2015

Intensivists and Organizational Performance

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INTENSIVISTS AND ORGANIZATIONAL PERFORMANCE

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A DISSERTATION

Submitted to the graduate faculty of The University of Alabama at Birmingham,

in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

BIRMINGHAM, ALABAMA

2015

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HEALTH SERVICES ADMINISTRATION

ABSTRACT

Because of the high intensity of care and the extremely complex medical conditions being treated, intensive care units (ICUs) represent one of the most significant units within a hospital. Despite the significance of the ICU, the majority of the care provided in the ICU has historically been managed and coordinated by referring or attending physicians, who often do not have the specialized training needed to effectively care for the exceedingly acute patients in the ICU. More recently, however, a growing number of hospitals have begun staffing the ICU with intensivists. Intensivists are uniquely trained physicians that specialize in providing care in hospital ICUs. Early studies have shown staffing the ICU with intensivists is associated with improved outcomes such as lower mortality rates, lower lengths of stay and reduced costs. Most of these studies, however, have been cross-sectional in design or have focused a single teaching facility or on a single diagnoses or procedure. In addition, no study has explored the environmental and market factors associated with the use of intensivists. The purpose of this study is to provide insight into the environmental and market factors associated with the use of intensivists and to broaden the scope and generalizability of knowledge regarding the benefits of utilizing intensivists. This study found that larger, system affiliated hospitals located in markets with higher per capita income and higher percentages of specialists are more likely to utilize intensivists. In addition, the study found that the use of intensivists is associated with lower average cost per patient day for patients with a principal diagnosis of acute myocardial infarction (AMI). This study also found that the association between the intensivist staffing and the average cost per patient day is nonlinear. Through ad hoc analysis, it was discovered that only the lowest and highest levels of intensivist staffing intensity were associated with lower cost per patient day. Finally this study found that the use of intensivists was associated with a reduction in AMI mortality rates and a decline in the occurrence rate of both pressure ulcers and perioperative hemorrhaging or hematoma for ICU patients.

Keywords: Intensivists, Staffing Strategy, Cost per Admission, Average Length of Stay, Inpatient Quality Indicators, Patient Safety Indicators

DEDICATION

To

Christiana, Anderson, Bailey Grace

Sterling and Kendall Faith

ACKNOWLEDGMENTS

There are so many people that helped me achieve this significant milestone and I am thankful for their investment in me. I would like to thank Dr. Weech-Maldonado for serving as my committee chair. He was constantly encouraging and offered tremendous wisdom and guidance through the entire process. I would also like to thank my other committee members for their feedback, guidance and support. I could not have selected a more perfect committee. I am grateful to each of them for the time and energy they devoted to me to ensure my ultimate success.

I would also like to thank my family, especially my precious wife Christiana. She was the one who was crazy enough to believe that we could do what we have done over the last five years. I am thankful for the sacrifices both she and our children made to make this accomplishment possible. I could not have done it without them.

Finally, I am thankful to God who poured is blessings on us during this journey. We stepped out in faith, and God provided all along the way. Everyone in our family has learned more about the abundance of God's grace and provisions during this process. I am thankful for this journey - it has been a learning experience for us all!

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INTRODUCTION

The cost of healthcare provided in the United States continues to be an area of concern in the United States (Bodenheimer 2005). Historically, healthcare expenditures in the U.S. have increased rapidly, consistently outpacing the overall rate of inflation in the economy (Dorman and Pauldine 2007) and in 2010, total healthcare spending in the U.S. reached $2.6 trillion, or $8,402 per person, representing 17.9% of gross domestic product (GDP) (Martin et al. 2012). When compared to other nations, the U.S. spends disproportionately more on healthcare per capita than any other developed nation (Reinhardt et al. 2002). Many argue that in order for the U.S. healthcare system to remain sustainable, the growth in healthcare costs must be controlled.

Despite the considerable spend on healthcare in the U.S., there are also significant concerns regarding the quality and safety of the care provided (Lindenauer et al. 2007, Kohn et al. 2000, Skekelle et al. 2013, Leape and Berwick 2005). Numerous studies have stressed both deficiencies in care and the occurrence of life-threatening errors (Jha et al. 2005, Kohn et al. 2000, James 2013, Berenholtz et al. 2002). In 1999, the Institute of Medicine (IOM) sounded the alarm regarding the quality and safety of healthcare when they estimated that up to 98,000 Americans die each year as a result of medical errors (Kohn et al. 2000). In a more recent study, this estimate was revised to up to 400,000 deaths per year (James 2013). Clearly, strategies to curb costs and improve quality and safety of healthcare continue to be needed.

Over the last two decades, numerous strategies and initiatives have been introduced with the objective of slowing the growth of healthcare costs and/or improving the quality and safety of care. Strategies such as pay-for-performance (Kahn et al. 2006, Kruse et al. 2012), value-based purchasing (Krumholz et al. 2013), the Leapfrog Group's quality-based payment incentives (Milstein et al. 2000, Birkmeyer and Dimick 2004), bundled payments (Orszag and Emanuel 2010), the use of electronic medical records (Kazley and Ozcan 2008), the careful management of nurse staffing ratios (Kane et al. 2007), the use of standardized order sets (Micek et al. 2006), utilizing computerized provider order entry (Kaushal et al. 2003, Bates et al. 1999) and the adoption of clinical best practices (Skekelle et al. 2013) have all sought to either control costs and/or improve the quality and safety of care. Another strategy that has been purported to reduce costs and/or improve the quality and safety of care is the use intensivists to staff the intensive care unit (ICU).

ICUs were developed by hospitals in the 1960's to satisfy the highly specialized postoperative care needs of patients who underwent newly developed cardiac procedures. Patients who underwent these innovative cardiac procedures needed continuous monitoring and care management after surgery and those needs were met in the newly formed ICUs. Once established, ICUs continued to expand and began to care for other patients who were either severely ill or had complex medical conditions that required high intensity care. Since the 1960s, hospitals have continued to develop and further delineate ICUs into medical ICUs, surgical ICUs (SICUs), pediatric ICUs (PICUs), neonatal ICUs (NICUs) and neurological ICUs (NICUs) (Ghorra et al. 1999, Krizer 2008, Bai et al. 2010).

Because of the type of patients being treated in ICUs and their unique care needs, attention soon shifted toward the distinct staffing needs within the ICU. In 1971, the care provided in ICUs, known as critical care, became a distinct skillset and the Society of Critical Care Medicine (SCCM) was formed support the specific needs of this newly formed disciple. During the 1970s critical care became a defined nursing specialty and later in 1995, the Committee on Manpower for Pulmonary and Critical Care Societies was formed to focus on the physician workforce needs in the area of critical care (Ghorra et al. 1999). This group recognized that critical care was a unique discipline and worked to define and solidify the distinct role of the intensivist (Rainey and Shapiro 2001). Intensivists are defined as physicians "who specialize in critical care with the experience and skill required to detect and address changes in patients' clinical conditions, often before complications occur. Intensivists can be surgeons, anesthesiologists, internists, or pediatricians with additional training and board certification in critical care. They are often the ICU director and must have the ability to manage and coordinate care by a variety of clinicians" (Belden 2002).

Despite the efforts over the last two decades to define the role of intensivists and emphasize their importance, until recently, most hospitals did not use intensivists to staff the ICU. Traditional physician staffing in hospitals, including the staffing of physicians in ICUs, has historically relied heavily on the independent referring physician as the initial admitter of patients to the hospital and then subsequently to the ICU. That same independent physician would then coordinate the care provided to those admitted patients during their stay in both the hospital and the ICU. In the ICU, this staffing approach has been called the "traditional" or "open" model of ICU staffing (Ghorra et al. 1999, Pronovost et al. 2004). Under this model, independent physicians are given admitting rights to a hospital. Once the physician has these admitting rights, they are free to admit their patients to the hospital and then to the ICU, as they deem appropriate. Once the patient is admitted to the ICU, the independent physician continues to direct the care provided to the patient. While the admitting physician might seek consultation from other specialists regarding specific issues, the care of the patient is principally directed by the admitting physician, who may or may not have extensive experience or specific training in critical care (Pronovost et al. 2004).

Specialized training and the ability to carefully manage patient care across multiple providers are especially important in the ICU because of the high acuity and complexity of the patient cases. The successful management of ICU patients is important to the hospital for a number of reasons. First, ICU patients are at extremely high risk for potential patient care deficiencies (Shojania 2001). This risk was highlighted with the formation of the Leapfrog Group in November 2000. The Leapfrog Group was formed with the goal of improving care and reducing medical errors for patients. A consortium of over one hundred Fortune 500 companies and other large private and public purchasers of health services founded the Leapfrog Group. These member companies represented over 35 million patient lives (Terry 2002) and the group sought to leverage its buying power in the healthcare marketplace to encourage providers to adopt its research-based quality and safety recommendations. One of the group's initial recommendations aimed at improving care and reduce errors was the staffing of ICUs with intensivists.

Another reason the successful management of the ICU is important to the hospital is that these critically ill patients are extremely costly to the organization. ICU patients utilize more resources and incur more cost than other patients (Scurlock et al. 2011). The ICU can represent as much as 30% of a hospital's budget (Dorman and Pauldine 2007) and at a national level, the care provided in these units accounts for more than 20% of the total acute care hospital costs (Pronovost et al. 2004), while only 15% of hospital beds in the United States are allocated to critical care (Pastores and Halpern 2015). This high level of spending on critical care is likely continue given that the number of patients being cared for in ICUs is increasing (Rosenfeld et al. 2000), and based on demographic trends, the number of patients requiring care in the ICU will continue to increase for the foreseeable future (Dorman and Pauldine 2007). Due the high cost of care in the ICU and the growth of these services, cost pressures in this area will continue to exist for hospitals and health systems.

Given the elevated risks of deficiencies in the quality of care and the continued cost pressures in the ICU, the ICU represents a key opportunity for improvements in costs, quality and safety within a hospital. As mentioned above, the use of intensivists has been purported to improve outcomes in the ICU and could potentially mitigate quality and safety risks and help alleviate inherent cost pressures. Given this potential, it is curious that many hospitals have continued to rely on the traditional staffing model in ICUs (Krizner 2008, Dorman and Pauldine 2007). One reason for the reluctance in using intensivists is the incremental costs required. The incremental costs include both physician recruiting expenses and ongoing intensivist and extender salaries (Kahn et al. 2007, Pronovost et al. 2004). While financial modeling has shown potential net savings to a hospital of between $700,000 and $4 million by using intensivists, the same study also presented scenarios with net losses to the hospital of up to $1.3 million (Kahn et al.

2007). In addition to the potential ongoing operating loss, the implementation of intensivists staffing necessitates a substantial up front financial investment with a return that is uncertain and realized over an extended time period (Kahn et al. 2007).

Another reason hospitals have been reluctant in utilizing intensivists in the ICU is physician push back (Kahn et al. 2007). As mentioned earlier, hospitals have historically relied on independent physicians to admit and coordinate the care provided in both the hospital and the ICU. Hospitals depend on these independent admitting physicians to generate the patient volume needed to sustain operations. With the implementation of intensivists staffing in the ICU, these affiliated physicians can perceive a loss of control over the care for their patients and a loss of income generated from the care provided in the ICU (Kahn et al 2007).

Despite these hurdles, a growing number of hospitals in the U.S. have begun to staff the ICU with intensivists. This study found that from 2007 to 2010, the number of hospitals utilizing intensivists almost doubled from 420 in 2007 to 804 in 2010. Under this new model, intensivists who are either employed or contracted by the hospital, direct the care in the ICU rather than the independent referring physicians. Early studies have provided moderate support for several benefits associated with intensivist staffing in the ICU (Pronovost 2007).

One benefit associated with the use of intensivists is decreased complications (Rosenfeld et al. 2000, Ghorra 1999) and lower patient mortality rates. ICU patients are at the highest risk of morbidity and mortality (De Vos et al. 2007). An article by Young and Birkmeyer (1999) identified nine studies focused on the association between the use of intensivists and ICU mortality rates. In their paper, the authors found that in five of the nine studies identified, the use of intensivists was associated with a statistically significant reduction in ICU mortality. In a later systematic review article, Pronovost et al. (2002) explored the relationship between high intensity intensivist staffing and ICU mortality rates. In their review, the authors identified twenty-six observational studies, including the nine in Young and Birkmeyer's article, which explored the relationship between the use of intensivists and multiple patient outcome variables including ICU mortality. The authors found that in 14 of the 15 studies, high intensity staffing was associated with reduced ICU mortality rates. In another study, however, Dimick et al. (2001) found that the use of intensivists was not associated with lower mortality rates for patients having undergone esophageal resection.

Two other purported benefits associated with the use of intensivists is a reduction in the average length of stay (ALOS or LOS) and a reduction in hospital expenses. Results from studies focused on costs and lengths of stay have been mixed, but in a structured literature review, Pronovost et al. (2002) found that in 14 of the 18 studies that included LOS as a measure, the LOS was reduced when intensivists were used in the ICU. In another study, Breslow et al. (2004) found that LOS was reduced from 4.35 days to 3.63 days after the implementation of an e-ICU program where intensivists provided ICU patient management services remotely from a centralized location using electronic monitoring and communication technologies. Finally in Dimick et al. (2001), the authors found that for patients who underwent an esophageal resection, daily rounds with an intensivist was associated with shorter lengths of stay and reduced hospital expenses.

While early studies have provided mixed support for the asserted benefits associated with the use of intensivists, it is important to note that almost all of these studies have been either a pre-post or cross-sectional study design, and have therefore been restricted by the inherent limitations of these designs. It is also important to note that the majority of these studies included a single teaching facility as its sample and/or focused on patients with a single prognosis, disease or procedure. In addition, none of these studies were grounded in theory. Finally, the author is unaware of any studies that have explored the organizational and environmental antecedents associated with hospitals utilizing intensivists. This study seeks to satisfy this gap in the literature, broaden our knowledge regarding the use of intensivists and increase the generalizability of the findings by broadening the sample of hospitals included in the study.

DISSERTATION PLAN

In order to achieve this purpose, this dissertation is comprised of three distinct papers looking at various dimensions regarding the use of intensivist. The three papers included in this dissertation are as follows:

Paper 1: Organizational and Market Factors of Hospitals Using Intensivists: A Longitudinal Analysis Of U.S. Hospitals 2007-2010

This paper uses resource dependence theory as a framework to explore the organizational and market factors associated with the use of intensivists. The analyses performed in this paper rely on 2007-2010 longitudinal data from the American Hospital Association's (AHA's) Annual Survey, the Area Resource File (ARF), the Bureau of Labor Statistics and the American Nurses Credentialing Center's website. The dichotomous dependent variable in the study was the use or nonuse of intensivists and the organizational independent variables included system membership, ownership status, and hospital size. The market independent variables included in the study were per capita income, percentage of residents 65 or older, percentage of specialists, Medicare HMO penetration, level of competition and the change in unemployment rate. Control variables used in the study included rural status, critical access status, teaching status, magnet status and the use or nonuse of hospitalists. The study utilized logistic regression with year and state effects.

Paper 2: The Association Between the Use of Intensivists and the Efficiency of Care Provided by the Hospital's ICU

This paper explored the relationship between the use of intensivists and the efficiency of care provided in the ICU. The study was grounded in agency theory and included 2007 to 2010 longitudinal data from the AHA Annual Survey and the Healthcare Cost and Utilization Project's (HCUP's) State Inpatient Databases (SIDs) for New York and Washington States. Patient-level data from the SIDs were aggregated and merged with hospital-level AHA data. The dependent variables included in the study were the average length of stay and the average cost per patient day by each principal diagnosis of interest. The principal diagnoses of interest were acute myocardial infarction (AMI), congestive heart failure (CHF), stroke and pneumonia. The independent variables used in the study were a dichotomous variable indicating the use or nonuse of intensivists and the intensivist FTEs per patient day for all ICU patients. The control variables included in the analysis were the level of competition, nurse staffing, occupancy rate, percentage of Medicare patients, percentage of Medicaid patients, the total number of beds, the number of medical/surgical bed, the presence of cardiac intensive care beds, the percentage of female ICU patients by each principal diagnosis, the percentage of non-white ICU patients by each principal diagnosis, the average age of ICU patients by each principal diagnosis and the average number of comorbidities by each principal diagnosis. Fixed effects regression with facility and year fixed effects and standard errors clustered at the hospital level was utilized for the analysis.

Paper 3: The Association Between the Use of Intensivists and the Quality of Care Provided by the Hospital's ICU

This paper used Donabedian's quality framework to study the relationship between the use of intensivists and the quality and safety of care provided in the ICU. The data used in this study included 2007-2010 longitudinal data from the AHA Annual Survey and the SIDs for New York and Washington States. The dependent variables used to operationalize quality included two risk-adjusted inpatient quality indicators (IQIs) from the Agency for Healthcare Research and Quality (AHRQ) and five risk-adjusted patient safety indicators (PSIs) from AHRQ. The IQIs included were the AMI and stroke mortality rates. The five PSIs were the pressure ulcer rate, the death rate among surgical inpatients with serious treatable conditions, the perioperative hemorrhage rate or hematoma rate, the postoperative respiratory failure rate and the pulmonary embolism or deep vein thrombosis rate. The independent variable was a binary variable indicating the use or nonuse of intensivists. The control variables included were the level of competition, the nurse staffing level, the ICU patient volume per diagnosis or procedure of interest, and the number of medical/surgical ICU beds. Regression with facility and year fixed effects was utilized for the analysis and standard errors were clustered at the hospital level.

ORGANIZATIONAL AND MARKET FACTORS OF HOSPITALS USING INTENSIVISTS: A LONGITUDINAL ANALYSIS OF U.S. HOSPITALS 2007-2010

by

GLENN BARTHWICK LIDDLE

In Preparation for *Medical Care Research and Review*

Format adapted for dissertation

PAPER 1

ORGANIZATIONAL AND MARKET FACTORS OF HOSPITALS USING INTENSIVISTS: A LONGITUDINAL ANALYSIS OF U.S. HOSPITALS

ABSTRACT

Intensivists are physicians who specialize in providing care in the ICU. For many years, however, very few hospitals utilized intensivists to staff the ICU. Recently this has changed, as the use of intensivists in hospitals has grown substantially. While studies have explored the clinical and financial benefits associated with the use of intensivists, little is known about the organizational and market factors associated with a hospital's strategic decision to use intensivists. The purpose of this study is to use the resource dependence framework to better understand the organizational and market factors associated with the use of intensivists. This study included all acute short-term hospitals in the United States that were categorized as either non-federal governmental, nongovernment not-for-profit or investor-owned for-profit. The 2007-2010 longitudinal data was sourced from the American Hospital Association (AHA) Annual Survey, the Area Resource File (ARF), the Bureau of Labor Statistics and the American Nurses Credentialing Center database of magnet facilities. Logistic regression was performed using state and year fixed effects, clustered at the hospital level. The results from the analyses show that larger, not-for-profit hospitals that operate as a part of a system in

competitive urban markets with relatively high levels of munificence are more likely to utilize intensivists.

INTRODUCTION

Critical care is defined as "the diagnosis and management of life-threatening conditions that require close or constant attention by a group of specially trained health professionals" (Morrow et al. 2012, page 1408) and this critical care is provided within the intensive care unit (ICU) of a hospital. Because of the high intensity and cost of care provided, ICUs are one of the most significant units within a hospital. The ICU is where providers grapple with the most complex medical cases (Bai et al. 2010) and make life and death decisions every day as they judiciously care for the sickest, most acute patients in the hospital (Krizner 2008). Hospital ICUs are also one of the most costly microsystems within individual hospitals and within the United States health care system. ICUs can account for up to 30% of a hospital's budget and from a national perspective, critical care accounts for more than 20% of the total acute care hospital costs (Dorman and Pauldine 2007) even though only 15% of the hospital beds in the United States are allocated to critical care (Pastores and Halpern 2015). The costs of critical care services accounts for approximately one percent of the gross domestic product (GDP) in the United States (Scurlock et al. 2011).

Historically, referring or attending physicians have directed the majority of patient care provided in hospital ICUs. Under this traditional medical staffing model, multiple physicians are responsible for the care provided to patients in the ICU. While other specialists might provide consultation and guidance regarding specific issues, the referring or attending physicians are ultimately responsible for the care of patients in the ICU. It is important to note that under this traditional model of ICU physician staffing, there is no centralized physician management or coordination (Pronovost et al. 2004).

While the majority of hospital ICUs are still staffed using this traditional model (Dorman and Pauldine 2007), there is a growing trend of using intensivists to oversee the medical care of ICU patients. (Intensivists on the Rise 2011).

Intensivists are "physicians who specialize in critical care with the experience and skill required to detect and address changes in patients' clinical conditions, often before complications occur. Intensivists can be surgeons, anesthesiologists, internists, or pediatricians with additional training and board certification in critical care. They are often the ICU director and must have the ability to manage and coordinate care by a variety of clinicians" (Beldon 2002, page 28). When deciding how to best deliver ICU medical care, hospital administrators can make a strategic choice to utilize intensivists rather than relying solely on referring and attending physicians. While there are non-trivial incremental costs associated with staffing an ICU with intensivists (Krinzer 2008), studies have shown that the use of intensivists is associated with lower mortality rates (Pronovost et al. 2002), decreased length of stay (Dimick et al. 2001), decreased complications (Rosenfeld et al. 2000, Ghorra 1999) and decreased ancillary costs (Pronovost et al. 2004, Cooney 2002). In addition, the use of intensivists has been associated with improved ICU bed utilization and efficiency (Pollack et al. 1988), which can lead to increased throughput and improved revenues for a facility. Hospital administrators are constantly exploring strategies to make their facility more effective and efficient, especially in the ICU (Brilli et al. 2007). Given this drive to improve the quality and efficiency of the care given and early findings regarding the use of intensivists, the use of intensivists may be an effective strategy for a hospital to improve the quality of care provided in the ICU while simultaneously reducing the costs of that care.

When choosing an ICU staffing strategy, prudent hospital administrators will certainly weigh the cost of using intensivists with the purported benefits of such a strategy. This cost/benefit analysis along with a consideration of various environmental and organizational characteristics will help determine whether the use of intensivists is a strategy that should be employed at a given facility. While there is growing knowledge regarding the costs and benefits associated with the use of intensivists, little is known about the organizational and environmental characteristics that are associated with the likelihood that a hospital will choose to utilize intensivists in its ICU. The purpose of this study is to use a resource dependence framework to better understand the organizational and environmental characteristics that are associated with a hospital making the strategic choice to utilize intensivists. A better understanding of the characteristics associated with the use of intensivists, combined with existing knowledge regarding the benefits of intensivists, will assist policymakers, payers and hospital administrators in identifying additional opportunities made possible from the use of intensivists.

CONCEPTUAL FRAMEWORK

Strategic management focuses on aligning an organization with the external environment in which it operates (Ginn and Young 1992). In order to survive, organizations must not only detect, but must also prudently adjust to changes in the external environment. Financial and regulatory pressures along with the changes necessitated by the Patient Protection and Affordable Care Act (ACA) of 2010 have required health care organizations, including hospitals, to make and implement strategic decisions designed to realign themselves with the rapidly changing environment in which they operate. This realignment of the organization requires internal structures and processes to be reevaluated, adjusted and restructured as needed to adapt to the new external realities that exist in the environment in which the entity operates.

An example of a change in the external environmental with which a hospital must strategically realign itself is the shift in focus from payments for services being based simply on the volume of procedures performed to being based on the quality of care provided and the clinical outcomes produced. Numerous initiatives including value-based purchasing (Kahn et al. 2006, Kruse et al. 2012, Van Herck et al. 2010) and Medicare's modified payments for hospitals with high readmission rates (Krumholz et al. 2013, Joynt and Jha 2013) are designed to shift from payments being based solely on volume to payments being based on outcomes. In order to survive in this new, quality-focused payment environment, hospitals must develop effective strategies to realign their organizational goals (or priorities) in response to this change.

In order to successfully realign the organization in response to this shift in payment structure, hospitals must improve the quality of care provided by the facility while simultaneously ensuring that the admitting physicians, on whom the facility depends for patient volume and revenue, remain both productive and satisfied. This effort to advance quality, especially in the ICU, will most certainly require changes to current patient care procedures and processes and the facility will need the buy-in and cooperation from the admitting physicians to make these initiatives successful. While there has been a recent trend in the employment of physicians by hospitals (Charles et al. 2013), historically, most admitting physicians are not employed by the hospital, but are simply independent physicians that have admitting privileges to the facility. Because the hospital depends on these independent admitting physicians for vital patient volume, revenue, and the successful implementation of quality initiatives, these independent physicians can be conceptualized as a resource needed by a facility to survive and successfully execute its mission of providing sustainable, cost-effective, high-quality patient care in a new era of outcomes-based reimbursement structures. One potential strategy that can be used by a hospital to reduce uncertainty and dependence on the external resource of independent physician providers is through employing or contracting with their own physicians, namely intensivists. By utilizing an intensivist or a group of intensivists to staff an ICU rather than independent physicians, hospital administrators can assert a greater level of control over the physicians working in the ICU through employment or other contractual arrangements. This increased control can reduce a hospital's dependence on independent physicians to produce the level of quality needed to ensure the maximization of revenue received from payers transitioning from pay for volume to pay for clinical outcomes.

Within the resource dependence framework, organizations are assumed to operate within an open system and pursue power, autonomy and the buffering from external pressures by seeking to reduce dependence and interdependence on external resources (Pfeffer 2005). Organizations need these external resources to survive and these resources are assumed to be scarce (Ulrich and Barney 1984). The need for external resources and the unknown capability to acquire those resources causes uncertainty within an organization and an organization will seek to minimize that uncertainty. To minimize this uncertainty and maximize its power, Ulrich and Barney (1984, page 472) state that an organization will make changes and realign itself as it attempts "to acquire control over resources that minimize their dependence on other organizations."

Differences in both the external environment in which an organization operates and in the characteristics of the organization can influence the type of modifications and realignment an organization makes in response to changes in its environment (Zinn et al. 1997). For example, if the organization is in an environment where the resources it needs for survival are "abundant and supply is certain," then the organization is less worried about dependency issues. If, however, the organization is in a less favorable environment where resources are scarce and there are uncertainties regarding resource supply, the organization will "develop strategies and structures to lessen dependency and increase control over the environment" (Zinn et al. 1997, page 68).

In previous studies exploring the organizational and environmental characteristics associated with the likelihood of a hospital adopting a certain strategy, the environment has been viewed through the lenses of munificence, dynamism and complexity. Munificence is "concerned with the availability and accessibility of environmental resources" (Menachemi et al. 2012, page 15), while dynamism "refers to changes that are difficult to predict in terms of both frequency and direction that can increase environmental uncertainty for organizations" (Zinn et al. 1997, page 69). Finally, complexity refers to "the number and diversity of competitors, suppliers, buyers, and other environmental actors that firm decision makers need to consider in formulating strategy" (Zinn et al. 1997, page 69).

In the context of hospitals, an environmental variable relating to munificence is the per capita income of the market in which the hospital operates. Per capita income is a good measure of the overall resources available to the community and the hospital. Ginn and Young (1992) suggest that hospitals located in markets with higher levels of income experience a more munificent position due to favorable revenue sources and are therefore more likely to invest in proactive strategies such as the use of intensivists to staff the ICU. Since intensivist programs require a significant investment in salaries (Pronovost et al. 2004), it is suggested that hospitals that operate in more munificent environments, such as those markets with a higher per capita income, will be more likely to invest in an intensivists program within their facility. Based on this, the following hypothesis is proposed:

> H_1 – Hospitals located in markets with higher per capita income per 1,000 will be more likely to utilize intensivists within the ICU.

Another variable relating to munificence is the percentage of physicians that are specialists in a market. Hospitals depend on patient revenue in order to survive and invest in programs and services that patients demand. Revenue is generated from patient admissions, and the specialists in a market control the majority of patient admissions. Zinn et al. (1997) suggest that a higher percentage of specialists in a market leads to an increase in munificence due to an increase in overall patient admissions and resulting revenue streams generated by caring for those admitted patients. As stated above, hospitals depend on this patient volume to generate revenues that allow the hospital to operate and invest in new technologies and strategies, such as the use of intensivists. Since patient admissions are driven primarily by the specialists in a market, a hospital located in an environment with a high level of specialists, all other things being equal, will have access to a larger number of potential patient admissions for the hospital to serve. This higher level of admissions will allow the hospital to generate a larger portion of revenue, which will allow the hospital to invest in strategies such as the use of intensivists. Given this, the following hypothesis is proposed:

> H_2 – Hospitals located in markets with a higher percentage of specialists will be more likely to utilize intensivists within the ICU.

In a similar vein, hospitals also develop and implement strategies based on the patient demographics for their given market. According to Rainey and Shapiro (2001), individuals 65 and older utilize five to six times more ICU days per 1,000 population than those under the age of 65. If the market that the hospital serves has a higher percentage of individuals 65 and over, one could argue that the hospital would serve many more individuals that require the services of the ICU. Since the hospital would have access to larger patient volumes and the associated revenue streams of elderly, more acute patients, they would be more likely to invest in the use of intensivists in the ICU. Based on this, the following hypothesis is proposed:

> H_3 – Hospitals located in markets with a higher percentage of adults age 65 and over will be more likely to utilize intensivists within the ICU.

Medicare HMOs provide insurance coverage for those 65 and over through a managed care model. Managed care plans have traditionally focused on providing quality care while also striving to contain cost (Chernew et al. 2004). These plans attempt to achieve this goal of cost containment through mechanisms such as utilization management, disease management, and aggressive provider contracting (Mays et al. 2004). Regardless of the mechanisms used, each of these strategies is designed to reduce the payments made to providers. As a result of these reduced payments, there will be fewer revenue dollars available to providers in markets where there is a higher percentage of individuals covered by a Medicare HMO plan. In these less munificent markets, providers will be less likely to invest in strategies such as the use of intensivists and therefore the following hypothesis is offered:

> H_4 – Hospitals located in markets with a higher percentage of Medicare HMO penetration will be less likely to utilize intensivists within the ICU.

Dynamism relates to the turbulence in a given market. When an environment consists of constant change and uncertainty, it makes it difficult for an entity to choose a strategic direction. Several studies have used the change in unemployment rate to operationalize this construct (Kazley and Ozcan 2007, Menachemi et al. 2011, Menachemi et al. 2012). In addition, in a recent systematic review of the literature that explored the variables used to measure munificence, dynamism and complexity in studies of health care organizations, it was found that the change in unemployment rate was the most common variable used to measure dynamism (Yeager et al. 2014). It can be argued that hospitals that operate in markets with a higher rate of change in unemployment operate in a more uncertain market and will therefore be less likely to invest in strategies such as the use of intensivists. Based on this, the following hypothesis is proposed:

> H_5 – Hospitals located in markets with a higher rate of change in unemployment will be less likely to utilize intensivists within the ICU.

Complexity relates to the number of players that exist within a given market. One variable that can be used to measure complexity is the amount of competition that exists within a given market. If there is a high level of competition among hospitals, it can be argued that the hospitals are fighting over a limited pool of resources and will be more likely to invest in new strategies and services that will differentiate their facility from the competition in order to gain the patient volume they need for survival (Ginn and Young 1992). The Herfindahl Index, which measures market concentration, will be used to operationalize market competition. The lower the index value, the lower the concentration and the higher the market competition. (Trinh and O'Connor 2000). Based on this, the following hypothesis is proposed:

> H_6 – Hospitals located in markets with higher competition will be more likely to utilize intensivists within the ICU.

Organizational characteristics will also influence a facility's ability or decision to invest in a certain strategy in response to its environment. For example, larger facilities and those that are a part of a hospital system are able to benefit from economies of scale and may have access to resources that a smaller independent facility may not have access to. These "slack resources" have been found to have significant influence in the strategic options available to hospitals (Bigelow and Mahon 1989). If an organization is able to benefit from economies of scale and has more access to internal resources, it seems reasonable to suggest that the organization will be more likely to invest in strategic initiatives such as the use of intensivists to staff the ICU. Based on this, the following two hypotheses are proposed:

H_7 – Hospitals that are a part of a hospital system will be more likely to utilize intensivists within the ICU.

H_8 – Larger hospitals will be more likely to utilize intensivists within the ICU.

METHODS

Sample

The unit of analysis for this study was the hospital-year and the study included acute short-term general hospitals in the United States that were either categorized by the AHA as non-federal governmental, nongovernment not-for-profit, or investor-owned for-profit facilities. Because of their differing nature, the analysis excluded specialty hospitals and federal governmental hospitals such as those operated by Veteran's Affairs and the armed services. The study was a longitudinal analysis utilizing a panel design that included hospitals that were operated during a four-year period from 2007 to 2010. The sample used in this study consisted of approximately 18,687 hospital-year observations, or approximately 4,672 hospitals per year, over the four-year study period.

Data

In order to test the proposed hypotheses, data from the American Hospital Association's (AHA's) Annual Hospital Surveys for the years included in the study were merged with data from the Area Resource File (ARF), magnet status data from the American Nurses Credentialing Center (ANCC), and unemployment data obtained from the Bureau for Labor Statistics. The AHA databases provided various hospital-level characteristics such as whether or not the hospital operated an ICU, whether or not the hospital utilized intensivists, the size and ownership status of the hospital, whether the hospital was part of a system, the teaching status of a hospital, the rural status, and its critical access status. In addition, the AHA dataset indicated the use or non-use of hospitalists (physicians employed by the hospital who are responsible for managing the care of hospitalized patients) (Wachter and Goldman 1996) and provided adjusted patient day data that was utilized to calculate the Hirschman-Herfindahl index (HHI) attributed to each hospital. The ARF provided environmental characteristics by county such as per capita income per 1,000, percentage of physicians that were specialists, percentage of the population that was over 65 and Medicare HMO penetration. The magnet status of the hospitals included in the analysis was obtained from the ANCC website. Finally, the change in unemployment data was calculated from unemployment rates obtained from U.S. Bureau of Labor Statistics website.

Variables

Table 1 list each variable used in this study and notes the definition and source of each. The dependent variable in this analysis was the use or non-use of intensivists. This variable was sourced from the AHA database and was coded as a dichotomous variable where 1 indicated the use of intensivists and 0 indicated that intensivists were not utilized by the facility.

The independent variables of interest in this analysis included each of the environmental and organizational variables chosen for study. The environmental variables chosen to measure munificence included per capita income per 1,000 (H_1), the percentage of physicians that were specialists (H_2) the percentage of the population age 65 or over (H_3) and Medicare HMO penetration (H_4).

To measure dynamism, the change in unemployment rate by county (H_5) was utilized. The change in unemployment data was sourced from the Bureau for Labor Statistics. Unemployment rates by county were obtained for the years 2006 through 2010 and the year over year change was calculated for each of the study years (2007, 2008, 2009 and 2010) for each county. The year over year change was calculated by subtracting the prior year value from the current year value and dividing the result of this calculation by the prior year value.

To measure complexity, market competition was operationalized through a calculated Hirschman-Herfindahl Index (HHI) based on hospital reported adjusted patient days using Health Services Areas (HSA) to define the geographic market to which a hospital belonged. HSAs have been used to define geographic markets in numerous hospital studies (Connor et al. 1997, Ho and Hamilton 2000, Seago et al. 2001). According to the AHA database documentation, the HSAs were determined by researchers from the Dartmouth Atlas of Health Care and represent a cluster of zip codes where patients receive the majority of their care. According to the documentation, there were 3,436 discreet HSAs for each of the years included in this study. Annual adjusted patient days for each facility were sourced from the AHA database and the HHI for each facility was calculated as the sum of squared market shares of adjusted patient days for each hospital in the HSA (Dranove and White 1998). The resulting HHI for each facility ranged between 0 and 1, with 1 representing a monopolistic market with no competition and with 0 representing a market with a high level of competition.

Finally, the organizational variables included in the analysis were system membership and hospital size. These two variables were sourced from the AHA databases. System membership was coded as a binary variable, with a 1 indicating the hospital was a member of a system or a 0 indicating the hospital was independent. Hospital size was operationalized as the total number of beds "set up and staffed" as reported in the AHA databases.

Several control variables were included in the analysis including rural status, teaching status, critical access status and use of hospitalists (regardless of the use of intensivists). Ownership status was also included and was represented as a series of dummy variables with for-profit entities serving as the reference category. In addition to these control variables, a hospital's magnet status was also included. Magnet status is a certification that can be earned by hospitals by meeting stringent requirements set forth by the American Nurses Credentialing Center (ANCC). By meeting these requirements and earning this certification, facilities visibly demonstrate a focus on high quality patient care and nursing excellence. Studies have found that achieving magnet status has been associated with reduced patient falls (Lake et al. 2010), lower odds of failure-to-rescue and lower odds of patient mortality (McHugh et al. 2013). In this study, magnet status was a dichotomous variable set to 1 for facilities that had achieved magnet status and 0 for all other facilities. The data for this variable was sourced from the American Nurses Credentialing Center website.

-------Insert Table 1 around here-------

Analysis

Once the data were properly merged and tested for underlying multivariate assumptions, multiple analyses were performed to describe the data and to test the proposed hypotheses. Univariate and bivariate analyses were performed to provide basic descriptive statistics of the data and to test the relationship between hospitals that utilize intensivists and those that did not use intensivists. T-tests and chi-square procedures were performed to determine whether there was a statistical difference between the two groups of facilities and the results of these analyses showed that there was a statistical difference between the two groups. In order to test for multicollinearity, the correlations between each of the predictor variables included in the study were calculated. None of the correlation coefficients in this analysis were greater than 0.8, so it was determined that none of the predictor variables were highly correlated. Because the dependent variable was a dichotomous variable, this study used logistic regression to determine the likelihood that a facility would utilize intensivists based on each of the independent variables included in the analysis. The resulting equation used in the analysis is as follows:

Logit(Use of Intensivists)= $ß_0 + ß_1$(per capita income per 1,000) + $ß_2$(percentage specialists) + $ß_3$(percent 65+) + $ß_4$(change in unemployment) + $ß_5$(Medicare HMO penetration) + $ß_6$(market competition) + $ß_7$(system membership) + $ß_8$(not-for-profit) + $ß_9$(governmental) + $ß_{10}$(number of beds) + $ß_{11}$(rural status) + $ß_{12}$(teaching status) + $ß_{13}$(critical access status) + $ß_{14}$(magnet status) + $ß_{15}$(use hospitalists) + $ß_{16}$(year) + $ß_{17}$(facility) E

Since most of the independent variables did not change from year to year, facility random effects were utilized in the analysis. By using random effects, we were able to analyze the effect of the time-invariant variables. With the random effects model, the unobserved effects were assumed to be uncorrelated with the explanatory variables. With this model, however, there was the risk of bias for any control variables not included in the analysis. In order to control for trends by state and over time, state and year fixed effects were utilized in the analysis. By utilizing state fixed effects we controlled for any interstate differences in regulations or other factors that may influence hospital behavior and by including year fixed effects, we control for any time based factors that may influence hospital behavior. Finally, we clustered at the hospital level to mitigate any issues related to repeated measures. All of the analyses were performed using SAS Version 9.3 and STATA Version 13. The p-values for all of the variables compared were considered to be statistically significant using $p < 0.10$ as the threshold.

RESULTS

Univariate Results

The univariate results from this study are shown in Table 2. These univariate results described the distribution of hospitals by the various dependent, independent and control variables for the first and last years in the study. From these results, one can see the growth in the use of intensivists from 2007 to 2010 with only 8.9% of the facilities in the sample using intensivists in 2007 compared to 17.3% of the facilities in 2010. In absolute values, the number of hospitals using intensivists almost doubled from 420 facilities in 2007 to 804 facilities in 2010. For most of the independent and control variables, the univariate analysis revealed that the distribution of hospitals in each category remained relatively constant between 2007 and 2010. For example, the mix of investor owned for-profit, non-government not-for-profit and government non-federal hospitals remained relatively constant with 16.8% being categorized as for-profit, 59.1% categorized as not-for-profit and 24.0% categorized as non-federal government in 2007 compared to 17.3%, 59.3% and 23.4% respectively in 2010.

Two areas where there was a shift from 2007 to 2010 were magnet status and the use of hospitalists. The number of facilities with magnet status grew from 176 in 2007 to 262 in 2010 and the percentage of hospitals using hospitalists went from 16.3% in 2007 to 41.1% in 2010. With these two exceptions, most independent and control variables experienced little variation between the base year of 2007 and the final year of the study, 2010.

-------Insert Table 2 around here-------

Bivariate Results

The bivariate analyses performed in this study are summarized in Table 3. These analyses compared the hospitals that utilized intensivists to those that did not use intensivists. The results indicate that there was a statistically significant difference between hospitals that utilize intensivists and those that do not. From an organizational characteristics perspective, the bivariate results indicated that hospitals that used intensivists tended to be larger in size, not-for-profit, and system affiliated.

When looking at the variables used to measure munificence, the results were mixed. As predicted by resource dependence theory, two of the variables seemed to indicate that hospitals that used intensivists tended to be in more munificent markets than hospitals that did not use intensivists. For example, hospitals using intensivists tended to be located in markets with a higher per capita income per 1,000 ($4.2174 versus $3.4769) and in markets with a higher percentage physicians that were specialists (35% versus 27.8%). The other two munificence variables, however, seemed to indicate the opposite. The bivariate results indicated that hospitals that used intensivists tended to have slightly smaller percentage of residents 65+ (12.7% versus 14.7%) and a higher percentage of Medicare HMO penetration (23.5% versus 19.0%).

The change in unemployment rate was used to operationalize dynamism and contrary to the predicted relationship, the bivariate results indicated that hospitals that used intensivists were located in markets with slightly higher change in unemployment rates (22.4 versus 20.8%). The level of competition in a market was used to operationalize complexity and the results indicated that hospitals that used intensivists were located in more competitive markets (HHI of 0.47 versus 0.72).

The bivariate analysis performed on the control variables indicated that hospitals that used intensivists tended to be urban and not considered a critical access facility. In addition, a higher percentage of facilities using intensivists were teaching facilities when compared to facilities that did not use intensivists (27.0% versus 2.8%). Similarly, a higher proportion of facilities using intensivists had obtained magnet status when compare to facilities that did not use intensivists (19.9% versus 2.6%). Finally, it appears that facilities that use intensivists were also more likely to utilize hospitalists with 80.2%

of the hospitals utilizing intensivists also using hospitalists. This is in contrast to hospitals that did not utilize intensivists where only 20.9% used hospitalists.

-------Insert Table 3 around here-------

Multivariate Results

The multivariate analyses supported several of the proposed hypotheses. Two of the four munificence hypotheses were supported by the data with H_1 (per capita income per 1,000) and H_2 (percentage of specialists) exhibiting statistically significant relationships in the predicted direction. The multivariate results showed that hospitals located in markets with higher per capita income per 1,000 (H_1) have a 0.064% higher likelihood of using intensivists (M/E 0.0006413, $p = 0.015$). In addition, the results indicated that hospitals in markets with a higher percentage of specialists have a 12.7% higher likelihood of using intensivists (M/E 0.127, $p = 0.002$). These results gave some credence to the concept that hospitals located in more munificent environments would be more likely to invest in strategies such as the use of intensivists. The data did not support, however, H_3 (percentage of population 65+) and H_4 (Medicare HMO penetration). Contrary to the predicted relationship, the results showed that hospitals located in markets with a higher percentage of population 65+ had a 20.5% lower likelihood of investing in intensivists (M/E -0.205, $p = 0.079$). The relationship between Medicare HMO penetration (H_4) and the use of intensivists was not statistically significant ($p = 0.81$).

According to the resource dependence theory framework, hospitals located in more dynamic environments operate in a more uncertain environment and would therefore be less likely to invest in strategies such as the use of intensivists. Change in unemployment rates was used to operationalize the concept of dynamism for this study, but the relationship between the change in unemployment rate and the use of intensivists was not found to be statistically significant.

Using resource dependence theory, it was predicted that hospitals operating in more complex environments would be more likely to invest in intensivists. The level of competition as measured by the Herfindahl index was used to operationalize this construct and the predicted relationship between the level of complexity in a market and a hospital's likelihood of utilizing intensivists was supported. Our analysis found that hospitals in more competitive markets had a 5.1% higher likelihood of utilizing intensivists (M/E -.054, $p < 0.001$).

Two organizational hypotheses were proposed and both predicted relationships were supported by the analysis performed. The results indicated that larger hospitals have a 0.015% higher likelihood of using intensivists (M/E 0.0001533, $p < 0.001$) and that system-affiliated hospitals also had a 1.2% higher likelihood of using intensivists (M/E. 0.012, $p = 0.06$).

-------Insert Table 3 around here-------

DISCUSSION

Using a resource dependence theory framework, several hypotheses related to environmental and organizational characteristics were proposed and tested. As suggested by resource dependence theory, munificence was found to be an important predictor of the use of intensivists. While two of the four munificence variables did not support the proposed hypotheses, both per capita income per 1,000 and the percentage of physicians that were specialists were found to predict the use of intensivists. This suggests when more resources are available in a market, hospitals are more likely to invest in strategies such as the use of intensivists. Conversely, hospitals located in markets with a lower level of resources are less likely to invest in intensivists. If this is true, and if evidence continues to mount supporting the notion that the use of intensivists is associated with improved quality and patient outcomes, this finding suggests that the lack of resources available to invest in intensivists potentially expands the divide between those who have ready access to high quality patient care and those who do not. If a hospital's decision to utilize intensivist is at least partially driven by the resources available within the market, then patients served by hospitals in lower resource markets will be less likely to receive the benefits of having an intensivists involved in their care. As the United States explores mechanisms to reduce disparities in the level of care provided across markets, perhaps some form of financial incentive for hospitals should be considered to encourage the use of intensivists regardless of the resources available within the market.

The complexity variable of competition operationalized as a HHI based on adjusted patient days was found to be statistically significant and in support of the proposed hypothesis. Our proposed hypothesis was that hospitals operating in more competitive markets would have a higher probability of utilizing intensivists. This finding tends to suggests that hospitals might be investing in the use of intensivists as a competitive advantage when competition is strong within the market it operates. This implies that patients receiving care in highly competitive markets are more likely to be the recipients of the purported benefits of intensivists directing care provided in the ICU.

Both the organizational hypotheses tested in our study, system membership and hospital size, were supported by our analyses. Hospital size was found to increase the probability of a hospital investing in the use of intensivists. System membership was also found to increase the probability of utilizing intensivists, The results appeared to support the notion that facilities within a system have access to "slack resources" often found within hospital systems and are willing to use these slack resources to invest in strategies such as utilizing intensivists. Like the munificence variables, this finding tends to support the idea that the abundance or lack of resources within a hospital or a hospital system could influence the type of care provided by a facility. Patients who are treated by larger, system affiliated facilities with slack resources are more likely to benefit from having an intensivist involved in their care than a patient that is treated at a smaller, independent facility.

The dynamism variable used in this study did not prove to be a statistically significant predictor of the use of intensivists by facilities. The change in unemployment rates for a given county failed to demonstrate a statistically significant relationship with the use of intensivists. Perhaps these results suggest that facilities are more concerned with the external resources available within the market (munificence), the level of competition (complexity) and the availability of slack resources within the organization (hospital size and system-affiliation) than the change and uncertainty in the market when deciding to either use or not use intensivists within the facility.

Several control variables were incorporated in this study, including rural status, teaching status, critical access status, ownership status, whether the facility had earned magnet status and whether the facility utilized hospitalists. All of the control variables were found to be statistically significant with the exception of rural status. According to the analysis performed, both governmental and not-for-profit facilities were more likely than for profit facilities to utilize intensivists. In addition, teaching facilities, facilities that had earned magnet status and facilities that utilized hospitalists were all more likely to utilize intensivists. Perhaps these results indicate that facilities that are more innovative and focused on high quality patient care (as exhibited by the achievement of magnet status and the use of hospitalists) are also more likely to invest in new strategies such as the use of intensivists.

Taken as a whole, the univariate, bivariate and multivariate analyses performed in our study appear to reveal a compelling and consistent depiction of facilities that utilize intensivists. Facilities that utilize intensivists appear to be larger, not-for-profit entities that operate as a part of a system in competitive urban markets with relatively high levels of munificence. These facilities are less concerned with the complexity and uncertainty present in its market than with the level of competition and how to best differentiate from other facilities in the market. Perhaps in an effort further differentiate from other facilities, entities that use intensivists are also more apt to utilize other strategies such as achieving magnet status or using hospitalists to care for patients within the facility.

POLICY AND RESEARCH IMPLICATIONS

While the use of intensivists to staff ICUs has grown, our results indicate that intensivists are still only utilized by a fairly small percentage of hospitals across the United States. Even after years of growth, intensivists were only utilized in less than a fifth of the facilities that met our criteria in 2010. If the evidence continues to point toward an association between the use of intensivists and improved quality and lower costs, policymakers should explore how to best encourage the use of intensivists in a greater number of ICUs, especially in markets that are challenged for resources. Perhaps financial incentives for hospitals, particularly those located in lower resource environments, should be considered to help offset the initial and ongoing investment required to hire and maintain intensivists in the ICU.

Even with enhanced financial incentives, it may not make financial nor operational sense for many small, rural facilities to utilize intensivists in the ICU. Future research should explore different approaches to using both financial and human resources more efficiently. For example, one approach that could be considered is incentivizing smaller facilities to shut down the ICU in their facility in favor of a transfer partnership with a larger, more resource-rich facility. By using this hub-and-spoke model, small facilities can focus on the less acute cases for which they are equipped to handle while the larger, more robust facilities can focus on handling the more acute, harder to manage cases that would benefit from resources like the use of intensivists in the ICU. Regardless of the approach, if evidence continues to point toward improved quality and reduced costs, policymakers should consider how to maximize the use of intensivists.

LIMITATIONS

There were several limitations present in our study. First, the data used in the study were secondary and self-reported in nature and therefore subject to the limitations that are commonly found with using these type data. Another limitation was that the particular type of intensivist staffing model utilized by each hospital was not considered in the analysis. There are several distinct ICU staffing models used by hospitals that vary in terms of the specific roles and responsibilities of the intensivists and other caregivers. The data used for this analysis did not include details regarding the specific model used by each facility. Another limitation was the dichotomous measure used in the analysis did not allow for the consideration of how long an intensivist had been used by a facility. The use of intensivists was based solely on whether the facility had reported intensivist FTEs. Finally, due to data limitations, our study was not able to discern and therefore differentiate between intensivists that might have been employed or simply contracted.

CONCLUSION

With the continued focus on improving quality and reducing costs within our healthcare system, policymakers and practitioners will continue to search for strategies that will help achieve these goals. The early evidence seems to support the notion that the use of intensivists in the ICU could help facilities improve the care provided to the sickest patients and reduce the costs of providing that care. While there have been some studies that have focused on the association between the use of intensivists and improved quality and reduced costs, no studies to date have explored the environmental and organizational characteristics of hospitals associated with the decision to utilize intensivists. This study aimed to provide additional knowledge around the factors that predict the use of intensivists. With a better understanding of which facilities utilize intensivists, policymakers and practitioners can have a better idea of how to best move forward with the use of intensivists in the ICU.

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TABLES

Table 1: A listing of all variables used in the analysis along with definitions and sources.

Variable	Description	Source
Dependent Variable		
Use of Intensivists	Coded as 1 if facility reported intensivist FTEs. Otherwise, coded as 0.	AHA Annual Surveys
Independent Variables		
-Munificence-		
Per capita income per 1,000	Total personal income of the residents of a given area divided by the resident population of the area divided by 1,000	ARF
Percentage of physicians that are specialists	Total number medical specialist divided by the total number of active physicians.	ARF
Percentage of the population 65 or older	Percentage of a county population age 65 or older.	ARF
Medicare HMO penetration	Percentage of Medicare eligible population enrolled in a Medicare Advantage (HMO) plan.	ARF
-Dynamism-		
Change in unemployment rate	Year over year change in the unemployment rate for each county (FIPS code). Calculated by subtracting the prior year value from the current year value and dividing the result by the prior year value.	Bureau of Labor Statistics
-Complexity-		
Level of Competition	Operationalized with the HHI using adjusted patient days for each facility within each HSA. Calculated as the sum of the squares of each hospital's market share within a given HSA. Market share for each hospital was calculated by dividing the hospital adjusted patient days by the total adjusted patient days for the market in which the hospital operated.	AHA Annual Surveys
-Organizational Characteristics-		
System	Binary variable indicating facility was part	AHA Annual

Variable	Description	Source
Membership	of a system. Coded to 1 if facility was part of a system. Otherwise, coded as 0.	Surveys
Hospital Size	Number of beds set up and staffed as reported by each facility.	AHA Annual Surveys
Control Variables		
Rural Status	Coded as a 1 if facility was considered a rural referral center, a critical access center or a sole community provider. Otherwise, coded as 0.	AHA Annual Surveys
Teaching Status	Coded as a 1 if facility was tagged as a teaching facility in the AHA databases. Otherwise, coded as 0.	AHA Annual Surveys
Critical Access Status	Coded as 1 if facility was tagged as a critical access facility. Otherwise, coded as 0.	AHA Annual Surveys
Magnet Status	Coded as 1 if facility maintained magnet status in the year being analyzed. Otherwise, coded as 0.	The American Nurses Credentialing Center website
Ownership status	Indicates whether a facility is governmental, not-for-profit or for-profit.	AHA Annual Surveys
Use of hospitalists	Coded as 1 if facility reported hospitalists FTEs. Otherwise, coded as 0.	AHA Annual Surveys

Table 2: Descriptive statistics of hospitals for the base year of 2007 and the final year of 2010

	2007		2010	
Dependent Variables				
Use intensivists (n, %)	420	8.9%	804	17.3%
Do not use intensivists	4,287	91.1%	3,842	82.7%
Total (n, %)	4,707	100.0%	4,646	100.0%
Independent Variables				
System Membership				
Independent (n, %)	2,196	46.7%	2,070	44.6%
Part of a system (n, %)	2,511	53.3%	2,576	55.4%
Hospital size ($\bar{x}$, σ)	166.15	183.86	166.34	189.69
Per capita income per 1,000 ($\bar{x}$, σ)	$3.4185	$1.1395	$3.6350	$1.0361
Percentage of residents 65+ ($\bar{x}$, σ)	14.1%	3.9%	14.6%	4%
Percentage of specialists ($\bar{x}$, σ)	28.8%	13.6%	28.3%	13.1%
Medicare HMO penetration ($\bar{x}$, σ)	18.6%	13.6%	20.9%	14.4%
Level of competition, HHI ($\bar{x}$, σ)	0.69	0.36	0.69	0.36
Change in unemployment rate ($\bar{x}$, σ)	0.016%	10.3%	3.5%	8.9%
Control Variables				
Ownership				
Investor owned, for profit (n, %)	792	16.8%	805	17.3%
Non-government, not-for-profit (n, %)	2,784	59.1%	2,755	59.3%
Government, non-federal (n, %)	1,131	24.0%	1,086	23.4%
Rural status				
Rural (n, %)	1,923	40.9%	1,935	41.6%
Non-rural (n, %)	2,784	59.1%	2,711	58.4%
Critical access				
Critical access (n, %)	1,263	26.8%	1,301	28.0%
Not critical access (n, %)	3,444	73.2%	3,345	72.0%
Teaching status				
Teaching facility (n, %)	276	5.9%	273	5.9%
Non-teaching facility (n, %)	4,431	94.1%	4,373	94.1%
Magnet status				
Magnet (n, %)	176	3.7%	262	5.6%
Non-magnet (n, %)	4,531	96.3%	4,384	94.4%
Use of hospitalists				
Use hospitalists	765	16.3%	1,909	41.1%
Do not use hospitalists	3,942	83.7%	2,737	58.9%

Table 3: Descriptive statistics by use of intensivists by hospital-year observations

n = 18,727 hospital-year observations			
	Hospitals Used Intensivists	**Hospitals Did Not Use Intensivists**	**p-value**
Independent Variables			
System Membership			<0.0001
Independent (%)	34.4%	47.4%	
Part of a system (%)	65.6%	52.6%	
Hospital size (x̄)	368.6	137.2	<0.0001
Per capita income per 1,000 (x̄)	$4.2174	$3.4769	<0.0001
Percentage of residents 65+ (x̄)	12.7%	14.6%	<0.0001
Percentage of specialists (x̄)	35.0%	27.8%	<0.0001
Medicare HMO penetration (x̄)	23.5%	19.0%	<0.0001
Level of competition, HHI (x̄)	0.47	0.72	<0.0001
Change in unemployment rate (x̄)	22.4%	20.8%	0.0086
Control Variables			
Ownership			<0.0001
Investor owned, for profit (%)	5.1%	18.7%	
Non-government, not-for-profit (%)	82.3%	55.9%	
Government, non-federal (%)	12.6%	25.4%	
Rural status			<0.0001
Rural (n, %)	9.6%	45.8%	
Non-rural (n, %)	90.4%	54.2%	
Critical access			<0.0001
Critical access (n, %)	0.6%	31.1%	
Not critical access (n, %)	99.4%	68.9%	
Teaching status			<0.0001
Teaching facility (n, %)	27.0%	2.8%	
Non-teaching facility (n, %)	73.0%	97.2%	
Magnet status			<0.0001
Magnet (n, %)	19.9%	2.6%	
Non-magnet (n, %)	80.1%	97.4%	
Use of hospitalists			<0.0001
Use hospitalists	80.2%	20.9%	
Do not use hospitalists	19.8%	79.1%	

Table 4: Multivariate logistic regression results of environmental and organizational factors associated with the use of intensivists

n = 18,687 hospital-year observations		
	Odds Ratio	**Marginal Effects**
Munificence variables		
Per capita income per 1,000	1.0095*	0.00064*
Percentage of physicians that are specialists	6.570**	0.127**
Percentage of the population 65+	0.048+	-0.205+
Medicare HMO penetration percentage	0.999	-0.00008
Dynamism variables		
Change in unemployment rate	1.086	0.00561
Complexity		
Competition - HHI	0.448***	-0.054***
Environmental variables		
System membership	1.194+	0.012+
Hospital size	1.002***	0.00015***
Control Variables		
Governmental, non-federal	2.749***	0.0684***
Non-governmental, not-for-profit	2.852***	0.0709***
Rural status	0.827	-0.013
Critical access	0.071***	-0.179***
Teaching status	1.650***	0.034***
Magnet status	1.741***	0.038***
Use of hospitalists	7.852***	0.139***
Significant at: + p < 0.1 * p < 0.05 ** p < 0.01 *** p < 0.001		

THE ASSOCIATION BETWEEN THE USE OF INTENSIVISTS AND THE EFFICIENCY OF CARE PROVIDED BY THE HOSPITAL'S ICU

by

GLENN BARTHWICK LIDDLE

In Preparation for *Health Services Research*

Format adapted for dissertation

PAPER 2

THE ASSOCIATION BETWEEN THE USE OF INTENSIVISTS AND THE EFFICIENCY OF CARE PROVIDED BY THE HOSPITAL'S ICU

ABSTRACT

Objective: Intensivists are physicians who specialize in providing care in the ICU. The use of intensivists increased dramatically from 2007 to 2010. The purpose of this study is to use agency theory to examine the relationship between the use of intensivists and the efficiency of care provided in the ICU.

Data Source/Study Setting: This longitudinal study used 2007-2010 data sourced from the American Hospital Association (AHA) Annual Survey and the Healthcare Cost and Utilization Project's (HCUP) State Inpatient Databases (SID) for New York and Washington States. The sample included acute, short-term, general hospitals in New York and Washington State that were categorized as either non-federal governmental, nongovernment not-for-profit or investor-owned for-profit.

Study Design: The study was a panel design and used facility and year fixed effects regression with clustering at the hospital level to explore the association between the use of intensivists and the efficiency of care provided in the ICU.

Principal Findings: The study found a nonlinear relationship between the use of intensivists and the average cost per patient day for patients with primary diagnoses of AMI and CHF. For AMI patients, only the lowest and the highest levels of intensivist staffing intensity were associated with a lower cost per patient day. For CHF patients, only the highest level of staffing was associated with a reduction in average cost per patient day.

Conclusions: As providers seek to improve the value of the healthcare provided, one potential strategy to reduce costs is the use of intensivists. This study found that certain intensities of intensivist staffing for certain types of patients is associated with lower average cost per patient day.

Keywords: Intensivist, average length of stay, cost per patient, agency theory

INTRODUCTION

The value of health care services can be conceptualized as the health outcomes achieved per dollar spent on those services (Porter 2010). Many have suggested that the value of healthcare services in the United States is lacking. The concern regarding the value received from health care services stems from both sides of the value equation; the rising cost of care (Bodenheimer 2005) and the corresponding lackluster (or even harmful) clinical results received from that care (Chassin and Galvin 1998). In other words, Americans are paying more for substandard clinical results. Because of these deficiencies, improving the value of health care services in the United States is a high priority for both policy makers and providers (Pronovost et al. 2007, Neese et al. 2010, Orszag and Ellis 2007).

In response to these concerns, policy makers, payers and providers are all under extreme pressure to develop and implement strategies that either improve the quality of the care provided or reduce the cost of providing that care. Recent policy, payer and provider initiatives such as the implementation of electronic medical records (Bardhan and Thouin 2012, Hillestad et al. 2005), pay-for-performance (Petersen et al. 2006), bundled payments (Orszag and Emanuel 2010) and provisions of the 2010 Affordable Care Act (ACA) (Koh and Sebelius 2010, Kocher and Adashi 2011) are designed to either improve quality or reduce cost of care.

One strategy that has been purported to improve quality while simultaneously increasing efficiency and reducing cost in the intensive care unit (ICU) is the use of intensivists. Intensivists are often employed or contracted by the hospital and are "physicians who specialize in critical care with the experience and skill required to detect and address changes in patients' clinical conditions, often before complications occur. Intensivists can be surgeons, anesthesiologists, internists, or pediatricians with additional training and board certification in critical care" (Beldon 2002, page 28). Intensivists are often the ICU director and are charged with managing and coordinating the costly care provided in the ICU (Beldon 2002).

The ICU is a significant component of hospital operations. The ICU can represent as much as 30% of a hospital's budget (Dorman and Pauldine 2007) and at a national level, the care provided in these units accounts for more than 20% of the total acute care hospital costs (Pronovost et al. 2004), while only 15% of hospital beds in the United States are allocated to critical care (Pastores and Halpern 2015). ICUs care for some of the sickest patients in the health care system (Krizer 2008) and these patients utilize more resources and incur more cost than other patients (Scurlock et al. 2011). The number of patients being cared for by hospital ICUs is increasing (Rosenfeld et al. 2000), and based on demographic trends, the number of patients requiring care in the ICU will continue to increase for the foreseeable future (Dorman and Pauldine 2007). Given these factors, it is easy to see the potential that improvements made in the operations of the ICU by staffing with intensivists could have considerable impact on the quality, efficiency and costs of the care provided within the hospital.

Several studies have examined the association between the use of intensivists and hospital efficiency and costs. For example, in Dimmick et al. (2001), the authors found that for patients who underwent an esophageal resection, daily rounds with an ICU physician was associated with shorter lengths of stay and reduced hospital expenses. Similarly, Breslow et al. (2004) found that length of stay (LOS) was reduced from 4.35

days to 3.63 days after the implementation of an e-ICU program where intensivists provided services remotely using electronic monitoring and communication technologies. Finally, in a structured literature review, Pronovost et al. (2002) found that in 14 of the 18 studies included in their analysis, LOS was reduced with the staffing of ICUs with intensivists

While these studies certainly lend credence to the positive effects on cost and efficiency associated with the use of intensivists, it is important to point out that the results have sometimes been mixed, that most of these studies included a small number of ICUs and/or the results related to a single type of patient, diagnosis or procedure treated. This paper seeks to build on the existing literature by expanding the focus to a larger number of facilities with ICUs and firmly grounding this study on a conceptual framework based on agency theory. In addition, this study seeks to provide policy makers and administrators a better understanding of the association between the use of intensivists and efficiency and costs within the hospital. This more generalizable understanding of the potential benefits of utilizing intensivists will help leaders in healthcare make decisions that generate the greatest value to patients, hospitals and the overall healthcare system.

CONCEPTUAL FRAMEWORK

Agency theory guided this study. In agency theory, there are two key roles within an organization. The first, the principals, are those who own the entity and the second, agents, are the individuals who are contracted by the principals to perform necessary tasks within the entity on behalf of the principals. Agency theory attempts to explain this relationship between the principal who delegates work and the agent who performs the work (Jensen and Meckling 1976, Eisenhardt 1989). This relationship between the principal and the agent is conceptualized as a contract. This contract is considered an agreement where one or more principals engage one or more agents to perform a service on their behalf. This arrangement between the principal and the agent assumes that some or all of the decision-making authority is delegated from the principal to the agent (Jensen and Meckling 1976). Because the decision-making authority is delegated from the principal to the agent and the perspectives and interests of the principal and the agent will inherently differ, contracts between the principal and the agent are not perfectly efficient. Inefficiencies in contracts are due to agency problems such as differing goals (Eisenhardt 1989), asymmetric information (Kohli and Kettinger 2004, Ludwig et al. 2010), and differences in risk preferences (Kohli and Kettinger 2004). Agency theory focuses on determining the most efficient contract between the principal and the agent (Eisenhardt 1988).

To address agency problems and work towards maximizing the efficiency of the contract, principals must align their goals with the goals of the agent. According to Eisenhardt (1988 page 492), "organizations are viewed as collectives of self-interested people with partially conflicting goals" and these goal conflicts are "resolved through alignment of goals through the use of incentives." To align the goals of the principal and the agent, the principal usually relies on various compensation and incentive programs for the agent (Lee et al. 2006). There are two key approaches to designing incentives intended to align the goals of the principal and the agent. The principal can either design incentives to reward the agent's actions (behavior-based) or the incentives can be structured to reward the outcomes of the agent's actions (outcome-based). The main decision to be made by the principal is on which of these to base agent incentives (Mott et al. 1998).

A hospital's goal is to provide high quality patient care in an efficient, cost-effective manner. Hospitals deliver this care through various structures and processes. Through a host of buildings, equipment, technology, departments, professionals and processes, hospitals strive to deliver care that results in better clinical outcomes for their patients while utilizing the fewest resources. To achieve this goal, a hospital must attempt to align its goals (as the principal) with the goals of each of the staff members and providers (as the agents). Many of these agents, such as nurses, lab techs, radiologists, etc., are employed by the hospital and therefore the hospital can rely on traditional employment rewards and incentives - behavior or outcomes based - to help align its goals with the agents' goals. In addition, the hospital can couple these rewards and incentives with information systems and other control processes that allow the hospital to reduce information asymmetries that exist between the two parties. While these mechanisms might be relatively effective for hospital employees, they are likely less effective in aligning the goals of the hospital with the goals of independent referring physicians.

Traditional physician staffing in hospitals, including the staffing of physicians in ICUs, has relied heavily on the independent referring physician as the initial admitter of patients to the hospital and the ICU. That same independent physician would then coordinate the care provided to those patients during their stay in the hospital and ICU.

These referring physicians are largely autonomous from the hospital and have little incentive to align their personal goals with the goals of the hospital. This traditional relationship between the hospital and the physician has been labeled as the “physician’s workshop” model. Under this model, independent physicians are given admitting rights to a hospital. Once the physician has these admitting rights, they are free to admit their patients to the hospital, as they deem appropriate. Once the patient is admitted to the hospital, the independent physician continues to direct the care provided to the patient, even though many of the resources necessary to provide that care (such as nurses, pharmacists, and allied health professionals) are actually managed and paid for by the hospital. Under this arrangement, the independent physician has significant control over the resources of the hospital, even though they have no direct financial connection with or obligation to the hospital (Esposto 2004). This model provides the hospital (serving as the principal) little control over the activities of the referring physician (serving as the agent) within the hospital and little opportunity to align its goals of providing high quality, efficient, cost-effective care with the goals of the physician. This is especially true regarding the efficiency achieved and the cost incurred by hospitals since physicians can control up to eighty percent of the cost in the hospital (Kohli and Kettinger 2004).

This lack of control of referring physicians is especially troubling in the ICU given the complexity of the cases. Hospital ICUs have the highest case-mix indexes of all hospital inpatient services (Bai et al. 2010). According to Esposto (2004, page 56), these “complex procedures open the door to unexpected costs and provide an opportunity for physicians to furtively demand resources that promote their interest at the expense of those of the hospital or even the patient.” Esposto (2004, page 59) continues by stating “the greater the hospital’s exposure to the risk of physician opportunistic behavior, the greater the probability that the hospital will seek alternative institutional arrangements to reduce the risk.” The hospital clearly needs additional leverage to align its goals with that of the physician, especially within the ICU. One of the mechanisms hospitals can use to increase this leverage and more effectively align its goals with those of the physician is through the use of intensivists.

Intensivists are often employed by the hospital, while some are under contract. Regardless of whether they are employed or contracted, under this model of staffing, referring physicians with negligible ties to the hospital's objectives no longer exclusively coordinate and control the care of patients in the ICU. By transferring the coordination and control of care in the ICU to the employed or contracted intensivists, the hospital gains greater ability to align the goals of the physician with the goals of the hospital through traditional incentives, rewards and information systems. Kohli and Kettinger (2004, page 375) state “that professional agents are more likely to be committed to the control of management when they are highly dependent on them for career advancement and when management has the legitimacy to distribute rewards.” By employing or contracting intensivists, the hospital is better able to control both the career advancement and the distribution of rewards to the physicians serving within the ICU, and is therefore able to more closely align the goals of the two parties. While agency problems will certainly continue to exist at some level, through the employment or contracting of intensivists, hospitals are able to effectively mitigate agency problems and enhance the alignment of the goals of the physicians with the organization's goals through incentives, rewards and information systems.

As stated above, the goals of the hospital include providing high quality care in an efficient, cost-effective manner. Efficiency relates to the ability to achieve desired results with the minimum amount of resources. One measure of efficiency within a hospital is the number of patients that are cared for with a given set of resources over a given period of time, which can be operationalized as the average length of stay (Pronovost et al. 2004). Average length of stay depicts the average number of days each patient stays in the hospital per admission. As patients are treated more efficiently, the average length of stay decreases and the throughput of the fixed number of beds within the facility is improved. Given that the intensivist staffing model has the potential to increase the efficiency of the contract between the principal (the hospital) and the agent (the physician) and improve the alignment of hospital's goals with those of the physicians serving in the ICU, the following hypothesis is proposed:

> H_1 – An increase in the use of intensivists is associated with lower length of stay among ICU patients.

Another measure of efficiency for a hospital is the average cost of care. As hospitals provide more efficient care, the average cost per patient day should decline. It has previously been suggested that the use of intensivists is associated with decreased ancillary cost (Pronovost et al. 2004, Cooney 2002). This study postulates that the use of intensivists allows a hospital to better align its goals with the employed or contracted intensivists. Through this alignment of goals, the intensivists are more incented to coordinate care across providers and adhere to various hospital directives. It is suggested that this increased coordination of care and adherence to standard policies and procedures will result in more efficient care being provided, which will lead to more cost effective care. For this study, the average cost per patient day by principal diagnosis was utilized to measure the cost of care provided to ICU patients. The following hypothesis is proposed in regards to the cost of care provided to ICU patients:

> H_2 – An increase in the use of intensivists is associated with lower costs among ICU patients.

METHODS

Data

The unit of analysis for this study was the hospital. Longitudinal hospital level data from the American Hospital Association's (AHA's) Annual Survey for the years 2007-2010 were merged with summarized patient level data from the Healthcare Cost and Utilization Project's (HCUP) State Inpatient Databases (SID). The AHA Annual Survey provides important data points for over 6,200 hospitals across the country. Data points incorporated in the survey include environmental and organizational details, physician and staffing metrics, service offerings, utilization statistics and other applicable details about each hospital. The SID is a patient level data source that is part of the HCUP catalog of databases that were created through a Federal-State-Industry partnership that is sponsored and coordinated by the Agency for Healthcare Research and Quality (AHRQ). The SID includes inpatient discharge records for all patients, regardless of payer, and contains a robust offering of clinical and non-clinical data for each patient. The SID includes data regarding diagnoses, procedures performed, admissions and discharge statuses, patient demographics, payment sources, total charges, length of stay and other pertinent patient level information.

Sample

The hospitals included in the analysis were acute, short-term, general hospitals in New York and Washington State. While there are SIDs available for approximately twenty-seven states for the years included in this study, not all states nor all years for each state included all variables needed for the analyses performed for this study. The availability of these required variables was the principal driver of the selection of states for this study. By analyzing the variables offered for each available state for the years to be included in the study, it was determined that the SIDs for New York and Washington State contained the required data elements and provided the desired heterogeneity of the geographic, demographic, environmental, ethnic and cultural attributes of the included hospitals and the patients served by those hospitals.

Furthermore, the sample was limited to hospitals that were categorized by the American Hospital Association (AHA) as non-federal governmental, nongovernment not-for-profit, or investor-owned for-profit facilities. Because of their differing nature, the analysis excluded specialty hospitals and federal governmental hospitals such as facilities operated by Veteran's Affairs and the armed services. In addition, only facilities that reported ICU beds to the AHA were included in the analysis.

The analytic sample consisted of between 169 and 174 hospitals per year from New York and Washington resulting in between 614 and 625 hospital-year observations, depending on the principal diagnoses being analyzed, over the four-year period.

Variables

Table 1 lists the variables utilized in this study and notes the definition and source of each. The dependent variables in this study included: 1) the average total length of stay for ICU patients by hospital; and 2) the average total cost per patient day for ICU patients by hospital. A separate measure was created for both of these dependent variables (average total length of stay and average total cost per patient day) for each of the four principal diagnoses of interest resulting in a total of eight hospital-level dependent variables. The four principal diagnoses of interest included acute myocardial infarction (AMI), congestive heart failure (CHF), stroke and pneumonia. Because the average length of stay and the average cost per patient can differ significantly by diagnosis, this study chose to segment patients by these four specific principal diagnoses and analyze the results for each of these patient segments independently. These four diagnoses were selected due to the availability of data and relatively high number of patients that had one of these diagnoses and utilized the ICU during their stay.

In order to create each hospital-level dependent variable, patients were first segmented by whether they utilized the ICU during their hospital stay. This was accomplished using the ICU utilization flag included in the SID. HCUP includes up to thirty utilization flags in each SID that indicate whether a patient utilized various services during their visit. These utilization flags were developed by HCUP using ICD-9 procedure codes and Uniform Billing (UB-92) revenue codes. This variable was coded as 1 if ICU services were utilized or 0 if not. This study only included patient stays where the ICU utilization flag was coded to 1, indicating that the patient utilized ICU services during their visit.

Once patient stays that utilized the ICU were identified, those patients were categorized by principal diagnosis using the ninth revision of the International Classification of Diseases (ICD-9). Table 2 lists each ICD-9 code included for each of the four principal diagnoses included in this study. The list of ICD-9 codes for each principal diagnosis used for this study were sourced from the Centers for Medicare and Medicaid Services' (CMS) measure methodology reports ("2013 Measures Updates and Specifications," 2013, "Hospital 30-Day Mortality," 2010) and were validated by reviewing several previous studies that also focused on these principal diagnoses (Adamczyk et al. 2013, Brinjikji et al. 2011, Foster et al. 2013, Griffin et al. 2013, Rodriguez et al. 2013).

Finally, to convert the patient-level data contained in the SIDs to hospital-level measures for each hospital included in the analysis, the patient-level data were aggregated into hospital-level measures. The average total cost per patient day by each principal diagnosis for all patients that utilized the ICU was calculated for each hospital. The standard SID tables only include the total charges for each patient, but a cost-to-charge conversion file is provided by HCUP that was used to convert total charges to total costs. In addition to the average cost per patient day, the average total length of stay for all patients that utilized the ICU was calculated for each principal diagnosis for each hospital.

The independent variable in the study was a dichotomous variable indicating either the use or non-use of intensivists at the hospital. This binary variable was coded to 1 if the facility reported intensivist FTEs or 0 if not. For a post hoc analysis, another set of independent variables was created based on the number of reported FTEs per patient day for all ICU patients. This set of independent variables included five dummy variables that were created based on the intensity of intensivist staffing. For these dummy variables, hospitals were placed into one of four quartiles based on the number of intensivist FTEs reported per the total number of patient days for all patients that utilized the ICU during their stay. The fifth category was for hospitals that reported no FTEs. This fifth category served as the reference category.

In addition to the dependent and independent variables, several control variables were included in the analysis. Control variables for environmental factors and hospital-level characteristics were included. To control for environmental factors, the level of competition, operationalized as the Hirschman-Herfindahl Index (HHI), was included. The HHI was calculated based on hospital reported adjusted patient days using Health Services Areas (HSA) to define the geographic market to which a hospital belonged. HSAs have been used to define geographic markets in numerous hospital studies (Connor et al. 1997, Ho and Hamilton 2000, Seago et al. 2001).

To control for hospital factors associated with hospital operational performance such as efficiency and effectiveness, several hospital-level control variables were included in the analysis. Nurse staffing has been found to effect hospital performance (McCue et al. 2003, Flood and Diers 1988, Glandon et al. 1989) and was therefore included as a control variable for this study. Occupancy rate and payer mix variables have been included in other studies exploring hospital performance (Bazzoli et al. 2014, Clement et al. 1997), therefore hospital occupancy rate, the percentage of patients that were Medicare and the percentage of patients that were Medicaid were included as a control variables for this study. Hospital size was controlled for with two variables: total number of beds set up and staffed at the hospital and the total number of medical/surgical ICU beds reported by the hospital. Finally, a dichotomous variable was also included indicating whether or not the hospital operated a cardiac intensive care unit along side a medical/surgical ICU unit.

In order to control for average patient acuity at the hospital level, average patient demographics and comorbidities were included. Demographic variables were calculated separately for each principal diagnosis and included the percentage of female patients that utilized the ICU, the percentage of non-white patients that the utilized the ICU, and the average age of patients that utilized the ICU. In addition, variables were created to represent the average number of comorbidities per ICU patient for each principal diagnosis. HCUP includes binary variables for up to twenty-nine comorbidities that could be present for each patient. These binary variables indicate the presence of additional preexisting medical conditions that are not directly related to the principal diagnosis or the main reason for the patient's stay in the hospital. These variables are created by HCUP using AHRQ software that determines the existence of each comorbidity based on ICD-9-CM diagnoses and the discharge DRG. For the purposes of this study, these binary variables were used to calculate an average number of comorbidities per ICU patient for each principal diagnosis to be included as a control variable in the analyses performed.

Analysis

Once the data from the various sources were merged and tested for missing values, outliers and other underlying multivariate assumptions, univariate analyses were performed to provide basic descriptive statistics regarding the sample hospitals and the patients served by those hospitals. In this analysis, characteristics and attributes regarding the hospitals and patients were described and compared between the base year of 2007 and the final year of 2010.

In addition to the univariate analyses, bivariate analyses were also performed to further describe the date included in the study. In these analyses, hospitals that used intensivists were compared to hospitals that did not use intensivists using t-test and chi-square procedures. These procedures tested whether there was a statistical difference between the two groups of hospitals.

In order to test the two proposed hypotheses, the dependent variables included in the panel data were regressed against the independent and control variables. Separate fixed effects models were run for each of the two dependent variables for each of the four principal diagnoses for a total of eight separate models. Hospital fixed effects models were used in order to control for unobserved, time invariant factors that may have affected the dependent variable. This would include any unobserved factors at the hospital, market or state level. For each of these models, year fixed effects were also included to control for any time-based factors that might influence hospital operations. In addition, the models were clustered at the hospital level. SAS Version 9.3 was used for data management processes and STATA Version 13 was used for all of the statistical analyses included in the study. A p-value of 0.10 or less was used as the statistical significance threshold.

RESULTS

The results from the univariate analyses are shown in Table 3. These results describe the dependent, independent and control variables for the sample hospitals included in the first and last years of the study period. For the dependent variables, the average costs per patient day for each of the principal diagnoses included in the study were relatively similar in the base and final years. The compound average growth rate of the average cost per patient day from 2007 to 2010 ranged from 0.71% for congestive heart failure to 3.67% for patients with a principal diagnosis of stroke.

Average length of stay for each of the principal diagnoses was also steady from the base year to the final year. There was less than a day difference in the average length of stay for all four of the principal diagnoses. Three of the four principal diagnoses exhibited a decline in the average length of stay from 2007 to 2010 while congestive heart failure showed a slight increase of 0.13 days from 9.49 to 9.62. The largest decline was seen in stroke patients declining 0.72 from an average length of stay of 9.73 in 2007 to 9.01 in 2010. Pneumonia patients experienced the longest average length of stays of 11.29 and 10.64 in 2007 and 2010 respectively, while AMI patients experienced the shortest stays of 6.97 in 2007 and 6.72 in 2010.

There was a notable increase in the use of intensivists in hospitals from the base year of 2007 to the final year of 2010. In 2007, only 26.44% of the sample hospitals used intensivists while in 2010, 40.24% used them. In addition to the use or non-use of intensivists, the intensity of intensivist staffing also increased from 2007 to 2010. In 2007, the average intensivist FTE per ICU patient day was 0.111, while in 2010 the average had increased to 0.174 intensivist FTE per ICU patient day, representing a 56.76% increase.

The univariate analysis results show the HHI increased slightly from 0.592 in 2007 to 0.610 in 2010. This slight increase in the HHI indicates that there was slightly less competition and slightly more market power among the sample hospitals in 2010 than in 2007. Hospital-level attributes such as occupancy rate, the percentage of Medicare patients and the presence of cardiac ICU beds were fairly static from 2007 and 2010. There was, however, a 14.5% increase in nurse staffing intensity from 2007 to 2010. There were also increases in the percentage of Medicaid patients and the Medicare HMO penetration. The percentage of Medicaid patients was 26.59% in 2007 and 28.33% in 2010 while Medicare HMO penetration grew slightly from 24.43% to 26.65%. The average size of hospitals in 2010 was slightly larger than in 2007.

The various patient characteristics included in the study varied slightly from 2007 to 2010. The difference in the average age of patients with each principal diagnosis of interest was less than one year, with the exception of pneumonia where the average age of patients declined 1.7 years. Similarly, the percentage of female patients in 2007 and 2010 was within 200 basis points from each other, with the exception of CHF patients where the percentage of female patients increased 2.83 percentage points. The percentage of non-white patients for each diagnosis increased between 1.45 and 3.59 percentage points between 2007 and 2010, with pneumonia exhibiting the largest increase. Finally, the average number of comorbidities for patients with all four principal diagnoses increased an average of 0.39 from 2007 and 2010.

In addition to the univariate descriptive analyses, bivariate analyses were also performed to compare hospitals that used intensivists to those that did not use intensivists. The results from these analyses are shown in Table 4. For the dependent variables in the study, both the average cost per patient day and the average length of stay for patients with all four principal diagnoses were found to be higher at hospitals that used intensivists than those that did not use intensivists. The difference in the average cost per patient day ranged from $214 for pneumonia patients to $595 for AMI patients. The difference in the average lengths of stay ranged from 2.74 days for pneumonia patients to 4.17 days for CHF patients. All eight of these differences were statistically significant at the 99% confidence level.

For the control variables included in the study, hospitals that used intensivists were found to be in more competitive markets than those that did not use intensivists. In addition, hospitals that used intensivists tended to be larger, have more medical/surgical ICU beds, be more likely to have a cardiac ICU (and experience higher overall occupancy rates). Hospitals that used intensivists also tended to have a lower percentage of Medicare and Medicaid patients, but were in markets with a higher percentage of Medicare HMO penetration. Interestingly, there was not a statistically significant difference in nurse staffing levels (0.51 versus 0.49).

For patient characteristics, hospitals that used intensivists had a higher percentage of ICU patients that were non-white for all four principal diagnoses. In addition, hospitals that used intensivists experienced statistically significant lower percentages of patients that were female for all the diagnoses except pneumonia. The analyses performed showed that hospitals that used intensivists had statistically significant younger ICU patients. Finally, with the exception of pneumonia, there was not a statistically significant difference in the average number of comorbidities for patients with each of the principal diagnoses of interest.

The results from the multivariate analyses performed to test the average length of stay hypothesis (H_1) are shown in Table 5. The multivariate analyses performed found no support for H_1. No statistically significant relationships were found between the use of intensivists and the average length of stay for patients with any of the four principal diagnoses included in the study.

While the average length of stay hypothesis (H_1) was not supported, the analyses performed did find a relationship between the average number of comorbidities and the average length of stay. As one might expect, there was a positive relationship ranging from 0.58 to 1.23 days between the number of comorbidities and the average length of stay for three of the four principal diagnoses of interest. Also as one might expect, the analyses found a positive relationship between the hospital occupancy rate and the average length of stay. Finally there was a positive relationship between competition as measured by HHI and the average length of stay for patients with a principal diagnosis of pneumonia. All of these results were at the 95% confidence level.

The results from the multivariate analyses performed to test the average cost of care hypothesis (H_2) are shown in Table 6. Limited support was found for H_2. With the exception of ICU patients with a principal diagnosis of AMI, no statistically significant relationships were found between the use of intensivists and the average cost per patient day. For ICU patients with a principal diagnosis of AMI, however, the use of intensivists in hospitals was associated with an average cost per patient day \$202.12 less than hospitals that did not use intensivists (p-value 0.097).

For the control variables used in the average cost per patient day analysis, a statistically significant positive relationship was found between the use of intensivists and Medicare HMO penetration for three of the four principal diagnoses of interest. For each percentage point increase in HMO penetration, the average cost per patient day was found to be \$78.63, \$61.21 and \$81.17 higher for CHF, pneumonia and stroke diagnoses respectively. Statistically significant negative relationships were also found between the use of intensivists and the percentage of female CHF patients, the average age for AMI patients and the presence of cardiac beds for pneumonia patients. No statistically significant relationships were found for the other control variables included in the analysis.

DISCUSSION

Using agency theory as a theoretical framework, this study posited that the use of intensivists in the ICU would allow hospital administrators to better align the goals of the hospital with the goals of the physicians practicing in the ICU, resulting in more efficient, cost-effective care being provided to the patients. The study focused on patients that utilized the ICU during their hospital stay and had a principal diagnosis of CHF, AMI, stroke or pneumonia. The study included all patients meeting these criteria that were cared for by hospitals in both New York and Washington State for the years 2007 through 2010.

The average length of stay was one measure used to operationalize the efficiency and cost of care provided. This study proposed that by utilizing intensivists in the ICU, the goal of the hospital to provide efficient care and the goals of the physicians providing that care would be more closely aligned and would therefore result in reduced average lengths of stays. The analyses performed, however, showed no statistically significant relationships between the use of intensivists and the average length of stay experienced by patients with any of the four principal diagnoses of interest. While there were limitations to this study discussed below, based on the analysis performed, the data does not appear to support the notion that the use of intensivists will help hospital management achieve the goal of improved efficiency as measured by average length of stay. Given this result, perhaps intensivists working in the ICU focus more on obtaining outstanding clinic results for patient than on moving the patients through the care process in the most efficient manner. Several studies have in fact found a relationship between the use of intensivists and improved outcomes such as patient mortality (Pronovost et al. 2002).

Average cost per patient day was also used to test the efficiency and cost of care provided to patients. Again based on agency theory, it was proposed that the use of intensivists would help the hospital better align its goals of providing cost-effective care with the goals of the physicians providing that care. The analysis performed provided limited support for this notion with the finding that the use of intensivists is associated with a reduced average cost per day for AMI patients. These mixed results spurred additional post hoc analysis concerning the relationship between intensivist staffing intensity and the cost of care provided by the hospital.

Based on the mixed finding regarding the average cost per patient day, additional post hoc analyses were performed to test the relationship between the staffing intensity of intensivists and the average cost per patient day. The results from these post hoc analyses can be found in Table 7. These analyses show that the association between the staffing of intensivists and the average cost per patient day are nonlinear. For AMI patients, only the lowest and the highest levels of intensivist staffing intensity were associated with a lower cost per patient day, while no statistically significant relationships were noted for the middle two quartiles. For CHF patients, only the highest level of intensivist staffing intensity was associated with a lower cost per patient day. No statistically significant association was found between the intensity of intensivist staffing and a reduced cost per patient day for pneumonia or stroke.

These post hoc analyses indicate that the benefits derived from the use of intensivists can vary based on the type of patient being treated and the intensity of the intensivist staffing being utilized. The results appear to support the notion that it is possible for hospitals to use intensivists to help align the hospital goals of cost effective care with the goals of the physician, at least for the care of certain types of patients and at certain levels of staffing intensity. The results suggest that hospital administrators should take a close look at the benefits gained or not gained in each specific scenario and should pay close attention to the intensivists staffing levels used to staff the ICU. The results of this study indicate that there are some cost benefits in using intensivists to staff the ICU, but those benefits do not extend across all types of patients and all staffing levels.

POLICY AND RESEARCH IMPLICATIONS

The use of intensivists represents a significant investment for both hospitals and the overall healthcare system. The question is whether this added cost is offset by the ability to provide more efficient, cost-effective care. This study and others before it have had mixed results and seem to indicate that benefits from utilizing intensivists are possible, but not necessarily in all circumstances. As researchers continue to explore the use of intensivists, special attention should be given to the specific scenarios in which the use of intensivists provides the most advantages. Why, for example, does the use of intensivists produce cost savings for AMI and CHF patients at certain levels of intensivist staffing intensity, but does not appear to produce cost savings for other patient types or levels of staffing intensity? Future studies should focus on determining the specific environmental and organizational factors that enable improved efficiencies and reduced costs when utilizing intensivists.

In addition to determining the specific factors that enable improved operations from the use of intensivists, more attention should be given to the appropriate staffing levels of intensivists in the ICU. This study found that the benefits could differ based on the staffing levels. Additional research should continue to explore the relationship between the specific staffing intensity of intensivists and the benefits derived from those staffing levels.

Finally, the use or non-use of intensivists in ICUs has noteworthy policy implications. As stated before, the use of intensivist represents a material investment and adds to the overall cost structure of the U.S. healthcare system. As policymakers grapple with the growing costs of healthcare and the need to improve the quality of the care provided, understanding the benefits of utilizing intensivists becomes imperative. Policymakers need to know whether the investments made in utilizing intensivists pay the dividends needed to offset the cost to the system. Policymakers also need to know whether the investments made in utilizing intensivists help improve the quality of care provided by the system. In order to answer these questions more definitively, policymakers should encourage further studies that explore the relationship between cost and quality and the use of intensivist.

LIMITATIONS

While this study attempted to broaden the knowledge regarding the use of intensivists, there were some limitations encountered during the course of the analyses performed. While this was one of the first studies to include a relatively large number of ICUs, the study was limited to the hospitals with ICUs in New York and Washington State. This limitation was due to many states limiting the availability of data that was needed for the analysis. While this limitation was encountered, the study still included a varied group of hospitals from two diverse states.

In addition to the limited number of states, the analysis was performed at the hospital level rather than the patient level. This was due to the limited nature of the data available. The data available regarding the use of intensivists was at the hospital level and only indicated the number of intensivists FTEs that were serving at the hospital at the point the AHA annual survey data was requested. The SID patient-level data used in the analyses did not indicate whether intensivists cared for the specific patients included in the data set. Given this limitation, patient-level data was aggregated to the hospital level and merged with the hospital-level data regarding the use of intensivists and other hospital characteristics.

Similar to the hospital-level intensivists measure, the length of stay measure used in the analysis was for the total hospital length of stay for each ICU patient. This measure included the time spent in both the ICU and non-ICU areas of the hospital as opposed to the length of stay attributed to just the ICU. Much like the other limitations, the availability of data was the driving force behind the limitation. ICU-specific length of stay was not available at the patient-level detail and therefore the average total length of stay was calculated for all patients that utilized the ICU during their stay for each of the principal diagnoses of interest.

Finally, the cost measures used in the analyses were based on the total patient charges multiplied by the hospital-level cost-to-charge ratio provided by HCUP. These hospital-level cost-to-charge ratios are updated annually and provide a means to convert the patient charges included in the SID to hospital cost. The ratios, however, are based on all-payer inpatient cost and therefore changes in payer mix by principal diagnosis were not taken into consideration. While diagnosis-specific cost-to-charge ratios would have been ideal, that data were not available and the annual hospital-specific ratios were deemed to be an adequate proxy across the four diagnoses of interest.

CONCLUSION

Hospital administrators and policy makers alike continue to search for strategies that improve the value of the care provided to patients. One strategy that has been proposed to reduce costs, improve efficiency and/or improve the quality of care provided is the use of intensivists in the hospital ICU. Several studies have explored the use of intensivists and its relationship with cost, efficiency and quality, yet the results of those studies have been mixed and have not been rooted in a theoretical framework. While the results have been mixed, there has been some support for the purported benefits of utilizing intensivists in the ICU.

This study attempted to build upon the existing knowledge regarding the benefits of intensivists and explored the relationship between the use of intensivists and the cost of care provided and the efficiency of that care. While no statistically significant relationships were uncovered between the use of intensivists and the average lengths of stays for patients, there was a relationship found between the use of intensivists and the average cost per patient day for certain patients and certain intensivist staffing intensities. While this study helped improve the body of knowledge regarding the use of intensivists, much work is still needed to more completely understand the benefits derived from the use of intensivists.

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TABLES

Table 1: A listing of all variables used in the analysis along with definitions and sources.

Variable	Description	Source
Dependent Variables		
Average cost per patient day (by each principal diagnosis of interest)	Average total visit cost per patient day per hospital for ICU patients with a principal diagnosis of AMI, CHF, stroke or pneumonia. Average cost was calculated separately for patients with each of the four primary diagnoses included in this study.	State Inpatient Databases
Average length of stay (by each principal diagnosis of interest)	Average total length of stay per hospital for ICU patients with a principal diagnosis of AMI, CHF, stroke or pneumonia. Average length of stay was calculated separately for patients with each of the four primary diagnoses included in this study.	State Inpatient Databases
Independent Variables		
Use of intensivists	Coded as a 1 if facility reported intensivist FTEs. Otherwise, coded as 0.	AHA Annual Surveys
Intensivists FTEs per patient day for all ICU patients	Total reported intensivist FTEs divided by the total number of patient days for all patients that utilized the ICU during their stay.	AHA Annual Surveys and State Inpatient Databases
Control Variables		
Level of competition	Operationalized with the HHI using adjusted patient days for each facility within each HSA. Calculated as the sum of the squares of each hospital's market share within a given HSA. Market share for each hospital was calculated by dividing the hospital adjusted patient days by the total adjusted patient days for the market in which the hospital operated.	AHA Annual Surveys
Nurse staffing	Number of full time registered nurses divided by the total inpatient days multiplied by 100.	AHA Annual

Variable	Description	Source
		Surveys
Occupancy rate	Total inpatient days divided by the number of staffed beds multiplied by 365.	AHA Annual Surveys
Percentage of Medicare patients	Total reported Medicare patient days divided by the total reported inpatient days.	AHA Annual Surveys
Percentage of Medicaid patients	Total reported Medicaid patient days divided by the total reported inpatient days.	AHA Annual Surveys
Medicare HMO penetration	Percentage of Medicare eligible population enrolled in a Medicare Advantage (HMO) plan.	ARF
Total Beds	Total number of beds set up and staffed.	AHA Annual Surveys
Number of medical/surgical ICU beds	Number of medical/surgical ICU beds reported by the facility	AHA Annual Surveys
Presence of cardiac intensive care beds	Coded as a 1 if facility reported cardiac intensive care beds. Otherwise, coded as 0.	AHA Annual Surveys
Percentage of female ICU patients (for each principal diagnosis)	Total number of ICU patients that were female divided by the total number of ICU patients. This was calculated separately for each principal diagnosis of interest.	State Inpatient Databases
Percentage of non-white ICU patients (for each principal diagnosis	Total number of ICU patients that were non-white divided by the total number of ICU patients. This was calculated separately for each principal diagnosis of interest.	State Inpatient Databases
Average age of ICU patient (for each principal diagnosis	Average age of ICU patients. This was calculated separately for each principal diagnosis of interest.	State Inpatient Databases
Average number of comorbidities	Average number of comorbidities for each ICU patient. This was calculated separately for each principal diagnosis of interest.	State Inpatient Databases

Table 2: A listing of all ICD-9 codes used to identify ICU patients with a principal diagnosis of AMI, CHF, stroke or pneumonia.

Diagnosis	ICD-9 codes used
AMI	410.00, 410.01, 410.10, 410.11, 410.20, 410.21, 410.30, 410.31, 410.40, 410.41, 410.50, 410.51, 410.60, 410.61, 410.70, 410.71, 410.80, 410.81, 410.90, 410.91
CHF	402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428.0, 428.1, 428.20, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, 428.9
Stroke	433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91, 436
Pneumonia	480.0, 480.1, 480.2, 480.3, 480.8, 480.9, 481, 482.0, 482.1, 482.2, 482.30, 482.31, 482.32, 482.39, 482.40, 482.41, 482.42, 482.49, 482.81, 482.82, 482.83, 482.84, 482.89, 482.9, 483.0, 483.1, 483.8, 485, 486, 487.0, 488.11

Table 3: Descriptive statistics of hospitals for the base year of 2007 and the final year of 2010.

	2007		2010	
Dependent Variables				
Average cost per patient day:				
CHF (x̄, σ)	2,378.88	1,031.64	2,429.83	778.42
AMI (x̄, σ)	3,479.57	1,621.07	3,814.68	1,932.85
Pneumonia (x̄, σ)	2,184.40	819.05	2,289.00	729.50
Stroke (x̄, σ)	2,523.43	1,001.85	2,811.21	1,009.15
Average length of stay:				
CHF (x̄, σ)	9.49	5.97	9.62	6.58
AMI (x̄, σ)	6.97	6.75	6.72	6.71
Pneumonia (x̄, σ)	11.29	5.31	10.64	4.94
Stroke (x̄, σ)	9.73	5.46	9.01	6.14
Independent Variable				
Use of Intensivists				
Use intensivists (n, %)	46	26.44%	68	40.24%
Do not use intensivists (n, %)	128	73.56%	101	59.76%
Intensivist FTEs per patient day (x̄, σ)	0.111	0.502	0.174	0.490
Control Variables				
Level of competition - HHI (x̄, σ)	0.592	0.366	0.610	0.364
Nurse staffing (x̄, σ)	0.462	0.241	0.529	0.277
Occupancy rate (x̄, σ)	71.51%	16.30%	71.56%	15.94%
Percentage of Medicare patients (x̄, σ)	45.70%	14.24%	45.34%	13.92%
Percentage of Medicaid patients (x̄, σ)	26.59%	17.80%	28.33%	17.36%
Medicare HMO penetration (x̄, σ)	24.43%	12.52%	26.65%	12.11%
Total number of hospital beds (x̄, σ)	303.70	274.84	324.47	293.03
Number of Med/Surg ICU beds (x̄, σ)	16.23	15.98	17.62	17.84
Presence of Cardiac ICU beds	52.30%	50.09%	53.85%	50.0%
Percentage of female ICU patients:				
CHF (x̄, σ)	47.67%	13.43%	50.50%	13.40%
AMI (x̄, σ)	45.64%	15.10%	43.97%	15.92%
Pneumonia (x̄, σ)	46.89%	12.40%	48.35%	14.08%
Stroke (x̄, σ)	51.37%	19.67%	50.58%	17.41%
Percentage of non-white ICU patients:				
CHF (x̄, σ)	25.82%	31.37%	28.27%	30.64%
AMI (x̄, σ)	23.02%	31.35%	25.68%	30.26%

	2007		2010	
Pneumonia ($\bar{x}$, σ)	24.38%	30.21%	28.27%	30.02%
Stroke ($\bar{x}$, σ)	26.39%	29.98%	27.84%	30.74%
Average age of ICU patients:				
CHF ($\bar{x}$, σ)	72.03	6.49	72.73	6.11
AMI ($\bar{x}$, σ)	71.09	5.52	71.29	6.14
Pneumonia ($\bar{x}$, σ)	65.05	11.90	63.35	12.01
Stroke ($\bar{x}$, σ)	71.29	5.50	71.69	6.02
Average number of comorbidities:				
CHF ($\bar{x}$, σ)	2.86	0.62	3.32	0.53
AMI ($\bar{x}$, σ)	2.28	0.61	2.68	0.63
Pneumonia ($\bar{x}$, σ)	3.28	0.78	3.65	0.71
Stroke ($\bar{x}$, σ)	2.46	0.64	2.80	0.61

Table 4: Descriptive statistics by use of intensivists by hospital-year observations.

	Hospitals Used Intensivists	Hospitals Did Not Use Intensivists	p-value
Dependent Variables			
Average cost per patient day:			
CHF (x̄)	$2,685.82	$2,274.19	<0.0001
AMI (x̄)	$4,044.00	$3,448.73	0.0001
Pneumonia (x̄)	$2,378.92	$2,165.09	0.0006
Stroke (x̄)	$2,949.62	$2,539.98	<0.0001
Average length of stay:			
CHF (x̄)	12.35	8.18	<0.0001
AMI (x̄)	9.40	5.49	<0.0001
Pneumonia (x̄)	12.78	10.04	<0.0001
Stroke (x̄)	11.52	8.51	<0.0001
Control Variables			
Level of competition - HHI (x̄)	0.43	0.69	<0.0001
Nurse staffing (x̄)	0.51	0.49	0.4159
Occupancy rate (x̄)	77.69%	69.08%	<0.0001
Percentage of Medicare patients (x̄)	43.33%	46.68%	0.0025
Percentage of Medicaid patients (x̄)	26.88%	29.51%	0.076
Medicare HMO penetration	28.27%	23.94%	<0.0001
Total number of hospital beds (x̄)	481.97	236.91	<0.0001
Number of Med/Surg ICU beds (x̄)	27.58	12.03	<0.0001
Presence of Cardiac ICU beds (x̄)	68.64%	44.64%	<0.0001
Percentage of female ICU patients:			
CHF (x̄)	45.43%	50.90%	<0.0001
AMI (x̄)	41.33%	45.60%	0.0012
Pneumonia (x̄)	47.55%	48.38%	0.4091
Stroke (x̄)	49.57%	53.61%	0.0023
Percentage of non-white ICU patients:			
CHF (x̄)	38.55%	22.88%	<0.0001
AMI (x̄)	33.05%	20.85%	<0.0001
Pneumonia (x̄)	37.62%	21.91%	<0.0001
Stroke (x̄)	36.70%	23.77%	<0.0001
Average age of ICU patients:			
CHF (x̄)	69.44	73.54	<0.0001

	Hospitals Used Intensivists	Hospitals Did Not Use Intensivists	p-value
AMI ($\bar{x}$)	68.89	72.27	<0.0001
Pneumonia ($\bar{x}$)	58.71	65.99	<0.0001
Stroke ($\bar{x}$)	68.78	72.22	<0.0001
Average number of comorbidities:			
CHF ($\bar{x}$)	3.15	3.10	0.3242
AMI ($\bar{x}$)	2.53	2.48	0.2977
Pneumonia ($\bar{x}$)	3.33	3.53	0.0015
Stroke ($\bar{x}$)	2.70	2.66	0.4913

Table 5: Fixed effects regression analysis for Average Length of Stay using a binary independent variable representing the use of intensivists.

	Average Length of Stay							
	CHF		AMI		Pneumonia		Stroke	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Independent Variable								
Use of intensivists	0.02	0.27	1.69	1.05	-0.09	0.55	0.03	0.36
Control Variables								
Competition (HHI)	4.48	4.44	12.66	8.57	6.38*	2.79	-3.84	4.83
Nurse staffing	1.56	1.17	2.91	2.90	-1.06	1.51	0.88	1.74
Occupancy rate	6.03*	2.70	-4.26	4.02	3.92	3.39	6.21*	2.99
% Medicare	-0.55	2.33	-1.39	2.46	1.35	2.61	1.54	2.63
% Medicaid	3.48+	2.01	-4.27	2.86	0.07	2.07	2.76	2.47
Medicare HMO %	-0.09	0.14	-0.16	0.30	0.08	0.13	0.33+	0.19
# Hospital beds	0.01	0.00	-0.01	0.01	-0.005	0.01	0.002	0.01
# ICU beds	-0.06	0.04	0.02	0.07	-0.01	0.29	.01	0.03
Cardiac beds?	-0.35	0.68	3.75	3.22	0.13	0.68	1.29	0.94
Percent female	2.50	2.05	-0.96	5.61	-0.03	1.21	0.25	1.33
Percent non-white	-0.88	1.28	4.95	3.76	1.09	1.31	1.14	2.13
Average age	0.00	0.05	0.03	0.11	0.04	0.03	0.06	0.06
# of comorbidities	0.46	0.34	1.23*	0.56	0.58*	0.26	0.87*	0.39
Significant at: + p < 0.1 * p < 0.05 ** p < 0.01 *** p < 0.001 Standard errors clustered at hospital level								

Table 6: Fixed effects regression analysis for Average Cost per Patient Day using a binary independent variable representing the use of intensivists.

	Average Cost per Patient Day							
	CHF		AMI		Pneumonia		Stroke	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Independent Variable								
Use of intensivists	-131.53	86.15	-202.12+	121.26	-23.80	63.64	2.11	89.61
Control Variables								
Competition (HHI)	-335.84	1,111.98	-1,327.98	2,302.44	-1,346.88	1,203.67	115.25	1,286.17
Nurse staffing	354.98	307.45	130.77	454.40	289.46	254.95	268.38	466.40
Occupancy rate	-330.60	494.30	831.37	892.35	-44.72	467.93	689.79	706.67
% Medicare	443.31	528.22	1,236.86	822.08	409.17	368.14	679.10	549.19
% Medicaid	467.95	481.65	1,305.57+	741.24	366.97	463.44	647.26	567.42
Medicare HMO %	78.63*	32.98	70.96	53.24	61.21*	26.78	81.17*	37.17
# Hospital beds	-0.55	0.87	-0.43	1.38	0.48	0.64	1.17	0.95
# ICU beds	2.27	8.96	16.89	12.98	3.86	5.87	0.67	9.82
Cardiac beds?	-204.88	193.09	-175.78	212.06	-288.66*	136.58	-661.53+	343.01
Percent female	-623.14*	288.43	-247.78	445.88	-65.04	261.57	-409.34	270.26
Percent non-white	-33.50	293.37	-417.09	302.71	-5.02	167.41	-418.21	302.76
Average age	-14.38	8.86	-31.18*	15.70	4.21	6.17	-7.31	13.13
# of comorbidities	-48.19	63.15	-112.67	108.69	22.61	64.59	-142.14	87.18
Significant at: + p < 0.1 * p < 0.05 ** p < 0.01 *** p < 0.001 Standard errors clustered at hospital level								

Table 7: Fixed effects regression analysis for Average Cost per Patient Day using four quartiles of intensivist staffing intensity as the independent variable.

	Intensity of Intensivists Staffing and Average Cost per Patient Day							
	CHF		AMI		Pneumonia		Stroke	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Independent Variable								
First quartile	-133.32	105.82	-245.17+	136.81	-105.06	69.00	-108.99	116.97
Second quartile	-14.578	173.30	88.59	202.34	205.40	126.55	287.83+	155.79
Third quartile	130.97	207.24	17.69	282.57	123.41	186.90	59.56	211.30
Fourth quartile	-339.69*	140.76	-425.37+	225.51	-150.74	133.34	-90.64	163.95
*Reference group is "no intensivists used."								
Control Variables								
Competition (HHI)	-535.72	1,187.93	-1,531.47	2,378.01	-1,537.96	1,264.53	-10.29	1,324.86
Nurse staffing	420.82	301.53	202.65	450.32	322.37	259.23	286.66	465.31
Occupancy rate	-369.53	511.32	736.40	926.38	-117.26	472.56	597.83	704.95
% Medicare	517.29	511.46	1,299.96	812.13	441.60	380.80	697.96	540.92
% Medicaid	543.67	470.24	1,386.70+	733.09	425.62	468.50	699.23	566.01
Medicare HMO %	81.75*	33.70	76.07	54.40	64.69*	27.40	83.29*	37.33
# Hospital beds	-0.37	0.88	-0.31	1.42	0.59	0.62	1.22	0.93
# ICU beds	2.50	7.82	18.60	13.93	5.00	5.47	2.18	9.15

Table 7: (Continued)

	Intensity of Intensivists Staffing and Average Cost per Patient Day							
	CHF		**AMI**		**Pneumonia**		**Stroke**	
Control Variables								
Cardiac beds?	-230.33	192.41	-177.92	219.09	-292.22*	143.57	-644.50+	346.30
Percent female	-637.81*	258.86	-206.18	431.85	-25.94	262.98	-383.39	270.01
Percent non-white	-65.23	284.80	-395.64	300.05	0.46	169.67	-382.81	311.28
Average age	-13.64	8.95	-31.08*	15.73	4.01	6.03	-7.79	13.38
# of comorbidities	-51.30	61.80	-130.74	104.13	11.74	63.92	-153.55+	86.79
Significant at: + p < 0.1 * p < 0.05 ** p < 0.01 *** p < 0.001 Standard errors clustered at hospital level								

THE ASSOCIATION BETWEEN THE USE OF INTENSIVISTS AND THE QUALITY OF CARE PROVIDED BY THE HOSPITAL'S ICU

by

GLENN BARTHWICK LIDDLE

In Preparation for *Medical Care*

Format adapted for dissertation

PAPER 3

THE ASSOCIATION BETWEEN THE USE OF INTENSIVISTS AND THE QUALITY OF CARE PROVIDED BY THE HOSPITAL'S ICU

ABSTRACT

Objective: Intensivists are physicians who specialize in providing care in the ICU. The use of intensivists increased dramatically from 2007 to 2010. The purpose of this study is to use Donabedian's quality framework to examine the relationship between the use of intensivists and the quality of care provided in the ICU.

Data Source/Study Setting: The 2007-2010 longitudinal data used in this study was sourced from the American Hospital Association (AHA) Annual Survey and the Healthcare Cost and Utilization Project's (HCUP) State Inpatient Databases (SID) for New York and Washington States. The sample included acute, short-term, general hospitals in New York and Washington State that were categorized as either non-federal governmental, nongovernment not-for-profit or investor-owned for-profit.

Study Design: The study was a panel design and used facility and year fixed effects regression, clustered at the hospital level to explore the association between the use of intensivists and the quality of care provided in the ICU.

Principal Findings: The study found that the use of intensivists is associated with reduction in AMI mortality rates and a decline in the occurrence rate of both pressure ulcers and perioperative hemorrhaging or hematoma for ICU patients.

Conclusions: As providers seek to improve the quality and safety of healthcare, one potential strategy is the use of intensivists in the ICU. This study found that the use of intensivist is associated with improvement in certain quality and safety indicators for ICU patients.

Keywords: Intensivist, quality, patient safety, Donabedian

INTRODUCTION

The quality and safety of the health care provided by hospitals in the United States has been a longstanding focus and concern for policymakers, payers and providers alike (Lindenauer et al. 2007, Kohn et al. 2000, Skekelle et al. 2013, Leape and Berwick 2005). The focus and concern is justified given the care provided by hospitals is frequently deficient, subject to life threatening errors, and varies widely across entities and various regions of the country (Jha et al. 2005, Kohn et al. 2000, James 2013, Berenholtz et al. 2002). It is estimated that 3% of all inpatients experience avoidable harm (Brennan et al. 1991) and the Institute of Medicine's (IOM) often-cited 1999 report highlighted the costly ramifications of these deficiencies in care by estimating that up to 98,000 Americans die each year as a result of medical errors (Kohn et al. 2000). A more recent study found the number of deaths due to preventable harm might be as high as 400,000 per year (James 2013). Clearly the lack of consistent, safe, error-free, high quality patient care continues to be an ongoing concern (Jha and Epstein 2010, James 2013) and developing strategies to improve the quality and safety of the care provided by hospitals continues to be a high priority for all stakeholders (Murff et al. 2003, Pronovost et al. 2007, Shekelle et al. 2013).

Policymakers, payers, providers and other stakeholders have employed numerous strategies over the years in the attempt to improve the quality and safety of care provided to patients. Strategies used by policymakers to help drive improvements have included “regulation, measurement of performance and subsequent feedback, and marketplace competition” (Lindenauer et al. 2007, page 487). In addition, pay-for-performance (Kahn et al. 2006, Kruse et al. 2012) and value-based purchasing programs such as

Medicare’s modified payments program (Krumholz et al. 2013) and the Leapfrog Group's quality-based payment incentives (Milstein et al. 2000, Birkmeyer and Dimick 2004) have been used by payers to encourage providers to improve the quality care they provide. Furthermore, hospitals are utilizing various strategies to improve quality such as implementing electronic medical records (Kazley and Ozcan 2008), managing nurse staffing ratios (Kane et al. 2007), instituting standardized order sets where appropriate (Micek et al. 2006), utilizing computerized provider order entry (Kaushal et al. 2003, Bates et al. 1999), and employing various other clinical best practices (Skekelle et al. 2013). Another strategy that has been purported to improve the quality and safety of care provided in hospitals is the use of intensivists to staff the intensive care unit (ICU) within the hospital.

Intensivists are “physicians who specialize in critical care with the experience and skill required to detect and address changes in patients’ clinical conditions, often before complications occur. Intensivists can be surgeons, anesthesiologists, internists, or pediatricians with additional training and board certification in critical care. They are often the ICU director and must have the ability to manage and coordinate care by a variety of clinicians” (Beldon 2002, page 28). Intensivists are often employed or contracted by the hospital to provide and coordinate the care provided in the ICU. The ICU is one of the most complex organizations within a hospital where life or death decisions are made on a regular basis (Krizner 2008). ICU patients exhibit extraordinarily high acuity levels and often struggle with extremely complex, life-threatening medical conditions. In addition, the ICU cares for some of the oldest and most vulnerable persons in our population. Rainey and Shapiro (2001) report that those

65-85 years of age utilize five or six times the number of ICU days than adults younger than 65. Given the demographic trends of the U.S., the number of these older, acute patients seeking care in ICUs will only increase (Shojania 2001).

Due to the high acuity, complex medical conditions and advancing age of the patients served in the ICU, this area of the hospital represents one of the highest risk areas for patient morbidity and mortality (De Vos et al. 2007). Given these factors, the ICU is also at high risk for potential patient care deficiencies and is an ideal target for quality improvement strategies (Shojania 2001). Quality improvement strategies are crucial in the ICU (De Vos et al 2007) and these strategies need focused and deliberate attention and execution, which could be provided by intensivists. Despite the high risk environment and the definitive need for quality improvement strategies, relatively few ICUs have historically utilized intensivists to manage the care provided in the ICU. According to Krizner (2008), only 20% of the nation's 6,000 ICUs had an intensivist presence in 2007. More recent AHA data, however, show that the use of intensivists in the ICU has experienced growth over the last few years. According to AHA data, there was a 34.4% growth in the use of intensivists from 2007-2009 (Intensivists on the Rise 2011).

There is evidence, although mixed, that the use of intensivists is associated with improved quality and safety in the ICU. Young and Birkmeyer (1999) identified nine studies that explored the association between the use of intensivists and ICU mortality rates. Of the nine studies identified, five found a statistically significant reduction in ICU mortality. A later systematic review by Pronovost et al. (2002), the authors explored the relationship between high intensity intensivist staffing and multiple patient outcome variables including ICU mortality rates. This study incorporated twenty-six observational studies, including the nine that were studied in Young and Birkmeyer's article. In their study, the authors found that in 14 of the 15 studies, high-intensity staffing was associated with lower ICU mortality rates. In another study, however, Dimick et al. (2001) found that the use of intensivists was not associated with lower mortality rates for patients having undergone esophageal resection.

It is important to note that the majority of these studies were either a pre-post study design or cross-sectional in nature. In addition to the limitations inherent in these designs, it is also notable that almost all of the studies were based on a single teaching facility or on a single procedure or patient diagnosis, therefore limiting the generalizability of the findings. Finally, none of the studies were grounded on a theoretical framework. The purpose of this study is to expand our knowledge regarding the use of intensivists as a hospital strategy to improve the quality and safety of the care provided to ICU patients. The study is longitudinal in nature and the sample used in the analyses will include a broader range of hospitals. In addition, this study will be based on a sound theoretical framework and will utilize risk adjusted quality and safety indicators developed by the Agency for Healthcare Research and Quality (AHRQ). This study seeks to provide important insights to hospital administrators and policymakers regarding the potential benefits of utilizing intensivists in the ICU.

CONCEPTUAL FRAMEWORK

In 2001, the IOM defined health care quality 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" (IOM 2001). When attempting to evaluate the quality of health care provided, Donabedian's model (1966) is widely accepted and is used often as the underlying framework of quality-focused studies (Mikeal et al. 1975, Tomlinson and Ko 2006, Hoenig et al. 2010, Qu et al. 2010, Ghaffari 2013). Donabedian's model suggests that health care quality is a function of the structure in which care is provided, the processes of care undertaken and the outcomes generated by the care (Donabedian 1966, Donabedian 1988).

In Donabedian's model, structure represents the settings in which care occurs. Structure includes both material and human resources along with the organizational configurations within the entity. Material resources include items such as financial capital, facilities and equipment while human resources include the quantity, type and qualifications of various personnel. The organizational configurations are the structures and methods within the organization such as the medical staff organization and methods of peer review (Donabedian 1988). Previous studies exploring the quality of care in the ICU have included structure variables such as physician staffing (Pronovost et al. 2002, Young, and Birkmeyer 1999), nurse staffing (Randolph and Pronovost 2002, Amaravadi et al. 2000, Tarnow-Mordi et al. 2000), and pharmacists participating during daily rounds (Randolph and Pronovost 2002). For our study, we will be including the use or non-use of intensivists as our structure variable.

Process in Donabedian's model refers to what is actually done when either giving or receiving care (Donabedian 1988). Process variables that have been explored in previous studies include the use of noninvasive ventilation (Girou et al. 2000), practicing continuous lateral rotational therapy (Washington and Macnee 2005, Kirschenbaum et al. 2002), and incorporating nutrition support (Harrington 2004, Roberts et al. 2003). For our study it is suggested that the use of intensivist leads to better processes within the ICU due to the specialization and focused training of the physician and the coordination and leadership he or she provides to the unit. For example, it is suggested that the use of intensivists leads to more effective therapeutic interventions, better monitoring of patients, a higher likelihood of coordinated daily rounds that include the entire care team, superior case reviews and the consistent use of admission and discharge protocols (Dey 2006). Through these improved processes of care, it is proposed that the outcomes of the care provided will be enhanced.

Outcomes are "defined as changes in the state of health of a patient that can be attributed to an intervention or to the absence of an intervention" (de Vos et al. 2007 page 268). Example outcomes that have been studied in the domain of intensive care are the incidence of ventilator-associated pneumonia (Hugonnet et al. 2004), the occurrence of deep vein thrombosis (Attia et al. 2001, Yang 2005) and hospital mortality rates (de Jonge et al. 2003). Similar to previous studies on outcomes, our analyses will include risk-adjusted in hospital mortality rates, in the form of AHRQ Inpatient Quality Indicators (IQIs), as a measure of quality. Donabedian's model suggests that improved structure will lead to improved processes and improved processes will to improved outcomes (Hillmer et al. 2005). Based on this, this study posits that improving the structure of care through the use of intensivists in the ICU will lead to improved processes in the ICU. These improved processes in the ICU will ultimately lead to improved outcomes for ICU patients. Based on this framework and the operationalization of quality as hospital mortality rates, this study hypothesizes the following:

H_1 - An increase in the use of intensivists is associated with lower in hospital mortality rates for ICU patients.

Safety is an important component of healthcare quality and outcomes. Hughes and Mitchell (2008, page 1) state "many view quality healthcare as the overarching umbrella under which patient safety resides." In addition, the IOM has identified six aims of healthcare including that it should be safe, effective, patient centered, timely, efficient and equitable (IOM 2001). Clearly, patient safety is an important component of quality. This study will operationalize patient safety in the form of multiple AHRQ Patient Safety Indicators (PSIs) and based on Donabedian's healthcare quality framework the following hypothesis is suggested:

H_2 - An increase in the use of intensivists is associated with improved patient safety rate for ICU patients.

METHODS

Data

Data for this study was longitudinal in nature and included the years 2007 through 2010. The data used was sourced from the American Hospital Association's (AHA's) Annual Survey and the Healthcare Cost and Utilization Project's (HCUP's) State Inpatient Databases (SIDs) for New York and Washington State. The AHA Annual survey contains information regarding over 6,200 hospitals including environmental and organizational details, physician and staffing metrics, service offerings, utilization statistics and other applicable details regarding each hospital included in the survey. The SIDs include detailed patient discharge information for all payers for nearly all hospitals in each state including patient diagnoses, procedures performed during the admission, utilization flags, comorbidities, major diagnosis codes, admission and discharge statuses, patient demographics and payment sources, total charges, lengths of stay and other important patient-level information.

Sample

The sample used in this study included acute, short-term, general hospitals in New York and Washington State that operated an ICU. In addition, the sample was limited to hospitals that were categorized by the American Hospital Association (AHA) as non-federal governmental, nongovernment not-for-profit, or investor-owned for-profit facilities. Because of their differing nature, the analysis excluded specialty hospitals and federal governmental hospitals such as facilities operated by Veteran's Affairs and the armed services. These criteria resulted in an analytic sample of between 169 and 174 hospitals per year. This sample of hospitals produced between 23 and 68 hospital-year observations depending on the diagnosis or condition being analyzed.

New York and Washington State were chosen for the sample primarily due to the availability of data elements needed for the analysis. SIDs are available for approximately twenty-seven states for the years included in this study, but not all states nor all years for each state included all variables needed for the analyses performed for this study. Variable availability was analyzed across all available states for all four years of the study and it was determined that the SIDs for New York and Washington State contained the required data elements. In addition, these two states provide the desired heterogeneity across hospitals and the patients served by those hospitals in regards to geographic, demographic, environmental, ethnic and cultural attributes.

Variables

Table 1 lists the variables utilized in this study and notes the definition and source of each. In order to generate the dependent variables needed for the analyses, patient-level SID data for all ICU patients from each hospital for each year included in the study were loaded into AHRQ's WinQI Quality Indicator software version 4.6 (AHRQ - WinQI 2014). The WinQI software, available as a free download from the AHRQ website, utilizes the SID patient-level data to calculate various hospital-level, risk-adjusted quality and safety indicators. The software is comprised of four modules that produce between twenty and forty indicators each. The two modules used for this study included the inpatient quality indicators (IQIs) and the patient safety indicators (PSIs), which produce up to thirty-four and twenty-four indicators respectively.

For IQI measures, WinQI used the SID data and controlled for age, sex, 3M's All Patient Refined Diagnosis Related Groups (APR-DRG), and four risk-of-mortality subclasses - minor, moderate, major or extreme. For PSI measures, the WinQI software used the loaded SID data to create hospital-level, risk-adjusted measures controlling for age, sex, modified Diagnosis-Related Group (MDRG) and at least one of twenty-five co-morbidities. (Geppert and Morara 2013).

Following guidance provided by AHRQ and previous studies that utilized the WinQI software package, any hospital observations with less than thirty patients at risk for any indicator were excluded from the analysis (Li et al. 2007, Chukmaitov et al. 2009). While risk-adjusted rates were calculated for all available indicators for both the IQI and PSI modules, only the indicators with at least 20 hospital-year observations available to run the fixed effects regression models were included in the final analyses. The seven dependent variables that met these criteria included two risk-adjusted inpatient quality indicators and five risk-adjusted patient safety indicators. The two inpatient quality indicators were mortality rates for AMI and acute stroke patients while the five patient safety indicators were the rate of pressure ulcers, the death rate of surgical patients with serious treatable conditions, the perioperative hemorrhage or hematoma rate, the postoperative respiratory failure rate and the perioperative pulmonary embolism or deep vein thrombosis rate.

The independent variable in the study was a dichotomous variable indicating either the use or non-use of intensivists at the hospital. This binary variable was coded to 1 if the facility reported intensivist FTEs or 0 if not.

Several control variables were included in the analysis. The level of competition within a market has been shown to be associated with the quality of care provided by a facility (Mutter et al. 2008, Propper 2004, Shortell and Hughes 1988) and therefore market competition operationalized as the Herfindahl-Hirschman Index (HHI) was included as a control variable. The HHI was calculated based on hospital reported adjusted patient days using Health Services Areas (HSA) to define the geographic market to which a hospital belonged. HSAs have been used to define geographic markets in numerous hospital studies (Connor et al. 1997, Ho and Hamilton 2000, Seago et al. 2001).

Nurse staffing levels were also included as a control variable. Numerous studies have shown that nurse staffing is associated with the quality of healthcare provided. Pronovost et al. (2001) found that patient complications were more likely in hospitals with fewer nurses than those with more nurses. Multiple other studies have also shown an association between nurse staffing and patient outcomes (Needleman et al. 2006, Needleman et al. 2002, Aiken et al. 2002, Blegen et al. 1998). Because of this association, nurse staffing level was included as a control variable in our analyses.

In addition to market competition and nurse staffing levels, patient volumes for specific diagnoses and procedures have also been shown to be associated with patient outcomes. In a study by Hughes et al. (1987) an analysis was performed that included over 500,000 patients undergoing 10 different procedures at over 750 hospitals. The authors in this study found a positive relationship between volume and the quality of care provided. Supporting this finding, a 2002 review article found substantial support in the literature for the positive relationship between volume and patient outcomes (Halm et al. 2002). Because of this established relationship between volume and patient care quality, the patient volume for each specific diagnosis for IQIs or the total number of patients meeting the criteria for each PSI were included as a control variable in our analysis. Related to individual procedures or diagnoses volumes, the relative size of the ICU, operationalized as the number of medical/surgical ICU beds, was also included as a control variable.

-------Insert Table 1 around here-------

Analysis

Univariate analyses were used to explore the various characteristics and attributes of the dependent and control variables included in the study. In addition, univariate analyses were performed to explore the distribution of the independent variable across the years included in the study. Specifically, descriptive statistics were performed to show the number of hospitals that used intensivists versus those that did not use intensivists for both the base year of 2007 and final year of 2010.

In addition to the univariate analyses, separate fixed effects regression models were run against the panel data for each of the seven dependent variables in order to test the proposed hypotheses. Facility fixed effects was used for each of these models in order to control for unobserved, time-invariant factors that may have affected the dependent variables. This would include any unobserved factors at the hospital, market or state level. Year fixed effects were also used to control for any time-based factors that might influence hospital operations. In addition, the models were clustered on hospitals. SAS Version 9.3 was used for data management and STATA Version 13 was used for all of the statistical analyses included in the study. A p-value of 0.10 or less was used as the statistical significance threshold.

RESULTS

Univariate Results

The results from the univariate analyses performed are shown in Tables 2 and 3. Table 2 provides the mean and standard deviation for each of the dependent and control variables used in the analyses. The results show that on average, the risk-adjusted mortality rate for acute stroke patients is higher than the mortality rate for AMI patients. When reflecting on the patient safety indicators included in the study, the results show a relatively high occurrence of death for surgical inpatients with serious treatable conditions when compared to the other adverse events included in the study. The average rates of occurrence for three of the remaining four patient safety indicators (pressure ulcers, perioperative hemorrhaging and pulmonary embolism) are fairly similar to each other. Finally it is noted that the average size of the ICU's included this study was approximately seventeen beds. Table 3 shows the univariate results for the independent variable used in the study. From these results one can see that the number of hospitals using of intensivists grew almost 48% from the base year of 2007 to the final year in 2010.

-------Insert Table 2 around here-------

-------Insert Table 3 around here-------

Multivariate Results

Tables 4 and 5 show the results from the multivariate analyses performed to test the two hypotheses. Table 4 shows the results related to H_1. Based on the analyses performed, there appears to be mixed support for H_1. As suggested in the hypothesis, the fixed effects model shows that an increase in the use of intensivists is associated with a 20.84 decrease in the AMI mortality rate per 1,000 patients (p-value of 0.030). The analyses do not, however, support the hypothesis for acute stroke patients. None of the control variables were statistically significant for either model with the exception of volume on the AMI model. Increased volume was shown to be associated with a slightly higher mortality rate. This was contrary to what was expected based on prior volume-based research.

Table 5 represents the results for the patient safety hypothesis. Like H_1, the analyses performed provide mixed support for H_2. As hypothesized, the increased use of intensivists was associated with decline in the rate of occurrence of both pressure ulcers and perioperative hemorrhaging or hematoma (both with p-values < 0). The rate of occurrence for respiratory failure, however, increased with the increased use of intensivists. Other findings in these analyses included a statistically significant positive relationship between nurse staffing levels and the occurrence of perioperative hemorrhaging or hematoma and pulmonary embolisms or deep vein thrombosis. Finally, a slight positive relationship was discovered between volume and pressure ulcers and an equally slight negative relationship was found between volume and perioperative hemorrhaging or hematoma.

-------Insert Table 4 around here-------

-------Insert Table 5 around here-------

DISCUSSION

Using Donabedian's quality framework, this study posited that the use of intensivists would improve the structure of the ICU, which would lead to improved processes. It is also suggested that these improved processes in the ICU would ultimately lead to improved outcomes for ICU patients, operationalized by improved patient mortality rates and reductions in the occurrence of adverse events. The study focused on all patients that utilized the ICU during their hospital stay at hospitals in both New York and Washington State for the years 2007 through 2010.

The findings of our study suggest that the use of intensivists can in fact help improve the quality and safety of care provided in hospital ICUs, especially for patients with certain diagnoses or those at risk for certain adverse events to occur. Perhaps introduction of intensivists into the structure of an ICU does lead to improved processes due to the unique specialization of the physician and the focused training he or she has received. In addition to the specialization and specific training of the physician, it is conceivable that the introduction of an intensivist in the ICU improves the coordination of care and provides the clinical leadership needed for improved processes and systems of care. This improved coordination and leadership could lead to more effective therapeutic interventions, better monitoring of patients, a higher likelihood of coordinated daily rounds that include the entire care team, superior case reviews and the consistent use of admission and discharge protocols. With these improved processes in place, based on Donabedian's framework, improved patient outcomes may be achieved.

There were other notable findings of the study. Specifically, it was interesting that this study found a statistically significant positive relationship between nurse staffing level and two of the five patient safety indicators. Based on previous research findings, one would expect that as nurse staffing increases, the occurrence of the adverse events included in the study would have decreased. Similarly, the relationships between volume and the quality and safety outcomes included in the study were also contrary to the expected results for two of the three statistically significant findings. While the results were opposite of what was expected, the coefficients were rather small. Regardless, these findings are certainly worthy of additional exploration. Perhaps the ICU environment is significantly different than the rest of the hospital and therefore relationships discovered in non-ICU environments are not fully applicable in the ICU setting.

While the results of this study were mixed, there does seem to be support for the use of intensivists as a strategy to help improve the quality and safety of the care provided in the ICU. The results seem to suggest that hospital administrators should take a close look at the possibility that utilizing an intensivist in the ICU could improve the processes of care provided in the ICU and in turn improve the quality and safety of care provided in that unit of the hospital.

POLICY AND RESEARCH IMPLICATIONS

This study suggests that the use of intensivists has the potential of improving the quality and safety of the care provided within the ICU. As policymakers, payers and providers continue to explore strategies to improve the quality of care, the expanded use of intensivists should be considered as one of the strategies to obtain the improvements being sought. Perhaps policymakers and payers should redouble their support of the Leapfrog Group's ICU physician staffing standard. This standard states that an intensivist is to be present in the ICU during daytime hours and is readily available to answer pages in a timely manner during night hours (Milstein et al. 2000). It has been estimated that the full implementation of this standard could save nearly 54,000 lives annually in the United States (Young and Birkmeyer 2000). In addition, perhaps policymakers should consider providing financial incentivizes to providers who adopt the standard, or inversely, begin financially penalizing facilities that do not implement an intensivists-based ICU staffing structure. Finally, hospital administrators should explore the possibility that the use of intensivists will help them adequately respond to new value-based reimbursement models.

An area of suggested future research is further exploring which specific processes enabled by the use of an intensivist are associated with improved patient outcomes. For example is it the increased training and specialization of the intensivist that promotes improved patient outcomes or is it the improved leadership and coordination of care? In addition, is it the enhanced monitoring of patients, the higher likelihood of coordinated daily rounds or superior case reviews that are associated with the improvements seen in the quality and safety of care? Through further research policymakers, payers and providers can continue to broaden their knowledge and understanding regarding the clinical benefits of utilizing the intensivist within the ICU.

LIMITATIONS

While this study attempted to build upon the current knowledge regarding the use of intensivists, there were some limitations encountered during the course of the analyses performed. While unlike previous studies this study included non-teaching hospitals and a larger sample of hospitals, the study was still limited to the hospitals with ICUs in New York and Washington State. This limitation was due to many states limiting the availability of data that was needed for the analysis. While this limitation was encountered, the study still included a varied group of hospitals from two diverse states and provided greater generalizability than many of the previous studies.

In addition, the data used in this study only indicated whether intensivists were used or not used at the hospital. If intensivists were used at the hospital, the data also included the number of intensivists FTEs. The data did not, however, provide visibility into whether the intensivists were contracted or employed. Furthermore, the data did not indicate the specific ICU staffing model used by the facility. Even when intensivists are utilized by a facility, there are several different staffing models that can be used by the facility that vary primarily by the degree to which control is given to the intensivist versus the admitting physician in regards to the care decisions that are made in the ICU (Shojania et al. 2001). While this data would have been helpful for the analysis, it was unavailable for the sample of hospitals used.

Finally, it should be noted that the mortality rates used in this study were the hospital mortality rates for ICU patients, not ICU-specific mortality rates. In other words, the mortality rate used in the study was based on ICU patients that died during their overall hospital stay as opposed to only including ICU patients that died while in the ICU. Previous studies have use one or both of these, but ideally for our study it would have been beneficial to have the ICU-specific mortality rates. Unfortunately, like the specific employment structure of the intensivists, this data was not available for this study.

CONCLUSION

The quality and safety of the care provided by hospitals in the United States will undoubtedly continue to be a major focus of policymakers, payers and providers alike. Previous studies have shown that there continues to be significant opportunities for improvement in this space. Various strategies will continue to be developed and executed in the hopes of improving quality and reducing the occurrence of adverse events in hospitals, including in the intensive care unit. This study, along with others before it, suggests that the use of intensivists is a viable strategy to improve the care provided in the ICU and is a strategy that should continue to be implemented and further studied.

This study attempted to build upon the existing knowledge regarding the benefits of intensivists and explored the relationship between the use of intensivists and the quality and safety of care provided in the ICU. While the results were mixed, this study appears to support the use of intensivists as a strategy to improve the quality and safety of care provided in the ICU. While this study helped improve the body of knowledge regarding the use of intensivists in the ICU, further research is still needed to more completely understand the clinical benefits derived from the use of intensivists.

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TABLES

Table 1: A listing of all variables used in the analysis along with definitions and sources.

Variable	Description	Source
Dependent Variables		
IQI15 - Risk-Adjusted Acute Myocardial Infarction (AMI) Mortality	In-hospital deaths per 1,000 hospital discharges for patients 18 years or older with a principal diagnosis of AMI (AHRQ - Inpatient Quality Indicators 2014).	State Inpatient Database
IQI16 - Risk-Adjusted Acute Stroke Mortality Rate	In-hospital deaths per 1,000 hospital discharges for patients 18 years or older with a principal diagnosis of acute stroke (AHRQ - Inpatient Quality Indicators 2014).	State Inpatient Database
PSI3 - Risk-Adjusted Pressure Ulcer Rate	Rate (per 1,000) of stage III or IV pressure ulcers as a secondary diagnosis for patients 18 years and older (AHRQ - Patient Safety Indicators 2014).	State Inpatient Database
PSI4 - Risk-Adjusted Death Rate among Surgical Inpatients with Serious Treatable Conditions	Death rate (per 1,000) of surgical patients 18 years and older with serious treatable complications such as deep vein thrombosis/pulmonary embolism, pneumonia, sepsis, shock/cardiac arrest or gastrointestinal hemorrhage/acute ulcer. (AHRQ - Patient Safety Indicators 2014).	State Inpatient Database
PSI9 - Risk-Adjusted Perioperative Hemorrhage or Hematoma Rate	Rate (per 1,000) of perioperative hemorrhage or hematoma cases for surgical patients 18 years or older (AHRQ - Patient Safety Indicators 2014).	State Inpatient Database
PSI11 - Risk-Adjusted Postoperative Respiratory Failure Rate	Rate (per 1,000) of postoperative respiratory failure (as a secondary diagnosis), mechanical ventilation or re-intubation cases for elective surgical patients 18 years or older (AHRQ - Patient Safety Indicators 2014).	State Inpatient Database
PSI12 Risk-Adjusted Pulmonary Embolism or Deep Vein Thrombosis Rate	Rate (per 1,000) of perioperative pulmonary embolism or deep vein thrombosis as a secondary diagnosis for surgical patients 18 years or older (AHRQ - Patient Safety Indicators 2014).	State Inpatient Database
Independent Variables		
Use of intensivists	Coded as a 1 if facility reported intensivist FTEs. Otherwise, coded as 0.	AHA Annual Surveys

Variable	Description	Source
Control Variables		
Level of competition	Operationalized with the HHI using adjusted patient days for each facility within each HSA. Calculated as the sum of the squares of each hospital's market share within a given HSA. Market share for each hospital was calculated by dividing the hospital adjusted patient days by the total adjusted patient days for the market in which the hospital operated.	AHA Annual Surveys
Nurse staffing	Full time registered nurses divided by the total inpatient days multiplied by 100.	AHA Annual Surveys
ICU patient volume per diagnosis or procedure of interest	Total ICU patient volume for each diagnosis/procedures of interest as defined by the AHRQ WinQI software.	State Inpatient Database
Number of medical/surgical ICU beds	Number of medical/surgical ICU beds reported by the facility	AHA Annual Surveys

Table 2: Descriptive statistics for dependent and control variables. Includes all observations for the years 2007 through 2010.

	Mean	Std. Dev.
Dependent Variables		
(All risk-adjusted, and stated as per 1,000 patients)		
Inpatient Quality Indicators (IQIs):		
IQI15 - AMI mortality rate	75.94	18.47
IQI17 - Acute stroke mortality rate	112.56	16.52
Patient Safety Indicators (PSIs):		
PSI3 - Pressure ulcer rate	17.86	11.08
PSI4 - Death rate among surgical inpatients with serious treatable conditions	166.50	27.69
PSI9 - Perioperative hemorrhage or hematoma rate	13.28	5.40
PSI11 - Postoperative respiratory failure rate	36.67	13.60
PSI12 - Perioperative pulmonary embolism or deep vein thrombosis rate	14.29	5.95
Control Variables		
Level of competition - HHI	0.601	0.365
Nurse staffing	0.498	0.259
Number of medical/surgical ICU beds	17.15	17.12
IQI15 volume	531.91	153.01
IQI17 volume	280.61	142.25
PSI3 volume	2,057.81	1,030.71
PSI4 volume	222.21	98.40
PSI9 volume	2,336.99	1,217.87
PSI11 volume	549.26	320.80
PSI12 volume	2,244.85	1,222.11

Table 3: Use of intensivists in the base year of 2007 and the final year of 2010.

	2007		2010	
Use of Intensivists - Independent Variable				
Use intensivists (n, %)	46	26.44%	68	40.24%
Do not use intensivists (n, %)	128	73.56%	101	59.76%
Total	**174**	**100%**	**169**	**100%**

Table 4: Fixed effects regression results for Inpatient Quality Indicators (IQIs) with the use of intensivists as a binary independent variable.

	IQI 15 - AMI Mortality Rate		IQI 17 - Acute stroke mortality rate	
	Coef.	S.E.	Coef.	S.E.
Independent Variable				
Use of intensivists	-20.84*	7.92	3.08	3.41
Control Variables				
Competition	178.10	298.71	183.93	110.72
Nurse staffing	-48.23	54.96	5.20	29.35
# ICU beds	0.57	0.50	0.15	0.15
Volume	0.10**	0.03	-0.05	0.03

Significant at: + $p < 0.1$ * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$
There were 23 and 71 hospital-year observations for IQI15 and IQI17 respectively
Standard errors clustered at hospital level

Table 5: Fixed effects regression results for Patient Safety Indicators (PSIs) with the use of intensivists as a binary independent variable.

	PSI 3 - Pressure ulcer rate		PSI 4 - Death rate among surgical inpatients with serious treatable conditions		PSI9 - Perioperative hemorrhage or hematoma rate		PSI 11 - Postoperative respiratory failure rate		PSI 12 - Perioperative pulmonary embolism or deep vein thrombosis rate	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Independent Variable										
Use of intensivists	-5.62***	0.67	18.32	11.87	-2.70***	0.56	7.02**	2.55	-0.19	1.06
Control Variables										
Competition	-2.38	146.93	265.75	365.68	-45.05	29.88	-147.84	103.60	34.89	28.34
Nurse staffing	137.65	16.58	29.12	46.72	17.48**	4.89	5.11	17.54	21.09*	9.66
# ICU beds	-0.46	0.11	0.38**	0.11	-0.03	0.03	-0.07	0.16	-0.006	0.02
Volume	0.008**	0.002	-0.39	0.24	-0.004*	0.002	-0.03	0.02	0.002	.002

Significant at: + p < 0.1 * p < 0.05 ** p < 0.01 *** p < 0.001
There were 26, 38, 67, 42 and 68 hospital-year observations for PSI3, PSI4, PSI9, PSI11 and PSI12 respectively
Standard errors clustered at hospital level

CONCLUSION

The purpose of this study, consisting of three distinct papers, was to satisfy gaps in the current literature and broaden our knowledge regarding the use of intensivists. Unlike previous studies, each paper was based on a theoretical framework and sought to increase the generalizability of findings by broadening the sample of hospitals included in the analyses.

The first paper in the study used resource dependence theory (RDT) to address a specific gap in the literature. No study had previously explored the antecedents of utilizing intensivists. The paper studied the market and organizational factors associated with a hospital's strategic decision to utilize intensivists to staff the ICU. The paper performed logistic regression on 2007-2010 longitudinal data and found partial support for the proposed market hypotheses. The analyses performed found that hospitals in more munificent markets, specifically those with higher per capita income and a higher percentage of specialists, are more likely to utilize intensivists. In addition, hospitals located in more complex environments, operationalized as market competition, were found to be more likely to invest in intensivists. No support was found for the dynamism hypothesis, which was operationalized as change in unemployment rates. Organizationally, hospitals that were larger, not-for-profit and operated as a part of a system were more likely to utilize intensivists.

Agency theory was used in the second paper to study the relationship between the use of intensivists and the efficiency of care provided to ICU patients. In this paper, it was suggested that the employment or contracting of intensivists by a hospital enables the hospital administrator, serving as the principal, to better align the hospital's goal of providing efficient care with the goals of the physician, serving as the agent. The paper operationalized efficiency through average length of stay and average costs per patient day for ICU patients with a principal diagnosis of AMI, CHF, stroke or pneumonia. The paper used 2007-2010 panel data and performed fixed effects regression with facility and year fixed effects to determine that the relationship between the use of intensivists and the average cost per patient day was nonlinear. Post hoc analyses were used to determine that only the lowest and highest intensities of intensivist staffing levels were associated with a reduction in the average cost per patient day for ICU patients with a principal diagnosis of AMI. The highest intensity staffing was also found to be associated with a reduction in average cost for CHF patients. No statistically significant relationship was found between the use of intensivists and average length of stay for ICU patients with any of the four principal diagnoses of interest.

Finally, in the third paper, Donabedian's quality framework was used to explore the relationship between the use of intensivists and the quality and safety of care provided to ICU patients. It was proposed that the use of intensivists would improve the structure of the ICU, which would lead to improved processes. The improved processes would then lead to improved outcomes. Using 2007-2010 longitudinal data and facility and year fixed effects regression, the study found that the use of intensivists was associated with a decrease in AMI mortality rates for ICU patients. In addition, the use of intensivists was associated with a reduction in the rate of occurrence of adverse events including pressure ulcers and perioperative hemorrhaging or hematoma.

Taken together, the papers included in this study have filled gaps in the current literature and provided important, and more generalizable, insight regarding the use of intensivists. The study showed that hospitals that operate in an environment with more "slack resources" are more likely to invest in the use of intensivists and therefore only patients located in these more munificent markets are going to benefit from care directed by an intensivists. The study has also shown that the level of intensivist staffing matters. Policymakers and administrators should consider the appropriate level of staffing required to generate the results desired. Finally, the study has shown that the benefits associated with the use of intensivists vary based on the types of patients being served. This knowledge better informs decision makers regarding the best use of the resources needed to implement intensivist staffing strategies.

While this study broadened our knowledge regarding intensivists, several areas of further exploration and future research have been suggested. For example, researchers should continue to explore why the benefits associated with the use of intensivists vary by both the type of patients being served and the intensity level of intensivist staffing utilized. A more granular understanding of the ideal staffing and patient scenarios will allow administrators and policymakers to more precisely target the most prudent investments in intensivist staffing.

Being able to more precisely target the most prudent investments intensivist staffing is especially important in the current environment. While the use of intensivists grew from 2007 to 2010, the majority of facilities still do not use intensivists. Understanding the best use of investment dollars in this space is extremely critical. Hospitals and the healthcare system have finite resources and knowing where to best invest those finite resources will help maximize the value equation (benefits received per dollar spent) for healthcare.

Finally, an enhanced understanding of the specific intensivist-related structures and processes associated with reductions in cost and/or improvements in quality is needed. For example, what is it about the intensivist role that produces improved results? Is it the improved coordination of care or is it the specialized training? Is it the enhanced monitoring of patients or is it the use of multi-disciplinary case reviews? Obtaining an understanding of the specific structures and processes that are associated with improvements in outcomes will further improve the ability of policymakers and administrators to maximize the investments made in the use of intensivists.

The utilization of critical care is growing and will continue to grow given the aging population in the United States. As more and more individuals require the care provided in ICUs, it will become more and more imperative that the care provided is efficient, safe and effective. The use of intensivists has been shown to reduce costs and improve the quality of care provided in the ICU. Given the continued growth in ICU volume and the significant financial and clinical ramifications related to treating these patients, researchers, policymakers and administrators should continue to explore the use of intensivists as a means to reduce costs and improve the quality of care provided in the ICU.

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APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

Institutional Review Board for Human Use

Form 4: IRB Approval Form
Identification and Certification of Research
Projects Involving Human Subjects

UAB's Institutional Review Boards for Human Use (IRBs) have an approved Federalwide Assurance with the Office for Human Research Protections (OHRP). The Assurance number is FWA00005960 and it expires on January 24, 2017. The UAB IRBs are also in compliance with 21 CFR Parts 50 and 56.

Principal Investigator:	LIDDLE, GLENN B
Co-Investigator(s):	
Protocol Number:	**E130404001**
Protocol Title:	*The Association Between the Use of Intensivists and Hospital Quality and Cost*

The above project was reviewed on 4/23/13. The review was conducted in accordance with UAB's Assurance of Compliance approved by the Department of Health and Human Services. This project qualifies as an exemption as defined in 45CF46.101, paragraph 4.

This project received EXEMPT review.

IRB Approval Date: 4/23/13

Date IRB Approval Issued: 4/23/13

Cari Oliver
Assistant Director, Office of the
Institutional Review Board for Human
Use (IRB)

Investigators please note:

IRB approval is given for one year unless otherwise noted. For projects subject to annual review research activities may not continue past the one year anniversary of the IRB approval date.

Any modifications in the study methodology, protocol and/or consent form must be submitted for review and approval to the IRB prior to implementation.

Adverse Events and/or unanticipated risks to subjects or others at UAB or other participating institutions must be reported promptly to the IRB.

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APPENDIX B

PROJECT REVISION/AMENDMENT FORM

UAB

Project Revision/Amendment Form

irb

Form version: June 26, 2012

In MS Word, click in the white boxes and type your text; double-click checkboxes to check/uncheck.

- Federal regulations require IRB approval before implementing proposed changes. See Section 14 of the IRB Guidebook for Investigators for additional information.
- Change means any change, in content or form, to the protocol, consent form, or any supportive materials (such as the Investigator's Brochure, questionnaires, surveys, advertisements, etc.). See Item 4 for more examples.

RECEIVED FEB 18 2015 OFFICE OF INSTITUTIONAL REVIEW BOARD

1. Today's Date	2/17/15

2. Principal Investigator (PI)

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Contact person who should receive copies of IRB correspondence (Optional)

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Phone	205-934-3113	Fax Number	205-975-6608
Office Address (if different from PI)	1705 University Blvd, SHP 553		

3. UAB IRB Protocol Identification

3.a. Protocol Number	E130404001
3.b. Protocol Title	The Association Between the Use of Intensivists and Hospital Quality and Cost

3.c. Current Status of Protocol—Check ONE box at left; provide numbers and dates where applicable

- ☐ Study has not yet begun — No participants, data, or specimens have been entered.
- ☐ In progress, open to accrual — Number of participants, data, or specimens entered:
- ☐ Enrollment temporarily suspended by sponsor
- ☐ Closed to accrual, but procedures continue as defined in the protocol (therapy, intervention, follow-up visits, etc.)
  Date closed: — Number of participants receiving interventions: — Number of participants in long-term follow-up only:
- ☒ Closed to accrual, and only data analysis continues
  Date closed: 11/1/14 — Total number of participants entered: N/A

4. Types of Change

Check all types of change that apply, and describe the changes in Item 5.c. or 5.d. as applicable. To help avoid delay in IRB review, please ensure that you provide the required materials and/or information for each type of change checked.

- ☐ **Protocol revision (change in the IRB-approved protocol)**
  In Item 5.c., if applicable, provide sponsor's protocol version number, amendment number, update number, etc.
- ☐ **Protocol amendment (addition to the IRB-approved protocol)**
  In Item 5.c., if applicable, provide funding application document from sponsor, as well as sponsor's protocol version number, amendment number, update number, etc.
- ☐ **Add or remove personnel**
  In Item 5.c., include name, title/degree, department/division, institutional affiliation, and role(s) in research, and address whether new personnel have any conflict of interest. See "Change in Principal Investigator" in the IRB Guidebook if the principal investigator is being changed.
  - ☐ **Add graduate student(s) or postdoctoral fellow(s) working toward thesis, dissertation, or publication**
    In Item 5.c., (a) identify these individuals by name; (b) provide the working title of the thesis, dissertation, or publication; and (c) indicate whether or not the student's analysis differs in any way from the purpose of the research described in the IRB-approved HSP (e.g., a secondary analysis of data obtained under this HSP).
- ☐ **Change in source of funding; change or add funding**
  In Item 5.c., describe the change or addition in detail, include the applicable OSP proposal number(s), and provide a copy of the application as funded (or as submitted to the sponsor if pending). Note that some changes in funding may require a new IRB application.
- ☐ **Add or remove performance sites**
  In Item 5.c., identify the site and location, and describe the research-related procedures performed there. If adding site(s), attach notification of permission or IRB approval to perform research there. Also include copy of subcontract, if applicable. If this protocol includes acting as the Coordinating Center for a study, attach IRB approval from any non-UAB site added.

☐	**Add or change a genetic component or storage of samples and/or data component—this could include data submissions for Genome-Wide Association Studies (GWAS)** To assist you in revising or preparing your submission, please see the IRB Guidebook for Investigators or call the IRB office at 934-3789.
☐	**Suspend, re-open, or permanently close protocol to accrual of individuals, data, or samples (IRB approval to remain active)** In Item 5.c., indicate the action, provide applicable dates and reasons for action; attach supporting documentation.
☐	**Report being forwarded to IRB (e.g., DSMB, sponsor or other monitor)** In Item 5.c., include date and source of report, summarize findings, and indicate any recommendations.
☐	**Revise or amend consent, assent form(s)** Complete Item 5.d.
☐	**Addendum (new) consent form** Complete Item 5.d.
☐	**Add or revise recruitment materials** Complete Item 5.d.
☒	**Other (e.g., investigator brochure)** Indicate the type of change in the space below, and provide details in Item 5.c. or 5.d. as applicable. Include a copy of all affected documents, with revisions highlighted as applicable. √DS IRB

▶ The title of the dissertation has been changed to "Intensivists and Organizational Performance" based on feedback from the dissertation committee. The title change is only a simplification of the original title; neither the data used for the dissertation nor the analyses to be performed have changed from the original plan and IRB submission. No changes have been made to the project except for the minor title change mentioned above.

5. Description and Rationale

In Item 5.a. and 5.b, check Yes or No and see instructions for Yes responses.
In Item 5.c. and 5.d, describe—and explain the reason for—the change(s) noted in Item 4.

☐Yes ☐No	**5.a. Are any of the participants enrolled as normal, healthy controls?** If yes, describe in detail in Item 5.c. how this change will affect those participants.
☐Yes ☐No	**5.b. Does the change affect subject participation, such as procedures, risks, costs, location of services, etc.?** If yes, FAP-designated units complete a FAP submission and send to fap@uab.edu. Identify the FAP-designated unit in Item 5.c. For more details on the UAB FAP, see www.uab.edu/cto.

5.c. Protocol Changes: In the space below, briefly describe—and explain the reason for—all change(s) to the protocol.

▶ The change to the title of the dissertation was based on committee member feedback. Only the title changed, no other changes were made to the original project.

5.d. Consent and Recruitment Changes: In the space below,
(a) describe all changes to IRB-approved forms or recruitment materials and the reasons for them;
(b) describe the reasons for the addition of any materials (e.g., addendum consent, recruitment); and
(c) indicate either how and when you will reconsent enrolled participants or why reconsenting is not necessary (not applicable for recruitment materials).

Also, indicate the number of forms changed or added. For new forms, provide 1 copy. For revised documents, provide 3 copies:
- **a copy of the currently approved document (showing the IRB approval stamp, if applicable)**
- **a revised copy highlighting all proposed changes with "tracked" changes**
- **a revised copy for the IRB approval stamp.**

▶

Signature of Principal Investigator [signature] Date 2/17/15

FOR IRB USE ONLY

☐ Received & Noted ☒ Approved ~~Expedited~~ Exempt* ☐ To Convened IRB

Signature (Chair, Vice-Chair, Designee) Date 2/19/15

DOLA 4-23-13

Change to Expedited Category Y / N / NA

*No change to IRB's previous determination of approval criteria at 45 CFR 46.111 or 21 CFR 56.111