial infarction, heart failure, and pneumonia) regardless of payer. Under Section 501 of the Medicare

Prescription Drug, Improvement and Modernization Act (MMA) of 2003 hospitals are encouraged to voluntarily report performance data on a set of ten “core measures”. The core measures include 10 process measures - 5 process measures for acute myocardial infarction (AMI), two process measures for congestive heart failure (CHF), and three process measures for pneumonia.

Conceptual model

The Donabedian model provides a conceptual framework for these three studies to examine the relationship among hospitals, their patient and environmental characteristics, and their performances. Donabedian conceptualized that quality of care can be measured in three dimensions – structure, process and outcomes.[39] Structure measures include administrative and related processes that support and direct the provision of care as well as the physical characteristics of the healthcare system. Structural characteristics are considered necessary but not sufficient elements in the delivery of health services and are typically considered indirect measures of quality. In other words, their presence enables the provision of quality health services but does not ensure it, whereas the absence of these structural characteristics decreases the probability of quality outcomes.[8]

Process measures tell us whether ‘good’ medical care has been applied and outcome measures indicate the impact of care on health status. According to Scott, organizational processes are the activities undertaken by an organization in pursuit of its objectives.[40] They are considered more proximal indicators of quality than structural characteristics because they are the actual activities performed by an organization. Process measures can be more sensitive in detecting differences in quality between hospitals and are particularly useful when they have been demonstrated to affect outcomes. However, like structural characteristics, they do not guarantee a quality outcome; they can only increase its probability.

This dissertation will use all three components of the Donabedian Model to examine patient safety and quality of care at US hospitals. According to the Donabedian paradigm, structural characteristics of hospitals influence outcomes through processes of care.[39] Thus, outcomes show a combined effect of processes and structure, and are considered as the ultimate measures of the effectiveness and quality of medical care. Additionally, outcome measures such as preventable adverse events are more directly related to hospital quality than mortality rates, in that they reflect the ability of physicians and support staff in providing care. The AHRQ patient safety indicators (PSI) are such outcome measures which reflect quality of care inside hospitals, and focus on potentially avoidable complications and iatrogenic events.

The first two studies of this dissertation use AHRQ PSIs to examine hospital performances as well as to examine the relationship between structure and outcome measures at these hospitals. They focus primarily on teaching status and location of hospitals. Within the structure–process–outcome framework, adverse events or patient safety outcomes indicate possible antecedent process failures; those process failures may in turn be associated with structural characteristics.[41] Additionally, adverse events are associated with other outcomes of care, including patient outcomes (e.g., morbidities and mortality) and system outcomes, including LOS and cost.

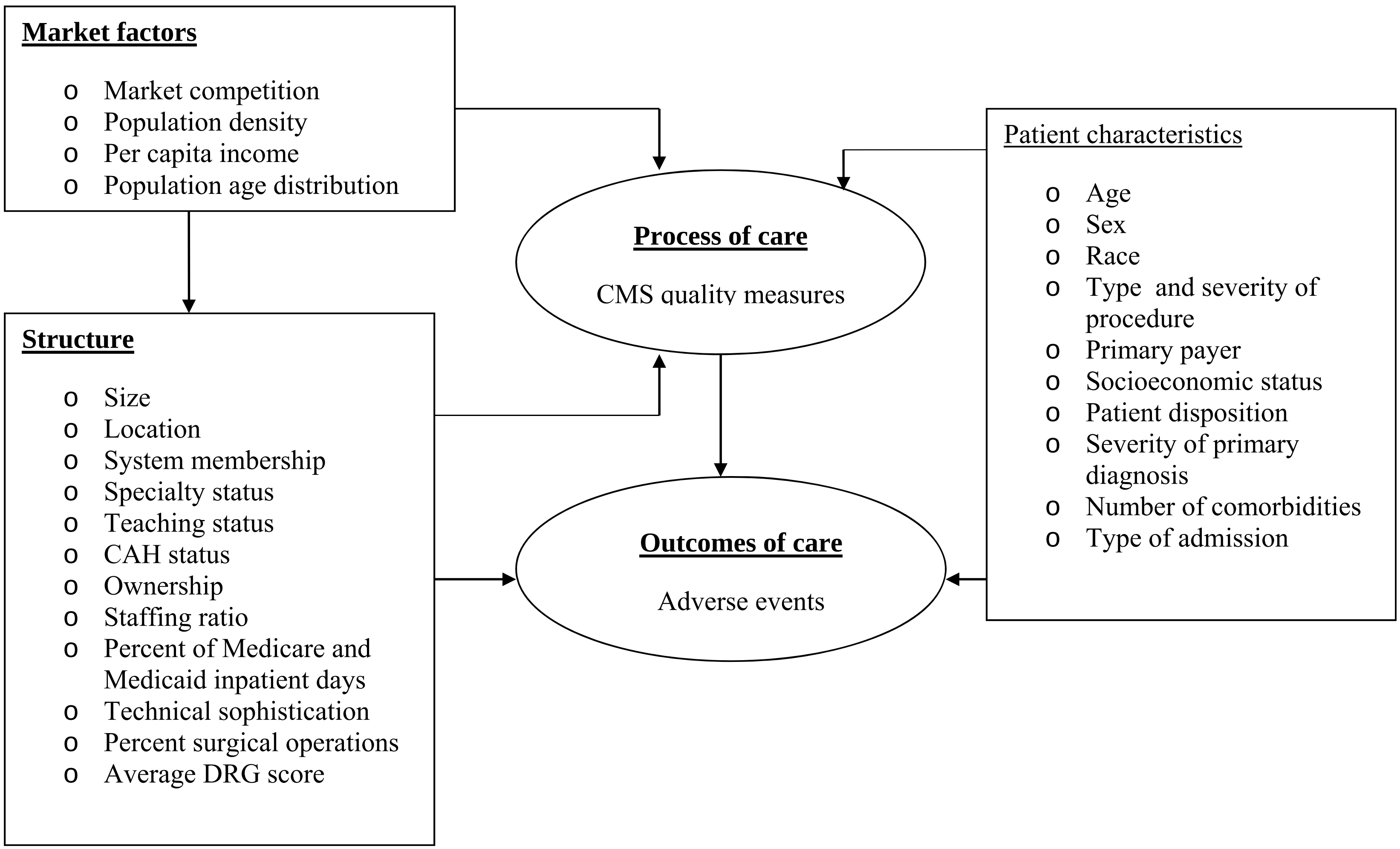
The first study of this dissertation explores an important component of structure, the relationship between teaching status of hospitals and post-operative patient safety outcomes and examines the patient and hospital factors associated with outcomes. Studies that have examined mortality and non-mortality outcomes at teaching and non-teaching hospitals have shown mixed results. Two reviews have examined quality of care at teaching and non-teaching hospitals.[26,27] They observed advantages for teaching hospitals in studies that examined mortality rates, but found mixed results in studies that examined non-mortality outcomes. Five studies[32-36] that examined patient safety or preventable adverse events found inconsistent results across teaching and non-teaching hospitals.

Another structural feature that distinguishes hospitals from each other and influences quality of care is the location of hospitals. Studies comparing quality of care in urban and rural hospitals are limited and those that exist have produced mixed results.[42-45] Rural and urban hospitals differ considerably in their organizational and service mix characteristics.[46-48] Additionally, many available patient safety metrics are not appropriate for rural or small hospitals because these hospitals do not have sufficient patient volume or do not provide certain services.[49] The second study explores the relationship between location of hospitals and a number of relevant patient safety outcomes. Further, it examines the differences in patient and hospital characteristics at urban and rural hospitals and investigates the role these factors play in the patient safety outcomes at these hospitals.

Even though the first two studies have focused on outcome measures, process measures have their own advantages. They are ‘‘the actual delivery and receipt of care’’ or the activities supporting the delivery and receipt of care. Many times outcome measures are noisy especially for low-volume hospitals and they need to be adjusted for differences in the case-mix of hospitals. On the other hand, process measures are easily measured and are actionable to enhance hospital performance. CMS "core" measures are such process measures which show how often hospitals give recommended treatments to patients with certain medical conditions or surgical procedures.

The third study of this dissertation focused on examining the relationship between CMS process of care measures and structural and market characteristics of hospitals. More importantly it will examine the impact of market competition on quality of care. Even though it has been shown that market competition influences quality of care[50, 51] none of the reviews that examined the association between organizational characteristics and patient safety or quality included the "environmental" level of analysis, which includes factors such as external regulation, resource availability, and level of market competition. Studies that have examined the relationship between competition and quality are often limited to insurance markets and focus both on inpatient cost and quality. This third study focuses on hospital markets and the impact they have on CMS process measures. Understanding whether competition drives quality improvement is crucial for assessing whether quality improvement objectives can be achieved by market approaches. Figure 1.1, shows the conceptual framework for these dissertation studies.

Figure 1.1 – Conceptual framework based on Donabedian Model



CHAPTER II

ASSOCIATION BETWEEN HOSPITAL TEACHING STATUS AND PATIENT SAFETY OUTCOMES

Introduction

Teaching hospitals play a major role in the US healthcare delivery system and claim to provide better quality care than non-teaching hospitals. Two recent literature reviews summarize a number of studies examining this claim.[26,27] Both reviews observed advantages for teaching hospitals in studies of mortality rates, but found mixed results in studies that examined non-mortality outcomes. Mortality rates are highly affected by risk adjustment approaches and are often criticized as poor indicators of hospital quality. Outcome measures such as preventable adverse events are more directly related to hospital quality than mortality rates, in that they better reflect the care provided. Five studies [32-36] have examined patient safety or preventable adverse events and found inconsistent results across teaching and non-teaching hospitals. The current analysis explores the relationship between hospital teaching status and post-operative complications and examines the patient and hospital factors associated with post-operative outcomes. Understanding the role that hospital and patient factors play in patient safety in teaching and non-teaching hospitals could help to guide efforts to improve quality in both types of hospitals.

Methods

Data Source

The Agency for Healthcare Research and Quality (AHRQ) 2003 Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample (NIS) was used for all analyses.[52] NIS includes all hospital discharge abstracts from a 20% stratified probability sample of nonfederal hospitals in 37 states. American Hospital Association's (AHA) Annual Survey data were linked for hospital-specific information.

Patient Safety Indicators

AHRQ developed Patient Safety Indicator (PSI) software to identify potential in-hospital patient safety problems using hospital discharge summaries.[53] The current analysis focuses on six PSIs that capture post-surgical complications. These PSIs were chosen because: 1) they are relatively common; 2) our analysis showed consistencies in their national average rates across three consecutive years; 3) surgical procedures are an important component of the training mission at teaching hospitals; and 4) these PSIs are associated with routine post-operative processes of care that are relatively attributable to delivery of inpatient care. The specific PSIs analyzed were post-operative hip fracture (PSI-08), post-operative hematoma or hemorrhage (PSI-09), post-operative physio-metabolic derangement (PSI-10), post-operative respiratory failure (PSI-11), post-operative pulmonary embolism or deep vein thrombosis (PSI-12), and post-operative sepsis (PSI-13). Table 2.1 provides definitions for each PSI.

Variable Definitions

Teaching Status

Following previous studies [34,14, 54-56] major teaching hospitals were defined as members of the Council of Teaching Hospitals (COTH).[57] Minor teaching hospitals were defined as non-COTH members having resident-to-bed ratios above 0 and a Council of Graduate Medical Education approved residency training program, medical school affiliation reported to the American Medical Association, or having an internship or residency program approved by the American Osteopathic Association. Non-teaching hospitals were defined as non-COTH hospitals with resident-to-bed ratio = 0.

Hospital-level Characteristics

Hospital-level variables included were the RN-to-bed ratio, resident-to-bed ratio, location, average DRG weight, and bedsize. All the patient safety indicators focused on post-surgical complications; hence a hospital-level variable for the relative volume of surgeries (percent of total inpatient admissions that were surgical) was included. The literature suggests that teaching hospitals treat sicker patients. To examine this, the average DRG weight across all-payer cases in each hospital was included in the analysis as a hospital-level index of case mix. Hospital ownership was not included because it was highly correlated with teaching status.

Patient-level Characteristics

Patient age, sex, source of admission, primary expected payer, and median income from patients' zip codes were included to adjust for patient characteristics including socioeconomic status. Patients' race was not included because 33% of the cases were missing that variable.

Two patient-level variables were included to adjust for case mix – Charlson's co-morbidity score [58] and a reassigned surgical DRG weight. The Charlson score encompasses 19 categories of co-morbidities with the overall score reflecting the burden of co-morbidities. DRG weights were reassigned to capture the complexity of surgical procedures; so, if a patient had a DRG with complications or co-morbidities then he/she was reassigned the paired DRG weight without complications or co-morbidities. This permitted the DRG weight to reflect the complexity of the primary surgical procedure independent of patient co-morbidities or whether complications occurred.

Statistical Analysis

The incidences of post-surgical complications were estimated using AHRQ PSI software (Version 3.0, February 2006).[53] The purpose of this analysis was to determine if the occurrence of PSIs varied by hospital teaching status, so the unit of analysis was the patient. The association between hospital teaching status and patient and hospital characteristics was examined using one-way ANOVA for continuous variables and Pearson chi-square test for categorical variables. Generalized estimating equation (GEE) regression models were used for multivariable analysis to adjust for clustering of patients within hospitals using logit link. Correlations among variables were examined to select relatively independent variables for inclusion in multivariable models.

Results

Out of 994 hospitals in the 2003 NIS, 646 had sufficient data to permit classification into the three teaching status categories - non-teaching (N=400), minor teaching (N=207) and major teaching (N=39). Analysis showed that those 348 hospitals that could not be classified due to missing data were not significantly different from the 646 hospitals included in the study in their risk-adjusted PSI rates but were different in their patient and hospital characteristics (Table 2.2). Bivariate analyses showed statistically significant differences in most patient and hospital characteristics by teaching status (shown in Tables 2.3 and 2.4).

Major teaching hospitals had significantly higher observed rates for all PSIs except for PSI-08 compared to both minor teaching and non-teaching hospitals. Minor teaching hospitals had significantly higher observed rates of PSI-12 and PSI-13 than non-teaching hospitals. Multivariable analyses indicated that patients in major teaching hospitals had higher odds for PSI-12 and PSI-13 and lower odds for PSI-11 after adjusting for patient and hospital characteristics. Minor teaching hospitals were not significantly different from non-teaching hospitals for any PSIs when hospital and patient variables were included in the models.

As shown in Table 2.5, the multivariable analysis demonstrated the importance of adjusting for important patient and hospital characteristics by revealing that many of these characteristics were related to the PSI rates. In particular, patients with more extensive surgical procedures (reflected by the reassigned DRG weight) had higher rates of all six post-operative complications. Similarly, patients with higher Charlson co-morbidity scores had higher odds for all PSIs other than PSI-12. Older patients had significantly higher odds for PSI-08, PSI-11 and PSI-12. Patients with private insurance had significantly lower odds for all PSIs. Female patients had lower odds for PSI-09, PSI-10, PSI-11, and PSI-13. For three PSIs where admission source is relevant, transfer and emergency cases were positively related to PSI-08 and PSI-12; whereas emergency cases were negatively related to PSI-09. Examining hospital characteristics, larger hospitals had higher rates for PSI-10, PSI-11 and PSI-12. Rural hospitals had lower odds for PSI-12 and PSI-13. RN-to-bed ratio was negatively related to PSI-13 but, surprisingly, positively related to PSI-09.

To further explore whether differences in post-surgical complication rates were due to different characteristics of the hospitals or because of the different patient populations they serve, multivariable regression analyses were performed for hospital variables and for patient-level variables separately (Table 2. 6). The results showed that teaching status was significant for PSI-12 in both the models, which was consistent with the final multivariable model containing all variables and with the bivariate model. In contrast, for PSI-11 and PSI-13 the final multivariable model containing all variables was significant, but none of the multivariable models containing just the hospital characteristics or just the patient characteristics were significant.

Discussion

The current analysis examined differences in post-surgical complications in major, minor, and non-teaching hospitals. Although an extensive empirical literature exists examining the effect of hospital teaching status on various outcomes, the current research used a national sample of patients, is more comprehensive in its adjustment approach, and analyzed multiple common post-surgical complications - outcome indicators that may more closely reflect quality of care and which had previously led to inconsistent results.

In bivariate models, major teaching status of the hospitals was associated with higher rates for all PSIs except for PSI-08. This PSI had considerably lower incidence than the other PSIs and may have been too rare to differentiate between types of hospitals.

Three types of multivariable models - one for only hospital characteristics, a second for only patient characteristics, and a third adjusting for both hospital and patient characteristics were used to identify complex relationships affecting differences in patient safety events by teaching status. Comparing these three models to the bivariate results indicated that for three of the PSIs (PSI-08, PSI-09 and PSI-10) teaching status was no longer significant after adjusting for either hospital or patient characteristics. These findings suggest that differences in the occurrence of most types of post-operative complications observed in simple bivariate analyses are probably the result of substantial differences in hospital characteristics and patient characteristics between major, minor, and non-teaching hospitals. The results indicate that major teaching hospitals have higher rates of post-operative complications, most likely because they do more complicated surgeries on patients who have more comorbidities. Likewise, teaching hospitals tend to be larger and are more likely to be located in urban areas, and have structural characteristics that have been associated with higher rates of post-operative complications. Thus, after adjusting for all hospital and patient characteristics, three of the significant bivariate results disappeared. However, three significant results remained – major teaching hospitals had higher rates of PSI-12 [34] and PSI-13 and significantly lower rates of PSI-11. Because the final multivariable models adjusted for a sizable number of hospital and patient characteristics, the significant relationships are likely attributable to differences related to the teaching status of hospitals. The lower rates of PSI-11 at major teaching hospitals may reflect these hospitals' potential to have sophisticated respiratory therapy programs for identifying and treating these complications aggressively.

The primary limitation of this analysis was the use of administrative data. Less complete recording practices, and uneven use of ICD-9-CM codes to record diagnoses, can lead to imprecise calculations of severity of illness.[59,60] To examine possible coding bias, the mean numbers of diagnoses were compared but no significant differences were found across teaching status.[61] Post-operative PSIs are calculated across a heterogeneous sample of patients, irrespective of patient-specific clinical conditions. The effect of teaching status on patient outcomes for different clinical conditions was not examined, but could be in subsequent studies. Data was unavailable on potentially important confounders such as patients' use of various services within the hospital, the severity of patients upon admission and throughout their stay, patient preferences, patients' access to care, experience of surgeons, individual surgeon's volume, and market competition.

The strength of this analysis was the broad national sample of hospitals, inclusion of multiple outcomes measures, and adjustments for relevant hospital and patient characteristics including case mix. Thus, the current findings add to the mixture of results from the five methodologically diverse studies currently in the literature [32-36] and enrich the ongoing debate about the quality of care and patient safety in teaching hospitals.

The results show that some PSI event rates vary according to teaching status. In particular, multivariable analyses suggest a strong relationship between teaching status and both PSI-12 and PSI-13. Evidence-based practice guidelines are available that should be followed to prevent these post-operative complications. Major teaching hospitals, in particular, should examine their processes to assure adherence to national guidelines and best practices.

The results confirm that teaching hospitals perform more complicated procedures and treat sicker patients. While these patient characteristics cannot and should not be changed, teaching hospitals may reduce post-operative complications by better assessing the risk for each patient and applying appropriate preventive measures. One other implication of the current findings for the complex relationship among hospital and patient characteristics is apropos to emerging pay-for-performance initiatives. Such initiatives must carefully take multiple patient characteristics along with hospital structure into consideration so that incentives fairly reward appropriate quality indicators. As shown here, outcome measures such as post-operative complications are often related more to patient characteristics than to hospitals' processes of care. Nonetheless, further examination of hospital characteristics will enrich our understanding of how best to improve patient care.

Table 2.1 – Definition of AHRQ defined post-surgical Patient Safety Indicators.

PSI	Definition	Numerator	Denominator	Key exclusions
Post-operative hip fracture (PSI-08)	Cases of in-hospital hip fracture per 1,000 surgical discharges with an operating room procedure	Discharges with ICD-9-CM code for hip fracture in any secondary diagnosis field	All surgical discharges age 18 years and older defined by specific DRGs and an ICD-9-CM code for an operating room procedure	Patients where the only operating room procedure is hip fracture repair, where the procedure for hip fracture repair occurs before or on the same day as operating room procedure, with principal diagnosis codes for seizure, syncope, stroke, coma, cardiac arrest, poisoning, trauma, delirium and other psychoses, or anoxic brain injury, MDC 8, metastatic cancer, lymphoid malignancy, bone malignancy or self-inflicted injury, MDC 14
Post-operative hemorrhage or hematoma (PSI-09)	Cases of hematoma or hemorrhage requiring a procedure per 1,000 surgical discharges with an operating room procedure	Discharges with ICD-9-CM codes for post-op hemorrhage or hematoma in secondary diagnosis field and code for post-op control of hemorrhage or drain of hematoma in any procedure code field	All surgical discharges age 18 years and older defined by specific DRGs and an ICD-9-CM code for an operating room procedure	Patients where the only operating room procedure is postoperative control of hemorrhage or drainage of hematoma, procedure for post-op control of hemorrhage or drainage of hematoma occurs before the first operating procedure, MDC 14

Table 2.1 – continued

PSI	Definition	Numerator	Denominator	Key exclusions
Post-operative physiologic and metabolic derangement (PSI-10)	Cases of specified physiological or metabolic derangements per 1,000 elective surgical discharges with an operating room procedure	Discharges with ICD-9-CM codes for post-op physiologic and metabolic derangements in secondary diagnosis field. Discharges with acute renal failure must be accompanied by dialysis.	All elective surgical discharges age 18 years and older defined by specific DRGs and an ICD-9-CM code for an operating room procedure	ICD-9-CM for chronic renal failure, Acute renal failure without diaglysis before or same day as operating room procedure, ketoacidosis, hyperosmolarity, coma, and principal diagnosis of (MI, cardiac arrhythmias, cardiac arrest, shock, or hemorrhage), MDC 14
Post-operative respiratory failure (PSI-11)	Acute respiratory failure per 1,000 elective surgical discharges with an operating room procedure	Discharges with ICD-9-CM codes of 518.81, 518.84 in any secondary diagnosis field or ICD-9-CM procedure codes for postoperative reintubation procedure based on number of days after the major operating procedure code: 96.04 ≥1 day, 96.70 or 96.71 ≥2 days, or 96.72 ≥0 days	All elective surgical discharges age 18 years and older defined by specific DRGs and an ICD-9-CM code for an operating room procedure	ICD-9-CM of neuromuscular disorder, Tracheostomy is the only operating room procedure, MDC 4, MDC5, and MDC14

Table 2.1- continued

PSI	Definition	Numerator	Denominator	Key exclusions
Post-operative pulmonary embolism or deep vein thrombosis (PSI-12)	Cases of pulmonary embolism or deep vein thrombosis per 1,000 elective surgical discharges with an operating room procedure	Discharges with ICD-9-CM codes for PE or DVT in any secondary diagnosis field	All surgical discharges age 18 years and older defined by specific DRGs and an ICD-9-CM code for an operating room procedure	Procedure for interruption of vena cava before or on same day as the first operating procedure, MDC 14
Post-operative sepsis (PSI-13)	Cases of sepsis per 1,000 elective surgery patients with an operating room procedure and LOS > 4 days or more	Discharges with ICD-9-CM code for sepsis in any secondary diagnosis field	All elective surgical discharges age 18 years and older defined by specific DRGs and an ICD-9-CM code for an operating room procedure	Principal diagnosis of infection, any code of immune-compromised state, or cancer, LOS < 4 days, MDC 14

Table 2.2 - Comparison of missing and non-missing hospital

Variables	**Missing Hospitals N=348**	**Non-missing hospitals N=646**
	Mean (SD)	**Mean (SD)**
Risk-adjusted rate for PSI-08	0.0002(0.0008)	0.0002(0.0011)
Risk-adjusted rate for PSI-09	0.0018(0.0034)	0.0018(0.0025)
Risk-adjusted rate for PSI-10	0.0008(0.0036)	0.0007(0.002)
Risk-adjusted rate for PSI-11	0.0063(0.0081)	0.0074(0.0131)
Risk-adjusted rate for PSI-12	0.0085(0.0298)	0.0069(0.0075)
Risk-adjusted rate for PSI-13	0.0108(0.0303)	0.0084(0.0125)
Age**	59.58 (17.3)	58.8 (16.88)
Surgical Procedure DRG weight for each patient**	3.59 (1.37)	3.52 (1.34)
Median household income quartile from patient’s zip code **	2.35 (1.09)	2.54 (1.08)
	N	**N**
Observed rate for PSI-08 per 1000 cases	0.3	0.3
Observed rate for PSI-09 per 1000 cases	2.1	2.2
Observed rate for PSI-10 per 1000 cases*	1.02	1.2
Observed rate for PSI-11 per 1000 cases*	8.9	9.4
Observed rate for PSI-12 per 1000 cases**	9	10.2
Observed rate for PSI-13 per 1000 cases	10.5	10.5
Hospital bed size*		
Small	154	225
Medium	88	197
Large	105	224
Hospital Control**		
0	84	255
1	93	108
2	65	127
3	58	67
4	47	89
Hospital location*		
Rural	176	267
Urban	171	379
	%	**%**
Sex**		
Male	30.24	69.44
Female	30.56	69.76

Table 2.2 – continued

Variables	**Missing Hospitals N=348**	**Non-missing hospitals N=646**
	%	**%**
Charlson comorbidty score**		
0	30.29	69.71
1	30.97	69.03
>= 2	30.06	69.94
Primary Payer**		
Medicare	30.57	69.43
Medicaid	27.9	72.1
Private	30.6	69.4
Other	30.63	69.37
Admission Source**		
Routine	31.04	68.96
Emergency	28.82	71.18
Facility	30.29	69.71

Note - * - significant at 0.05, **- significant at <0.0001

Table 2.3 – Hospital-level characteristics*

Variables	Non-Teaching N=400	Minor Teaching N=207	Major Teaching N=39
Observed rate for PSI-08 per 1000 cases	0.25	0.28	0.27
Observed rate for PSI-09 per 1000 cases	2.01	2.09	2.54
Observed rate for PSI-10 per 1000 cases	0.9	1.07	1.82
Observed rate for PSI-11 per 1000 cases	8.09	8.21	13.26
Observed rate for PSI-12 per 1000 cases	7.3	8.94	16.35
Observed rate for PSI-13 per 1000 cases	8.76	10.83	11.94
	Mean (SD)	**Mean (SD)**	**Mean (SD)**
Resident-to-bed ratio	0 (0)	0.06 (0.13)	0.37 (0.36)
RN-to-bed ratio	1.03 (0.57)	1.24 (0.51)	1.78 (0.72)
Surgical admissions as % of total	29.49 (10.78)	30.04 (8.57)	35.1 (10.09)
DRG weight to capture case mix	1.13 (0.19)	1.22 (0.25)	1.49 (0.29)
Hospital bed size	107(92.6)	253.36 (172.19)	567.92 (390.94)
	%	**%**	**%**
Hospital location			
Rural	59.5	13.04	5.12
Urban	40.5	86.95	94.87

Note - * - All variables are significant at <0.0001

Table 2.4 – Patient-level Characteristics[*]

Variables	**Non-Teaching Patient N = 352137 %= 29.42**	**Minor Teaching Patient N= 556067 %= 46.46**	**Major Teaching Patient N = 288608 %= 24.11**
	Mean (SD)	**Mean (SD)**	**Mean (SD)**
Age	60.17 (17.71)	59.67 (17.47)	57.53 (17.10)
Median income from patient's zip code	2.48 (1.05)	2.61 (1.07)	2.50 (1.13)
Surgical Procedure DRG weight for each patient	3.26 (1.14)	3.43 (1.30)	3.69 (1.44)
	%	**%**	**%**
Hospital location			
Rural	23.28	3.76	2.08
Urban	76.72	96.24	97.92
Hospital Bed Size			
0-99	19.21	1.29	0
100-199	28.43	19.66	4.16
200-299	26.89	20.39	7.07
300-399	22.82	25	9.37
>=400	2.64	33.66	79.41
Admission Source			
Emergency	31.85	30.41	23.26
Transfers	2.72	4.86	8.46
Routine	64.88	64.71	68.27
Primary Payer			
Medicare	46.43	44.11	40.03
Medicaid	5.66	6.54	8.88
Private, Including HMO	39.88	41.36	42.95
Other	8.04	7.99	8.15
Sex			
Male	42.2	45.66	49.5
Female	57.8	54.34	50.5
Charlson Co-morbidity Index			
0	59.16	57.83	55.68
1	22.99	23.54	23.62
> = 2	17.83	18.62	20.68

Note - * - All variables are significant at <0.0001

Table 2.5 - Final Multivariable Model [OR (CI)]

Predictors	Post-op Hip Fracture (PSI-08)	Post-op Hematoma/ Hemorrhage (PSI-09)
Teaching status		
Non teach	Reference	Reference
Minor teach	1.07 (0.72-1.57)	1.01 (0.86-1.17)
Major teach	1.26 (0.73-2.17)	1.01 (0.79-1.27)
Hospital location		
Urban	Reference	Reference
Rural	0.83 (0.47-1.48)	0.99 (0.80-1.23)
# of Staffed beds		
0-99	Reference	Reference
100-199	1.95 (0.84-4.53)	1.02 (0.79-1.31)
200-299	1.51 (0.63-3.61)	1.12 (0.87-1.45)
300-399	1.36 (0.57-3.24)	1.03 (0.79-1.33)
>400	1.49 (0.61-3.67)	1.16 (0.87-1.55)
% surgical admissions	0.98 (0.97-1.01) [1]	0.99 (0.99-1.01)
RN-to-bed ratio	0.83 (0.61-1.13) [1]	1.16 (1.03-1.32) [*, 1]
DRG weight to capture hospital case mix	1.31 (0.88-1.95) [1]	1.001(0.73-1.35)
Age	1.09 (1.07-1.11) [***, 2]	0.99 (0.99-1.0001)
Sex		
Male	Reference	Reference
Female	1.1 (0.83-1.45)	0.86 (0.80-0.93) [**, 2]
Charlson Comorbidity		
0	Reference	Reference
1	1.21 (0.86-1.71)	1.15 (1.04-1.27) [**, 2]
≥2	1.46 (1.03-2.08) [*, 2]	1.36 (1.22-1.51) [***, 2]
Payment category		
Medicare	Reference	Reference
Medicaid	0.92 (0.44-1.9)	0.95 (0.79-1.15)
Private	0.45 (0.23-0.87) [*, 2]	0.76 (0.66-0.87) [***, 2]
Other	1.73 (0.78-3.81)	0.60 (0.48-0.75) [***, 2]
Admission source		
Routine	Reference	Reference
Emergency	1.88 (1.38-2.58) [***, 2]	0.75 (0.68-0.83) [***, 2]
Transfers	2.28 (1.12-4.61) [*, 2]	1.22 (0.90-1.66)
Median income from patient's zip code	0.96 (0.83-1.1)	1.01 (0.96-1.04)
Surgical procedure DRG weight for each patient	1.06 (1.01-1.1) [**, 2]	1.08 (1.06-1.09) [***, 2]

Table 2.5 – continued

Predictors		Post-op Physio-Metabolic Derangement (PSI-10)	Post-op Respiratory Failure (PSI-11)
Teaching status			
	Non teach	Reference	Reference
	Minor teach	0.81 (0.6-1.11)	0.92 (0.79-1.07)
	Major teach	0.81 (0.48-1.37)	0.73 (0.57-0.94) [*]
Hospital location			
	Urban	Reference	Reference
	Rural	0.77 (0.46-1.29)	0.91 (0.71-1.16)
# of Staffed beds			
	0-99	Reference	Reference
	100-199	1.92 (0.96-3.86) [1]	1.18 (0.84-1.64)
	200-299	3.13 (1.58-6.23) [**, 1]	1.54 (1.09-2.18) [*]
	300-399	1.68 (0.84-3.35)	1.61 (1.15-2.25) [**, 1]
	>400	2.99 (1.44-6.22) [**,1]	1.54 (1.04-2.27) [*, 1]
% surgical admissions		0.99 (0.97-1.01)	0.99 (0.99-1.01)
RN-to-bed ratio		1.20 (0.92-1.55)	0.99 (0.87-1.13)
DRG weight to capture hospital case mix		1.68 (0.90-3.15)[1]	1.02 (0.65-1.60)[1]
Age		1.001(0.99-1.01)	1.01(1.01-1.02)[***, 2]
Sex			
	Male	Reference	Reference
	Female	0.80 (0.70-0.90) [**, 2]	0.77 (0.72-0.81)[***, 2]
Charlson Comorbidity			
	0	Reference	Reference
	1	2.42 (2.05-2.86) [***, 2]	2.42 (2.23-2.63) [***, 2]
	≥2	4.63 (3.8-5.63) [***, 2]	4.29 (3.89-4.73) [***, 2]
Payment category			
	Medicare	Reference	Reference
	Medicaid	0.82 (0.60-1.13)	1.16 (1.01-1.34) [*, 2]
	Private	0.65 (0.54-0.77) [***, 2]	0.79 (0.72-0.86) [***, 2]
	Other	0.65 (0.44-0.96) [*, 2]	0.83 (0.71-0.98) [*, 2]
Admission source			
	Routine	NI	NI
	Emergency		
	Transfers		
Median income from patient's zipcode		1.01 (0.95-1.08)	0.95 (0.91-0.98) [**, 2]
Surgical procedure DRG weight for each patient		1.24 (1.22-1.26) [***, 2]	1.37 (1.35-1.40) [***, 2]

Table 2.5- continued

Predictors	Post-op PE/DVT (PSI-12)	Post-op Sepsis (PSI-13)
Teaching status		
Non teach	Reference	Reference
Minor teach	1.12 (0.96-1.31) [1,2]	1.16 (0.95-1.4)
Major teach	2.02 (1.37-2.98) [**, 1,2]	1.42 (1.06-1.91) [*]
Hospital location		
Urban	Reference	Reference
Rural	0.73 (0.61-0.89) [**]	0.75 (0.57-0.99) [*]
# of Staffed beds		
0-99	Reference	Reference
100-199	1.28 (1.04-1.56) [*, 1]	0.99 (0.68-0.92)
200-299	1.41 (1.11-1.77) [**, 1]	1.06 (0.72-1.56)
300-399	1.48 (1.17-1.87) [**, 1]	1.01 (0.68-1.48)
>400	1.60 (1.19-2.15) [**, 1]	0.89 (0.57-1.37)
% surgical admissions	1.001 (0.99-1.01)	0.99 (0.98-1.01) [1]
RN-to-bed ratio	1.08 (0.91-1.28)	0.77 (0.64-0.94) [*, 1]
DRG weight to capture hospital case mix	0.77 (0.56-1.07) [1]	0.96 (0.63-1.45) [1]
Age	1.01 (1.005-1.01) [**, 2]	1.004 (0.99-1.01)
Sex		
Male	Reference	Reference
Female	1.01 (0.97-1.05)	0.82 (0.73-0.93) [**, 2]
Charlson Comorbidity		
0	Reference	Reference
1	1.30 (1.25-1.36)[2]	1.34 (1.17-1.54) [***, 2]
$\geq$2	1.83 (1.74-1.92)[2]	1.55 (1.33-1.82) [***, 2]
Payment category		
Medicare	Reference	Reference
Medicaid	1.05 (0.96-1.14)	1.13 (0.90-1.41)
Private	0.79 (0.76-0.84) [***, 2]	0.68 (0.57-0.79) [***, 2]
Other	0.74 (0.68-0.81) [***, 2]	0.68 (0.51-0.92) [**, 2]
Admission source		
Routine	Reference	NI
Emergency	1.77 (1.71-1.84) [***, 2]	
Transfers	1.72 (1.54-1.92) [***, 2]	
Median income from patient's zipcode	0.99 (0.97-1.01)	0.98 (0.92-1.03)
Surgical procedure DRG weight for each patient	1.10 (1.09-1.11) [***, 2]	1.23 (1.22-1.25) [***, 2]

Note - ***- significant at <0.0001, ** - significant at <0.01, * - significant at <0.05, NI – Not Included, [1]- significant at 0.05 level in hospital characteristics multivariable model, [2]- significant at 0.05 level in patient characteristics multivariable model

Table 2.6 – Results for teaching status of the hospitals from various regression models.

Predictors	Post-op Hip Fracture (PSI-08)	Post-op Hematoma/ Hemorrhage (PSI-09)	Post-op Physio-Metabolic Derangement (PSI-10)
Bivariate Model[1]			
Non teach	Reference	Reference	Reference
Minor teach	1.11(0.80-1.55)	1.07(0.93-1.23)	1.29(0.96-1.74)
Major teach	1.05 (0.71-1.56)	1.25(1.06-1.47)*	2.04(1.29-3.24)*
Multivariable Model with Hospital Variables[2]			
Non teach	Reference	Reference	Reference
Minor teach	1.03(0.7-1.52)	1.05(0.86-1.16)	0.84(0.62-1.12)
Major teach	1.16(0.67-2.01)	1.01(0.8-1.27)	0.81(0.48-1.37)
Multivariable Model with Patient Variables[3]			
Non teach	Reference	Reference	Reference
Minor teach	1.15(0.82-1.6)	1.04(0.9-1.19)	1.06(0.78-1.42)
Major teach	1.23(0.83-1.82)	1.16(0.97-1.37)	1.44(0.94-2.2)
Multivariable Model with All Variables[4]			
Non teach	Reference	Reference	Reference
Minor teach	1.07(0.72-1.57)	1.01(0.86-1.17)	0.81(0.6-1.11)
Major teach	1.26(0.73-2.17)	1.01(0.79-1.27)	0.81(0.48-1.37)

Table 2.6 – continued

Predictors	Post-op Respiratory Failure (PSI-11)	Post-op PE/DVT (PSI-12)	Post-op Sepsis (PSI-13)
Bivariate Model[1]			
Non teach	Reference	Reference	Reference
Minor teach	1.13(0.96-1.34)	1.41(1.26-1.58)*	1.26(1.05-1.52)*
Major teach	1.73(1.28-2.32)*	2.55(1.91-3.40)*	1.44(1.16-1.79)*
Multivariable Model with Hospital Variables[2]			
Non teach	Reference	Reference	Reference
Minor teach	0.94(0.79-1.11)	1.14(1.01-1.3)*	1.1(0.9-1.34)
Major teach	1.08(0.81-1.45)	1.8(1.38-2.34)***	1.24(0.94-1.63)
Multivariable Model with Patient Variables[3]			
Non teach	Reference	Reference	Reference
Minor teach	1.05(0.9-1.23)	1.33(1.16-1.53) ***	1.16(0.96-1.39)
Major teach	0.87(0.67-1.13)	2.52(1.65-3.84) ***	1.18(0.92-1.52)
Multivariable Model with All Variables[4]			
Non teach	Reference	Reference	Reference
Minor teach	0.92(0.79-1.07)	1.12(0.96-1.31)	1.16(0.95-1.4)
Major teach	0.73(0.57-0.94)*	2.02(1.37-2.98)**	1.42(1.06-1.91)*

Note - ***- significant at <0.0001, ** - significant at <0.01, * - significant at <0.05;

[1] - Bivariable analysis;

[2] -Multivariable model for hospital characteristics. Variables included - hospital location, % surgical admissions, RN-to-bed ratio, number of staffed beds, mean DRG weight for hospital;

[3] - Multivariable model for patient characteristics. Variables included – age, Charlson comorbidity index, payment categories, admission source, median income from patient's zip, downcoded DRG weight for each patient;

[4] - Multivariable Model for all variables. Variables included - age, Charlson comorbidity index, payment categories, admission source, median income from patient's zip, downcoded DRG weight for each patient, hospital location, % surgical admissions, RN-to-bed ratio, number of staffed beds, mean DRG weight for hospital

CHAPTER III

ASSOCIATION BETWEEN HOSPITAL LOCATION AND PATIENT SAFETY OUTCOMES

Introduction

An important question associated with the quality of healthcare delivered in U.S. hospitals is whether rural hospitals provide care that is comparable to their urban counterparts. Rural and urban hospitals differ considerably in their organizational and service mix characteristics.[46-48] Rural hospitals are generally smaller and less complex organizations than urban hospitals. They rely more on generalists (e.g., primary care physicians and general surgeons), and thus perform less complex and a smaller variety of procedures.[47,62] Additionally, because of their location and the limited range of services they provide, rural hospitals often serve as a link between rural residents and urban care facilities.[46,47]

Studies comparing quality of care in urban and rural hospitals are limited, and those that exist have produced mixed results. Several studies found worse risk-adjusted mortality outcomes at rural hospitals compared to urban hospitals,[42-44] whereas one study that adjusted for potential confounders found no difference.[45] However, mortality rates are highly affected by risk adjustment approaches and are often criticized as poor indicators of hospital quality.[63]

Outcome measures such as preventable adverse events are more directly related to hospital quality than are mortality rates, in that they more closely reflect the delivery of care. Two studies that compared patient safety outcomes or adverse event rates among urban and rural hospitals showed better patient safety outcomes[36] and lower adverse event rates[32] at rural hospitals compared to urban hospitals. In the first study, Brennan and colleagues reviewed medical records to examine rates of adverse events in New York State hospitals. After controlling for patient age and severity of illness the researchers concluded that rural hospitals in upstate New York had significantly fewer adverse events than urban hospitals.[32] In the second study, Romano and colleagues used risk-adjusted rates for 19 Patient Safety Indicators (PSIs) to compare urban and rural hospitals and found that rural hospitals had the lowest overall PSI rates (indicating they had a higher level of patient safety), while urban teaching hospitals had the highest rates, and non-teaching urban hospitals were in the middle.[36]

Although these previous studies found lower adverse event rates in rural hospitals, their comparisons of hospitals relied on both location (urban/rural) and teaching status and did not disentangle the effects of each. Thus, no study to date has compared patient safety outcomes across hospitals based exclusively on their urban/rural location. More importantly, the available studies compared urban and rural hospitals that differed substantially in size and other hospital characteristics and failed to adjust for these structural factors, making any differences observed between locations difficult to interpret.

It is important to understand the differences in patient safety across urban and rural hospitals and the factors contributing to them, especially when developing future standard of care recommendations and patient safety interventions for these hospitals. When comparing hospitals on patient safety performance and outcomes, it is crucial to examine metrics that are relevant to the services provided.[46] However, many available patient safety metrics are not appropriate for rural or small hospitals because these hospitals do not have sufficient patient volume or do not provide certain services.[49]

The current analysis is focused on small hospitals with fewer than 100 beds. The size of hospitals was limited to achieve comparable groups between urban and rural hospitals. This analysis explores the relationship between location of hospitals and a number of patient safety outcomes that are relevant to all hospitals. Further, it examines the differences in patient and hospital characteristics at small urban and small rural hospitals and explores the role these factors play in the patient safety outcomes at these hospitals.

Methods

Data Sources

The 2005 Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample (NIS) was used for all patient level data in the analyses. NIS is a 20% stratified probability sample of all hospital discharge abstracts from non-federal US hospitals in 37 states.[64] American Hospital Association (AHA) annual survey data for 2005 were used for hospital-specific information.[65]

Selection of hospitals

The NIS for 2005 includes 1054 hospitals. Certain states (GA, HI, IN, KS, MI, NE, OH, OK, SC, SD, TN and TX) do not report AHA identifiers in the NIS; leaving 655 hospitals available for analysis. Hospital size is often used as a proxy for many hospital structural characteristics. The type and volume of services offered by the hospital, personnel availability, and presence of tertiary services differ by size. Different types of services contribute to different types of patient safety problems, thus adverse events likely vary by size. In addition, different hospital service availability is likely to influence the patient population served.[62] To make comparisons between urban and rural hospitals meaningful, the current analyses restricted the sample of hospitals to those with fewer than 100 beds. This left 292 hospitals in the sample, 185 of which were rural and 107 of which were urban.

Selection of Patient Safety Indicators

The Patient Safety Indicator (PSI) software was developed by Agency for Healthcare Research and Quality (AHRQ) to identify potential in-hospital patient safety problems using hospital discharge summaries.[66] Specifically, PSIs screen for problems that patients experience as a result of exposure to the healthcare system and that are likely amenable to prevention by changes at the provider or system level. Each of the 20 provider-level PSIs indicates the rate of occurrence of a specific category of complications or adverse events.

To avoid unstable PSI estimates, AHRQ recommends using PSI rates only if there are more than 30 cases in the PSI denominator.[67] Therefore, seven PSIs which had 30 or fewer cases in either the small urban or small rural hospitals were dropped from the analysis. Additionally, many of the hospitals in the sample had a low prevalence of certain clinical conditions; hence PSIs were selected so that at least 80% of both urban and rural hospitals had patients who qualified to be in the denominator for these PSIs. This reduced the PSIs used in the analyses to nine: Complications of anesthesia (PSI 1), Death in low mortality DRGs (PSI 2), Decubitus ulcer (PSI 3), Failure to rescue (PSI 4), Iatrogenic pneumothorax (PSI 6), Selected infections due to medical care (PSI 7), Postoperative hemorrhage or hematoma (PSI 9), Postoperative pulmonary embolism or deep vein thrombosis (PSI 12), and Accidental puncture and laceration (PSI 15). Table 3.1 provides definitions for these PSIs.

Definition of Variables

Location of hospitals

The NIS definition of urban and rural hospitals was used to categorize hospitals. This definition considers all hospitals located in a metropolitan statistical area (MSA) as urban and those located outside an MSA as rural.

Hospital-level Characteristics

The primary objective of the current analysis is to examine the relationship between location of the hospital and patient safety outcomes and then to explore whether that relationship varies depending on hospital and patient characteristics. A variety of variables were included in the analyses to capture the characteristics of the hospitals and the patients they serve. Hospital-level variables included in the analysis are described below and their distribution is shown in Table 3.2.

The NIS bed size categories are specific to the hospital's location and teaching status, thus confounding size with these other characteristics. Accordingly, the number of set up and staffed beds in the AHA annual survey dataset was used to identify hospitals with fewer than 100 beds. PSI rates have been shown to vary by bed count,[62] hence hospitals were categorized into smaller (0-49 beds) and larger (50-99 beds) groups to examine the effect of relative hospital size on occurrence of PSIs. Hospital control was divided into three categories – government, not-for-profit and for-profit hospitals. System membership may facilitate a hospital's ability to comply with standards of care through sharing lessons learned and resources across multiple hospitals, so a variable for hospital system membership was included in the analysis. Hospital teaching status was not included because teaching hospitals with fewer than 100 beds are rare (2.4%). Many small rural hospitals and some small urban hospitals have Critical Access Hospital (CAH) status. CAH designation entails cost-based reimbursement for Medicare patients, rather than DRG-based rates. This minimizes a hospital's incentive to code complications that do not affect their reimbursements,[68] which can lead to underreporting of patient safety events. To examine this, a variable for CAH status was included in the analysis. JCAHO accreditation has been found to be associated with better patient safety outcomes hence it was included in the analysis.[69] Skilled personnel availability is a major issue for rural hospitals.[70] To examine its impact on the patient safety outcomes, a variable capturing registered nurses' ratio to hospital beds was included in the analysis.

Several variables were created to capture the types and intensities of services provided at these hospitals. Small urban hospitals may provide more services than small rural hospitals of comparable size, which may affect the patient safety standards and outcomes at these hospitals.[46, 62, 71] Thus, an index of service intensity was created by identifying all the services listed in the AHA annual survey database that were offered by at least 25% of the sample hospitals. A count of these 32 services was used to divide hospitals into four groups. Hospitals with fewer than 16 services were classified as low service intensity, medium service intensity hospitals had between 16 to 20 services, high service intensity hospitals had between 21 to 25 services, and highest service intensity hospitals had more than 25 services. A hospital-level variable for the percent of total inpatient admissions that were surgical was included as an index of exposure to certain adverse event conditions. Likewise, to capture differences in hospital case mix, the average relative value weight[72] for each DRG was identified and averaged for each hospital.

Patient-level Characteristics

Patient-level characteristics available in the NIS that were included in the analyses are described below and their distribution is given in Table 3.3. Due to service limitations, rural hospitals may not control the total episode of care. Rather they sometimes act as a referral source by transferring patients to larger hospitals after stabilizing them. Therefore, transferred-out patients were not included in the current analysis, but a variable for percent of patients transferred to another acute care hospital was included. The patient age, sex, type of admission, and primary expected payer were included in the analyses. The type of admission was divided into three categories – emergency, urgent, and other. Trauma cases were included in the emergency category. The other category included all the elective, newborn and other type of admissions. Patients' race was not included in the analysis because many states suppress race, causing 33% of the cases to be missing on that variable. Charlson's weighted approach was included to adjust for case mix; it assigns a score to each patient based on their pre-existing co-morbid conditions.[58] The number and intensity of procedures might affect the outcome; thus, the number of procedures and the intensity of the primary procedure were included in the analysis. AHRQ software was used to classify the procedures into two intensity categories – minor diagnostic/ therapeutic procedures and major diagnostic/ therapeutic procedures, based on their invasiveness and resource use.[73]

Statistical Analysis

The incidence rates of potential safety related events for each of 9 PSIs were estimated by applying PSI software developed by AHRQ (version 3.1, March 2007) to the NIS. For each PSI, the sample included all cases meeting the denominator criteria, divided into those with and those without a patient safety event. The purpose of this analysis was to determine if the occurrence of patient safety events is related to the location of the hospitals, so the unit of analysis was the patient. The bivariate association between hospital location and patient and hospital characteristics was determined using one-way ANOVA for continuous variables and Pearson chi-square test for categorical variables.

Generalized estimating equation (GEE) regression models were used for multivariable analysis to adjust for clustering of patients within hospitals. Small rural hospitals were used as the reference group. Correlations among the variables were examined to identify possible multicollinearity and used to select variables that were relatively independent (Pearson correlation coefficient < 0.5) for inclusion in multivariable models.

Results

Table 3.2 lists the hospital-level characteristics at both types of hospitals. As expected, a majority of small rural hospitals had CAH designation. A higher percent of small urban hospitals were JCAHO accredited (57%) compared with small rural hospitals (33%). Small urban hospitals were more likely than small rural hospitals to be affiliated with a hospital system (50.7% vs. 45.4%) and to be for-profit (28.9% vs. 5.4%) but surprisingly had a lower RN-to-bed ratio (1 per bed vs 1.3 per bed). Small urban hospitals had a higher percentage of surgical admissions as well as a higher average DRG weight, indicating that they either treat sicker patients or perform more complicated procedures, or both.

Table 3.3 lists the characteristics of the patients in small urban and small rural hospitals. The patients in the small urban hospitals were younger and had lower Charlson comorbidity scores than their counterparts at small rural hospitals. Small urban hospitals had more emergency admissions (36.3% vs. 31.8%) and performed more procedures per patient (1.2 vs. 0.8) and also transferred fewer patients to another short-term hospital (4.5 % vs. 5.9%) compared with small rural hospitals.

In most cases, the observed rates for the 9 PSIs examined were higher for small urban hospitals than for small rural hospitals (Figure 3.1). The bivariate analyses done to examine the statistical relationships between the PSIs and hospital- and patient-characteristics show that the patients admitted to the small urban hospitals were at significantly higher risks for decubitus ulcer (PSI 3), selected infections due to medical care (PSI 7), and accidental puncture/laceration (PSI 15); whereas patients admitted to small rural hospitals had significantly higher risk for complications of anesthesia (PSI 1). The bivariate results also show that the risk of occurrence of PSI event increased with age, higher Charlson comorbidity index, and number of procedures.

Table 3.4 lists selected results from multivariable models that include all patient and hospital characteristics (additional results from the models are available in Table 3.5). Teaching status of the hospitals was highly correlated with size and location and hence was dropped from multivariable models. Small urban hospitals had significantly higher odds for decubitus ulcer (PSI 3) after adjusting for important patient and hospital characteristics (i.e, age, sex, Charlson comorbidity index, primary payer, admission type, patient-level and hospital-level case mix index, bed size group, hospital control, system membership, CAH designation, JCAHO accreditation, percent transfers, number of procedures, procedural intensity, and service intensity).

The results from multivariable analyses show that many of the patient and hospital characteristics were related to the PSI occurrences. Older patients and patients with more comorbidities had higher odds for 4 out of 9 PSIs. The number of procedures was significantly related to 8 out of 9 PSIs, indicating that patients with more procedures were at higher risk for PSI occurrences. Major procedural intensity was associated with higher odds for accidental puncture/laceration (PSI 5), but lower odds for death in low mortality DRGs (PSI 2), decubitus ulcer (PSI 3), failure to rescue (PSI 4), and selected infections due to medical care (PSI 7).

Because of the absence of AHA identifier for 11 states in the NIS, many small hospitals could not be included in the analysis. The 292 sample hospitals were compared to the rest of the small hospitals with fewer than 100 beds in the AHA 2005 database (Table 3.6). Missing hospitals were more likely to be urban, for-profit, have a higher RN-to-bed ratio, a lower service intensity index, and were less likely to have CAH status, whether identified from all other small hospitals in the AHA database (N = 2982) or limited to those states which reported AHA identifiers in the NIS (N = 1728).

Discussion

Relatively few studies have compared patient safety or quality of care between urban and rural hospitals.[42-45, 32, 36] Most of these were limited to a single state or to a single clinical condition. The current research used a broad national sample of patients and analyzed multiple PSIs to compare care results at urban and rural hospitals. A broad set of performance measurements, such as PSIs, provides an overall measure of quality that is more appropriate to compare patient safety between urban and rural hospitals than a single indicator such as mortality, which is confounded by patient characteristics and preferences.[47]

The current analyses showed that location of hospital was significantly related to several PSI rates in bivariate models, but diminished after adjusting for relevant hospital and patient characteristics. This finding reinforces that hospital and patient characteristics cannot be overlooked when comparing groups of hospitals on patient safety and other quality measures.

The unadjusted results from the current analyses support other studies that suggest that rural hospitals have better patient safety than urban hospitals.[32,36] Although these previous studies found lower adverse event rates and better patient safety in rural hospitals, their comparisons of hospitals relied on both location (urban/rural) and teaching status. They did not examine how patient safety varies among urban and rural hospitals based exclusively on location of hospitals. Moreover, important structural and patient characteristics were not taken into consideration when comparing hospitals on patient safety metrics.

The results of the current analyses answer several questions. The bivariate analyses indicate that small rural hospitals have lower unadjusted patient safety incidence (indicating better performance) than small urban hospitals. The multivariable analyses suggest that these better rates occur in spite of treating older patients with more comorbidities. However, the factors that appear to explain the higher patient safety incidence in small urban hospitals are related to service intensity; small urban hospitals perform more and higher intensity procedures, and have a higher percentage of surgical admissions than similarly sized rural hospitals. It is likely that these service intensities place them at greater risk of adverse outcomes such as accidental puncture/laceration (PSI 15).

The results indicate that patients admitted to small urban hospitals have higher risk for decubitus ulcer, which could result from their higher rates of surgical and emergency admissions and procedures. Another possible explanation is related to the fact that small urban hospitals are more likely to be JCAHO accredited. Literature has shown that JCAHO accreditation was consistently associated with more extensive implementation of patient safety systems[69] which may increase compliance with standards of care and reporting of patient safety events in JCAHO-accredited hospitals. The results of the current study also confirm the findings by Li and colleagues that CAH conversion was associated with better performance for iatrogenic pneumothorax, selected infections due to medical care, and accidental puncture/laceration.[74]

To explore if the differences in the PSI occurrences were due to different hospital characteristics or due to the different patient populations they serve, multivariable logistic regression analysis using backward elimination procedure was performed for those 4 PSIs which were significant at the bivariate level: Complications of anesthesia (PSI 1), Decubitus ulcer (PSI 3), Selected infections due to medical care (PSI 7), and Accidental puncture / laceration (PSI 15). The results showed that hospital location stayed significant for 3 PSIs – patients in small rural hospitals had higher odds of complications of anesthesia (PSI 1) and patients in small urban hospitals had higher odds for decubitus ulcer (PSI 3) and accidental puncture / laceration (PSI 15). But the location of hospital was no longer significant for selected infections due to medical care (PSI 7), indicating that other hospital and patient characteristics probably play a larger role in the occurrence of this PSI than hospital location.

In rural areas, emergency medical services often face economic and geographic constraints;[70] therefore one might expect higher fatality rates at these hospitals because of difficulty in getting an emergency patient to a hospital in a timely fashion. To examine this, an additional analysis was done that included an interaction term for location of hospital and emergency admissions in the multivariable model. But the results suggested otherwise, showing that emergency patients admitted to small urban hospitals had significantly higher odds of 3 PSIs (death in low mortality DRGs, selected infections due to medical care, and accidental puncture/laceration) compared to small rural hospitals.

The results of this study are limited to small hospitals with fewer than 100 beds. They cannot be generalized to all urban and rural hospitals in the US. Comparison to missing hospitals indicates that the NIS sample with AHA identifiers differs in some hospital characteristics from other hospitals. Less complete recording practices, and uneven use of ICD-9-CM codes to record diagnoses can lead to imprecise calculations of severity of illness.[75] All nine PSIs are calculated across a heterogeneous sample of patients, irrespective of their clinical diagnoses. Though the multivariable models were adjusted for service intensity of the hospitals, data were unavailable on patients' use of various services within the hospital and on the severity of patients throughout their stay. Information on unmeasured confounders, such as patient preferences, was not available in the data and consequently was not adjusted for in the present analysis. The data also do not provide information on patient safety initiatives hospitals have implemented.

Another limitation is the absence of "present-on-admission" data. Such information will be available in future releases of NIS data, but is not currently available. The current AHRQ PSI software uses secondary diagnoses, some of which might be present-on-admission, to identify potential adverse events. Houchens and colleagues analyzed differences in PSI rates with and without present-on-admission information for 13 PSIs and found that for most PSIs, the impact of removing secondary conditions that were present on admission was moderate.[76] However they found that over 80% of the decubitus ulcer rate was present-on-admission. Thus, the current finding that decubitus ulcer rates are higher in small urban hospitals may reflect a prevalent comorbidity rather than an in-hospital complication. At the present time, therefore, it cannot be concluded that any of the PSIs indicate significant differences between small urban and small rural hospitals when differences in patient, hospital, and service characteristics are taken into consideration.

This study adds empirical results to the literature about patient safety rates in small urban and small rural hospitals. It used a broad national sample of hospitals, included multiple outcomes measures, and adjusted for relevant hospital and patient characteristics including case mix. To our knowledge, this is the first study that has compared patient safety outcomes between a comparable sample of urban and rural hospitals. The results from this study deviate from the findings in the literature that urban-rural differences in patient safety rates exist. This is likely because the hospitals in this study were chosen to achieve comparable groups, whereas previous studies have compared hospital groups that differed radically in terms of size and other structural, service, and patient characteristics. Limiting the size of hospitals helped to account for structural characteristics known to be associated with quality of care, such as teaching status or ownership status.[77] The IOM report on rural healthcare quality insists on better understanding of the characteristics of the conditions under which care is delivered.[70] This study also highlights the importance of understanding the factors that differ between urban and rural hospitals while developing hospital-relevant patient safety interventions at these hospitals.

Figure 3.1 – Observed PSI rates per 100 cases

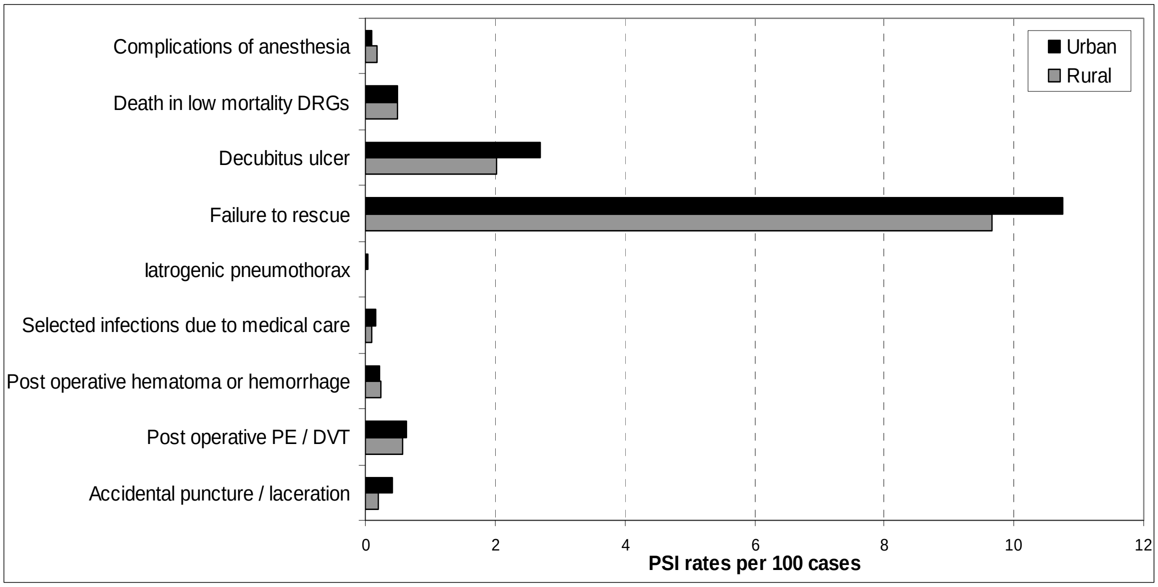


Table 3.1 – Definition of AHRQ PSIs

PSI	Definition	Numerator	Denominator
Complications of anesthesia	Cases of anesthetic overdose, reaction, or endotrachial tube replacement per 1,000 surgery discharges with an operating procedure.	Discharges with ICD-9-CM diagnosis codes for anesthesia complications in any secondary diagnosis filed among cases meeting the inclusion and exclusion rules for the denominator	All surgical discharges, 18 years and older or MDC 14 (pregnancy, childbirth, and puerperium), defined by specific DRGs and an ICD-9-CM code for an operating room procedure. Exclude cases: • with ICD-9-CM diagnosis codes for anesthesia complications in the principal diagnosis field or in a secondary diagnosis field if present on admission, if known • with codes for self-inflicted injury, poisoning due to anesthetics (E8551, 9681-4, 9687) and any diagnosis code for active drug dependence, or active non-dependent abuse of drugs
Death in low mortality DRGs	In-hospital deaths per 1,000 patients in DRGs with less than 0.5% mortality	Discharges with disposition of "deceased" among cases meeting the inclusion and exclusion rules for the denominator.	Discharges, 18 years and older or MDC 14 (pregnancy, childbirth, and puerperium), in DRGs with less than 0.5% mortality rate. If a DRG is divided into "without/with complications," both DRGs must have mortality rates below 0.5% to qualify for inclusion. Exclude patients with any code for trauma, immunocompromised state or cancer.
Decubitus ulcer	Cases of decubitus ulcer per 1,000 discharges with a length of stay greater than 4 days.	Discharges with ICD-9-CM code of decubitus ulcer in any secondary diagnosis field among cases meeting the inclusion and exclusion rules for the denominator.	All medical and surgical discharges 18 years and older. Exclude cases: • with LOS < 5 days • with ICD-9-CM of decubitus ulcer if present on admission, if known • MDC 9 • MDC 14 • with any diagnosis of hemiplegia, paraplegia, or quadriplegia • with an ICD-9-CM of spina bifida or anoxic brain damage • with an ICD-9-CM procedure code for debridement or pedicle graft before or on the same day as the major operating room procedure (surgical cases only) • admitted from a long-term care facility • transferred from an acute care facility.

Table 3.1 - continued

PSI	Definition	Numerator	Denominator
Failure to rescue	Deaths per 1,000 patients having developed specified complications of care during hospitalization.	Discharges with a disposition of "deceased" among cases meeting the inclusion and exclusion rules for the denominator.	Discharges 18 years and older with potential complications of care listed in failure to rescue definition (i.e., pneumonia, DVT/PE, sepsis, acute renal failure, shock/cardiac arrest, or GI hemorrhage/acute ulcer). Exclude cases: • age 75 years and older • neonatal patients in MDC 15 • transferred to an acute care facility • transferred from an acute care facility • admitted from a long-term care facility
Iatrogenic pneumothorax	Cases of iatrogenic pneumothorax per 1,000 discharges.	Discharges with ICD-9-CM code of 512.1 in any secondary diagnosis field among cases meeting the inclusion and exclusion rules for the denominator.	All medical and surgical discharges age 18 years and older defined by specific DRGs. Exclude cases: • with ICD-9-CM code of 512.1 in the principal diagnosis field or secondary diagnosis present on admission, if known. • MDC 14 • with an ICD-9-CM diagnosis code of chest trauma or pleural effusion • with an ICD-9-CM procedure code of diaphragmatic surgery repair • with any code indicating thoracic surgery or lung or pleural biopsy or assigned to cardiac surgery DRGs
Selected infections due to medical care	Cases of ICD-9-CM codes 9993 or 99662 per 1,000 discharges.	Discharges with ICD-9-CM code of 9993 or 99662 in any secondary diagnosis field among cases meeting the inclusion and exclusion rules for the denominator.	All medical and surgical discharges 18 years and older **or** MDC 14 (pregnancy, childbirth, and puerperium), defined by specific DRGs. Exclude cases: • with ICD-9-CM code of 9993 or 99662 in the principal diagnosis field or secondary diagnosis present on admission, if known • with length of stay less than 2 days • with any diagnosis code for immunocompromised state or cancer • with Cancer DRG

Table 3.1 - continued

PSI	Definition	Numerator	Denominator
Post-operative hematoma or hemorrhage	Cases of hematoma or hemorrhage requiring a procedure per 1,000 surgical discharges with an operating room procedure.	ICD-9-CM codes for postoperative hemorrhage in any secondary diagnosis field and a code for drainage of hematoma in any procedure code field or a code for postoperative control of hemorrhage in any procedure code field.	All surgical discharges 18 years and older defined by specific DRGs and an ICD9-CM code for an operating room procedure. Exclude cases: • with preexisting condition of postoperative hemorrhage or postoperative hematoma • where the only operating room procedure is postoperative control of hemorrhage or drainage of hematoma • where a procedure for postoperative control of hemorrhage or drainage of hematoma occurs before the first operating room procedure.• MDC 14
Post-operative PE / DVT	Cases of deep vein thrombosis (DVT) or pulmonary embolism (PE) per 1,000 surgical discharges with an operating room	Discharges among cases meeting the inclusion and exclusion rules. with ICD-9-CM codes for deep vein thrombosis or pulmonary embolism in any secondary diagnosis field	All surgical discharges age 18 and older and an ICD-9-CM code for an operating room procedure. Exclude cases: • with preexisting DVT or PE where a procedure for interruption of vena cava is the only operating room procedure • where a procedure for interruption of vena cava occurs before or on the same day as the first operating room procedure • MDC 14
Accidental puncture / laceration	Cases of technical difficulty (e.g., accidental cut or laceration during procedure) per 1,000 discharges.	Discharges among cases meeting the inclusion and exclusion rules. with ICD-9-CM code denoting technical difficulty (e.g., accidental cut, puncture, perforation, or laceration) in any secondary diagnosis field.	All medical and surgical discharges age 18 years and older defined by specific DRGs. Exclude cases: • with ICD-9-CM code denoting technical difficulty (e.g., accidental cut, puncture, perforation, or laceration) in the principal diagnosis field or secondary diagnosis present on admission, if known • MDC 14

Table 3.2 - Characteristics of small urban and small rural hospitals

Variables	**Small Rural N = 185**		**Small Urban N = 107**		**P-value**
	N	**Column %**	**N**	**Column %**	
Bed size					
Smaller (0-49 beds)	111	60	55	51.4	0.15
Larger (50-99 beds)	74	40	52	48.6	
Hospital ownership					
Government	70	37.8	14	13.1	<0.0001
Not-for-profit	105	56.7	62	57.9	
For-profit	10	5.4	31	28.9	
System membership	84	45.4	54	50.7	0.40
CAH affiliation	118	63.8	28	26.2	<0.0001
JCAHO accreditation	62	33.5	61	57.0	<0.0001
Service intensity Index					
Low	32	19.2	29	31.9	0.09
Medium	37	22.1	16	17.5	
High	50	29.9	28	30.8	
Highest	48	28.7	18	19.8	
	Mean	**SD**	**Mean**	**SD**	
RN-to-bed ratio	1.3	1.0	1.0	0.6	0.005
Percent surgical admissions	19.0	15.7	29.0	24.3	<0.0001
Average DRG weight per hospital	238.7	39.5	260.7	63.1	0.0003

Table 3.3 –Patients characteristics at small urban and small rural hospitals

Variables	Small Rural Hospital Patients N= 272,600		Small Urban Hospital Patients N = 227,609		P-value
	Mean	**SD**	**Mean**	**SD**	
Age	52.3	29.2	48.9	28.9	<0.0001
Number of procedures	0.8	1.4	1.2	1.6	<0.0001
Percent of patients transferred to another hospital	5.9	2.4	4.5	3.0	<0.0001
	N	**Column %**	**N**	**Column %**	
Sex					
Male	104489	38.3	86556	38.1	0.029
Female	168111	61.7	141053	61.9	
Primary expected payer					
Medicare	127407	46.8	90014	39.7	<0.0001
Medicaid	51717	19.0	36589	16.1	
Private	66791	24.5	84580	37.3	
Other	26295	9.6	15563	6.8	
Admission type					
Emergency	81394	31.8	72697	36.3	<0.0001
Urgent	83476	32.6	38718	19.3	
Other	90927	35.5	88754	44.4	
Charlson comorbidity score	164568	60.4	146482	64.4	<0.0001
0	58354	21.4	44178	19.4	
1	49678	18.2	36949	16.2	
=>2					
Procedure intensity					
Minor	68039	55.8	68340	50.9	<0.0001
Major	53919	44.2	65782	49.1	

Table 3.4 - Selected Results from Multivariable models

	Complications of anesthesia	**Death in low mortality DRGs**	**Decubitus ulcer**
Small Urban hospitals	0.65(0.38-1.11)	1.48(0.93-2.37)	1.32(1.06-1.64)*
Large hospitals (50-99 beds)	1.64(0.82-3.28)	0.54(0.30-0.97)*	0.66(0.47-0.91)*
Hospital ownership[1]			
Not-for-profit hospitals	0.91(0.52-1.58)	0.89(0.50-1.59)	1.05(0.82-1.34)
For-profit hospitals	0.97(0.43-2.21)	0.92(0.34-2.49)	1.30(0.88-1.92)
Percent transfer per hospitals	0.99(0.91-1.07)	0.95(0.86-1.04)	0.99(0.96-1.02)
Age	1.01(0.99-1.02)	1.07(1.05-1.09)***	1.03(1.02-1.03)***
Male	1.27(0.91-1.79)	1.99(1.21-3.26)**	1.13(1.02-1.25)*
Charlson index[2]			
1	0.99(0.68-1.46)	1.84(1.04-3.26)*	1.07(0.94-1.22)
= > 2	0.75(0.39-1.45)	3.44(1.84-6.44)**	1.27(1.12-1.43)**
Primary payer[3]			
Private	0.79(0.47-1.33)	0.59(0.22-1.63)	0.64(0.52-0.80)***
Medicaid	0.52(0.22-1.24)	1.16(0.26-5.11)	1.28(0.97-1.68)
Other payers	0.73(0.33-1.59)	1.27(0.32-4.98)	0.68(0.44-1.06)
Number of procedures	1.09(0.99-1.18)	1.45(1.28-1.63)***	1.11(1.08-1.14)***
Major procedural intensity	0.93(0.27-3.19)	0.27(0.11-0.65)**	0.63(0.53-0.74)***
Admission type[4]			
Urgent	2.05(1.07-3.95)*	1.90(1.04-3.46)*	0.76(0.67-0.87)***
Other	2.95(1.61-5.44)**	1.82(0.83-3.93)	0.64(0.54-0.75)***

Table 3.4 - continued

	Failure to rescue	**Iatrogenic pneumothorax**	**Selected infections due to medical care**
Small Urban hospitals	0.94(0.76-1.17)	1.01(0.63-1.63)	1.07(0.71-1.62)
Large hospitals (50-99 beds)	0.99(0.76-1.31)	1.72(0.79-3.72)	0.79(0.40-1.59)
Hospital ownership[1]			
Not-for-profit hospitals	0.99(0.77-1.28)	1.37(0.67-2.82)	1.29(0.73-2.28)
For-profit hospitals	1.36(0.95-1.94)	1.48(0.56-3.91)	3.07(1.68-5.62)**
Percent transfer per hospitals	0.99(0.94-1.04)	0.98(0.89-1.08)	1.12(1.05-1.18)**
Age	1.03(1.02-1.04)***	1.01(0.99-1.03)	1.01(0.99-1.01)
Male	1.06(0.94-1.19)	0.55(0.35-0.88)*	1.31(1.04-1.65)*
Charlson index[2]			
1	0.99(0.84-1.17)	0.97(0.62-1.52)	1.14(0.85-1.52)
= > 2	1.75(1.51-2.03)***	0.88(0.51-1.51)	0.95(0.71-1.27)
Primary payer[3]			
Private	1.11(0.91-1.35)	1.14(0.64-2.07)	0.69(0.45-1.05)
Medicaid	1.38(1.08-1.75)**	0.53(0.16-1.73)	0.62(0.34-1.11)
Other payers	1.35(1.05-1.73)*	1.29(0.62-2.69)	0.76(0.42-1.36)
Number of procedures	1.26(1.21-1.31)***	1.49(1.39-1.59)***	1.41(1.35-1.47)***
Major procedural intensity	0.36(0.28-0.46)***	0.63(0.33-1.20)	0.62(0.47-0.83)**
Admission type[4]			
Urgent	0.79(0.65-0.96)*	0.81(0.43-1.54)	0.78(0.55-1.11)
Other	0.71(0.58-0.87)**	1.38(0.80-2.38)	0.75(0.46-1.21)

Table 3.4 - continued

	Post-op hemorrhage/ hematoma	Post-op PE/ DVT	Accidental puncture/ laceration
Small urban hospitals	0.68(0.42-1.12)	1.20(0.91-1.58)	1.25(0.92-1.70)
Large hospitals (50-99 beds)	0.98(0.59-1.63)	1.29(0.82-2.03)	1.26(0.82-1.96)
Hospital ownership[1]			
Not-for-profit hospitals	1.23(0.70-2.14)	1.05(0.66-1.66)	0.68(0.49-0.93)*
For-profit hospitals	1.01(0.45-2.29)	1.20(0.65-2.22)	0.57(0.35-0.94)*
Percent transfer per hospitals	1.03(0.94-1.13)	1.03(1.00-1.07)*	0.98(0.93-1.04)
Age	1.00(0.99-1.01)	1.02(1.02-1.03)***	0.99(0.99-1.00)
Male	0.91(0.65-1.25)	1.12(0.89-1.39)	0.78(0.66-0.92)**
Charlson index[2]			
1	1.08(0.75-1.56)	1.42(1.14-1.77)**	0.82(0.71-0.94)**
= > 2	0.66(0.38-1.16)	1.95(1.54-2.48)***	0.66(0.53-0.83)**
Primary payer[3]			
Private	1.50(0.95-2.38)	1.23(0.96-1.57)	0.98(0.82-1.17)
Medicaid	2.29(1.32-3.98)**	1.21(0.72-2.05)	1.13(0.80-1.60)
Other payers	1.24(0.67-2.30)	0.75(0.48-1.18)	0.75(0.58-0.97)*
Number of procedures	1.42(1.33-1.51)***	1.22(1.18-1.26)***	1.44(1.36-1.52)***
Major procedural intensity	1.57(0.36-6.79)	0.89(0.51-1.57)	11.75(8.29-16.66)***
Admission type[4]			
Urgent	1.36(0.78-2.34)	1.00(0.74-1.36)	1.56(1.21-2.03)**
Other	2.06(1.29-3.27)**	0.63(0.49-0.80)**	1.94(1.51-2.49)***

Note - [1] – government as reference category, [2]- 0 as reference category, [3] – Medicare as reference category,

[4]- emergency as a reference category, * - < 0.05, ** - <0.001, *** - < 0.0001

Table 3.5 – Results from Multivariable models – rest of the variables

	Complications of anesthesia	**Death in low mortality DRGs**	**Decubitus ulcer**
JCAHO accreditation	1.58(0.88-2.85)	1.30(0.74-2.28)	1.28(0.99-1.66)
CAH affiliation	1.74(0.75-4.05)	1.58(0.84-2.97)	0.89(0.67-1.18)
Average DRG weight per hospital	0.99(0.99-1.01)	1.01(0.99-1.01)	1.00(0.99-1.00)
Percent surgical admission	0.98(0.96-1.00)	1.00(0.98-1.02)	0.99(0.98-1.00)
Service intensity index[1]			
Medium	1.73(0.59-5.01)	2.26(1.04-4.92)*	0.95(0.69-1.31)
High	1.39(0.61-3.14)	1.38(0.70-2.71)	1.15(0.89-1.48)
Highest	1.31(0.62-2.79)	1.49(0.77-2.88)	1.05(0.76-1.44)
RN-to-bed	0.74(0.46-1.17)	1.06(0.59-1.88)	1.01(0.86-1.18)
System membership	1.26(0.79-1.99)	0.79(0.47-1.32)	0.89(0.69-1.15)

Table 3.5 – continued

	Failure to rescue	**Iatrogenic pneumothorax**	**Selected infections due to medical care**
JCAHO accreditation	1.01(0.78-1.31)	1.57(0.70-3.52)	0.91(0.44-1.87)
CAH affiliation	1.07(0.78-1.48)	0.98(0.33-2.93)	0.25(0.12-0.53)**
Average DRG weight per hospital	0.99(0.99-1.00)	0.99(0.99-1.00)	1.00(0.99-1.01)
Percent surgical admission	1.00(0.99-1.01)	0.99(0.97-1.01)	0.99(0.97-1.01)
Service intensity index[1]			
Medium	0.91(0.68-1.24)	1.01(0.33-3.02)	0.79(0.37-1.69)
High	1.10(0.86-1.40)	1.04(0.47-2.29)	1.02(0.63-1.66)
Highest	1.18(0.91-1.52)	0.69(0.29-1.62)	0.91(0.55-1.51)
RN-to-bed	0.89(0.69-1.13)	0.43(0.23-0.82)*	0.58(0.28-1.21)
System membership	0.93(0.75-1.16)	0.91(0.57-1.45)	0.65(0.37-1.11)

Table 3.5 - continued

	Post-op hemorrhage/ hematoma	**Post-op PE/ DVT**	**Accidental puncture/ laceration**
JCAHO accreditation	1.08(0.67-1.75)	0.96(0.65-1.44)	1.00(0.74-1.34)
CAH affiliation	1.04(0.53-2.05)	1.21(0.76-1.92)	1.43(0.92-2.22)
Average DRG weight per hospital	0.99(0.99-1.00)	1.00(0.99-1.01)	1.00(0.99-1.00)
Percent surgical admission	1.01(0.99-1.02)	0.99(0.98-1.00)	1.01(1.00-1.01)*
Service intensity index[1]			
Medium	1.48(0.65-3.41)	1.18(0.72-1.93)	1.12(0.70-1.79)
High	0.85(0.42-1.69)	0.99(0.64-1.52)	0.94(0.63-1.41)
Highest	1.11(0.59-2.06)	0.99(0.66-1.48)	0.86(0.59-1.24)
RN-to-bed	0.94(0.57-1.56)	0.95(0.66-1.37)	0.97(0.74-1.27)
System membership	1.00(0.60-1.67)	1.06(0.78-1.43)	1.39(1.03-1.88)*

Note - [1] – low as reference category, * - < 0.05, ** - <0.001, *** - < 0.0001

Table 3.6– Analysis of sample and missing small hospitals with fewer than 100 beds using AHA 2005 data

Variables	Sample hospitals N = 292	Missing hospitals N =2982	P value
	N (%)	**N (%)**	
Bed size			0.44
0-49 beds	166 (56.85)	1764 (59.15)	
50-99 beds	126 (43.15)	1218 (40.85)	
Hospital Location†			<0.0001
Urban	107 (36.64)	1488 (49.9)	
Rural	185 (63.36)	1494 (50.1)	
CAH			<0.0001
Yes	146 (50)	1022 (34.27)	
No	146 (50)	1960 (63.73)	
JCAHO			0.15
Yes	123 (42.12)	1388 (46.55)	
No	169 (58.88)	1594 (53.45)	
Hospital ownership			<0.0001
Government	84 (28.77)	788 (27.34)	
Not-for-profit	167 (57.19)	1209 (41.95)	
For-profit	41 (14.04)	885 (30.71)	
Service index intensity			<0.0001
Low	61 (23.64)	994 (46.64)	
Medium	53 (20.54)	360 (16.89)	
High	78 (30.23)	407 (19.1)	
Highest	66 (25.58)	370 (17.36)	
System membership			0.84
Yes	138 (47.26)	1391 (46.65)	
No	154 (52.74)	1592 (53.35)	
	Mean (SD)	**Mean (SD)**	
RN-to-Bed ratio	1.2 (0.9)	1.6 (1.4)	<0.0001
Percent surgical admissions	22.7 (19.9)	20.4 (14.3)	0.54

Note - † In the AHA dataset, hospital location is divided according to Core based statistical area. Urban hospitals include all the hospitals in division and metropolitan areas and rural hospitals include all the hospitals in micropolitan and rural areas.

CHAPTER IV

DOES HOSPITAL COMPETITION IMPROVE QUALITY OF CARE: AN ANALYSIS OF CMS QUALITY INDICATORS

Introduction

Most of the empirical research on the effect of competition on quality has occurred in recent years. Studies that examined the effect of hospital competition on quality of care can be grouped in two categories – studies that used data before 1983 when the prospective payment system (PPS) was implemented and studies that used data after 1983. Based on the data before PPS was implemented, studies show a positive association between competition and quality or cost.[78] However, studies that analyzed the data after 1983, show mixed evidence because of the PPS and the penetration of managed care. Of the studies that examined the effect of competition on quality, a few studies[18, 50,51,79,90,92,93] found a positive effect, two studies[80,93] found a negative effect whereas two other studies[12,81] found no effect at all.

Recently, the Centers for Medicare and Medicaid Services (CMS), along with other organizations such as the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) and the American Hospital Association, initiated an effort called the Hospital Quality Alliance (HQA) to measure hospitals' performance over time. Under the HQA, hospitals nationwide report data to CMS on indicators of the quality of care for three common clinical conditions - acute myocardial infarction (AMI), congestive heart failure (CHF), and pneumonia. There are ten indicators of quality - five for AMI, two for CHF and three for pneumonia. Additionally, the Medicare Modernization Act, passed in 2003, established financial incentives for hospitals to provide CMS with data on indicators of quality. Furthermore, hospitals received bonuses based on their performance on these measures.

There are a number of studies that have examined hospital performance using CMS quality indicators. A few looked at AMI mortality as their outcome of interest and examined its relation with hospitals' characteristics.[4,82-84] Some examined if certain characteristics of the hospitals predict better performance scores[4,84] whereas others analyzed the effect of pay- for-performance and public reporting on hospitals' performance.[85-87]

For example, Jha and colleagues examined whether hospital ownership, size, teaching status and location of hospital were associated with higher performance scores. They found that not-for-profit, teaching hospitals in the Northeast or Midwest had a small significant increase in performance. Further, results showed that academic hospitals had higher performance scores for AMI and CHF but lower for pneumonia and that smaller hospitals had better scores for pneumonia compared with larger hospitals.[4] In another study, Popescue and colleagues examined the effect of being a cardiac specialty hospital on AMI and CHF measures.[84] They found that, in general, specialty cardiac hospitals performed similarly to that of competing general hospitals, but the top ranked cardiac hospitals performed better than general hospitals. However, the overall adherence was very high in all types of hospitals. Their findings are supported by an internal study done at CMS which found that CMS composite scores increased significantly for all conditions during the first 2 years of implementation and were associated with improvements in mortality at participating hospitals.[82,83] Goldman and Dudley performed a cross-sectional analysis of Hospital Compare data for 2005 for 10 process measures.[88] After adjusting for several organizational characteristics they found that the difference in quality varied by condition and size of hospital. Rural hospitals had better adherence for pneumonia measures but lower adherence to AMI and CHF measures when compared with their urban counterparts.

Although these studies focused on certain structural characteristics of the hospitals, none of them evaluated the effect of external factors such as market competition on the performance of the hospitals. Market competition has consistently been shown to promote economic efficiency and productive efficiency of firms. This relationship holds for several reasons. First, competitive measures coming from outside the firm may lead to an improvement in its internal organization. With greater market competition, the inefficient firms are expected to earn lower profits, and in extreme cases, their business survival may be at stake. Consequently, such firms have an incentive to improve their efficiency as a result of competition. Second, competition introduces a selection process and at the end of the process, only those survive that perform well. Third, competition also forces firms either to invest in new technologies and ideas or to risk being left behind.

Most of the studies that investigated the relationship between competition and quality of care are limited to insurance markets. Studies that examined the relationship between hospital competition and quality of care showed that market competition had a statistically significant impact on quality outcomes.[18, 50,51,79,80,90-92] There is substantial evidence that quality of care generally improves with competition among hospitals. Kessler and colleagues showed that competition was associated with approximately 4% lower AMI mortality and in the competitive markets patients received higher quality of care.[50] Their findings also indicated that oligopoly hospitals lower the quality of care for low-valuation patients in order to be able to charge their high-valuation patients more, leading uncompetitive markets to have greater variation in quality and expenditures.

In another study, Kessler and Geppert found that competition was associated with improved resource utilization for patients. Therefore, patients with higher acuity levels received more resources which were reflected in better outcomes for these patients.[51] Santarre and Vernon supported these findings by demonstrating that more quality of care per dollar can be obtained by attracting for-profit hospitals to competitive markets with existing not-for-profit and governmental hospitals.[90]

Two studies that have examined the effect of market competition on quality indicators found a positive relationship between competition and quality. In the first study, Jiang and colleagues examined the effect of market competition on quality and cost using inpatient quality indicators developed by AHRQ. They used state inpatient data from ten states to explore organizational and market characteristics associated with superior hospital performance. Their results showed that several organizational characteristics, like system membership and for-profit ownership status as well as higher market competition were associated with superior performance of hospitals.[18] In the other study, Castle and colleagues examined the effect of competition and excess supply on nursing home quality measures and found that markets with high competition showed improved quality scores for half of the quality measures.[92]

Even though most of the studies show substantial evidence that a positive association exists between hospital competition and improved quality of care, a few studies show a negative association or no effect at all. For example, in their study, Gowrisankaran and colleagues found that higher competition for Medicare enrollees was associated with an increase in risk-adjusted mortality rates, therefore decreasing quality of care for those patients.[80] Their finding was supported by Mukamel and colleagues who examined the relationship between hospital competition and quality of care and found that higher competition was associated with worse risk-adjusted mortality outcomes.[93]

In another study, Shortell and Hughes found no significant association between hospital competition and inpatient mortality rates.[81] Their finding was supported by a second study by Mukamel and colleagues who examined the effect of hospital competition on risk adjusted mortality rates for Medicare patients. Their results showed no significant relationship between hospital competition and quality.[93]

Thus the literature on the effect of competition on quality shows mixed results. In some studies the findings show that competition reduces costs, improves quality, and increases efficiency of production in markets for hospital services. On the other hand some studies suggest that competitive markets may cause competition to lead to excess capacity and therefore higher costs, and potentially increased adverse patient health outcomes thus lowering the quality of care.

The third study of this dissertation examines the relationship between hospital competition and quality of care. It explores the structural and market factors associated with quality of care. In recent times, where both public and private sectors are giving hospitals incentives to meet goals for improved quality of care, it is important to understand particular organizational and market characteristics that are associated with quality. Such understanding will help to design payment incentives that are aimed at motivating low-performing hospitals to improve their performance over time.

Conceptual framework

Hospitals that are engaged in competition with each other may adjust their strategies to increase their profits (value) and ensure their survival in the market. One of the main goals of hospitals in competitive markets is to attract a larger patient market share which results in larger profits. Competitive markets are expected to result in greater efficiencies, lower prices, and greater responsiveness to preferences of consumers. The argument for competition rests on the belief that competition between hospitals will have two consequences. First, that competition between healthcare providers will push prices towards marginal cost. And second, hospitals will also compete on the basis of quality and this competition will give incentives for providers to provide the optimal level of quality.

There are two-main types of hospital competition: price- and quality-competition. Price competition occurs when hospitals reduce their prices in order to attract more patients and contracts with third-party payers. The main expected outcome of this competition is enhanced operating efficiency (lower average and marginal costs). Quality competition occurs when hospitals try to attract more patients by enhancing their quality and reputation.

Hospitals compete on quality, both in terms of quality of medical services and quality of amenities. The importance of competition for quality is likely to be greater in markets in which hospitals compete for patients directly. In markets where patients' choice of hospitals are increasingly important, hospitals are likely to compete more on quality attributes that patients observe and value. Such markets where decisions are based on beneficiary hospital preferences, perceptions of quality are important competitive tools.[93]

The Hospital Quality Alliance (HQA) Premier project that began in October 2003 involved more than 260 hospitals nationally and tracked their process and outcome measures. It was based on a pay-for-performance model that included financial incentives and public recognition for top-performing hospitals as well as financial penalties for hospitals that did not improve above a pre-defined quality measure threshold by the third year of the project. As a part of the project, each participating hospital's performance on selected measures was published on the CMS Hospital Compare website. The underlying assumption was that by using this information, consumers would have the potential to select a hospital that best meets their preferences in those areas and therefore hospitals would compete with each other to improve quality to attract more patients. The public reporting of hospital performance was considered as a means for promoting quality. Additionally, literature shows that this public reporting does influence provider behavior.[94] Hence under these conditions, hospitals will compete for patients and the competition will be based on quality and services but not on price.

This relationship can be explained by a quality- quantity utility maximizing model of hospital behavior. In this model, quality of care will be broadly defined as a combination of patient outcomes, input intensity as well as hospital reputation. The input intensity will include numbers and types of services that patients receive during their stay. Here the hospital will make decisions about quality and associated intensity of inputs while trying to maximize their profits.

An important determinant of a hospital's position in the quality-quantity space is the level and precision of consumer information about quality. While perfection in consumer information about the quality of medical care is not to be expected, improvements in information level that are combined with more competition will generally lead to improved outcomes. In the HQA Premier project, the hospitals are given incentives for improved quality of care and their performance is publicly reported, inducing hospitals to improve their quality to maintain their reputation. Therefore, under HQA, hospitals in competitive markets would be expected to have increased performance scores.

In the quality-quantity utility behavioral model, a hospital will increase its utility by providing better quality to attract more patients. Quantity cannot be increased in a competitive market without increasing quality.[95] Therefore, hospitals will invest in more resources (quality improvement initiatives, bonuses, technologies, higher staffing ratio etc.) hoping to obtain more profit by attracting more patients through increased quality and intensity.

This behavior of hospitals to maximize their profits by moving towards quality or performance improvement in a competitive market can be explained by the structure-conduct-performance (S-C-P) paradigm from industrial organization theory. This paradigm is based on three features – the structure of the market, the conduct of the firms, and their performance.[96,97] It states that causality runs from structure to conduct to performance.

The basic tenet of the S-C-P paradigm is that the economic performance of an industry is a function of the conduct of buyers and sellers which in turn is a function of the industry's structure.[98] Here, economic performance is measured in terms of welfare maximization (resources employed where they yield the highest valued output) or efficiency of firm measured by the extent of its market power. Conduct refers to the activities of industry's buyers and sellers which include but are not limited to utilization capacity, research and development, inter-firm competition or co-operation etc. Structure includes variables such as the number and size of firms, market competition, degrees of product differentiation and level of barriers to entry. This paradigm from industrial organization is similar to Donabedian's healthcare paradigm of 'structure-process-outcome'. Both paradigms state that performance of the firm is a collective result of structure and conduct/process. This framework is used to examine the effect of hospital competition on hospital performances.

Methods

Data sources

The study population consisted of acute care hospitals from four states (Arizona, Iowa, New Jersey and Washington) that contributed to the State Inpatient Database (SID) of the Healthcare Cost and Utilization project (HCUP) for years 2004 – 2006. The SID is a collection of inpatient discharge abstracts from the participating states. The American Hospital Association annual survey data for year 2005 were used for all hospital specific information. The Area Resource File (ARF) data were used for socio- demographic information. The ARF is a national county-level health resource information database.

Hospital Compare data for years 2005-2006 were used for hospital performance measures. Hospital Compare is a national dataset of voluntary reporting of hospital performance, sponsored by the CMS. The dataset includes information about processes of care for all patients who have one of three important conditions (acute myocardial infarction, heart failure, and pneumonia) regardless of payer. Under Section 501 of the Medicare Prescription Drug, Improvement and Modernization Act (MMA) of 2003, hospitals are encouraged to voluntarily report performance data on a set of ten "core measures". The core measures include 10 process measures - five process measures for acute myocardial infarction (AMI), two process measures for congestive heart failure (CHF), and three process measures for pneumonia. The description of these process measures is given in Table 4.1. Additional measures were added over time but this study focuses only on the starter set of ten measures. Hospital performance is expressed as the percent adherence to guidelines for a population of patients eligible to receive the relevant intervention. The final sample consisted of 270 hospitals after excluding hospitals with missing data in the AHA annual survey or Hospital Compare data, and hospitals that did not have enough patient volume to report data.

CMS composite quality score

In this study, hospital performance was measured as better adherence to recommended CMS process of care measures. These CMS measures are a much more direct reflection of quality in that they reflect the actual process of care and unlike outcome measures; they do not need to be risk adjusted. In addition, organizations like CMS and JCAHO have been collecting information on this particular set of performance measures since the late 1990s, hence the hospitals are comfortable with collecting and reporting the related data, making CMS measures the ideal measures to examine whether market competition forces hospitals to provide better quality of care.

A composite quality score was calculated for the CMS measures for each hospital using HQA composite quality score methodology.[99] This methodology is a modification of the opportunity model developed by the Hospital Core Performance Measurement project (HCPM) for Rhode Island's public reporting program in 1998. A hospital's composite score for a condition equals the percentage of patients subjected to all the measures for which the hospital fulfilled the indicated action. For example, AMI has five measures - administered aspirin on arrival and at discharge, angiotensin converting enzyme inhibitor (ACEI) or angiotensin receptor blocker (ARB) for left ventricular systolic dysfunction (LVSD), and beta blocker at arrival and at discharge. Under this methodology, the denominator for AMI includes all patients who should have received all five measures and the numerator is the actual number of patients who received all five. All the numerators and denominators of all individual performance measures are then summed to get a composite numerator and composite denominator. The final composite score is then calculated by dividing the composite numerator by the composite denominator. Three composite scores were calculated representing the three clinical conditions for each hospital for each year. The scores for each condition range from 0-1.

Definition of variables

Market structure

Hospital competition as measured by the Herfindahl–Hirschman Index (HHI) was included as a market structure characteristic. The HHI for each hospital was calculated by a fixed radius approach. Under the fixed radius approach, every hospital is assigned a unique market area, which is the region enclosed by a circle centered on the hospital and defined by a fixed radius. The fixed radius approach has the advantage of including a hospital's nearby competitors even if they are located on the other side of a geopolitical boundary. Wong and colleagues recommended using 15 miles as a fixed radius.[100] Their recommendation was based on findings by Luft and colleagues who found that a fixed radius of 13.5 miles was the median distance and 17.6 miles was the mean distance to capture 90% of a hospital's discharges in California.[101] The HHI variable has values from 0 to 10,000. A value of 0 indicates wide open competition and no market power whereas a value of 10,000 means complete monopoly.

Other market characteristics that can influence hospital quality performance include socioeconomic and population characteristics. These data were obtained from Area Resource Files. Population distribution and percentage of uninsured people reflect the availability of resources and demand for hospital services that are essential to hospital operation. Especially, the population size in certain age groups is one of the important determinants of hospital utilization.

Hospital level characteristics

A number of variables such as ownership of hospitals, system membership, teaching status of hospitals, percent Medicare inpatient days, RN-to-patient days ratio, and an index of hospital case mix were included in the analyses to examine their effect on hospital performance. Size of the hospitals, location, JCAHO accreditation, and service intensity index were originally included in the model. However, analyses indicated that they were highly correlated with hospital competition. Thus, they were excluded from the primary analyses. A variable for nursing skill-mix was not included in the analysis because it was missing more than 30% of the data.

A recent study showed that system affiliated and for-profit hospitals are more likely to adopt information systems and have quality improvement initiatives.[102] Likewise, a considerable body of research shows a positive relationship between for-profit hospitals and better quality outcomes. Hence hospital ownership and system affiliation were included in the analyses. Hospital ownership was divided into three groups – not-for-profit, for profit and public hospitals. System membership from the AHA annual survey was used to identify hospitals affiliated with systems.

Other hospital characteristics that also influence hospital performance include nurse staffing and payer mix. Higher nurse staffing levels have been found to be associated with better patient outcomes.[13] A variable for nurse staffing was created as the total number of hours worked by licensed nurses (registered nurses [RNs] and licensed practical nurses [LPNs]) per adjusted patient day. Literature shows that payer mix has an effect on intensity of care and outcomes.[103] Inpatient care provided for Medicaid or uninsured patients is much less profitable than inpatient care for Medicare patients[103] so to capture this, a payer mix variable was included in the analysis. It was calculated as the percent of Medicare insured patients to the total patients. Additionally, a higher percent of elderly patients in a certain population can affect quality of care through a demand for specific care like AMI care through volume-outcome relationships. Hospitals with higher perceived quality may attract higher proportions of severely ill patients. So if these severity differences are not adjusted then the high quality hospitals may appear as lower quality in the data.[104] Therefore a hospital case mix index was calculated for each hospital and was included in the analysis. It was calculated by averaging DRG weights across all-payer cases for each hospital.

Statistical analysis

The purpose of this analysis was to determine if hospital competition is associated with better performance so the unit of analysis was hospitals. Hospital competition for years 2004 and 2005 was examined for its effect on CMS composite scores for years 2005 and 2006. Each hospital in the sample had two observations for competition as well as for each composite score. Based on the distribution, hospital competition was divided into three comparable categories – high competition (HHI = 0 - <1800), medium competition (HHI = 1800 - <10,000) and monopoly (HHI = 10,000). The CMS composite scores and hospital competition between two years of data was compared using paired t-tests. The bivariate association between control variables and CMS composite scores was examined using simple linear regression models and one way ANOVA models where appropriate. Correlations among variables were examined to select relatively independent variables for inclusion in multivariable models.

Random effects regression models were used for multivariable analysis because of the limited within-subject variation among hospitals. Further, to examine whether the effect of competition on quality stays the same with different levels of competition, sensitivity analysis was done with 2, 4 and 5 levels of competition. The two levels of competition were – competition (0-<10,000) and monopoly (10,000); four levels of competition were –high (0-<1100), medium (1100 -<5,000), low (5,000 -<10,000) and monopoly (10,000). And the five levels were – very high (0-<1100), high (1100 -<1800), medium (1800 -<5000), low (5000-<10,000) and monopoly (10,000). Competition was not analyzed as a continuous variable because the distribution was highly skewed.

The effect of hospital competition on quality of care was also estimated by quantile regression (QR) for quintile effects. QR estimates if competition has different effects for different outcome levels[105]. The QR model was estimated for quantiles 0.1, 0.25, 0.5, 0.75 and 0.9 using standard QR. The QR variance-covariance matrix was estimated by bootstrap with 1,000 replications, and differences in quantile effects were tested using standard Wald tests. All analyses were performed using SAS version 9.2 and STATA version 10.0.

Results

The Hospital Compare database was linked to the AHA database to get hospital-specific information. To prevent unstable estimates, CMS recommends considering only those hospitals that had more than 25 cases for a particular condition in each year. Out of 329 hospitals that had data from both Hospital Compare and AHA, 59 hospitals had less than 25 patients in a year for either AMI or CHF or pneumonia; hence they were dropped from the data leaving 270 hospitals for further analysis. These 270 hospitals were significantly different in their hospital characteristics from the 165 hospitals that did not report data or hospitals that reported data but did not have more than 25 cases a year (Table 4.2). Most of the missing hospitals were smaller hospitals with less than 100 beds (81.21%). They were largely rural (43.63%) and public hospitals (52.55%) with no JCAHO accreditation (59.39%).

Descriptive statistics showed that the overall hospital competition did not change substantially from 2004 to 2005. Hospitals in Iowa were in less competitive markets and hospitals in New Jersey were in highly competitive markets (Table 4.3). The composite scores for AMI and Pneumonia increased significantly from 2005 to 2006 indicating better quality of care for these clinical conditions (Table 4.3).

A HHI of around 3,000 suggests that competition is limited and markets with HHI values below 1800 are considered moderately or very competitive markets.[106] The distribution of hospitals by HHI in this sample indicates that many hospitals were located in competitive markets, with 31% of hospitals in markets with HHI below 1800. Based on the distribution of HHI (Figure 4.1), the hospitals were divided into three categories – high competition (HHI = 0-<1800), medium competition (HHI = 1800 - <10,000) and monopoly (HHI =10,000).

Table 4.4 shows the characteristics of sample hospitals. There were 81 hospitals (30.92%) in the high competition category, 88 (33.59%) in the medium competition category and 93 (35.5%) in the monopoly category. In addition, the majority of the sample hospitals were non-teaching (68%) and not-for-profit hospitals (67%). Bivariate analyses showed statistically significant differences in most hospital characteristics related to hospital quality as shown in table 4.5 for each composite score. But only case mix index and percent uninsured patients were significantly associated with all three scores. Hospitals in highly competitive markets had significantly better scores for CHF but lower scores for pneumonia compared with medium competitive and monopoly markets.

The Breusch and Pagan Lagrangian multiplier (LM) test for random effects was performed to decide between a random effects regression and a simple OLS regression. The null hypothesis in the LM test was that variance across entities is zero i.e. no panel effect. The results from LM tests showed that random effects regression models were more appropriate for this analyses than simple OLS regression models.

Random effects multivariable analysis was performed for each composite score adjusting for hospital characteristics such as hospital ownership, teaching status, system membership, nurse staffing and case mix index; and socio-demographic characteristics such as percent Medicare days and percent uninsured patients. The results from multivariable models showed that hospital competition had an effect on the CHF composite score but no effect on AMI or pneumonia quality scores. In highly competitive markets, hospital competition was significantly associated with better CHF performance (Table 4.6). In the highly competitive markets the hospitals' CHF score improved by 4.7%. However, none of the control variables was significantly associated with all three scores. Public hospitals had lower CHF composite scores indicating poorer quality of care compared with for-profit hospitals. Further, the results showed that system membership was associated with better AMI scores, teaching status was associated with better CHF scores and nurse staffing was associated with better pneumonia scores. Uninsured status was associated with lower AMI and CHF scores. In addition, the results showed that hospitals in Iowa and New Jersey had better outcomes for pneumonia compared with hospitals in Arizona. An additional analysis was done excluding the competition variable from the multivariable model to examine effect of the rest of the structural characteristics on quality of care (Table 4.7). It was performed only for the CHF composite score. The direction and magnitude of effect of the other structural variables on quality scores did not change much after exclusion of the competition variable indicating that other structural characteristics were probably more related to quality than competition.

Table 4.8 reports the effects of hospital competition on quantiles of composite scores. It shows that high levels of competition had a significant positive effect on AMI and medium levels of competition had a significant positive effect on pneumonia composite scores at the 0.1 level of quality. In highly competitive markets, AMI score increased by 46% per year in the lower quantiles of quality and in markets with medium competition, the pneumonia score increased by 3.6% per year for hospitals in the lower quantiles of quality. The medium level of competition had a positive effect on CHF composite scores at the 0.75 level of quality signifying that CHF scores increased by 2.6% for hospitals in medium competitive market and with above average quality scores.

A sensitivity analysis was computed for each composite score using different levels of competition. Three types of sensitivity analysis were done with two, four, and five levels of competition. Results from the sensitivity analysis are listed in table 4.8. Although the multivariable models contained all the control variables, only the regression coefficients for levels of competition are listed in table 4.9. The results revealed that even with different market structures, hospital competition had no effect on either AMI or pneumonia scores. But in highly competitive markets, hospital competition was always significantly associated with better CHF performance.

An additional sensitivity analysis was done using quantile regression methods with different market structures (Table 4.10). The overall results from quantile regression analyses showed that hospital competition was associated with quality. In models with five levels of competition (0-<1100, 1100-<1800, 1800-<5000, 5000-

<10,000, 10,000) low levels (HHI = 5000 -<10,000) and very high levels (HHI = 0-<1100) of hospital competition were associated with significant positive increase in AMI scores for low performing hospitals. The same increase in AMI scores and CHF scores was seen for the hospitals which were performing above average (at 0.75 levels of quality) in markets with low levels and medium levels of hospital competition respectively. However, for pneumonia, medium and high levels of competition were associated with decreases in quality scores for hospitals which were performing at 0.75 levels of quality. But in the same models with five levels of competition, low and medium levels of competition were associated with significant positive increase in pneumonia quality scores for poor performing hospitals (at 0.1 level of quality).

In models with four levels of competition (0-<1800, 1800-<5000, 5000-<10,000, 10,000) low levels of competition were associated with positive increases for AMI and pneumonia scores. Medium levels of competition were associated with increased CHF scores but decreased pneumonia scores. In models with two levels, competition was significantly associated with increased CHF scores.

Discussion

This study analyzed the effect of market competition on hospital quality using Hospital Compare data. The findings from this study support the hypothesis that higher market competition is associated with better quality of care. The results demonstrate that in highly competitive markets, CHF scores increased by 4.7% per year indicating that, overall, competition was significantly associated with better CHF performance. Competition had no effect on AMI or pneumonia performances in the random effects multivariable models but competition was significantly associated with hospital quality for all the conditions in quantile regression models. The level of competition did not change during the study period; hence the change in hospital quality is likely to be a response to other factors.

From the available literature, one might assume that the quality of care would be higher in large, teaching and not-for-profit hospitals[4,18,88]. The bivariate results from this study support an association between these characteristics and hospitals' performance. Teaching hospitals, not-for-profit hospitals and hospitals within a system were positively related with all three scores. However, the results no longer stayed significant after adjusting for various hospital and patient characteristics in the multivariable model suggesting that the significant results observed in simple bivariate analyses were probably due to the substantial differences in hospital characteristics and patient characteristics between the hospitals in different market structures.

This analysis was focused on 10 measures of quality for three clinical conditions which account for 15 percent of Medicare admissions. Results from this study did not find a significant relationship between percent of Medicare admissions and quality of care. This is surprising because a higher percent of Medicare patient has been shown to have a positive effect on intensity of care and outcomes[103] and in addition, these performance measures are tied to the pay-for-performance initiative by CMS so, one would expect better quality of care for Medicare patients. This study also found that hospitals in Iowa and New Jersey performed better for pneumonia measures compared with hospitals in Arizona. This finding for Iowa is consistent with the fact that rural hospitals are found to have better adherence for pneumonia process measures[4,88] and about 62% of the Iowa hospitals are rural. But the same cannot be said for New Jersey where almost all of the hospitals are urban and in highly competitive markets.

The results from the random effects multivariable models showed that hospital competition was associated with better CHF performance. However, the competition and quality score variables in the current study sample had skewed distributions. In such cases, quantile regression models are more robust in response to large outliers. The other methods of regression analysis estimate the approximate conditional mean of the response variable given certain values of the predictor variables, whereas quantile regression results estimates either the median or other quantiles of the response variable. They are more applicable in cases where there is no relationship or only a weak relationship is found between the means of response and predictor variables.

The quantile regression results from the current study showed that hospitals in highly competitive markets and with poor AMI performance had an improvement of 46% in their AMI performance. This substantial increase of almost 50% in their performance indicates that competition is related to changes in quality of care in specific situations. The same effect is observed for hospitals in medium competitive markets and with poor pneumonia performance. However, the effect of competition on quality decreases as the markets move from very competitive markets to monopoly markets.

Sensitivity analysis was performed in three ways – first, by using different market structures to analyze the effect of competition in random effects models, second, by using different market structures in quantile regression models and third, by changing the value of fixed radius from 15 miles to 20 miles to calculate HHI. The results from the first and third analyses indicated that competition improves CHF performance of the hospitals but only in highly competitive markets. However, results from the quantile sensitivity analysis demonstrated that competition was significantly associated with hospital performance in more circumstances. The pattern was most interesting at 0.1 and 0.75 levels of quality. Hospitals with poor quality of care (at 0.1 levels of quality) improved their performance for all the measures. This indicated that competition does affect quality of care where it is most needed. Even in markets with low levels of competition, hospitals were incentivized to improve their performance. Surprisingly in medium competitive markets, hospitals with better than average quality (at 0.75 level of quality) had decreased pneumonia scores suggesting declining quality of care for pneumonia at these hospitals. One possible explanation for this fact could be the distribution of pneumonia scores in the study sample. Even a slight decrease in the pneumonia scores over two years may lead one to believe that competition was associated with poor pneumonia performances in this specific situation. However this warrants further investigation.

There are several limitations in this study. First, the study was focused only on two years of data for quality and market competition. Hence, there was not much variation in market competition or in other structural attributes of the hospitals. In addition, the hospitals started reporting data to CMS in 2004. This study is focused on data from 2005 and 2006 during which hospitals were getting comfortable with publically reporting their data. Also, this data reporting was voluntary which introduced a selection bias among the study sample. Hospitals which did not report the data voluntarily or which did not have enough sample size for inclusion in the study were considered as missing hospitals. The preliminary analysis showed that those hospitals were significantly different than the sample hospitals in their structural characteristics but further analysis could not be done because they were missing data on quality scores. This also limited the generalizability of study findings. The findings from this study indicate that the variability in the performance may be due to several important organizational and population factors. However, several key organizational characteristics such as size, location, nursing skill mix, JCAHO accreditation and service intensity index were not included in the analysis because of a multicolinearity problem thus limiting the scope of the model. In addition, this study did not consider competition from other sources such as managed care competition or competition for physicians in markets while evaluating quality of care at the hospitals.

Other important issues include endogeneity and omitted variable bias. Measures of competition that are based on a fixed radius definition are endogeneous because hospitals with better performance attract more patients from far away areas. Additionally, information on other important characteristics, such as the medical staff composition, availability of clinical information systems, or quality improvement initiatives is not available in the SID. Moreover, the organizational characteristics in this study were limited to those available in the AHA survey database. Another important reason for increased demand is physician preferences. Many times physicians prefer specific hospitals or patients favor specific physicians. Date on these important variables were not available.

The CMS quality scores reflect specific processes of care and they do not capture all dimensions of quality. The significance of process measures and the importance that clinicians place on these measures, and most importantly the difficulty in providing the specific aspects of appropriate care were not available for analyses and hence their effect on quality could not be determined. Further, there has been no validation of the CMS scoring approach. And little is known about how well the composite score differentiates high quality hospitals from low quality hospitals. Although the CMS scoring approach is simple and transparent, it does not differentially separate hospitals that achieve excellence in quality for measures that are more difficult to achieve. Additionally, this analysis is limited only to four states and to those hospitals which decided to report Hospital Compare data voluntarily. This limits the generalizability of the findings.

This study contributes to the existing literature on the effect of competition on quality measures in a number of ways. Most of the previous studies examined mortality outcomes while comparing the effect of competition on quality of care. However, mortality rates are highly affected by risk adjustment approaches and are often criticized as poor indicators of hospital quality. This study is focused on CMS quality indicators which reflect the actual processes of care and are much clearer metrics of quality than mortality outcomes. In addition, this study examined measures of quality that do not need risk adjustment and covered three often studied clinical areas focusing on more recent time period. Use of quantile regression analysis was the biggest strength of this study. It was more appropriate for this study given the distribution of hospital competition and quality scores in the study sample and it demonstrated that hospitals at different levels of quality behave differently with different levels of competition. The results of the study reflect the basic behavioral response of hospitals to incentives. The results of this study emphasize that competition does affect quality of care and in markets where incentives are designed to improve quality of care, it is important to understand the organizational and market factors that are related to quality.

Table 4.1 – Description of CMS Quality Indicators

Quality Indicators	Description
Acute Myocardial Infarction	
Aspirin at arrival	AMI patients without aspirin contraindications who received aspirin within 24 hours before or after hospital arrival.
Aspirin prescribed at discharge	Patients without aspirin contraindications who are prescribed aspirin at hospital discharge.
ACEI or ARB for LVSD	Patients with left ventricular systolic dysfunction (LVSD) and without angiotensin converting enzyme inhibitors (ACEI) and angiotensin receptor blocker (ARB) contraindications who are prescribed either an ACEI or ARB at hospital discharge.
Beta blocker at arrival	Patients without beta blocker contraindications who received a beta blocker within 24 hours after hospital arrival.
Beta blocker at discharge	Patients without beta blocker contraindications who are prescribed a beta blocker at hospital discharge.
Heart Failure	
LVF Assessment	Patients with documentation in the hospital record that left ventricular function (LVF) were assessed before arrival, during hospitalization, or planned for after discharge.
ACEI or ARB for LVSD	Patients with left ventricular systolic dysfunction (LVSD) and without angiotensin converting enzyme inhibitor (ACEI) and angiotensin receptor blocker (ARB) contraindications who are prescribed either an ACEI or ARB at hospital discharge.
Pneumonia	
Initial Antibiotic Timing	Patients who receive their first dose of antibiotics within 4 hours after arrival at the hospital.
Pneumococcal Vaccination	Patients age 65 and older who were screened for pneumococcal vaccine status and were administered the vaccine prior to discharge, if indicated.
Oxygenation Assessment	Patients who had an assessment of arterial oxygenation by arterial blood gas measurement or pulse oximetry within 24 hours prior to or after arrival at the hospital.

Table 4.2- Comparison between missing and non-missing hospitals‡

Variables	**Non-missing N= 270**		**Missing N = 165**	
	N	**%**	**N**	**%**
Hospital ownership				
Public	67	24.82	90	52.55
For -profit	22	8.15	32	19.39
Not-for-profit	181	67.04	43	26.06
System membership	146	54.07	82	49.69
Hospital location				
Urban	183	69.85	93	56.37
Rural	79	30.15	72	43.63
JCAHO accreditation				
Yes	187	71.37	67	40.61
No	75	28.65	98	59.39
Hospital Size				
0-99 beds	93	35.5	134	81.21
100-199 beds	62	23.66	11	6.67
200-299 beds	45	17.18	6	3.64
> 300 beds	62	23.66	14	8.48

Note -‡ - All comparisons are significant at $p<0.05$ level

Table 4.3 – Comparing composite scores and hospital competition across years

Variables	Year 1		Year 2	
	N	**Mean (SD)**	**N**	**Mean (SD)**
Hospital competition[1]				
Overall[*]	260	5346.54 (3903.3)	262	5328.27 (3891.79)
Arizona	56	4760.05(4279.3)	58	4610.7(4275)
Iowa	75	8512.25(2180.56)	75	8464.82(2193.32)
New Jersey	72	2247.35(2589.71)	72	2255.36(2584.17)
Washington	57	5854.5(3365.15)	57	5812.9(3328.18)
AMI composite score[2,*]	176	0.94 (0.04)	166	0.95 (0.04)
CHF composite score[2]	224	0.86 (0.12)	226	0.89 (0.12)
Pneumonia Composite score[2,*]	251	0.88 (0.05)	247	0.9 (0.04)

Note – [1] - Hospital competition variable was for years 2004 and 2005

[2] - AMI, CHF and pneumonia composite scores were for years 2005 and 2006.

*- significant at $p<0.05$

Figure 4.1 – Distribution of hospital competition

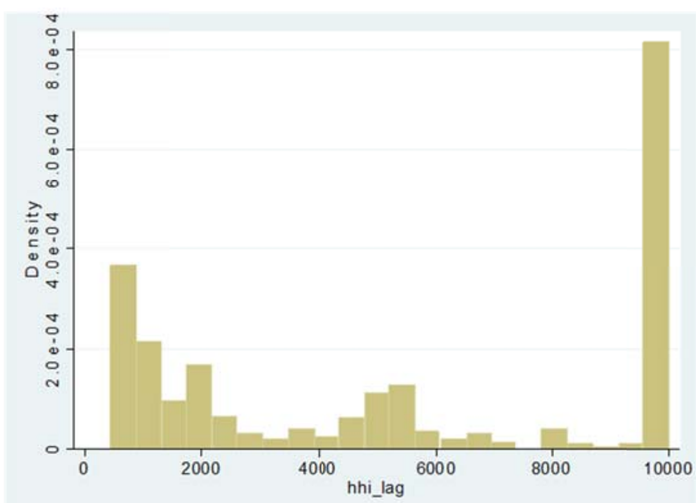


Table 4.4 – Hospital-level characteristics of the sample hospitals

	N	**Column %**
Levels of hospital competition		
High	81	30.92
Medium	88	33.59
Monopoly	93	35.5
Hospital ownership		
Public	67	24.81
For – profit	22	8.15
Not- for-profit	181	67.04
Teaching status of hospital		
Yes	86	31.85
System membership		
Yes	146	54.07
	N	**Mean (SD)**
% Medicare inpatient days	270	26.91 (12.74)
Nurse staffing	270	1.45(0.63)
% people without health insurance	270	13.72(4.81)
Case mix index for hospital	260	269.3(44.86)

Table 4.5 – Results from bivariate analyses

	AMI composite score	CHF composite score	Pneumonia composite score
	Mean (SD)	**Mean (SD)**	**Mean (SD)**
Levels of hospital competition			
High[p,f]	0.95(0.04)	0.91(0.06)	0.88(0.04)
Medium	0.96(0.04)	0.89(0.1)	0.9(0.04)
Monopoly [f]	0.94(0.05)	0.82(0.2)	0.9(0.05)
Hospital ownership			
Public[f]	0.93(0.06)	0.78(0.2)	0.88(0.06)
For – profit[p]	0.94(0.05)	0.87(0.07)	0.87(0.04)
Not- for-profit[f,p]	0.95(0.04)	0.9(0.09)	0.9(0.04)
Teaching status of hospital			
Yes[a,f]	0.96(0.04)	0.92(0.06)	0.89(0.04)
No	0.94(0.05)	0.85(0.14)	0.89(0.05)
System membership			
Yes[a,f]	0.95(0.03)	0.9(0.1)	0.9(0.04)
No	0.94(0.05)	0.85(0.14)	0.89(0.05)
	Regression coefficient	**Regression coefficient**	**Regression coefficient**
% Medicare inpatient days[f]	0.00003	0.003	-0.00006
Nurse staffing	0.007	0.005	0.003
% people without health insurance[a,f,p]	-0.003	-0.004	-0.003
Case mix index for hospital[a,f,p]	0.00009	0.0003	-0.0002

Note – [a]- Significant for AMI composite score at $p<0.05$ level,

[f] – Significant for CHF composite score at $p<0.05$ level, [p]- Significant for pneumonia composite score at $p<0.05$ level

Table 4.6 – Results from random effects multivariable regression models

	AMI Coef. (95 % CI)	CHF Coef. 95 % CI	Pneumonia Coef. 95 % CI
Hospital competition[1]			
High (0 - <1800)	0.0084 (-0.0101 - 0.0268)	0.0471(0.0039 - 0.0903)*	-0.0067(-0.0229 - 0.0094)
Medium(1800 - <10,000)	0.0073(-0.01- 0.0248)	0.0312(-0.0068 - 0.0692)	-0.0022(-0.016 - 0.01156)
% Medicare inpatient days	-0.0001(-0.0008 - 0.0005)	0.0015(-0.0001 - 0.0031)	-0.0001(-0.0001 - 0.0004)
Hospital ownership[2]			
Public	-0.0161(-0.0491 - 0.0168)	-0.091(-0.1635 - -0.0185)*	-0.0148(-0.0413 - 0.0116)
Not-for-profit	-0.0025(-0.0246 - 0.0195)	0.0006(-0.0552 - 0.0565)	0.0071(-0.0137 - 0.028)
Nurse staffing	0.0082(-0.004 - 0.0206)	0.0054(-0.0227 - 0.0335)	0.0123(0.0026 - 0.0219)*
System membership	0.0161(0.0018 - 0.0304)*	0.0179(-0.0152 - 0.051)	0.0075(-0.0041 - 0.0191)
Teaching status	0.0066(-0.0068 - 0.0202)	0.0352(0.0019 - 0.0683)*	-0.007(-0.0193 - 0.0052)
% uninsured people	-0.0023(-0.0046 - -0.0001)*	-0.0081(-0.0133 - -0.003)**	-0.001(-0.0028 - 0.0008)
Case mix index for hospitals	0.00001(-0.0001 - 0.0001)	0.0001(-0.0001 - 0.0003)	-0.0001(-0.0002 - 0.00001)
State[3]			
state = IA	0.0120(-0.0195 - 0.0436)	-0.0267(-0.0988 - 0.0453)	0.0395(0.0134 - 0.065)**
state =NJ	0.0101(-0.0117 - 0.0319)	-0.0017(-0.0553 - 0.0518)	0.0241(0.0042 - 0.0439)*
state =WA	0.0125(-0.0090 - 0.0341)	0.0027(-0.0463 - 0.0517)	0.0141(-0.0041 - 0.0322)
Goodness of fit tests			
R square – overall	0.1322	0.2721	0.1838
Wald chi sq	31.81	108.28	68.23
Prob> Wald chi sq	0.0026	0.00	0.00
Lagrangian multiplier (LM) test	0.00	0.00	0.00

Note - 1- Monopoly (10,000) as a reference category, 2- for profit hospitals as a reference category, 3- Arizona as a reference category, *- significant at 0.05 level, ** - significant at 0.01 level

Table 4.7 – Comparison of multivariable models with and without competition variable for CHF

	CHF **Coef. 95 % CI**	**CHF without competition variable** **Coef. 95 % CI**
Hospital competition[1]		
High (0 - <1800)	0.0471(0.0039 - 0.0903)*	
Medium(1800 - <10,000)	0.0312(-0.0068 - 0.0692)	
% Medicare inpatient days	0.0015(-0.0001 - 0.0031)	0.0014(-0.0001 - 0.003)
Hospital ownership[2]		
Public	-0.091(-0.1635 - -0.0185)*	-0.0907(-0.163 - -0.0177)*
Not-for-profit	0.0006(-0.0552 - 0.0565)	0.0003(-0.055 - 0.0566)
Nurse staffing	0.0054(-0.0227 - 0.0335)	0.0008(-0.0272 - 0.0288)
System membership	0.0179(-0.0152 - 0.051)	0.021(-0.012 - 0.0541)
Teaching status	0.0352(0.0019 - 0.0683)*	0.047(0.0154 - 0.0787)**
% uninsured people	-0.0081(-0.0133 - -0.003)**	-0.0097(-0.014 - -0.004)***
Case mix index for hospitals	0.0001(-0.0001 - 0.0003)	0.0001(-0.0001 - 0.0003)
State[3]		
state = IA	-0.0267(-0.0988 - 0.0453)	-0.0589(-0.1252 - 0.0074)
state =NJ	-0.0017(-0.0553 - 0.0518)	-0.0038(-0.0576 - 0.05)
state =WA	0.0027(-0.0463 - 0.0517)	-0.0077(-0.0559 - 0.0403)

Table 4.8 – Results from quanitile regression models‡

Composite scores	**Quantile effects**				
	0.1	**0.25**	**0.5**	**0.75**	**0.9**
High hospital competition					
AMI composite score	0.463*	0.001	0.004	0.003	0.004
CHF composite score	0.017	0.02	0.018	0.02	0.014
Pneumonia composite score	0.022	-0.88	-0.008	-0.01	-0.007
Medium hospital competition					
AMI composite score	0.019	0.002	0.008	0.01	0.007
CHF composite score	0.002	0.01	0.018	0.026*	0.013
Pneumonia composite score	0.036*	-0.003	-0.009	-0.011	-0.005

Note - ‡ - The effects are from the full model that includes hospital ownership, teaching status, system membership, staffing level, % Medicare inpatient days, % uninsured people and case mix index. Monopoly is the reference category.

*- significant at $p<0.05$

Table 4.9 – Results from sensitivity analyses using random effects models‡

	Hospitals N (column %)	**AMI Regression Coef. (95 % CI)**	**CHF Regression Coef. (95 % CI)**	**Pneumonia Regression Coef. (95 % CI)**
Hospital competition – 2 levels (monopoly as a reference category)				
Monopoly (10,000)	185 (35.44)	Reference	Reference	Reference
Competition (<10,000)	337 (64.56)	0.007(-0.008-0.024)	0.036(-0.0006-0.07)	-0.003(-0.16-0.009)
Hospital competition – 4 levels (monopoly as a reference category)				
Monopoly (10,000)	185 (35.44)	Reference	Reference	Reference
High (0 - <1100)	118 (22.61)	0.002 (-0.017-0.021)	0.0535 (0.0063-0 .1008)*	-0.0078 (-0.0255 -0 .0098)
Medium (1100 - <5,000)	132 (25.29)	0.0015 (-0.018 - 0 .0209)	0.0426 (-0.0026-0 .0879)	-0.0159 (-0.0328 - 0.001)
Low (5,000- <10,000)	87 (16.67)	0.0148 (-0.006-0.0358)	0.0203 (-0.0235-0 .0642)	0.002 (-0.0139 -0 .018)
Hospital competition – 5 levels (monopoly as a reference category)				
Monopoly (10,000)	185 (35.44)	Reference	Reference	Reference
Very High (0-<1100)	118 (22.61)	0.004(-0.0156-0.0239)	0.0552(0.0072-0.1032)*	-0.0055(-0.0232-0.012)
High (1100-<1800)	41 (7.85)	0.0086(-0.0148-0.0321)	0.0472(-0.0086-0.103)	-0.0211(-0.043-0.0008)
Medium (1800-<5,000)	91 (17.43)	0.0004(-0.02-0.021)	0.0422(-0.0053-0.0899)	-0.011(-0.0286-0.0066)
Low (5,000 - <10,000)	87 (16.67)	0.0157(-0.0053-0.0367)	0.0212(-0.0229-0.0654)	0.0025(-0.0132-0.0183)

Note -‡ - The effects are from the full model that includes hospital ownership, teaching status, system membership, staffing level, % Medicare inpatient days, % uninsured people and case mix index

*- significant at $p<0.05$

Table 4.10- Results from sensitivity analysis using quantile regression models‡

	0.1	**0.25**	**0.5**	**0.75**	**0.9**
5 levels of competition for AMI					
Very high (0- <1100)	0.05*	0.001	0.001	0.003	0.007
High (1100- <1800)	0.035	-0.002	0.005	0.004	0.004
Medium (1800- <5000)	0.009	-0.001	0.003	0.001	0.006
Low (5000- <10,000)	0.049*	0.016	0.012	0.013*	0.007
Pseudo R^2	0.2073	0.0809	0.0704	0.0693	0.0515
5 levels of competition for CHF					
Very high (0- <1100)	0.039	0.025	0.022	0.025	0.018
High (1100- <1800)	0.001	0.012	0.021	0.017	0.006
Medium (1800- <5000)	0.006	0.008	0.028	0.034**	0.014
Low (5000- <10,000)	0.012	0.009	0.01	0.009	0.017
Pseudo R^2	0.316	0.1854	0.1116	0.0839	0.0617
5 levels of competition for PN					
Very high (0- <1100)	0.022	-0.011	-0.01	-0.008	-0.001
High (1100- <1800)	0.021	-0.022	-0.01	-0.025**	-0.02*
Medium (1800- <5000)	0.034*	-0.016	-0.013	-0.018*	-0.008
Low (5000- <10,000)	0.039*	-0.001	-0.001	-0.007	0.007
Pseudo R^2	0.1518	0.1176	0.0807	0.089	0.1219
4 levels of competition for AMI					
Very high (0-<1100)	0.039	-0.001	0.001	0.001	0.005
Medium (1100- <5000)	0.008	-0.002	0.005	0.003	0.005
Low (5000- <10,000)	0.044*	0.015	0.012	0.008	0.006
Pseudo R^2	0.1989	0.0831	0.0749	0.0665	0.0567
4 levels of competition for CHF					
Very high (0-<1100)	0.041	0.024	0.025	0.034**	0.018
Medium (1100- <5000)	0.005	0.01	0.029	0.034**	0.014
Low (5000- <10,000)	0.012	0.011	0.012	0.014	0.021
Pseudo R^2	0.3496	0.224	0.1199	0.0814	0.0618
4 levels of competition for PN					
Very high (0-<1100)	0.025	-0.01	-0.01	-0.006	-0.001
Medium (1100- <5000)	0.031	-0.018	-0.013	-0.019*	-0.01
Low (5000- <10,000)	0.04**	0.001	-0.001	-0.006	-0.001
Pseudo R^2	0.1668	0.1361	0.0997	0.0945	0.1197
2 levels of competition for AMI					
Competition (0 -<10,000)	0.022	0.002	0.006	0.006	0.006
Pseudo R^2	0.1766	0.0802	0.0674	0.0634	0.0556

Table 4.10 - continued

	0.1	**0.25**	**0.5**	**0.75**	**0.9**
2 levels of competition for CHF					
Competition (0 -<10,000)	0.011	0.009	0.019	0.026*	0.014
Pseudo R^2	0.3463	0.2228	0.1176	0.0776	0.0596
2 levels of competition for PN					
Competition (0 -<10,000)	0.036*	-0.005	-0.008	-0.011	-0.005
Pseudo R^2	0.1628	0.1274	0.0968	0.0883	0.1143

Note -‡ - The effects are from the full model that includes hospital ownership, teaching status, system membership, staffing level, % Medicare inpatient days, % uninsured people and case mix index

*- significant at p<0.05, ** - significant at p<0.01

CHAPTER V

DISCUSSIONS AND CONCLUSIONS

The three studies discussed in this doctoral dissertation project examined the association between organizational factors and quality of care in terms of care processes and outcomes. The focus of these studies was on important structural attributes of hospitals, namely – teaching status, location and market competition. The first study examined the association between teaching status of the hospitals and post-operative patient safety indicators, adjusting for important confounders including different patient and hospital attributes. The second study explored the association between hospital location and patient safety indicators. This study focused exclusively on small hospitals with less than 100 beds to achieve comparable groups between urban and rural hospitals. The third study explored the association between hospital competition as well as other structural factors and publicly reported CMS process indicators, trying to understand how organizational structure and processes affect outcomes of care.

All three studies used data from the Healthcare Cost and Utilization Project (HCUP) overseen by the Agency for Healthcare Research and Quality. The first two studies used the Nationwide Inpatient Sample whereas the third study used the State Inpatient Datasets. Other data sources used to address the research objectives of the studies include the American Hospital Association's (AHA) annual survey database, Area Resource File, and the CMS Hospital Compare dataset. The main focus of these studies was the structural attributes of the hospitals; so the AHA annual survey database provided to get hospital specific information in all the studies. Area Resource Files are the databases containing county- specific information about health care professionals, hospital and health care facilities, census, and population data. The CMS Hospital Compare data is a set of process and outcome measures which give information on how well hospitals care for patients with certain medical conditions or surgical procedures. The State Inpatient Datasets provide information on all the discharges in all hospitals in that particular state. The results from a few states or an individual state database cannot be generalized to the entire United States. However, results from the Nationwide Inpatient Sample can be generalized to the entire United States because it includes all hospital discharge abstracts from a 20% stratified probability sample of nonfederal hospitals. Additionally, it contains data on patient and hospital level characteristics that can be used for risk adjustment.

The main components of this dissertation addressed the important question of the association between organizational factors and quality of care. The three studies are linked by the common concern of how organizational factors along with other patient and socio-demographic characteristics affect outcomes of care. The evidence gathered in these three independent but related studies are current, based on recent data and inform policy makers about designing incentives or quality improvement initiatives that are targeted at these hospitals.

The final section of this dissertation discusses in brief, the results from these studies and their importance. It also discusses the policy implications of these findings and the direction for future research.

Summary of findings

All three studies evaluated quality of care and patient safety using commonly available hospital performance indicators. Findings from all three studies demonstrated the importance of adjusting for important patient and hospital characteristics by revealing that many of these characteristics are related to hospital performance indicators.

The first study of this dissertation examined the association between hospital teaching status and post –operative patient safety indicators. The analysis focused on the association between non-teaching, minor teaching and major teaching hospitals, and six post-surgical PSIs. The findings from this study indicated that patients in major teaching hospitals had higher odds for post-operative pulmonary embolism or deep vein thrombosis, and post-operative sepsis, and lower odds for post-operative respiratory failure after adjusting for patient and hospital characteristics. Minor teaching hospitals were not significantly different from non-teaching hospitals for any PSIs when hospital and patient variables were included in the models.

The second study explored the relationship between location of hospitals and a number of patient safety outcomes that are relevant to all hospitals and examined whether this relationship varies depending on hospital and patient characteristics. It focused on hospitals with fewer than 100 beds to achieve comparable groups between urban and rural hospitals. The findings from this study showed that location of hospital was significantly related to several PSI rates in bivariate models, however only one was significant after adjusting for relevant hospital and patient characteristics. In particular, small urban hospitals had significantly higher odds for decubitus ulcer after adjusting for patient and hospital characteristics. In addition, the results showed that isolating potential effects of hospital structure on outcomes requires controlling for the variation in patient characteristics, such as age and comorbidities, which increase patients' risk for incurring patient safety events.

The third study of this dissertation examined the association between hospital competition and quality of care and explored the structural and market factors associated with it. CMS performance measures for three clinical conditions were used to evaluate quality of care at the sample hospitals. Hospital competition for years 2004 and 2005 was used to examine CMS composite scores for years 2005 and 2006. Random effect regression models were used for multivariable analysis. In addition, sensitivity analysis was completed with varying market structure ranges. The effect of hospital competition on quality of care was also estimated by quantile regression (QR) for quintile effects. The findings from this study suggest that higher market competition was associated with better quality of care in certain situations. The results demonstrated that in highly competitive markets, CHF scores increased by 4.7 % per year indicating that competition was significantly associated with better CHF performance. The quintile regression analysis showed that hospitals in highly competitive markets and with poor AMI performance had a substantial increase of almost 50% in their AMI performance indicating that high competition among hospitals does affect quality of care for this condition. In addition, the results showed that other hospital characteristics such as for-profit status, teaching status and system membership were associated with better quality of care thus emphasizing the importance of organizational factors while evaluating quality of care.

Contribution to the existing literature

The three studies discussed in this dissertation are among the few studies that have used a nationally representative sample and adjusted for relevant patient as well as hospital characteristics. These studies used non-mortality outcomes such as hospital performance indicators to evaluate quality of care. Mortality rates are highly affected by risk adjustment approaches and are often criticized as poor indicators of hospital quality. Non-mortality outcomes such as preventable adverse events are often preferred as outcome measures because they are more directly related to hospital quality. Most of the existing literature examining the association between organizational factors and non-mortality outcomes has shown mixed results.[8,20,21] Many studies that examined non-mortality outcomes have focused on a single condition[32,43,44,55] or single state[32,44] so the results were not generalizable to all US hospitals. A few studies used a national sample to examine patient safety events[31, 34-36] but none adjusted for all relevant patient and hospital characteristics.

The first study of this dissertation contributed empirical results to the existing extensive literature on the quality of care and patient safety at teaching hospitals. This study was different from the previous studies in many ways – first, it used a nationally representative sample of hospitals, second, the teaching status of the hospitals was very well defined and third, it examined multiple post- surgical outcomes that are associated with routine post-operative processes of care and are relatively attributable to delivery of care at these hospitals.

To our knowledge, the second study of this dissertation is the only study that examined patient safety at the hospitals solely based on the location of the hospitals. Many previous studies compared urban and rural hospitals that differed substantially in size and other hospital characteristics, but failed to adjust for these structural factors, making any differences observed between locations difficult to interpret. The second study of this dissertation was limited to smaller hospitals, thus letting the results truly reflect the effect of location on the specific patient safety indicators.

The final study of this dissertation examined the effect of hospital competition on CMS performance indicators. Many studies have evaluated hospitals using CMS indicators but none considered the effect of market factors on hospitals' ability to provide good quality of care. The third study of this dissertation focused on CMS quality indicators and examined effect of hospital competition on quality of care. The results of this study demonstrated that competition does affect quality of care and in markets where incentives are designed to improve quality of care, it is important to understand the organizational and market factors that are related to quality.

All three studies are different from each other in terms of the data that they used, their unit of analysis, dependent measures, and type of control variables used. But they all established the importance of organizational factors while evaluating quality of care in hospitals. Together, they showed that for-profit status, teaching status, size, location of hospitals; higher nursing staffing and system membership are associated with better hospital performance.

Limitations

Use of administrative data

All three studies used administrative data in their analysis. One of the major disadvantages of using administrative data in the analysis is its retrospective nature, less complete recording practices, and inconsistent use of ICD-9-CM codes to record diagnoses that can lead to imprecise calculations of severity of illness.[60,75,107] In addition, data are unavailable on patients' use of various services within the hospital, such as intensive care unit stays, and on the severity of patients upon admission and throughout their stay. Information on unmeasured confounders like patient preferences, patients' access to care, and physician experience is not available in the data. The data also do not provide information on patient safety initiatives hospitals have implemented.

Another limitation of administrative data that was used in these studies is the absence of "present-on-admission" data. The current AHRQ PSI software uses secondary diagnoses, some of which might be present-on-admission, to identify potential adverse events. This can lead to inaccurate calculation of patient safety events. Houchen and colleagues found that over 80% of the decubitus ulcer rate was present on admission. But when they compared PSI rates with and without present-on-admission data, they found moderate difference between the rates.[76]

Hospital performance indicators

Two types of performance indicators were used in this dissertation - patient safety outcome indicators and CMS process indicators. When comparing hospitals on performance indicators, it is crucial to examine metrics that are relevant to the services provided. However, many available patient safety indicators or CMS quality indicators are not appropriate for small hospitals that do not have sufficient patient volume or do not provide certain services.

Moreover, like many indicator sets provided by AHRQ, patient safety indicators are based on the ease of data collection. They are calculated across a non-homogenous sample of patients, irrespective of clinical condition. They are limited by virtue of their reliance on administrative data, which are subject to variability in coding practices and incentives for inaccurate administrative recording of adverse events.[108] In addition; these coding practices may vary systematically by hospital size, location, or teaching status thus making it difficult to get valid estimates of PSIs from administrative data. Furthermore, even if they are widely used, they do not provide valid, reliable or systematic knowledge of healthcare quality. PSIs do not cover the full range of healthcare settings required to assess or monitor accurately the performance of the healthcare system as a whole. Even though several studies have used the PSIs to identify significant gaps and variations in safety, the PSIs are still regarded by AHRQ as a screening tool to flag potentially safety related events rather than as a definitive measures to evaluate quality.[109]

On the other hand, both CMS and JCAHO have been collecting data on the CMS performance indicators since the late 1990s. These CMS composite scores are simple and transparent but there is no validation of their scoring approach. It is important to select a minimum level of accuracy based on false negative rates or lack of sensitivity while using these indicators as a performance measure. In addition, little is known about how the composite score differentiates high quality hospitals from low quality hospitals. The CMS scoring approach does not differentially credit hospitals that achieve excellence in quality for measures that are more difficult to achieve.

Even though use of administrative data is the major limitation of these studies, it is also the biggest strengths of their results. Using administrative data allowes one to use discharge information from a large nationally representative sample of hospitals thus increasing the generalizability of findings.

Policy implications of the research

Apart from the specific policy implications that are listed at the end of each study chapter, there are general policy implications of using hospital performance indicators to evaluate quality of care in hospitals. Under the MMA act of 2003, the Reporting Hospital Quality Data for Annual Payment Update (RHQDAPU) program authorized CMS to pay hospitals that report designated quality measures a higher annual update to their payment rates. CMS has already adopted a few PSI measures along with HQA performance indicators for fiscal year 2010 reporting. All three studies in this dissertation focused on the measures that are used by CMS to give hospitals a financial incentive to report the quality of their services. Hospitals are already implementing patient safety and quality interventions to take advantage of CMS initiatives.

The findings from this research provide useful insight into the areas where these patient safety and quality initiatives should focus. For example, the ratio of RNs to beds was found to be protective against post-operative sepsis. Much attention has focused on nursing resources as a means for reducing complications. Hospitals, and especially hospitals that have high rates of post-operative complications should examine whether their nursing ratios are adequate and make efforts to increase them if necessary.

Additionally, the results identified the organizational factors that are relevant to certain types of hospitals that need to be considered before evaluating quality of care at these hospitals. For example, transfers are especially relevant to rural hospitals, and presence of medical residents is relevant to teaching hospitals. Additionally, there is a variation in the capacity of hospitals depending upon their size and location to monitor quality and patient safety and to finance, organize and implement interventions to improve their outcomes. Moreover, hospitals differ in their organizational structures, availability of resources, types of services offered and the type of patient safety issues. The results from this dissertation highlight the importance of understanding these factors before enacting any policies about public reporting of performance or payment incentives that are relevant to these hospitals.

Future directions

The three studies in this dissertation contributed to the existing literature on examining linkage between organizational variables and quality of care. They used secondary datasets, examined patient outcomes only for a certain group of indicators or clinical conditions, and limited their risk adjustments only to the variables that were already present in data. Two studies did cross-sectional analysis of data whereas the third study used only two years of data.

Studies that examine either structure- process or structure-outcomes do not capture the complexity of health care delivery in hospitals. Future research needs to focus on all three components of the Donabedian Framework to evaluate the full effect of organizational variables on quality of care. To identify key organizational variables, future studies on this topic should include case studies of hospitals that have made significant improvements in quality or have maintained high ranking over time. Secondary data based studies should focus on alternative measures of quality, cover hospitals in a wider range of locations and should use multiple years of data.

Most of the available studies have used quantitative methods to examine the association between organizational variables and quality of care. However, qualitative methods such as chart reviews, interviews, and surveys allow researchers to collect more detailed and focused information which is not possible with quantitative approaches and secondary data. Combining both methods will help understand a more complete picture of how health care organizations perform and how they can improve quality. In addition, it is observed that changes in the structure or processes at one level of a hospital often have positive and/or negative consequences at different levels of the organization. Future studies should consider the nested structure of the units and teams/subunits within a hospital while evaluating quality of care.

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