The Dissertation Committee for Jere Thornhill Hammer certifies that this is the approved version of the following dissertation:

Rapid Response Team Characteristics

and

Death among Surgical Inpatients with Treatable Serious Complications

in a North Texas Hospital Council

Committee:

____
Sharon A. Brown, Supervisor

____
Deborah Volker

____
Alexandra Garcia

____
Heather Becker

____
Terry Jones

____
Susan McBride

Rapid Response Team Characteristics and Death among Surgical Inpatients with Treatable Serious Complications in a North Texas Hospital Council

by

Jere Thornhill Hammer, BSN; MS; MSN

Dissertation

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Doctor of Philosophy

The University of Texas at Austin

December, 2009

Dedication

This work is dedicated with love and gratitude to my family, friends, and colleagues.

I could not have completed this journey without each of you.

Acknowledgments

Special thanks to the Hospital Council Research Director and the Chief Nurse Officers of the participating hospitals, without whose guidance, expertise, and support, this research could not have been accomplished. Your dedication to nursing excellence was an inspiration to me!

Rapid Response Team Characteristics and Death among Surgical Inpatients With Treatable Serious Complications in a North Texas Hospital Council

Publication No._____________

Jere Thornhill Hammer, PhD.

The University of Texas at Austin, 2009

Supervisor: Sharon A. Brown

In 1999, the Institute of Medicine estimated as many as 98,000 patients died each year in US hospitals as the result of medical errors. Five years later, another report estimated 195,000 people died unnecessarily. A recent study of patient safety in American hospitals concluded that 87% of Medicare deaths identified over a three-year period were "potentially preventable." The rapid response team (RRT) has been recommended as an effective strategy for reducing avoidable patient deaths as measured by patient safety indicator #4 (PSI#4), *Death among surgical inpatients with treatable serious complications* [formerly failure to rescue]. There is no research evidence to support the recommendation. The purpose of this exploratory research study was to describe RRT characteristics, determine RRT penetration, and measure PSI#4 (*Death among surgical inpatients*) rates among hospitals in a large metropolitan area hospital council. A retrospective, descriptive design was used during analysis of survey data collected from members of the hospital council and secondary analysis of administrative data submitted by the same hospitals to a regional data warehouse. All of the hospitals represented by survey submissions had implemented RRTs. The majority of teams was nurse-led and could be activated by a wide range of hospital staff and family members. The hospitals

used evidence-based criteria for RRT activation. There was a downward trend in the regional PSI#4 rate from 2003 to 2008, which was not statistically significant, but may be considered clinically significant. Nurse administrators viewed RRTs as effectively supporting nursing care. This study provided a first look at RRTs in relation to an untested patient safety indicator that measured avoidable patient deaths. More research with a larger sample size with adequate power to support statistical analysis of differences in PSI #4 rates over time will provide evidence regarding relationships among hospital characteristics, RRT characteristics, and avoidable deaths among surgical inpatients.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

Background and Significance

In 1999, the Institute of Medicine (IOM) estimated as many as 98,000 patients died each year in U.S. hospitals as the result of medical errors (Kohn, Corrigan, & Donaldson, 1999). Five years later, another report estimated 195,000 people died unnecessarily (HealthGrades, 2004). A recent study of patient safety in American hospitals concluded that 87% of Medicare deaths identified over a three year period were "potentially preventable" (HealthGrades, 2007, p. 2). The message to consumers seems to be that hospitals are hazardous to their health. The high incidence of unnecessary patient deaths has important implications for acute care nursing. Nurses are in a unique position to impact hospital safety because of the amount of time spent with patients compared to other members of the health care team. Research that explores interventions effective in improving patient outcomes sensitive to nursing is crucial to safe patient care.

Several patient outcome measures are useful in quantifying specific risks for injury or death in the inpatient setting and have been used to reflect hospital quality. One such measure, *Death among surgical inpatients with treatable serious complications*, evolved from a patient safety indicator (PSI) developed by the Agency for Healthcare Research and Quality (AHRQ) that was originally known as *PSI#4-Failure to rescue* (*FTR*) (AHRQ, 2003, 2007, 2008). Silber and his team first introduced the concept of FTR as a hospital quality indicator in the study of unexpected deaths in post-anesthesia patients (Silber, Williams, Krakauer, & Schwartz, 1992). Silber conceptualized FTR as avoidable deaths due to any hospital complication acquired by surgical patients. He found that patient characteristics were more closely related to complication rates, while hospital characteristics were more closely related to FTR. Nursing colleagues used Silber's definition when examining the impact of nurse staffing on patient and nursing outcomes (Aiken, Clarke, Cheung, Sloane, & Silber, 2003; Aiken, Clarke, Sloane, Sochalski, & Silber, 2002). An AHRQ panel of researchers built on Silber's definition when developing FTR as a PSI. In the end, the AHRQ defined PSI#4 (*FTR*) as avoidable deaths among all adult inpatients with at least one of six specific hospital acquired complications: pneumonia, deep vein thrombosis/pulmonary embolus (DVT/PE), sepsis, acute renal failure, shock/cardiac arrest, or gastrointestinal (GI) hemorrhage/acute ulcer (AHRQ, 2003). A research team commissioned by the AHRQ found FTR to be sensitive to nursing among hospitalized surgical inpatients (Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2001). Over the years, researchers continued to debate the most appropriate operational definition for FTR (Moriarty, Naessens, Finnie, & Johnson, 2005; Needleman & Buerhaus, 2007; Silber et al., 2007). The AHRQ (2008) changed the name and definition of PSI#4 from *FTR* to *Death among surgical inpatients with treatable serious complications (Death among surgical inpatients)* in August 2008. The new definition differs from the original FTR definition by applying only to surgical patients, excluding patients at 90 years of age or older instead of 75, and deleting acute renal failure as one of the hospital acquired complications. The revised definition of PSI#4 (*Death among surgical inpatients*) is of particular interest to nursing because of the critical roles nurses play in identifying complications and coordinating care for individual patients. Until research using the new PSI#4 definition is conducted and published, the concept of FTR must be reviewed in order to understand PSI#4 (*Death among surgical inpatients*).

Researchers found significant relationships between nurse staffing and patient outcomes, including FTR (Kane, Shamliyan, Mueller, Duval, & Wilt, 2007). Several studies found FTR to be sensitive to nurse staffing levels and saw lower FTR rates with higher registered nurse (RN) staffing levels (Aiken et al., 2002; Needleman et al., 2001; Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2002). Today, nurse administrators in acute care settings are challenged to make evidence-based decisions regarding patient safety in an environment of low RN staffing and lean financial resources (Clarke, 2007; Hinshaw, 2008; Talsma, Grady, Feetham, Heinrich, & Steinwachs, 2008).

In late 2004, the Institute for Healthcare Improvement (IHI) began a national movement to save patient lives by improving hospital safety (Berwick, Calkins, McCannon, & Hackbarth, 2006). The 100,000 Lives Campaign encouraged acute care facilities to implement one or more of six safety recommendations: 1) rapid response team (RRT), 2) American College of Cardiology/American Heart Association guidelines for care of myocardial infarction (MI), 3) medication reconciliation, 4) Centers for Disease Control and Prevention (CDC) guidelines for preventing central line infections, 5) CDC guidelines for preventing surgical wound infections, and 6) CDC guidelines for preventing ventilator-associated pneumonia (VAP).

A rapid response team (RRT) is defined by the IHI (n.d.) as a “team of clinicians who bring critical care expertise to the bedside”(paragraph 2). Resembling code or cardiac arrest teams, RRTs differ in their proactive approach to patient safety. Many facilities with RRTs report increased patient safety, as measured by number of cardiac arrests, transfers to ICU, or hospital deaths (Mailey et al., 2006; Repasky & Pfeil, 2005). RRTs have also been credited with improving staff morale, empowering staff decision making, and increasing job satisfaction as measured by survey and anecdotal reports (Scholle & Mininni, 2006; Thomas, Force, Rasmussen, Dodd, & Whildin, 2007). There is limited research addressing the effectiveness of RRTs in reducing patient mortality and some authors question the statistical methods used by the IHI to calculate the number of lives saved by the campaign (Chan et al., 2008; DeVita et al., 2006; Robeznieks, 2006; Tee, Calzavacca, Licari, Goldsmith, & Bellomo, 2008; Winters, Pham, & Pronovost, 2006; Winters et al., 2007). Additional research could help determine if RRT patients were indeed rescued from complications that would otherwise have resulted in death.

Purpose of the Study

Patients admitted to U.S. hospitals receive 24 hour nursing care. Nurses are in the best position to identify changes in patient conditions and mobilize appropriate resources to successfully meet changing patient needs because of this 24 hour oversight capacity. Nurse surveillance of patients is based in part on nursing vigilance or “a state of scientifically, intellectually, and experientially grounded attention to and identification of clinically significant observations/signals/cues; calculation of risk inherent in nursing practice situations; and readiness to act appropriately and efficiently to minimize risks and to respond to threats” (Meyer & Lavin, 2005, paragraph 3). Nurses can prevent or quickly analyze the adverse effects of patient care and identify hospital-based causes of complications, including mortality, most effectively when the nursing work environment includes adequate staffing and an appropriate staff mix (Aiken et al., 2002; Needleman et al., 2002). PSI#4 (*FTR*) has been shown to be sensitive to nurse staffing among surgical patients with more RN hours per patient day associated with lower FTR rates (Aiken et al., 2003; Aiken et al., 2002; Needleman et al., 2002). Nursing leaders need to know which practices prevent or contribute to errors and related mortality. The RRT has been recommended as an effective strategy for reducing PSI#4 (*FTR*) incidents (Daly et al., 2007; Kirk, 2006); however, there is no known research evidence to support the recommendation.

The purpose of this exploratory research study was to describe RRT characteristics, determine RRT penetration, and measure PSI#4 (*Death among surgical inpatients*) rates among hospitals in a large metropolitan area. This research study provided descriptive data for consideration by nursing and health care leaders who strive to base decisions about allocation of limited resources on scientific evidence. In addition, knowledge gained about practices purported to improve patient safety could benefit staff nurses. Nursing, the largest health care profession, was inextricably linked to patient safety (IOM, 2004). Spurred by organizational changes to contain costs, research evidence showed fewer adverse events and lower patient mortality with higher nurse staffing levels (Aiken et al., 2002; Estabrooks, Midodzi, Cummings, Ricker, & Giovannetti, 2005; Needleman & Buerhaus, 2003). Although there was no research evidence in the literature linking RRT and PSI#4 (*FTR*) or (*Death among surgical inpatients*), the RRT was quickly accepted, based on subjective reports, as a strategy that could "rescue" patients from complications related to hospital care and, ultimately, decrease patient mortality (Jacobs, 2006). RRTs utilized expert nurses from intensive care areas to provide critical care at the bedside in an effort to prevent or correct impending adverse patient outcomes (Berwick et al., 2006; Lee, Bishop, Hillman, & Daffurn, 1995). Since nursing shortages often occurred in critical care areas (Buerhaus, Staiger, & Auerbach, 2000), the implementation of RRTs may have negatively affected patient care in the intensive care unit as experienced nurses were pulled away to help nurses on other units. Research was needed to inform or validate nursing management and practice decisions about RRTs and to evaluate RRT implementation.

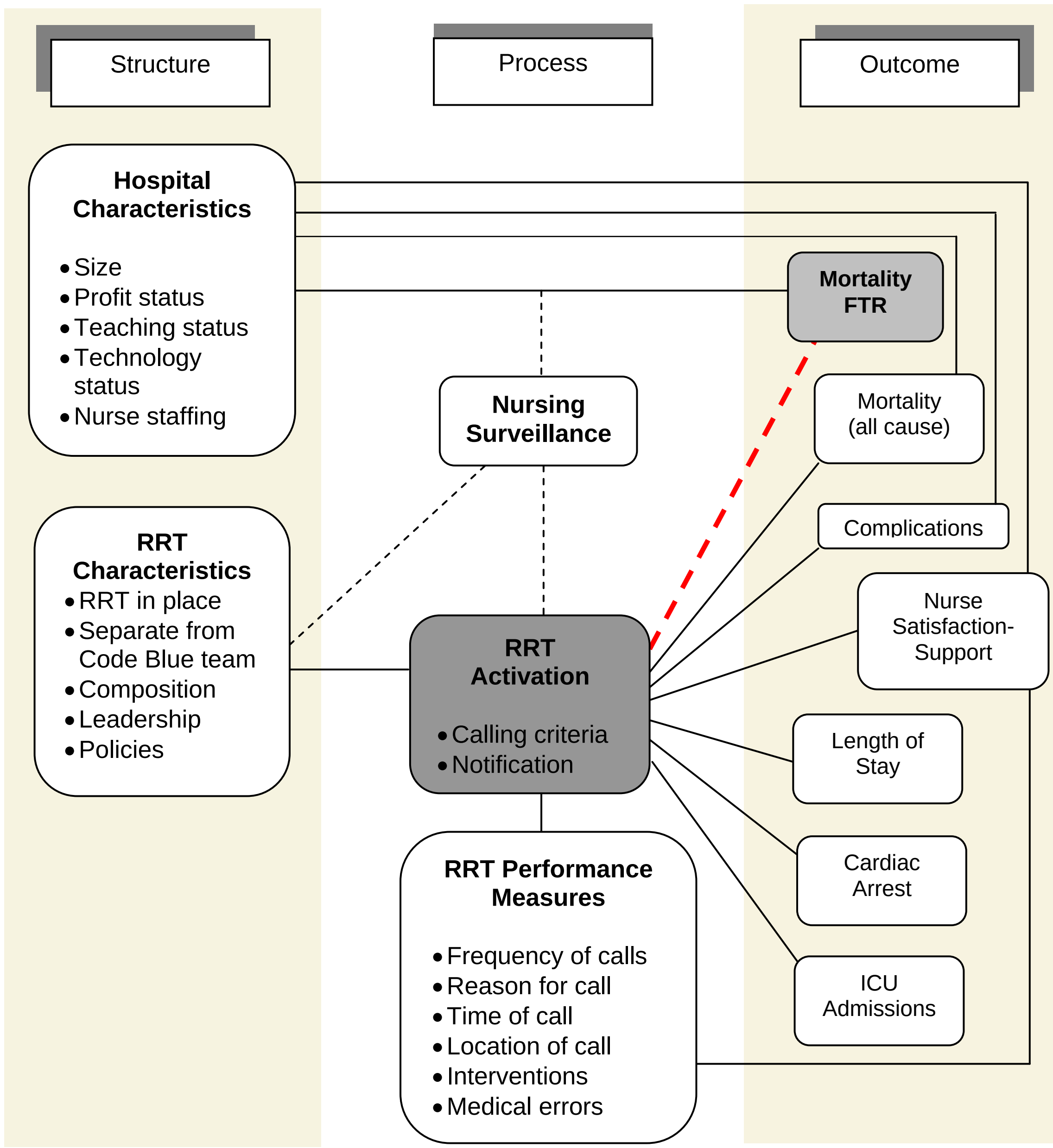
CONCEPTUAL FRAMEWORK

Concepts and tested or proposed conceptual relationships derived from the research literature guided the study. Concepts and relationships were organized within a model using the structure-process-outcome (SPO) framework described by Donabedian (1966; 1992) (see Figure 1). Donabedian (1992), known as the father of quality assurance (Best & Neuhauser, 2004), used the SPO approach to evaluate the quality of medical care and performance. The SPO approach is particularly helpful when looking at issues related to the quality of care delivered and the safety of patients while in the health care system.

Structure

Donabedian (1992) defined structure as the "physical and organizational properties" (p. 357) of the health care environment. Structure properties in the conceptual model included hospital and RRT characteristics. Hospital characteristics described organizational size, ownership, and human resources. Nurse staffing was an important

Figure 1: Conceptual framework



Relationship supported by research evidence

------------ Proposed relationship, unsupported by research evidence hospital characteristic that reflected the methods and measures used by the hospital administration to assign nursing staff for patient care. RRT characteristics described the structure of the team and varied by geographic location and type of health care system. Each of these structure components had the potential to affect both processes and outcomes.

Process

Process components entailed the steps taken in the provision of patient care; for example, interventions and treatments(Donabedian, 1966; 1992). No process variables stood out in the FTR research literature, however; nurse surveillance was discussed by several nurse authors as a significant factor in patient care and safety (Aiken, n.d.; Clarke, 2004; Correa-de-Araujo, Stone, & Clarke, 2004). Although not identified by the specific term, the surveillance function was more prominent in the RRT literature as researchers focused on nurses' recognition of patient characteristics that indicated a change in condition and resulted in RRT activation (Cioffi, 2000; Jolley, Bendyk, Holaday, Lombardozzi, & Harmon, 2007; Priestley et al., 2004). Surveillance was included in the conceptual model because of the critical role nurses play in assessing patients, recognizing potential or actual complications, and mobilizing appropriate resources to meet individual patient needs. The process of RRT activation consisted of information about how the RRT was activated including prominent calling or activation criteria and the RRT notification procedure. RRT performance measures identified how the RRT was utilized, interventions initiated by the team, and medical errors associated with the RRT event (Braithwaite et al., 2004; DeVita et al., 2004; Hourihan, Bishop, Hillman, &

Daffurn, 1995; Jones, Bates et al., 2005; Kenward, Castle, Hodgetts, & Shaikh, 2004; Lee et al., 1995; Offner, Heit, & Roberts, 2007; Parr, Hadfield, Flabouris, Bishop, & Hillman, 2001; Schmid, 2007).

Outcome

Donabedian (1992) described outcomes as providing information about the end results of medical care. Outcomes in the research literature for the current study included mechanisms related to nurse satisfaction/support and patient outcomes. Information about nurse satisfaction and support was usually obtained from survey data or interviews and related to job satisfaction, nursing attitudes, and nursing perceptions (Aiken et al., 2002; Boyle, 2004; Daffurn, Lee, Hillman, Bishop, & Bauman, 1994; Galhotra, Scholle et al., 2006; Halm et al., 2005).

The outcome variable of mortality was notable for the various operational definitions used by researchers in the published literature (AHRQ, 2003; 2008; Chan et al., 2008; Hourihan et al., 1995; Needleman et al., 2001; Silber et al., 2000; Silber et al., 1992). Two types of mortality specified in the conceptual model were labeled “FTR” and “all cause.” While each type of mortality referred to patient deaths, the causes of death were different. Conceptually, researchers agreed that FTR constituted avoidable patient deaths due to hospital acquired complications, especially among surgical patients (AHRQ, 2003; 2008; Needleman et al., 2001; Silber et al., 2000; Silber, Rosenbaum, Williams, Ross, & Schwartz, 1997; Silber et al., 1992). Operationally, researchers disagreed about the interval of time in which death occurred (in-hospital, 30 days from admission, 30 days from complication, 30 days from surgery, etc.) and the precipitating event(s) associated with death (specific complications, any complication, any reason, etc.).

Conceptual Relationships

Conceptual relationships derived from the literature are depicted in the model by a solid line connecting two variables. The first relationship found in the FTR research literature was between hospital characteristics and FTR. Silber et al. (1992) found that patient characteristics were more closely associated with complication rates and hospital characteristics were more closely associated with FTR rates. An important conceptual relationship in the nursing literature was the link between nurse staffing and FTR. More hours per patient day of care provided by RNs were associated with fewer patient complications and lower FTR rates (Jiang, Stocks, & Wong, 2006; Needleman et al., 2001, 2002). Higher nurse-to-patient ratios were associated with high patient mortality and FTR rates (Aiken et al., 2002; Boyle, 2004; Needleman et al., 2001, 2002). More RNs with baccalaureate and higher education levels were associated with lower FTR rates (Aiken et al., 2003). Nurse staffing was directly correlated with nurse satisfaction (Aiken et al., 2002; Boyle, 2004; Friese, Lake, Aiken, Silber, & Sochalski, 2008; Halm et al., 2005). The proposed relationship between nursing surveillance and the hospital characteristic of nurse staffing and the outcome of FTR was indicated by a broken line from surveillance to the solid line connecting hospital characteristics and FTR.

Proposed conceptual relationships derived from the RRT research literature are designated by a dashed line connecting two concepts. The link between surveillance and RRT characteristics was suggested by a study that analyzed clinical criteria of patients at risk for cardiac arrest (Cretikos et al., 2007). Several research teams looked at nurse or staff surveillance and RRT activation (Daffurn et al., 1994; Offner et al., 2007; Parr et al., 2001). Daffurn et al. also established a relationship between RRT activation and nurse satisfaction. The relationship between RRT activation and patient outcomes was predominant among the research findings (Bellomo et al., 2003; Bristow et al., 2000; Buist et al., 2002; DeVita et al., 2004; Hillman et al., 2005; Hourihan et al., 1995). The association between RRT activation and RRT performance measures was examined by several researchers (Braithwaite et al., 2004; Hourihan et al., 1995; Jones, Bates et al., 2005; Kenward et al., 2004; Lee et al., 1995; Priestley et al., 2004). Finally, nurse satisfaction was associated with both RRT performance measures and patient outcomes the data seemed to show that as RRT rates increased, overall death rates decreased (Galhotra, Scholle et al., 2006; Jolley et al., 2007; Salamonson, van Heere, Everett, & Davidson, 2006).

One conceptual relationship was missing from the body of research literature. There were no studies that explored the association between RRT activation and the patient outcome of interest to this research study - FTR (or Death among surgical inpatients).

Problem Statement/Research Questions

Anecdotal reports and case presentations were used to promote the use of RRTs as a way to reduce FTR events (Daly et al., 2007; Kirk, 2006). There was no research evidence

to support the recommendation. To provide beginning research evidence to support RRTs, this study answered the following research questions:

1. How many hospitals in the target area have formal RRTs in place?
    a. For hospitals with formal RRTs, in what month and year did RRT implementation begin?
    b. What is the degree of RRT penetration over time?
2. How are hospital characteristics related to size, profit status, teaching status, and technology status different between hospitals with RRTs and hospitals without RRTs?
3. What are characteristics in RRT structure among target hospitals?
    a. In how many hospitals is the RRT separate from the cardiopulmonary arrest or Code Blue team?
    b. What is the team composition?
    c. Who is the team leader?
4. What are characteristics in RRT process among the target hospitals?
    a. How many hospitals have written criteria for activating the RRT?
    b. What are the written criteria for activating the RRT?
    c. Who can activate the RRT?
    d. How are RRT members notified of a call?
    e. Which performance measures are used to evaluate the RRT?
    f. How do respondents rate the overall effectiveness of the RRT?
        i. Overall effectiveness in supporting nursing staff in patient assessment, diagnosis, intervention, and evaluation?
        ii. Overall effectiveness in decreasing patient complications?

iii. Overall effectiveness in saving patient lives?

5. What are hospital rates for PSI#4 (*Death among surgical inpatients with treatable serious complications*)?

    a. What is the annual PSI#4 rate by hospital for 2003-2008?

    b. What is the regional PSI#4 rate?

CONCEPTUAL DEFINITIONS

The major concepts in this study are defined below.

1. Formal rapid response team – a designated group of health care professionals with critical care expertise, often including a physician, a nurse, and a respiratory therapist (Berwick et al., 2006), which is called to patient care areas outside critical care units in response to changes in patient status to help stabilize the patient.

    a. Rapid response team penetration - the percentage of hospitals in a specific geographic area that have implemented RRTs (see Appendix A for operational definition).

    b. Rapid response team process - the guidelines and criteria used to establish and activate the team and document team activities (see Appendix A for operational definition).

    c. Rapid response team composition - the type of health care professionals designated as official members of the team (see Appendix A for operational definition).

    d. Rapid response team effectiveness - overall success of the team as determined by nurse executives in the facility (see Appendix A for operational definition).

2. Hospital characteristics - attributes that describe a hospital, such as size, profit status, technology status, and teaching status (see Appendix A for operational definitions).
3. Hospital acquired complications - specific medical problems occurring after a patient's admission to the hospital for unrelated medical treatment
4. PSI#4 (*Death among surgical inpatients with treatable serious complications*) - death among adult surgical inpatients due to specific, preventable hospital-acquired complications of pneumonia, deep vein thrombosis/pulmonary embolus, sepsis, shock/cardiac arrest, or gastrointestinal hemorrhage/acute ulcer (AHRQ, 2008).
5. PSI#4 (*Death among surgical inpatients*) rate - deaths per 1000 patient discharges due to specific complications of care acquired during hospitalization (AHRQ, 2008) (see Appendix A for operational definition).

ASSUMPTIONS

1. Administrative data in the form of hospital discharge abstracts are appropriate to examine the relationship between hospital characteristics, PSI#4 (*Death among surgical inpatients*), and rapid response team events from a systems perspective.
2. Administrative data are a sufficiently complete, accurate, and reliable resource in conducting research into these issues.
3. Large data samples have enough power to distinguish differences among low occurrence, high-risk outcomes (Burns & Grove, 2005; Polit & Hungler, 1999), such as, PSI#4 (*Death among surgical inpatients*).

LIMITATIONS

1. Administrative data have the potential for data collection bias, coding errors, old coding systems, inaccurate or incomplete documentation, over-reporting risk, under-reporting adverse events, lack of fit between data and conceptual framework, sampling error, measurement error, and missing data when using data from administrative databases (Grover, Hammermeister, & Shroyer, 1995; Iezzoni, 2003; Lange & Jacox, 1993; Waltz, Strickland, & Lenz, 2005).
2. Secondary analysis of existing data has potential disadvantages because the data were originally collected for previous studies or other purposes (Polit & Hungler, 1999). The existing data set may be incomplete or difficult to use for the new research hypotheses or questions. Questions or hypotheses may have to be modified somewhat to fit the existing data.
3. The results of this study cannot be generalized to all US acute care health facilities because the convenience sample was obtained from one specific metropolitan area.
4. Hospital members of the hospital council may be unique in the implementation of RRTs because of the association or support provided by council membership.
5. The study sample size of hospitals is relatively small.
6. Survey fatigue may affect the quality of responses.
7. Administrative data collection was limited to the years 2003 to 2008.
8. Retrospective data limited control of bias (DeVita et al., 2004).
9. The effectiveness of RRTs was rated by administrative nurses rather than staff nurses who have more direct contact with the team and more familiar with the positive or negative aspects of the RRTs.

Summary

This chapter introduced the topic of the study; presented background information; and stated the purpose, research problem, research questions, definitions, assumptions, and limitations of the study. The primary purposes of the study were to ascertain RRT penetration in a large metropolitan area and measure PSI#4 rates using a conceptual framework developed from the research literature. The findings of this study could contribute to nursing knowledge, influence health care policy, and inform evidence-based practice related to patient safety.

Chapter 2: Review of the Research Literature

INTRODUCTION

Measuring health care quality is central to health services research. Hospital quality is often quantified using structure, process, and outcome measures (Shojania, Showstack, & Wachter, 2001). Examples of structural measures of quality include hospital teaching status and level of technology. Process measures include specific medication or treatment protocols used in patient care. Common outcome measures include death, disease, and patient satisfaction. Recently, investigators identified hospital patient outcomes that are "sensitive" to nursing care and showed a decreased occurrence with increased nurse staffing (Needleman et al., 2001). The researchers identified nine nurse-sensitive outcomes: pressure ulcers, urinary tract infections, pneumonia, length of stay, upper gastrointestinal bleeding, shock, falls, restraints, and failure to rescue. This chapter focuses on the last outcome, failure to rescue (FTR), which is a specific measure of patient mortality and a non-specific measure of hospital quality.

Every adverse patient outcome is important to the health care provider. FTR is of particular concern because the measure focuses on preventable patient deaths due to complications acquired during hospitalization (AHRQ, 2003; Needleman et al., 2002; Silber et al., 1992). Nationwide the FTR rate was approximately 123 deaths per 1000 patient discharges (AHRQ, March, 2007). Outcomes research conducted over the past 15 years has helped inform the health care community about the usefulness of FTR as a measure of hospital quality. A prominent nurse researcher, Linda Aiken, said, "The failure to rescue patients is primarily a failure of the nurse surveillance system" (Aiken, 2002, paragraph 5). Nurses are essential to patient safety and hospital quality. Nursing staff plays a critical role in 24 hour patient assessment. Registered nurses have the knowledge, skills, and abilities to detect subtle changes in patient status (Clarke, 2004; Correa-de-Araujo et al., 2004). The surveillance function has been negatively impacted by low staffing levels as seen in fewer nursing hours per patient day, higher nurse to patient ratios, and fewer RN staff at the bedside.

Nursing workforce supply and demand issues are complex and accurate predictions of future needs are difficult. Research indicates that the current nursing shortage will continue through the year 2020 (Auerbach, Buerhaus, & Staiger, 2007). The need for 40% more nursing staff is predicted (Correa-de-Araujo et al., 2004). Inadequate levels of nurse staffing have been linked to patient mortality, patient complications, low patient satisfaction, and FTR (Lankshear, Sheldon, & Maynard, 2005). Researchers found a 7% increase in patient mortality for every patient added to the nurse's workload above four patients (Aiken et al., 2002). Medication errors, patient falls, and cardiopulmonary arrests decreased as RN hours of patient care increased (Blegen & Vaughn, 1998). Hospital acquired pneumonia decreased as RN staffing and RN hours per patient day increased (Cho, Ketefian, Barkauskas, & Smith, 2003). Increased RN care correlated with decreased urinary tract infections, length of stay, upper gastrointestinal bleeding, and shock (Needleman et al., 2002). Research also showed a significant drop in FTR rates as nurse staffing increased (Aiken et al., 2002; Needleman et al., 2002).

The best way to improve the nurse surveillance system and reduce failure to rescue rates may be to increase RN staffing (Clarke & Aiken, 2003). Another strategy, the RRT, has been proposed as an effective way to support nurse surveillance and save patient lives (Repasky & Pfeil, 2005; Saver, 2006a, 2006b; Scholle & Mininni, 2006; Thomas et al., 2007). Similar to the traditional cardiopulmonary arrest emergency system that has been in place in most hospitals since the mid 1960s (Whitcomb & Blackman, 2007), a RRT can be activated by the nurse or any concerned health care provider and within minutes a specially trained team is at the patient's bedside to assist the nurse in preventing further deterioration in the patient's status and ultimately prevent cardiopulmonary arrest (Offner et al., 2007).

In late 2004, the IHI (n.d.) encouraged U.S. hospitals to implement RRTs to prevent unnecessary patient deaths from cardiopulmonary arrest due to failure to recognize changes in patient status, failure to communicate concerns or respond to calls from concerned staff, or failure to transfer to a higher level of care and mobilizing appropriate resources to meet individual patient needs. The global outcome variable, FTR, was notable for the various operational definitions used by researchers. Anecdotal, single systems reports showed fewer cardiac arrests and increased nurse satisfaction after implementation of the RRT (Comeau & Adkinson, 2007; Daly et al., 2007; Kirk, 2006; Mailey et al., 2006; McCarthy & Blumenthal, 2006; Morse, Warshawsky, Moore, & Pecora, 2006; Pryor, Tolchin, Hendrich, Thomas, & Tersigni, 2006; Repasky & Pfeil, 2005).

Surgenor et al. (2007) contended that RRTs are "specifically designed to address failure to rescue" (p. 154). Kirk (2006) stated that the RRT "mitigates the failure to rescue" (p. 293). Anecdotal evidence supports the use of RRTs to reduce patient mortality (Daly et al., 2007); however, research has not examined the relationship between rapid response systems and failure to rescue rates or PSI#4 (*Death among surgical inpatients*) rates.

The purpose of this chapter is to present the results of the research literature review for PSI#4 (*Death among surgical inpatients*) [formerly FTR] and RRTs. Studies were included in the review if they were primary research studies measuring FTR rates or examining RRT for adult patients in medical-surgical settings; published in peer-reviewed journals; and found in CINAHL or MEDLINE online databases. The search was further limited to include articles published in English between 1990 and 2008.

FAILURE TO RESCUE: BACKGROUND AND RESEARCH

FTR was classified as patient safety indicator (#4) and was identified as a valuable gauge of hospital quality (AHRQ, 2003; Silber et al., 1992). Initially developed by Silber et al. (1992), FTR was linked to hospital characteristics such as board certification rates for anesthesiologists and nurse-to-patient ratios. Needleman et al. (2001) included a modified version of FTR in a study done for the Health Resources Services Administration exploring outcomes potentially sensitive to nursing. The AHRQ further refined and tested FTR, then included the measure as one of 20 Patient Safety Indicators (PSI) reflective of hospital quality (AHRQ, 2003; Romano et al., 2003). Since the AHRQ adopted FTR as a measure of patient safety, conflict and controversy has existed between the two primary groups of researchers with opposing views on the appropriate operational definition for FTR (Needleman & Buerhaus, 2007; Silber et al., 2007). In August 2008, the AHRQ changed the name and definition of PSI#4 from *FTR* to *Death among Surgical Inpatients with Treatable Serious Complications* to coordinate with the National Quality Forum (NQF) terminology (AHRQ, 2008). The new definition differs from the original FTR definition by applying only to surgical patients, excluding patients at 90 years of age or older instead of 75, and deleting acute renal failure as one of the hospital acquired complications. The remaining complications are coded as FTR 2-DVT/PE, FTR 3-Pneumonia, FTR 4-Sepsis, FTR 5-Shock or Cardiac Arrest, FTR 6-GI Hemorrhage/Acute Ulcer and each sub code has specific exclusion criteria (AHRQ, 2008). The revised definition has not yet been examined in published research.

A review of the FTR research literature using two electronic databases (CINAHL and MEDLINE) revealed 20 primary research studies conducted in the US and published between 1992 and 2007. Articles that met inclusion criteria for FTR research are summarized in Appendix B. Seven studies focused on establishing or testing the FTR outcome measure or metric (Horwitz, Cuny, Cerese, & Krumholz, 2007; Isaac & Jha, 2008; Jiang et al., 2006; Romano et al., 2003; Rosen et al., 2005; Silber et al., 1997; Talsma, Bahl, & Campbell, 2008) twelve studies used a specific FTR metric to study the effects of other variables on patient outcomes (Aiken et al., 2003; Aiken et al., 2002; Boyle, 2004; Friese & Aiken, 2008; Friese et al., 2008; Halm et al., 2005; Kutney-Lee & Aiken, 2008; Needleman et al., 2002; Rosen et al., 2006; Rosen et al., 2005; Silber et al., 2000; Silber et al., 2002), and one study explored patient-level characteristics of FTR cases (Bobay, Fiorelli, & Anderson, 2008). This section reviews what we have learned about FTR from these research studies.

FTR as an indicator of hospital quality

Prior to 1990, hospital quality was measured by number of deaths (death rate) or number of complications (complication rate) reported by the institution (Silber et al., 1992). In early 1990, Jeffrey Silber, an anesthesiologist, and his colleagues proposed a third measure, “failure rate,” (p. 615) as a new patient outcome. Failure rate or FTR was believed to be more accurate for comparing quality across hospitals than overall death rate or complication rate (Silber et al., 1992). The overall death rate was simply the number of patient deaths divided by the total number of patients. The complication rate was determined by dividing the number of patients with complications by the total number of patients. FTR, defined as death due to a hospital acquired complication, was calculated by dividing the number of deaths in patients with complications by the total number of patients with complications. The researchers hypothesized that the three measures were influenced by different factors. Overall death rate was associated with both hospital and patient characteristics while complication rate was influenced primarily by patient characteristics. Using administrative data for a group of surgical patients, Silber found FTR rates more closely linked to hospital characteristics, like number of beds and nurse-to-patient ratio, than either overall death rate or complication rate.

Silber directed another study that supported earlier findings about the shortfalls of complication rates as a measure of hospital quality (Silber et al., 1997). The researchers first ranked a sample of hospitals by the death rate, complication rate, and failure rate for patients undergoing specific surgical procedures. Second, they compared the correlations among the hospital rankings by type of measure used. There was a high correlation between hospitals ranked by death rate and those ranked by FTR rate (r = 0.9, *P*<0.001). The correlation between hospitals ranked by death rate and those ranked by complication rate was low (r=0.208, *P*=0.013) as was the correlation between hospital rankings by FTR rate and those by complication rate (r= -0.09, *P*=0.287). The researchers concluded that complication rate was a poor measure of hospital quality for surgical procedures.

Failure to rescue and the other Patient Safety Indicators (PSIs) were originally developed, refined, and tested using administrative data from non-federal hospitals (Romano et al., 2003). A subsequent study using administrative data from the Veteran's Administration (VA) tested the construct validity and incidence rate of the PSIs in a group of patients undergoing elective surgery (Rosen et al., 2005). FTR was one of the most frequent occurring PSIs. FTR rates were higher in the VA sample than a non-VA acute care hospital sample, but lower than a Medicare sample. Data analysis provided evidence that the PSIs have construct validity using factor analysis. Three factors explained the relationships among the PSIs: postoperative complications; mortality and disability; and complications related to procedures. FTR was the PSI with the highest loading on mortality and disability (0.84).

FTR is measured in different ways

Although FTR was consistently defined as avoidable patient deaths due to hospital acquired complications, four different operational definitions emerged from the research. The definitions are compared in Table 1.

Silber et al. (1992) calculated the failure rate by dividing the number of in-hospital deaths among surgical patients who developed a complication by the number of surgical patients with complications. Five years later, Silber et al. (1997) further defined

FTR as an in-hospital death following a complication meeting two of four criteria related to onset and seriousness of the adverse event during hospitalization. The authors identified 26 complications among the surgical patients in the sample.

In subsequent research (Silber et al., 2000; Silber et al., 2002), FTR was operationally defined as the 30-day death rate among surgical patients after a complication divided by the number of surgical patients with complications. This definition was also used in three other research studies; however, the 30 day mortality rate was defined as deaths that occur within 30 days of admission (Aiken et al., 2003; Aiken et al., 2002; Halm et al., 2005). Needleman et al. (2002) defined FTR as an in-hospital death resulting from one of five hospital-acquired complications: cardiac arrest or shock, deep vein thrombosis, upper gastrointestinal bleeding, pneumonia, or sepsis. The AHRQ (2003) defined FTR as “deaths per 1000 patients due to specific complications of care acquired during hospitalization” (p.18). Deaths were defined as in-hospital deaths. Complications of care consisted of acute renal failure, cardiac arrest or shock, deep vein thrombosis/pulmonary embolus, gastrointestinal hemorrhage/acute ulcer, pneumonia, or sepsis. Very specific inclusion/exclusion criteria were developed and are shown in Table 3.

Although the AHRQ recently changed the name and definition of FTR in Version 3.2 of the AHRQ Quality Indicator software (AHRQ, 2008), research using the modified indicator, PSI#4 (*Death among surgical inpatients*), has not yet been published.

Table 1: Operational definitions of FTR

Silber et al. (1992) FTR = in-hospital death following a complication that was present during or after surgery, or present on day 3 or later (except cardiac emergencies which could occur at any time during the hospitalization, or present in association with a diagnostic or therapeutic procedure at anytime during the hospitalization serious enough to have a potentially adverse effect on the patient's outcome. (Listed 26 complications.)
Silber et al. (2000) FTR=30 day death rate after a complication or without a recorded complication/1000 patients with complications FR = D/(C + D|noC) or the number of patients who died (D) divided by the number of patients with complications (C) + the number of patients who died without complications noted in the claims data (D|no C)
Needleman et al. (2002) FTR = (in-hospital) death of a patient with one of five life-threatening complications: 1. pneumonia 2. shock or cardiac arrest 3. upper gastrointestinal bleeding 4. sepsis 5. deep vein thrombosis
AHRQ (2003) “Deaths per 1000 patients due to specific complications of care acquired during hospitalization,” (p.18). Complications of care include: ▪ pneumonia ▪ deep vein thrombosis/ pulmonary embolus ▪ sepsis ▪ acute renal failure ▪ shock/cardiac arrest ▪ gastrointestinal hemorrhage/acute ulcer

FTR among surgical patients is sensitive to hospital characteristics

The research review identified several hospital characteristics that affected FTR rates among surgical patients. Higher anesthesiologist board certification rates were significantly related to lower FTR rates (Silber et al., 2002; Silber et al., 1992). FTR rates were also lower when anesthesia was administered or directed by an anesthesiologist (Silber et al., 2000).

The FTR rate among surgical patients was sensitive to nurse staffing in several large studies (Aiken et al., 2002; Friese & Aiken, 2008; Friese et al., 2008; Kutney-Lee & Aiken, 2008; Needleman et al., 2002), but was not statistically significant in a smaller study (Halm et al., 2005). A cross-sectional study of the relationship between RN staffing and patient deaths was conducted with surgical patients as measured by mortality and FTR rates (Aiken et al., 2002). Examining survey data from Pennsylvania nurses, discharge patient data, and administrative data from 168 Pennsylvania hospitals, they found higher risk adjusted patient mortality and FTR rates among surgical patients in hospitals with high patient-to-nurse ratios. For each additional patient assigned to a nurse, there was a 7% increase in both patient mortality rate and FTR rate (OR 1.07, CI 95%).

Using 1997 hospital administrative data sets from 799 hospitals in 11 states, Needleman et al. (2002) studied the effect of nurse staffing levels on eight adverse patient outcomes, including FTR. Of all the adverse outcomes, FTR had the highest rate of occurrence: 18.6% among medical patients and 19.7% among surgical patients. The research team found a statistically significant inverse relationship between RN hours per patient day and FTR among surgical patients (P=0.008). They also predicted higher RN staffing levels would be associated with a 4 to 6 percent reduction in the FTR rates among surgical patients.

Halm et al. (2005) replicated Aiken's 2002 study in a 572-bed Minnesota hospital. They did not find a significant relationship between nurse staffing and FTR in their small cross-sectional study, thus, concluding that staffing levels were appropriate. The lack of significance could be due to the small sample size in the replicated study. Aiken et al. (2002) examined 232,432 patient discharges compared to 2,709 patient discharges in the Halm et al. study. Although there are no standard guidelines for sample sizes in studies using logistic regression (Munro, 2005), Bewick, Cheek, and Ball (2005) recommended a large sample size in order to detect subtle differences between the variables. Aiken's work with other researchers (Friese & Aiken, 2008; Friese et al., 2008) examined the relationship between nurse staffing and surgical patient outcomes among oncology patients in Pennsylvania hospitals. Both studies found that better staffing was associated with lower FTR.

Another factor related to nurse staffing, nurse education level, was negatively associated with FTR rates among surgical patients (Aiken et al., 2003; Kutney-Lee & Aiken, 2008). Using data from the 2002 study, Aiken and her colleagues examined the relationship between nurse education level and FTR rates (Aiken et al., 2003). They concluded, "…in hospitals with higher proportions of nurses educated at the baccalaureate level or higher, surgical patients experienced lower mortality and failure-to-rescue rates" (p. 1617). Data analysis showed a 5% decrease in the likelihood of both patient mortality and FTR with each 10% increase in the number of nurses on staff with a baccalaureate degree or higher (OR .95, 95% CI). Kutney-Lee and Aiken found similar results among surgical patients with severe mental illness.

In addition to education level, nurse-perceived autonomy/collaboration was negatively associated with FTR rates (Boyle, 2004). Boyle's research looked at the relationship between hospital nursing characteristics and patient outcomes at the unit level rather than the hospital level using a cross-sectional approach. The study found a significant negative relationship ($r = -0.53$) between perceived autonomy/collaboration and FTR rates with autonomy/collaboration explaining 24% of the variance related to FTR.

Accuracy of FTR measurement may be affected by the method used

AHRQ researchers applied the final list of Patient Safety Indicators to the 1995-2000 Health Care Utilization Project (HCUP), National Inpatient Sample (NIS) data to establish a national profile of patient safety in hospitals (AHRQ, 2003; Romano et al., 2003). The total FTR rate was 17.4 percent. When the researchers looked at PSI trends by year, the FTR rate decreased by 6 percent from 18.6 percent in 1995 to 17.4 percent in 2000. FTR was lowest among older children and young adults, when examined by age, and highest among African Americans when examined by ethnicity.

Researchers found the AHRQ FTR indicator overestimated the number of cases by 30% to 50% when compared to chart reviews (Horwitz et al., 2007; A Talsma et al., 2008). Many of the misidentified cases were the result of coding errors. Although the indicator could be useful for internal quality assessment, researchers warned against using the measure to compare institutions. The new PSI#4 (*Death among surgical inpatients*) measure has not been tested or studied for accuracy in independent research.

FTR rates may be influenced by the data source used

Jiang et al. (2006) compared the relationship between FTR rates and nurse staffing from data from the American Hospital Health (AHA) Annual Survey of Hospitals and data extracted from the California Office for Statewide Health Planning and Development (OSHPD). FTR was significantly related to nurse staffing only with data from the state database. The researchers concluded the state database contained more complete data than the national database; however, the AHA Annual Survey is commonly used for nurse staffing research. The current study used hospital data from a regional data warehouse.

Rapid Response Systems: Background and Research

The in-hospital rapid response concept originated in Australia around 1990 and was known as the medical emergency team (MET) (Daffurn et al., 1994; Hillman, Parr, Flabouris, Bishop, & Stewart, 2001; Hourihan et al., 1995; Lee et al., 1995; Parr, Bishop, Hillman, Duffurn, & Thebridge, 1998). Modeled after trauma response teams, the MET was created to reduce deaths from cardiac arrest by bringing intensive care expertise to the bedside before the patient required resuscitation (Hillman, 2004; Hillman, Chen, & Brown, 2003; Hourihan et al., 1995; Lee et al., 1995; Parr et al., 1998). The premise was that the MET would be called at the first sign of trouble and the team would intervene to prevent cardiac arrest thus decreasing the high death rate associated with cardiopulmonary resuscitation.

In England, a related concept was being developed called the Critical Care Outreach (CCO) team (Priestley et al., 2004). In the United States, the term Rapid

Response Team (RRT) appeared in the literature as a work redesign strategy aimed at reducing in-patient mortality (Haraden & Rutherford, 2004). In December 2004, the IHI launched the 100,000 Lives Campaign (Berwick et al., 2006). The goal of the campaign was to save at least 100,000 patient lives by improving safety in acute care hospitals (Whittington, Simmonds, & Jacobson, 2005). Participating hospitals were asked to implement at least one of six recommended interventions, including RRTs (Berwick et al., 2006). Like METs, RRTs were based on "principles of early recognition, response, and rescue" (Schmid, 2007, p. 81).

The First Consensus Conference on Medical Emergency Teams met during the International Conference on Medical Emergency Teams in Pittsburgh, Pennsylvania during the summer of 2005 to discuss rapid response systems (DeVita et al., 2006). Consensus members considered various response models and recognized different levels of response capability. As a result, conference experts agreed upon standardized definitions. The term MET was designated for teams with comprehensive critical care capabilities to diagnose, prescribe, and implement ICU-level care at the bedside. In contrast, the term RRT would imply a team of clinicians with fewer critical care capabilities, but that would ensure rapid assessment, stabilization, and transfer of critically ill patients. The Consensus group did not recommend using the term CCO as a response model, because of the additional focus on active identification of at-risk patients. Use of the terms MET and RRT in the literature seem to be divided between type of article and geographic region. Most research articles and journal articles from outside the US used the term MET. Many journal articles in the US used the term RRT.

Twenty-five research articles published between 1994 and 2008 were found by searching two electronic databases (CINAHL and MEDLINE) using keywords: rapid response, rapid response team, and medical emergency team. Search criteria included research studies evaluating the impact of RRT on patient outcomes in acute care settings, especially FTR; published in English in peer-reviewed journals; and found in designated databases. The search was limited to articles published from 1990 to 2008. Articles that met inclusion criteria are summarized in Appendix C.

Fourteen studies were conducted in Australia, two in the United Kingdom, and nine in the US. Early studies focused primarily on utilization and immediate outcomes of the MET intervention (Hourihan et al., 1995; Lee et al., 1995; Parr et al., 2001). Later studies examined before and after effects of RRT on one or more patient outcomes (Bellomo et al., 2004) or compared MET and non-MET cohorts (Bristow et al., 2000; Hillman et al., 2005; Priestley et al., 2004). Targeted patient outcomes included cardiac arrest, unplanned transfer to ICU, death after cardiac arrest, and length of stay. No study measured FTR. One study explored the use of the MET review as a means of detecting medical errors (Braithwaite et al., 2004). Three studies described patterns and rates of MET calls and cardiac arrests (Galhotra, DeVita, Simmons, & Schmid, 2006; Jones, Bates et al., 2005; Schmid, 2007). Three studies explored nurses' perceptions of the MET event (Cioffi, 2000; Daffurn et al., 1994; Galhotra, Scholle et al., 2006). One study looked at hospital-wide code and mortality rates (Chan et al., 2008). This section describes what is known about METs or RRTs from the research.

Team composition varies by facility

Twenty-one of the articles used MET terminology; one addressed a physician-led RRT; three articles described nurse-led teams. The composition of the MET was vaguely defined in some articles (Hourihan et al., 1995; Lee et al., 1995) and not defined in others (Kenward et al., 2004; Schmid, 2007). Researchers from Australia generally described the MET as consisting of at least three members: one ICU physician, one ICU nurse, and one medical physician (Bellomo et al., 2004; Bellomo et al., 2003; Bristow et al., 2000; Jones, Bates et al., 2005; Jones, Bellomo et al., 2005; Jones et al., 2007; Parr et al., 2001). One researcher from England described a Critical Care Outreach Team composed of critical care nurses led by a nurse consultant (Priestley et al., 2004). Researchers from the University of Pittsburgh identified eight team members with specific roles, including three physicians and three nurses, with emergency equipment to form a “virtual mobile intensive care unit” (Foraida et al., 2003, p. 88). Jolley et al. (2007) and Chan et al. (2008) described teams composed of critical care nurses and respiratory therapists.

Formal activation criteria are important for identification of at-risk patients

Response team activation was generally guided by explicit objective criteria based on a decline in patient vital signs or behavior. Criteria also included a subjective “worried” or “concerned” criterion. MET activation occurred most often in response to objective criteria (Daffurn et al., 1994; DeVita et al., 2004; Galhotra, DeVita, Simmons, & Schmid, 2006; Hourihan et al., 1995; Lee et al., 1995; Offner et al., 2007; Parr et al., 2001). Subjective criteria or staff concern was the main reason for MET activation in two studies (Bellomo et al., 2004; Bellomo et al., 2003) and the second most common reason in at least one study (Offner et al., 2007). Cioffi (2000) found nurses used the “worried” criterion more than any other group of health care providers (p. 263). Cretikos et al. (2007) tried to find a set of objective activation criteria that could identify the most at-risk patients without capturing patients who were not in real danger of an adverse event. The set of criteria with the highest specificity included the respiratory rate, heart rate, systolic blood pressure, and level of consciousness. The sensitivity of this set of criteria was low and the positive predictive value was less than 16 percent. In contrast, Bellomo et al. (2003) concluded staff could prevent most in-hospital cardiac arrests by activating the RRT based on physiological instability. DeVita et al. (2004) noted barriers to MET utilization improved when written, objective guidelines were published and well distributed.

Surgical patients are more likely to survive after RRT intervention

Several research articles described the patient requiring RRT interventions. Surgical patients were more likely to survive after the RRT than medical patients (Kenward et al., 2004). Bellomo et al. (2004) found a 37 percent decrease in post-operative death among major surgery patients after MET implementation. Jones, Bates et al. (2005) found MET implementation resulted in a sustained decrease in surgical patient mortality.

RRT effectiveness in improving select patient outcomes is mixed

Fifteen studies measured the impact of RRT on specific patient outcomes. Thirteen of the studies showed statistically significant changes in adverse patient outcomes after implementing a MET or RRT (Begun, Zimmerman, & Dooley, 2003;

Bristow et al., 2000; Buist et al., 2002; Chan et al., 2008; DeVita et al., 2004; Foraida et al., 2003; Hourihan et al., 1995; Jolley et al., 2007; Jones, Bellomo et al., 2005; Jones et al., 2007; Offner et al., 2007; Priestley et al., 2004). Outcome measures included unplanned ICU admission, overall in-hospital deaths, non-ICU cardiac arrest, death without DNR order, post-cardiac arrest bed days, MET scores, length of stay, preventable adverse events (medical errors), patient with adverse occurrences, mean hospital stay, patient mortality after MET, and physiologic measures (pulse, respiratory rate, blood pressure).

The most commonly measured and most controversial outcome, non-ICU cardiac arrest, was measured in 11 of the outcome studies. Seven studies showed a statistically significant decrease in the number of cardiac arrests outside the ICU after instituting a MET or RRT in a single institution or system (Bellomo et al., 2003; Chan et al., 2008; DeVita et al., 2004; Jolley et al., 2007; Jones, Bates et al., 2005; Offner et al., 2007). The percent reduction in cardiac arrests after MET implementation ranged from 17 percent (DeVita et al., 2004) to 65 percent (Bellomo et al., 2003). Measuring the number of cardiac arrests outside the ICU is considered by many researchers to be a poor indicator of MET or RRT effectiveness. The controversy arises around evidence that the differences in overall hospital cardiac arrests are not statistically significant after MET or RRT implementation (Bristow et al., 2000; Chan et al., 2008; Jolley et al., 2007; Kenward et al., 2004). A study conducted one year after MET implementation in a single institution found the decrease in cardiac arrests was not statistically significant. There was no significant difference in the frequency of cardiac arrests in two studies comparing outcomes in a group of MET hospitals with those in a group of non-MET hospitals (Bristow et al., 2000; Hillman et al., 2005). Although Jolley et al. (2007) and Chan et al. (2008) saw a decrease in the number of codes outside the CCU, there was no statistically significant difference in hospital-wide patient mortality rates due in part to low number of events that occurred in a single facility.

Rapid response systems are well-accepted by nursing staff

All the nurses responding to a questionnaire about MET events were satisfied with their experiences and would activate the team again in the future (Daffurn et al., 1994). Nurses who activated an emergency response team for patients in distress believed the interventions saved lives, enhanced patient outcomes, and made the hospital setting a better place to work (Daffurn et al., 1994; Galhotra, Scholle et al., 2006; Priestley et al., 2004). Ninety-eight percent of nurses surveyed (n=300) were grateful they could activate the rapid response systems in the event of worsening patient status (Galhotra, Scholle et al., 2006).

Sustained use of the RRT requires recurring staff education

Several authors spoke of the need for periodic staff education on the subject of the METs or RRTs. Although Daffurn et al. (1994) identified positive attitudes towards the RRTs among staff nurses in their study, they also noted the nurses were unsure about activation criteria and were unable to locate written information about the MET. The researchers concluded that frequent staff education was critical for proper operation of the rapid response system. Bristow et al. (2000) suggested one reason for apparent lack of effect of the MET on overall patient mortality was underutilization of the intervention by staff closest to the patient. As mentioned earlier, one research team found sustained MET utilization after disseminating an activation protocol (DeVita et al., 2004). Foraida et al. (2003) studied the impact of four strategies on MET utilization: (1) reviewing sequential emergency pages, (2) communicating with health care providers who delayed or failed to activate the MET, (3) constructing objective activation criteria, and (4) distributing MET calling criteria. The last two strategies were most effective in increasing MET usage.

Conclusions and Questions

Current research is limited to the work of a few research teams in Australia and the US. No study has examined the relationship between RRT and FTR; however, studies have measured patient outcomes included in FTR metrics, such as, cardiac arrest. Members of the First Consensus Conference on Medical Emergency Teams described a MET patient as "one who has deteriorated, physiologically or psychologically, to the point that he or she is at risk of serious harm and therefore urgently requires a clinical response" (p. 2465). A MET patient is at increased risk for death as the result of a hospital-acquired complication or FTR if the emergency response is initiated too late to save the patient.

FTR rates are measured by one of four operational definitions. FTR has been found to be sensitive to nurse staffing among surgical patients. Most of the patients requiring rapid response interventions were adult medical patients. RRTs have been shown to decrease adverse outcomes, such as, cardiac arrest, but are less effective in decreasing cardiac arrest fatalities. No study examined the effects of specific patient care interventions, such as, RRT on FTR rates. The newly revised PSI#4 (*Death among surgical patients*) is untested.

Findings from the literature do not provide sufficient evidence to conclude that RRTs target potential FTR patients and consequently decrease FTR rates. There is limited evidence that surgical patients were more likely to survive after a RRT call than medical patients (Bellomo et al., 2004; Jones et al., 2007; Kenward et al., 2004), which suggests a potential positive impact on PSI#4 (*Death among surgical inpatients*).

Although qualitative studies show positive perceptions of RRTs among nursing staff, more research is needed related to patient outcomes. Future research designs must include sufficient power to detect significant differences among FTR rates after RRT implementation. Low frequency, high risk events such as FTR are difficult to study effectively in a single facility. Researchers should examine FTR rates in response to interventions such as RRTs in multi-hospital systems or in geographic regions with large numbers of hospitals where data can be aggregated to allow greater statistical power and improved data analysis.

Until there is adequate evidence on which to formulate decisions related to implementation and staffing of RRTs, nurse executives and clinical managers must continue to rely on individual case results, logic, and intuition. Nurses should continue to share experiences about RRTs with colleagues. Nurses would be hard pressed to deny the logic that early intervention must surely reduce adverse outcomes. Most nurses recognize the importance of intuition when something is just not right with a patient. No matter the value, these ways of knowing are not enough to answer the question about the relationship between RRTs and PSI#4 (*Death among surgical inpatients*). The time for research-based answers is now.

Chapter 3: Methodology

The initial purpose of this research study was to describe RRT characteristics and degree of penetration in a large metropolitan area of north Texas and explore the relationship between degree of RRT penetration and PSI#4 (*Death among surgical inpatients*) rates. The small sample size prohibited correlational analysis so the research methods were limited to descriptive analyses. This chapter includes descriptions of the quantitative research methodology used to conduct the study.

Study design

A retrospective, descriptive design was used to analyze survey data collected from members of the hospital council and conduct secondary analysis of administrative data submitted by the same hospitals to a regional data warehouse. The survey data were primarily quantitative, although comment fields were provided for each survey item that produced qualitative data for analysis. Administrative data included quantitative information from hospital discharge abstracts. A non-experimental, quantitative study design was appropriate because the researcher did not manipulate or randomize variables (Polit & Hungler, 1999). Secondary analysis allowed the researcher to explore relationships among existing variables, concentrate on a particular group of patients, and change the unit of analysis (Polit & Hungler, 1999).

The research questions (Table 2) were satisfactorily answered using existing administrative data and data collected by a researcher-designed survey. Study data available from these two sources were appropriate for descriptive and correlational analyses.

Table 2: Research questions

1. How many hospitals in the target area have formal RRTs in place?
    a. For hospitals with formal RRTs, in what month and year did RRT implementation begin?
    b. What is the degree of RRT penetration over time?
2. How are hospital characteristics related to size, profit status, teaching status, and technology status different between hospitals with RRTs and hospitals without RRTs?
3. What are characteristics in RRT structure among target hospitals?
    a. In how many hospitals is the RRT separate from the cardiopulmonary arrest or Code Blue team?
    b. What is the team composition?
    c. Who is the team leader?
4. What are characteristics in RRT process among the target hospitals?
    a. How many hospitals have written criteria for activating the RRT?
    b. What are the written criteria for activating the RRT?
    c. Who can activate the RRT?
    d. How are RRT members notified of a call?
    e. Which performance measures are used to evaluate the RRT?
    f. How do respondents rate the overall effectiveness of the RRT?
        i. Overall effectiveness in supporting nursing staff in patient assessment, diagnosis, intervention, and evaluation?
        ii. Overall effectiveness in decreasing patient complications?
        iii. Overall effectiveness in saving patient lives?
5. What are hospital rates for PSI#4 (*Death among Surgical Inpatients with Treatable Serious Complications*)?
    a. What is the annual PSI#4 rate by hospital for 2003-2008?
    b. What is the regional PSI#4 rate?

A database is "a collection of data organized for rapid search and retrieval, usually by a computer; often a consolidation of many records previously stored separately" (Vogt, 1999, p. 69). There are two major types of large databases related to inpatient care: clinical and administrative (Burns & Grove, 2005; Lange & Jacox, 1993). Clinical databases contain records related to the provision of patient care. Administrative databases, the most commonly used source of data for outcomes research, are produced by health care institutions for billing, handling insurance claims, reporting to external agencies, and monitoring the quality of internal processes (Aday, Begley, Lairson, & Balkrishnan, 2004; Burns & Grove, 2005; Waltz et al., 2005). Most administrative databases store details about patient demographics, procedures, diagnoses, medication use, and disposition (Aday et al.). Administrative databases offer researchers access to large amounts of relatively economical, computerized data that can be used with statistical software packages, and may allow tracking of variables over time (Aday et al., 2004; Iezzoni, 2003; Merne Smaldone & Connor, 2003; Waltz et al., 2005). Database-driven research has made significant contributions to improving health care quality (Iezzoni). Administrative data in the form of hospital discharge abstracts are appropriate to examine the relationship between health care interventions, and failure to rescue (FTR) outcomes.

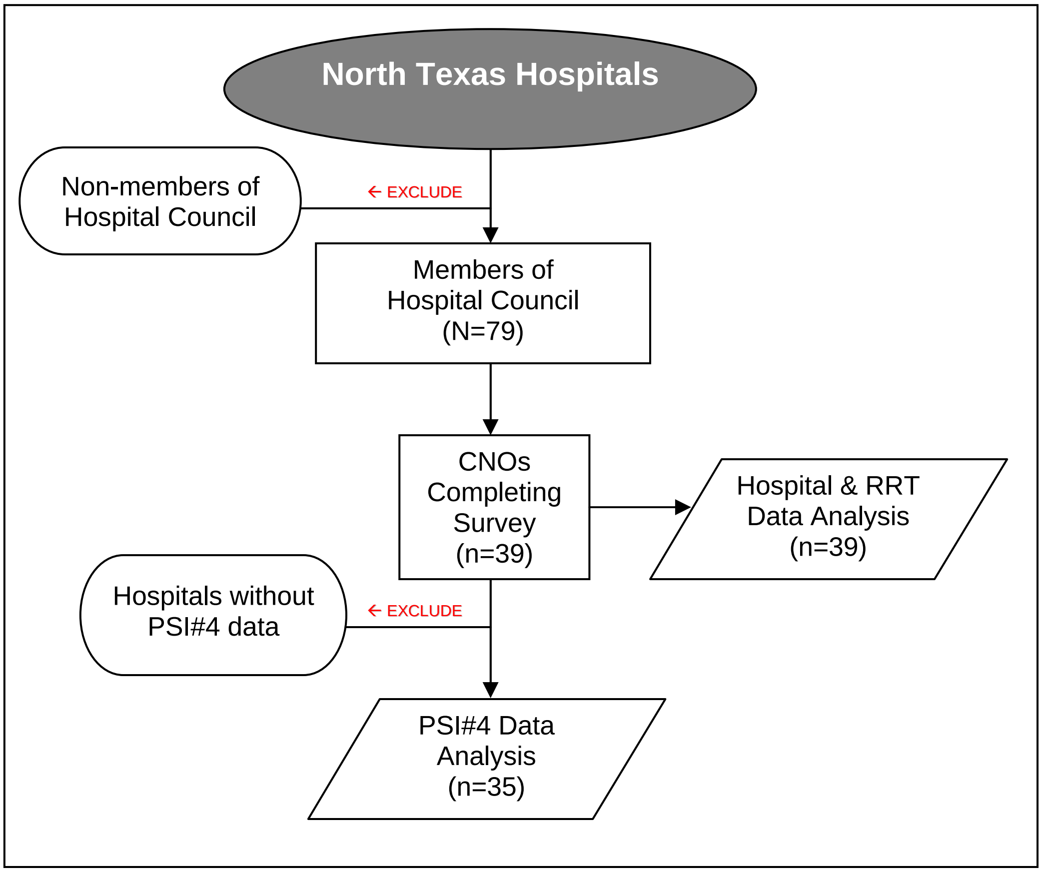
Careful research design, including selection of well-maintained administrative data sources and clear operational definitions of outcome variables, address the psychometric issues of accuracy, completeness, and reliability associated with large databases (Grover et al., 1995; Iezzoni, 2003). Even though large databases have some disadvantages including exclusion of uninsured patients and those hospital services not covered by insurance (Iezzoni, 2003), the rich source of existing health data along with progressive improvement and standardization of information make them valuable data sources for outcomes research (Grover et al., 1995; Iezzoni, 2003; Polit & Hungler, 1999).

Survey data were related to the structures and processes used in the implementation of RRTs in acute care hospitals in the target area. The survey was developed by the researcher based on the literature review and critiqued by two experienced researchers for clarity and format. Survey items were carefully constructed to collect data related to hospital and RRT characteristics, including total number of adult medical-surgical beds; profit, technology, and teaching statuses; and RRT team composition, calling criteria, and documentation. Survey research provided flexibility in data collection and was appropriate in this study because the information requested was factual and suited for “extensive analysis” (Polit & Hungler, 1999, p. 201).

SETTING

The setting for the study was a non-profit Hospital Council, which has promoted health care quality and patient safety in North Texas since 1978. The Council consisted of a group of 79 acute care hospitals located within 50 to 100 miles of the network offices. The Council collects and analyzes collaborative data and produces public use data files for research. This study utilized hospital discharge data from the Council to compute PSI#4 (*Death among surgical inpatients*) rates for individual hospitals and the Council region. In addition, the research survey distributed to nurse leaders representing member hospitals explored hospital characteristics, RRT characteristics, and perceived effectiveness of the RRT.

Figure 2: Study Sample Inclusion/Exclusion Decisions



STUDY SAMPLE

This study drew a convenience sample from among hospitals in a large metropolitan area. Inclusion and exclusion criteria were based on membership in a regional Hospital Council. Approximately 79 institutional members of the Council were eligible to participate in the study. The study excluded hospitals in the region that were not members of the Council. Thirty-nine eligible participants elected to join the study by submitting a completed survey; all 39 were included in descriptive data related to hospital and RRT characteristics. Sample hospitals were excluded from statistical analysis of PSI#4 (*Death among surgical inpatients*) rates if they did not provide acute care services to adults or did not submit discharge abstract data to the Hospital Council. PSI#4 data were available for, 35 of the sample of 39 participants. Figure 2 diagrams inclusion and exclusion decisions and the resulting sample sizes.

PROCEDURES

The research director at the Hospital Council served as the gatekeeper and protector of hospital data by masking hospital identities and data from the primary researcher. The CNO from each of the 79 council hospitals served as the point of contact for the research study. All communication with the CNO went through the Hospital Council's research director via email or telephone contact. Each CNO received an email invitation to participate in the study by completing a web-based survey entitled *Rapid Response Team Practices*. Each CNO was assigned a unique identification number (ID#) by the Hospital Council's research director so that survey results could be linked to hospital administrative data by the primary investigator by matching the survey data with the PSI#4 data using the pre-assigned unique ID#.

The survey was distributed via the Web in the form of a 15 item self-administered questionnaire (Appendix D) to CNOs from each of the participating Council hospitals. Reminders were sent by the Hospital Council research director via email to CNOs whose surveys were still pending after the agreed upon deadline. A maximum of three reminders were sent at two week intervals to increase the rate of return. Data from completed surveys were downloaded into a spreadsheet, cleaned, and then uploaded into SPSS 16.0 for Windows for analysis.

Operational definitions

The researcher identified and operationally defined the study variables within the database. Ransom, Joshi, and Nash (2005) summed up the critical importance of this step of the research design process when they said, “All good measurement begins and ends with operational definitions” (p. 100). Understanding how the data elements in the database were defined and matching them accurately with study variables decreased measurement error (Lange & Jacox, 1993). Operational definitions for each of the variables of interest in this study were previously described in Appendix A.

Dependent variable

Past researchers have used one of four FTR definitions in examining patient outcomes related to this Patient Safety Indicator (PSI#4) (Table 1) (AHRQ, 2003; Needleman et al., 2001; Silber et al., 2000; Silber et al., 1992). Although conceptually similar, operational definitions differ in the type of mortality measured (in-hospital or 30-day mortality), the targeted patient population (medical or surgical), and the identification of hospital-acquired complications (limited to specific complications or unlimited). In 2008, the AHRQ changed the name and definition of PSI #4 from FTR to “Death among Surgical Inpatients with Treatable Serious Complications” in Version 3.2 of the AHRQ Quality Indicator software. Table 3 compares the two indicators. The rationale for revising PSI #4 was to “harmonize” the AHRQ definition with that of the National Quality Forum (NQF) that had “better criterion and construct validity” (J. Geppert, personal communication, October 16, 2008). The new PSI #4 (Death among surgical patients) definition is similar to the former FTR definition except the new definition is applicable only to surgical patients, patients are excluded at 90 years of age instead of 75, and one of the complications (acute renal failure) has been deleted. The remaining complications are coded as FTR 2-DVT/PE, FTR 3-Pneumonia, FTR 4-Sepsis, FTR 5-Shock or Cardiac Arrest, FTR 6-GI Hemorrhage/Acute Ulcer and each sub code has specific exclusion criteria (AHRQ, 2008).

This study used the new AHRQ (2008) operational definition of PSI#4 (*Death among surgical inpatients*), because research using the new definition is just beginning. This study added to the body of knowledge related to interventions that may prevent deaths due to hospital acquired complications by describing PSI#4 outcomes among multiple hospitals. The PSI#4 (*Death among surgical inpatients*) rates were computed using Quality Indicator (QI) software Version 3.2. The QI software used discharge data to identify deaths among surgical patients with treatable serious complications after adjusting for risk factors. The risk adjustment module was enhanced in Version 3.2 of the QI software from earlier versions. PSI rates were risk-adjusted for case mix and performance differences. The database included the Uniform Hospital Discharge Data Set (UHDDS) required by the government for reimbursement of health care costs covered by federal agencies, which led to greater standardization of data across hospitals (Iezzoni, 2003).

Independent variables

1. RRT status was the presence or absence of a fully implemented team defined by Berwick et al. (2006) as:

   > Rapid response teams, also referred to as medical emergency teams, resemble code teams in that they are staffed by health care professionals with critical care expertise, often including a physician, a nurse, and a respiratory therapist. However, unlike a code team, a rapid response team is summoned before a code occurs (p. 324).

2. RRT penetration was based on the number of hospitals in the sample with fully implemented teams. Data collected from the research survey were used to compute percentages that were analyzed by year from January 2003 through December 31, 2007. The researcher described RRT penetration at the regional level and the dependent variable, PSI#4 (*Death among surgical inpatients*), at both the hospital and regional levels.
3. RRT leadership was defined by whether the team was led by a physician, RN, respiratory therapist, or other provider. Data collected from the research survey examined the frequency of leadership by different members.

Other variables

Other variables of interest included hospital characteristics, RRT process, RRT composition, and perceived RRT effectiveness. Data related to the distribution of these variables were collected by the research survey.

1. Hospital characteristics data regarding profit status (public, non profit, for profit), technology status (presence or absence of open heart surgery or transplant program), teaching status (non-teaching, minor teaching, major teaching), and total number of adult medical/surgical units allowed the researcher to identify similarities and differences among hospitals with and without RRTs.
2. RRT process data identified whether the RRT was separate from the Code Blue team, whether written guidelines were available to activate the RRT, and described the type of activation or calling criteria available among the sample hospitals with RRTs.
3. RRT composition data described specific team memberships among the target hospitals. The researcher used the data to compare and contrast team makeup among target hospitals and identified potential relationships between team composition and PSI#4 (*Death among surgical inpatients*) rates.
4. RRT effectiveness was rated by nurse executives responding to the research survey on a four-point scale ranging from poor to excellent. The effectiveness rating was examined how well the RRT supported nursing care, reduced patient complications, and saved patient lives.

DATA ANALYSIS METHODS

Descriptive statistics in the form of frequency distributions, central tendency, and variability (Polit & Hungler, 1999) were used in the analysis of data related to each of the three research questions. Survey data were loaded into SPSS® version 16.0 for analyses.

PSI#4 (*Death among surgical inpatients*) rates were computed using the AHRQ QI software Version 3.2 from data submitted by member hospitals to the regional data warehouse. The sample size did not support the use of inferential statistics to test differences between groups (Polit & Hungler, 1999).

Institutional Review Board Approvals

The researcher requested Institutional Review Board (IRB) approval from The University and the Hospital Council. An expedited approval was granted because patient data contained in the administrative database were de-identified by the Council. There were minimal risks to hospital participants. Completion of the research survey constituted implied consent to participate in the study. Hospital level data reported by the hospitals and survey data collected by the researcher were safeguarded and confidentiality was assured.

Table 3: Comparison of the original and revised QI software specifications for PSI#4

<table>
<tr><td colspan="2">AHRQ PSI #4 (Version 3.1)</td><td colspan="2">AHRQ PSI #4 (Version 3.2)</td></tr>
<tr><td colspan="2">Failure to rescue</td><td colspan="2">Death among surgical inpatients with treatable serious complications</td></tr>
<tr><td colspan="2">Numerator:
Discharge status of death</td><td colspan="2">Numerator:
Discharge status of death</td></tr>
<tr><td colspan="2">Denominator:</td><td colspan="2">Denominator:</td></tr>
<tr><td>Inclusion</td><td>Exclusion</td><td>Inclusion</td><td>Exclusion</td></tr>
<tr><td>1) Secondary diagnosis codes of:
- Acute Renal Failure
- Sepsis
- Pneumonia
- GI hemorrhage/Acute Ulcer
- Shock/Cardiac Arrest (and selected procedure codes)
- DVT/PE</td><td>1) Patients age 17 years and younger; age 75 years and older; OR
2) MDC* 15; OR
3) Patients transferred to an acute care facility; OR
4) Patients transferred from an acute care facility; OR
5) Patients transferred from a long-term care facility
6) Exclusion for each complication of care</td><td>1) Surgical DRG and major operating room procedure code, AND
2) Principal procedure within 2 days of admission OR admission type of “elective”
3) Secondary diagnosis codes of:
- Sepsis
- Pneumonia
- GI hemorrhage/Acute Ulcer
- Shock/Cardiac Arrest (and selected procedure codes)
- DVT/PE</td><td>1) Patients age 17 years and younger, OR
2) Patients age 90 years and older, OR
3) MDC* 15, OR
4) Patients transferred to an acute care facility, OR
5) Exclusion for each complication of care</td></tr>
<tr><td colspan="4">* Major diagnostic category</td></tr>
</table>

(J. Geppert, personal communication, October 16, 2008)

Chapter 4: Research Findings

Due to the limitations in the data imposed by the use of an existing dataset, this study evolved in terms of its research design. The study was originally proposed as a descriptive, correlational study. Instead, the investigator used exploratory, descriptive methods to investigate hospital characteristics, RRT characteristics, RRT penetration, overall RRT effectiveness, and PSI#4 (*Death among surgical inpatients*) rates in a large metropolitan area of north Texas. This chapter includes a description of the research sample and the research findings by the corresponding research question.

SAMPLE

Survey invitations were sent via email to a convenience sample of 79 chief nurse officers (CNOs) whose hospitals are members of a large metropolitan Hospital Council. Thirty-nine participants (49%) completed the 15 item web-based survey. Three of the survey participants reported no adult medical-surgical units within their facilities. Although these three facilities had implemented RRTs, none had data related to PSI#4 (*Death among surgical inpatients*) because they did not admit or treat adult patients. The three participants without adult medical-surgical units were included in analysis of research questions one through four, which explored hospital and RRT characteristics, but were excluded from research question five, which involved PSI#4 analysis.

RESULTS

Research Question 1

How many hospitals in the target area have formal RRTs in place?

a. *For hospitals with formal RRTs, in what month and year did RRT implementation begin?*

b. *What is the degree of RRT penetration over time?*

All of the participants responding to the survey (39/39) had formal RRTs in place that met the definition used by Berwick et al. (2006). A follow-up email was sent to the CNOs who had not completed surveys in an effort to determine if only facilities with RRTs completed the survey. The email message asked a single question: Does your facility currently have a formal Rapid Response Team (RRT) as defined below?

> Rapid response teams, also referred to as medical emergency teams, resemble code teams in that they are staffed by health care professionals with critical care expertise, often including a physician, a nurse, and a respiratory therapist. However, unlike a code team, a rapid response team is summoned before a code occurs (p. 324).

Five additional CNOs responded to the follow-up email; two subsequently completed the survey. All five CNOs indicated their facilities had fully implemented RRTs making a total of 42 facilities with RRTs and no facilities without RRTs. No information or survey was received from 37 of the target hospitals. Hospital and RRT characteristics were analyzed for the 39 hospitals represented by completed surveys.

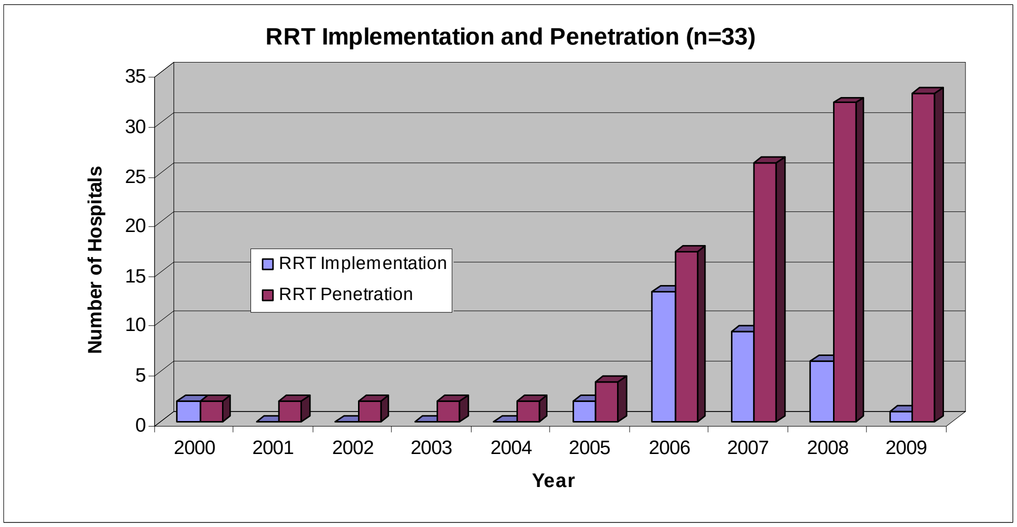
The date of implementation response field was part of survey item 6 and required the respondent to type in a short-answer. First, the respondent was asked if the facility currently had a formal RRT in place. There were four possible responses presented in a multiple choice format. The first response choice said, “Yes (Please specify implementation date below).” Respondents with formal RRTs in place had to type in the month and date information into the space provided below all the multiple choice responses. The implementation date field said, “If yes (MM/YYYY Format).” The majority of respondents did not provide the month of RRT implementation. Thirty-three of 39 participants provided information about the year of RRT implementation, which ranged from 2000 to 2009. The greatest number of RRTs were implemented in 2006 (13/33) and 2007 (9/33). Table 4 shows the pattern of RRT implementation.

Table 4: Year of RRT implementation (n=33)

Year	2000	2005	2006	2007	2008	2009
#RRTs	2	2	13	9	6	1

RRT implementation and penetration are shown in Figure 3. Implementation represents the number of RRTs added each year from 2000 through July 2009. Penetration is the cumulative number of hospitals in the Hospital Council with RRTs. Implementation dates are known for 33 of the 39 hospitals responding to the survey. Six survey respondents did not report implementation dates and three other respondents only confirmed the presence of teams in their facilities via follow-up emails. RRT penetration in the Hospital Council began with the implementation of two RRTs in the year 2000 and has grown to the current number of 42 hospitals with documented RRTs.

Figure 3: RRT implementation and penetration by year.

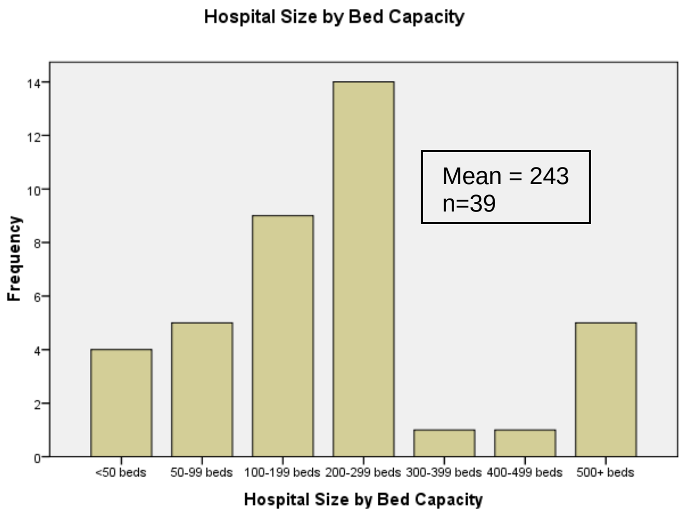


Research Question 2

How are hospital characteristics related to size, profit status, teaching status, and technology status different between hospitals with RRTs and hospitals without RRTs?

The second research question could not be answered because all of the hospitals represented by surveys had RRTs in place (n=39) and there was no comparison group without RRTs. RRTs were confirmed in three additional facilities by email follow-up with the designated CNOs. Participant identities were masked by the research director at the Hospital Council. Because the primary researcher was unable to identify which participants had responded to the survey and which had not submitted responses, there was no way to collect missing data. Hospital characteristics from survey data are important to review in order to evaluate the representativeness of the sample for the population.

Figure 4: Hospital size by total bed capacity.



One survey item was intended to gather data about the number of medical-surgical nursing units in each facility. Some responses to this item were difficult to interpret because of unusually large numbers reported by the respondents. An alternative measure, total bed capacity as reported in the 2007 AHA annual survey, was used to place hospitals into one of seven size categories. Thirty-two of the 39 hospitals reporting data in this study submitted bed capacity information to the AHA. The Hospital Council's research director masked the hospital identities and provided the data to the researcher. Figure 4 shows the distribution of hospitals by size category in a bar chart. The mean size among these hospitals was 243 beds.

Respondents were asked to select one of three profit status choices: public, nonprofit, or for profit; 100% of respondents (39) answered the three corresponding survey items. The majority (59%) of participants represented nonprofit facilities. Table 5 shows the frequency distribution for profit status.

Table 5: Profit status

n=39	Frequency	Percent
Public	3	7.7
Non Profit	23	59.0
For Profit	13	33.3
Total	39	100.0

Each participant identified the hospital teaching status as non-teaching (no post-graduated medical residents or fellows), minor teaching (1:4 or smaller trainee-to-bed ratios), or major teaching (higher than 1:4 trainee-to-bed ratio). As shown in Table 6, approximately three-fourths of the participants were in non-teaching hospitals.

Table 6: Teaching status

n=39	Frequency	Percent
Non Teaching	29	74.4
Minor Teaching	3	7.7
Major Teaching	7	17.9
Total	39	100.0

Hospitals were categorized as high technology if they had facilities for open-heart surgery or major organ transplantations, or both. Slightly more than half of the participants selected “high technology.” The remaining participant hospitals had no open-heart or transplant facilities and chose the “low technology” option (see Table 7).

Table 7: Technology status

n=39	Frequency	Percent
High tech	23	59.0
Low tech	16	41.0
Total	39	100.0

Research Question 3

What are characteristics in RRT structure among target hospitals?

a. *In how many hospitals is the RRT separate from the cardiopulmonary arrest or Code Blue team?*
b. *What is the composition?*
c. *Who is the team leader?*

Survey items 7, 10, and 11 collected information about the RRT structure. The RRT was separate from the Code Blue or cardiopulmonary arrest team in 84% of the hospitals (32/38). RRT membership generally consisted of respiratory therapists (95%, 37/39), ICU nurses (90%, 35/39), and physicians (23%, 9/39). Other members primarily included nursing staff (emergency nurses, patient care nurses, charge nurses, supervisors) and medical staff (hospitalists, residents, interns, any physician available). One respondent commented a physician could respond if available, but did not check the “physician” as a member. Another facility had a pharmacist available if needed.

Except for one team, when a physician was a team member (nine teams), the physician was also the RRT team leader (eight teams, 21%). The one exception was the team with a physician member that was led by the emergency nurse member. The facility that indicated a physician could respond if available, also commented that a physician could be the team leader if available, but did not check “physician” as team leader. Intensive care nurses were team leaders for 25 teams (64%). Other team leaders included a cardiovascular clinician, and a nursing supervisor. Two participants did not supply a response to the team leader survey item.

Research Question 4

What are characteristics in RRT process among the target hospitals?

a. *How many hospitals have written criteria for activating the RRT?*
b. *What are the written criteria for activating the RRT?*
c. *Who can activate the RRT?*
d. *How are RRT members notified of a call?*
e. *Which performance measures are used to evaluate the RRT?*
f. *How do respondents rate the overall effectiveness of the RRT?*
    - *Overall effectiveness in supporting nursing staff in patient assessment, diagnosis, intervention, and evaluation?*
    - *Overall effectiveness in decreasing patient complications?*
    - *Overall effectiveness in saving patient lives?*

All of the hospitals represented by survey responses utilized written guidelines for RRT activation. Table 8 identifies the frequency of commonly shared guidelines for 38 facilities; one facility did not respond to this item. Other guidelines included family member activation, symptoms of stroke, new onset of seizures, or bleeding (2 hospitals); changes in temperature, cardiac rhythm, or urinary output (1 hospital); unexpected pain, failure to respond to treatment, or for any reason (1 hospital).

Table 8: Guidelines for RRT activation

Guideline	Frequency	Percentage
Pulse oximetry	38	100.0
Heart rate	38	100.0
Systolic blood pressure	38	100.0
Respiratory rate	38	100.0
Level of consciousness	37	97.4
Staff worried	37	97.4
Chest pain	34	89.5

Patient care nurses had activated the RRT in 87% of the facilities represented in the sample, followed by the treating physician (82%), unlicensed assistive personnel (62%), and family members (59%). Three respondents indicated that anyone could activate the RRT (8%), one participant said the charge nurse could activate the team, one facility allowed the family to request the RRT through the nurse, and one facility was establishing a process for direct family activation.

RRT members were notified of team activation by beeper/pager messages from the operator (56%), overhead page by the operator (51%), beeper/pager messages from the unit (31%), and overhead page from the unit (15%). Other mechanisms of notification included use of a special phone or pager system (2 facilities) and wireless phones carried by RRT members (2 facilities).

Table 9: Overall RRT effectiveness ratings

	Excellent		Good		Fair		Poor	
	n	%	n	%	n	%	n	%
Supports nursing care	30	76.9	8	20.5	0	0	0	0
Decreases patient complications	23	59.0	12	30.8	3	7.7	0	0
Saves patient lives	25	64.1	11	28.2	1	2.6	0	0

Note: One case is missing from data

RRT performance was evaluated primarily by number of calls per month (87%), number of cardiac arrests outside the ICU (87%), mortality rate (77%), and minutes to arrival (72%). Performance measures less frequently used included PSI#4 (*Death among Surgical Inpatients*) rates (18%), hospital length of stay (18%), and ICU length of stay (13%). Respondents also wrote in the following additional measures: delay in activating RRT based on triggers, number of transfers to ICU, patient diagnosis, patient disposition, interventions, reason for call, and patient condition at 48 hours and discharge.

The CNO participants rated the overall effectiveness of the RRT in three areas: nursing care, patient complications, and patient mortality on a four-point scale. Table 9 shows the frequency of responses. Comments submitted in response to a request to explain the effectiveness ratings included:

- We are still working toward higher utilization of the RRT.
- Since inception our code blue rate outside ED and ICU has fallen while the number of CAT calls (Critical Assessment Team) has risen.
- From time to time we have a code rapid called and within 2-5 minutes we have a code blue called.
- We still need to work to improve comfort with calling for RRT and with education of family members' awareness
- We don't activate our team often but when necessary the team has been a tremendous asset.
- Saves patients lives-although we track mortality, not aware that we have analyzed specific to the RAT [Rapid Assessment Team].
- It has been difficult to get staff buy in on this process. We do not have in-house hospitalists so we do not have a physician on our team. I think the process would work better with a physician responding on the team.
- Our program has been very effective at decreasing patient complications in the acute care areas and has decreased mortality.
- Only charge nurse can call RRT.

Research Question 5

What are hospital rates for PSI#4 (Death among Surgical Inpatients with Serious Treatable Complications)?

a. *What is the annual PSI#4 rate by hospital for 2003 to 2008?*

b. *What is the regional PSI#4 rate?*

PSI#4 (*Death among Surgical Inpatients*) data were obtained and analyzed for 35 hospitals from the Hospital Council for six calendar years from 2003-2008. Data were unavailable for four survey participants. Three participants with missing data did not have adult medical-surgical units. PSI#4 (*Death among surgical inpatients)* calculations exclude patients under 18 years of age (AHRQ, 2008). The fourth hospital with mission data had both a RRT and adult medical-surgical units, but did not submit data to the Hospital Council's data warehouse.

Annual PSI#4 (*Death among surgical inpatients*) rates were calculated by the research director of the Hospital Council for 33 survey hospitals from administrative data submitted to the data warehouse using the AHRQ QI Software, Version 3.2. Prior to importing the PSI#4 (*Death among surgical inpatients*) data into SPSS® 16.0 for analysis, the spreadsheet data were copied and sorted by hospital characteristics. When sorted by hospital size, zero annual rates were most prevalent among hospitals with fewer than 200 beds (20/21), as were maximum annual PSI#4 rates (5/6). All of the maximum annual rates were among non-teaching facilities (6/6). Figure 5 shows the frequency distribution of hospital PSI#4 (*Death among surgical inpatients*) rates grouped into nine categories or ranges for each year.

Figure 5: PSI#4 Frequency Distribution

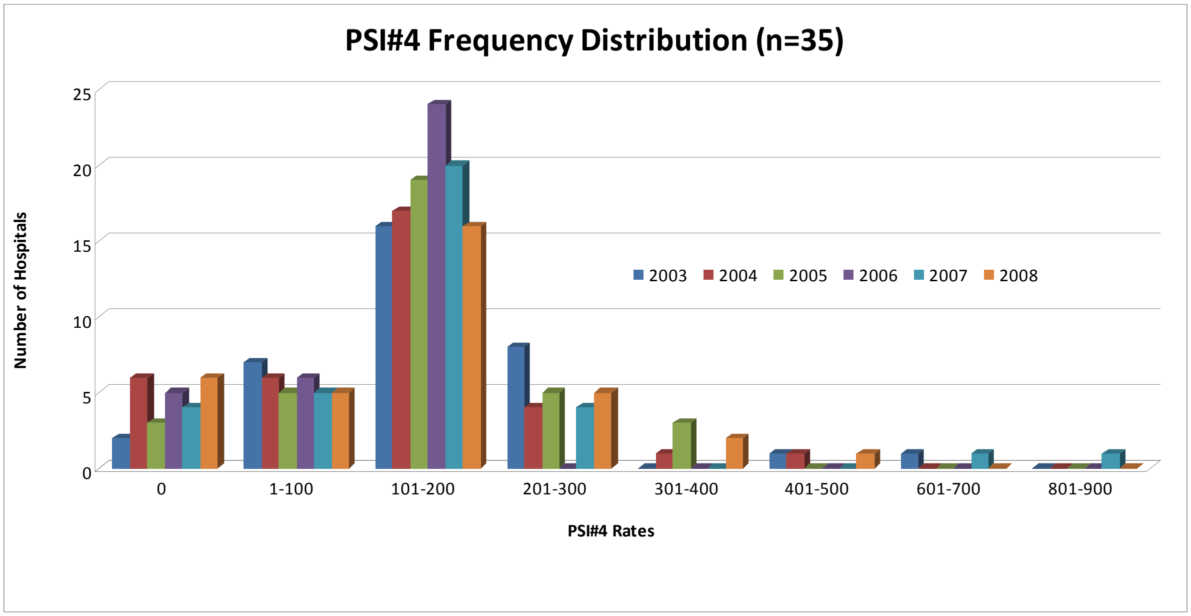


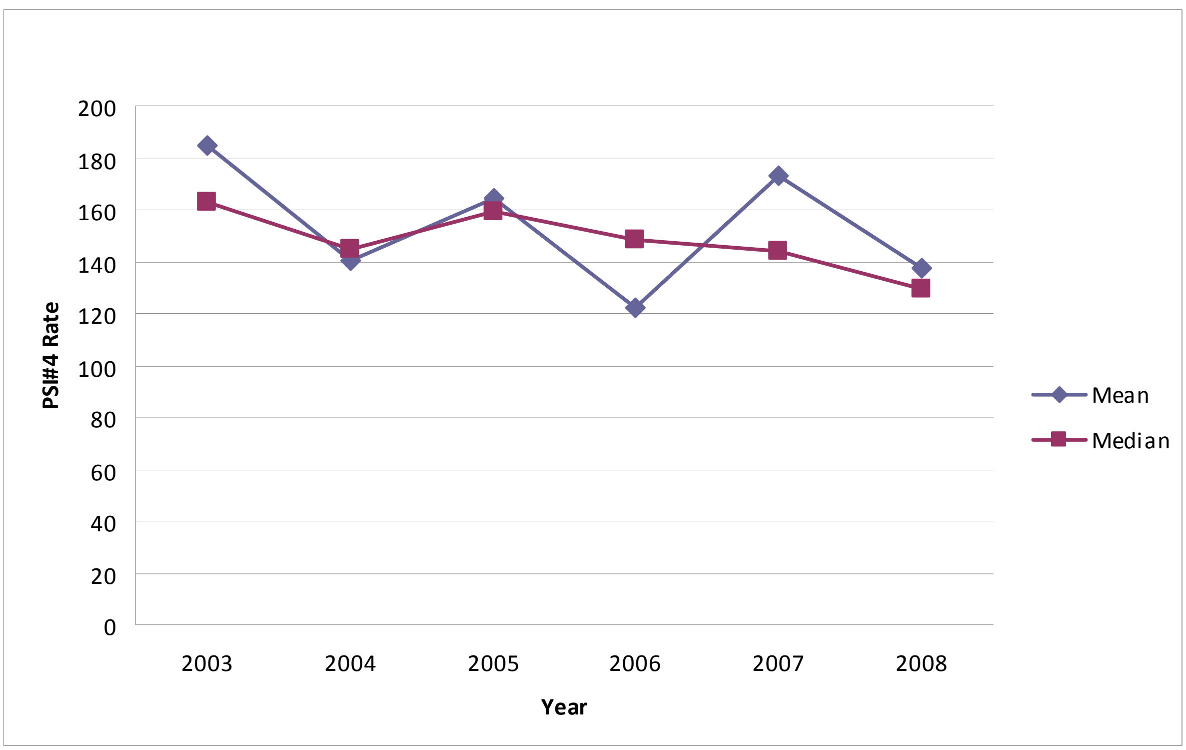
Table 10: Regional PSI#4 (Death among Surgical Inpatients) Rate Means, Medians, Minimums, and Maximums

	2003	2004	2005	2006	2007	2008
Mean	169.98	140.53	169.64	126.12	178.52	145.49
Median	158.10	145.07	161.66	149.32	147.71	140.80
Minimum	.00	.00	.00	.00	.00	.00
Maximum	628.23	452.59	391.77	199.75	848.36	434.84

Table 10 shows the regional PSI#4 (*Death among surgical inpatients*) rate means, medians, minimums, and maximums. The rate represents deaths per 1000 discharges. The numerator contains all surgical patient deaths that meet the definition for PSI#4. The denominator contains all surgical patient discharges with specified complications (pneumonia, deep vein thrombosis/pulmonary embolus (DVT/PE), sepsis, shock/cardiac arrest, or gastrointestinal (GI) hemorrhage/acute ulcer) (AHRQ, 2008). Zero rates occur if either the numerator or denominator is zero.

Figure 6 compares the mean and median regional rates by year. Both the means and medians for 2008 were slightly lower than those for 2003 with differences of 24.49 and 17.8 points respectively. PSI#4 ates for 2003, 2004, and 2005 were collapsed into a single value and compared to the collapsed rate for years 2006, 2007, and 2008. The difference between the two rates were not statistically significant based on results of the Wilcoxon Signed Ranks Test (p=.23) and the Paired Samples t-Test (p=.49).

Figure 6: Regional PSI#4 (*Death among surgical inpatients*) rates (n=35).



Chapter 5: Conclusions and Recommendations

In this chapter the research discussion closes with a summary of the study and major findings, study limitations, conclusions, and recommendations of future actions for nursing policy, practice, education, and research.

SUMMARY

The inspiration for this research study evolved out of an interest in the relationship between nursing and the original Patient Safety Indicator #4 (PSI#4) known as Failure to Rescue (FTR), which is now called *Death among Surgical Inpatients with Treatable Serious Complications*. The AHRQ first adopted FTR as PSI#4 in 2003 after several years spent refining the original concept suggested by a group of medical researchers studying hospitals characteristics and adverse surgical patient outcomes (Silber, Rosenbaum, Schwartz, Ross, & Williams, 1995; Silber et al., 1997; Silber et al., 1992). The final AHRQ definition of FTR was based on research funded by the Health Resources and Services Administration (HRSA) (Needleman et al., 2001). Controversy about the operational definition of FTR and the push for more research led to the adoption of a revised definition in 2008 (J. Geppert, personal communication, October 16, 2008). Instead of applying to all adult inpatient discharges with one of six specific hospital acquired complications, the revised definition applies only to surgical inpatients and eliminates acute renal failure as a complication of care. Table 3 compares the two definitions in detail.

Previous nursing research suggested that more registered nurses at the bedside are important for improved patient outcomes (Aiken et al., 2003; Aiken et al., 2002;

Needleman et al., 2002). The IHI encouraged hospitals to implement RRTs to support nurses in early assessment, diagnosis, and treatment of negative changes in patient conditions in an effort to reduce avoidable patient deaths (Berwick et al., 2006; IHI, n.d.). No published research evidence supports the efficacy of RRTs in reducing either the former PSI#4 (*FTR*) or the current PSI#4 (*Death among surgical inpatients*). This exploratory research study adds to the body of knowledge by describing hospital and RRT characteristics, determining RRT penetration in the region, and measuring PSI#4 (*Death among surgical inpatients*) rates in a group of hospitals in a large metropolitan area.

A retrospective, descriptive design was used to answer five research questions that explored hospital characteristics, RRT characteristics, RRT effectiveness, and PSI#4 (*Death among surgical inpatients*) rates among hospitals in a large metropolitan area using a structure-process-outcome framework (Donabedian, 1966). The study involved recruitment of a convenience sample from the institutional membership of a large hospital council in north Texas. Chief Nurse Officers (CNOs) from the member hospitals were identified as the most appropriate survey recipients. Survey data were collected from council members to answer questions about hospital characteristics, RRT structure, RRT process, and RRT effectiveness. Thirty-nine web-based surveys were received (49.4% response rate) via SurveyMonkey. Administrative data submitted to a regional data warehouse by the same hospitals were used to calculate PSI#4 (*Death among surgical inpatients*) rates from 2003 through 2008.

PSI#4 (*Death among surgical inpatients*) rates were calculated using Version 3.2 of the AHRQ Quality Indicator software (2008) by the research director from administrative data submitted by member hospitals to the Hospital Council's data warehouse. Hospital identities were masked by the Hospital Council's research director who assigned the same unique ID# to hospital discharge data that was associated with the corresponding survey data. The data file was forwarded to the primary researcher, merged with the survey data by unique ID#, and analyzed using SPSS 16.0 for Windows.

Research Question 1

How many hospitals in the target area have formal RRTs in place?

a. For hospitals with formal RRTs, in what month and year did RRT implementation begin?

b. What is the degree of RRT penetration over time?

All hospital CNOs that responded to the survey indicated that they had RRTs in place. Data for 39 hospitals collected from a web-based survey and three follow-up responses from CNOs that did not submit surveys indicated that 42 formal RRTs were in place among the 79 members of the Hospital Council. Responses to the question about implementation date did not always include the month of implementation, but 33 participants provided the year of RRT implementation. Dates ranged from 2000 to 2009. Only two RRTs were in place among the Hospital Council members from 2000 to 2005. Two more hospitals added teams in 2005. Most hospitals employed RRTs during 2006 (13), 2007 (9), and 2008 (6). One hospital implemented a team in 2009. The increased number of RRTs beginning in 2006 may be related to the *100,000 Lives Campaign* launched in December 2004 by the IHI (Berwick et al., 2006; IHI, n.d.). The movement was a response to the Institute of Medicine's report *To Err is Human: Building a Safer Health System* (Kohn et al., 1999) that reported 44,000-98,000 unnecessary deaths in U.S. hospitals each year. The campaign was a nationwide effort sponsored by the IHI to reduce the number of avoidable hospital deaths by 100,000 in one year. The increase in RRTs in 2006 could also have been in response to higher PSI#4 rates in observed in 2005.

Annual membership data were not available from the Hospital Council from 2000 to 2008 so penetration rates could not be precisely calculated before 2009. The Hospital Council's research director indicated that membership varied only slightly, if at all, from 2003 to 2008 (Hospital Council Research Director, personal communication, September 11, 2009). All of the survey participants (39) and the three hospitals identified in the email follow-up question had RRTs. RRT status was unknown for 37 of the 79 current hospital members and was a limitation for this research question.

The format and location of the survey item regarding implementation date seemed to confuse respondents. The item was embedded in another item and the response field required the respondent to type in the month and year of implementation using the MMYYYY format. The month and year of RRT implementation date should have been included as two separate items with a drop-down menu or individual response choices for the month of implementation in one question and a drop-down menu or individual response choices for the year of implementation in the next question.

Research Question 2

How are hospital characteristics related to size, profit status, teaching status, and technology status different between hospitals with RRTs and hospitals without RRTs?

Survey questions regarding hospital characteristics included items related to hospital size, profit status, teaching status, and technology status and these data were collected from all participants (39). Differences could not be determined for hospitals with and without RRTs since 100% of the CNOs responding to the survey represented hospitals with RRTs in place. Other CNOs may not have responded to the survey request due to lack of interest, lack of time, competing survey requests (survey fatigue), heavy workloads, low priority topic, or the fact that the research was student-led.

Table 11: Comparison of Sample and Population Characteristics

	Sample (n=39)		Population (N=68)*	
Total bed capacity	9,474		14,032	
Minimum	15		13	
Maximum	1025		1029	
Mean	243		215.3	
Profit Status	n	%	n	%
Public	3	8	9	13
Non Profit	23	59	39	58
For Profit	13	33	16	23
Unknown	0	0	4	6
Teaching Status	n	%	n	%
Non-teaching	29	74	59	87
Minor teaching	3	8	3	4
Major teaching	7	18	6	9
Technology Status	n	%	n	%
High tech	23	59%	10	15
Low tech	16	41	58	85

*(Hospital Council Research Director, personal communication, September 28, 2009)

The characteristics of the responding hospitals were reviewed. RRT hospitals ranged in size based on total bed capacity from 15 to 1025 beds. The average bed capacity was 243. The largest group of hospitals was the 200-299 bed capacity range. Slightly more than half of the hospitals were non-profit and high-technology. Three-fourths were non-teaching facilities. Table 11 includes a comparison of survey hospital characteristics with those of the population of hospitals that reported data to the Hospital Council data warehouse (N=68). The sample hospitals were fairly representative of the population for size. There was a larger percentage of for-profit hospitals in the sample (33%) than in the population (23%), greater percentages of minor (8%) and major (18%) teaching hospitals in the sample compared to the population (minor 4%, major 9%) and more high technology hospitals in the sample (59%) than in the population (15%). Consequently, given the characteristics of this sample of hospitals, these hospitals may be somewhat unique in their implementation of RRTs.

Research Question 3

What are characteristics in RRT structure among target hospitals?

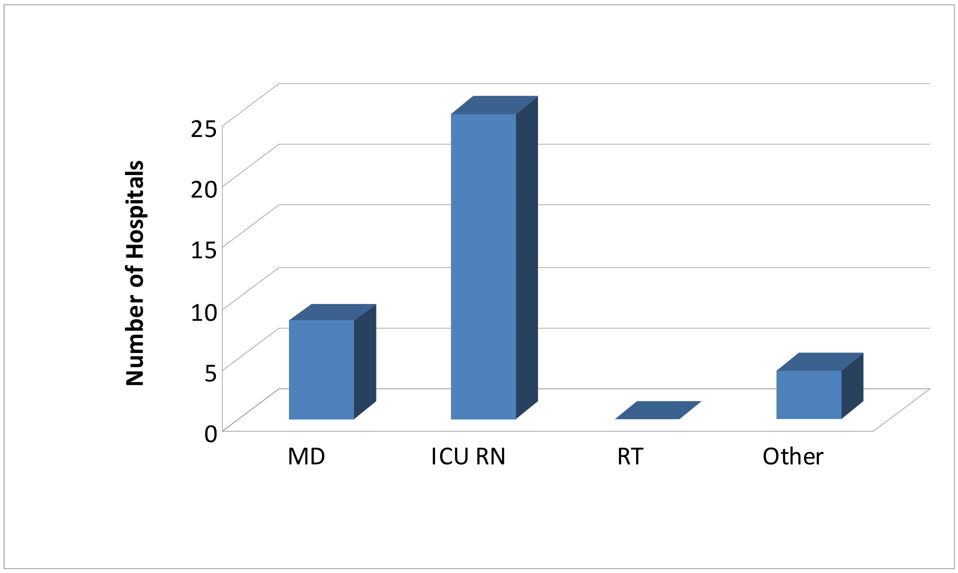
a. *In how many hospitals is the RRT separate from the cardiopulmonary arrest or Code Blue team?*
b. *What is the composition?*
c. *Who is the team leader?*

RRT structure was assessed by three survey questions that addressed separation from the cardiopulmonary arrest team, team membership, and team leadership. The RRT was separate from the Code Blue team in 32 hospitals. Two of the six hospitals with combined RRT and cardiopulmonary arrest teams commented that clinical staff was trained to activate either the RRT or Code team based on patient needs. Data were missing for one hospital.

All of the RRTs in the sample had nurse members. The majority were comprised of Intensive Care Unit (ICU) RNs and a respiratory therapist (RT). A group of nursing researchers found that most teams from a sample of more than 500 hospitals across the US included ICU nurses, but other than that commonality the teams varied in composition (Donaldson, Shapiro, Scott, Foley, & Spetz, 2009). Nine teams from the sample also had physician members (an additional hospital indicated that a physician could respond if available). Six of the teams with physician members were from non-teaching hospitals, two were from minor teaching hospitals, and one was from a major teaching hospital. The survey sample contained 10 teaching hospitals; three minor teaching and seven major teaching facilities. The low number of physician members from teaching hospitals was unexpected and contrary to that reported in a large evaluation study in which more teaching hospitals had physician team members than non-teaching hospitals (Donaldson et al., 2009).

Most teams in the sample were led by ICU RNs (68%). With one exception, a physician led the team whenever physician members were present. The RT member was never identified as the team leader (see Figure 7). RRTs reviewed in the research literature usually included physicians as members and team leaders (Bellomo et al., 2004; Bellomo et al., 2003; Braithwaite et al., 2004; Bristow et al., 2000; Buist et al., 2002; Daffurn et al., 1994; DeVita et al., 2004; Foraida et al., 2003; Galhotra, DeVita et al., 2006; Galhotra, Scholle et al., 2006; Hourihan et al., 1995; Jones, Bates et al., 2005; Jones, Bellomo et al., 2005; Jones et al., 2007; Lee et al., 1995; Offner et al., 2007; Parr et al., 2001).

Figure 7: Team Leader (n=37)



For the most part, RRT outcomes research was done by physician researchers in facilities where the teams were physician-led. Nurse researchers who examined patient outcomes tended to be in facilities with nurse-led teams (Bader et al., 2009; Jolley et al., 2007). No published research examined the differences in outcomes between physician-led and nurse-led teams (Chan et al., 2008; DeVita et al., 2006).

Research Question 4

What are characteristics in RRT process among the target hospitals?

a. How many hospitals have written criteria for activating the RRT?

b. What are the written criteria for activating the RRT?

c. Who can activate the RRT?

d. How are RRT members notified of a call?

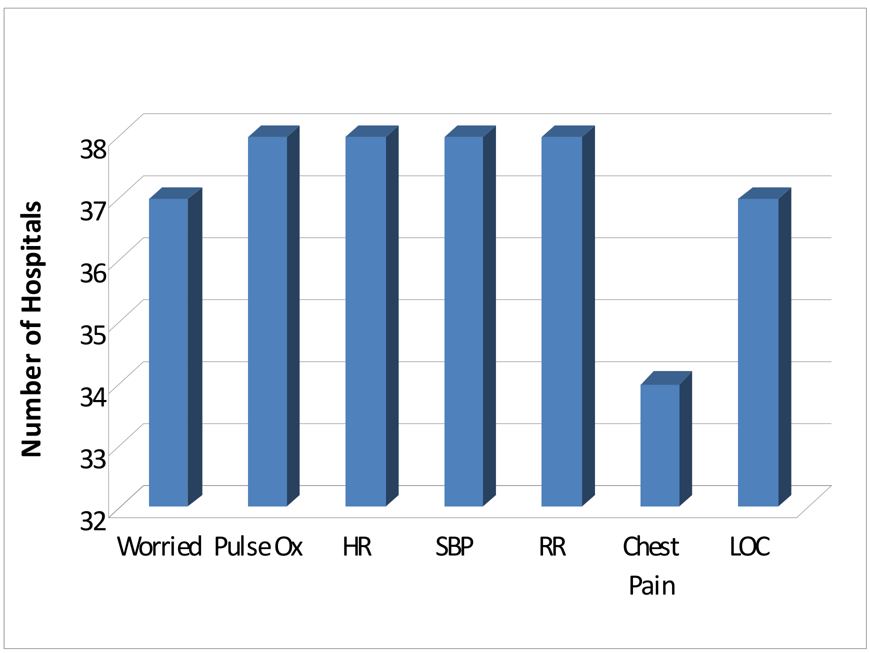
e. Which performance measures are used to evaluate the RRT?

f. How do respondents rate the overall effectiveness of the RRT?

- *Overall effectiveness in supporting nursing staff in patient assessment, diagnosis, intervention, and evaluation?*
- *Overall effectiveness in decreasing patient complications?*
- *Overall effectiveness in saving patient lives?*

Survey items regarding the types of written criteria for activating the RRT were developed from research evidence (Cretikos et al., 2007). Survey participants were asked to select all criteria that applied to their facilities from a list of seven choices (Figure 8).

Figure 8: Frequency Distribution of Written Criteria (n=38)

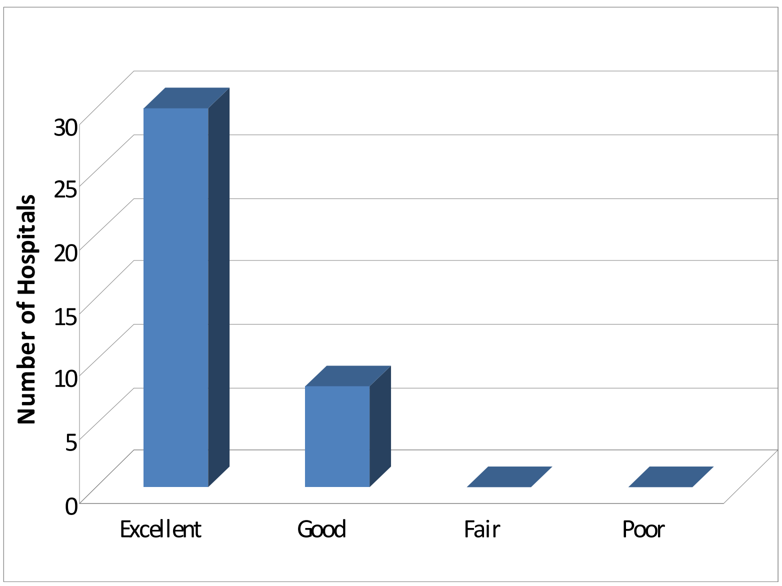


Space was provided for respondents to type in other criteria. Data were analyzed for 38 surveys and missing for one participant. All of the hospitals generally used written guidelines for RRT activation that reflected evidence-based criteria. Thirty-three hospitals included all of the criteria presented as choices in the survey. The other five hospitals providing survey information included 6 of the 7 recommended criteria.

When identifying who could activate the RRT, participants were given four response choices and asked to select all that applied to their facilities. Thirty-seven of the 39 survey participants completed the item. Instead of selecting each response choice, two respondents answered by typing in the space provided for adding other activators that "anyone" could call the RRT. With these two responses included, 54% of hospitals indicated that the patient care nurse (RN), patient care physician, unlicensed assistive personnel, and family members may activate the RRT. One hospital limited RRT activation solely to the charge nurse. All other participants (36) allowed the patient care nurse (RN) to activate the team and 34 (92%) hospitals included the patient care physician. Twenty-six (70%) facilities let unlicensed staff call the RRT and 25 (68%) hospitals incorporated families. One facility allowed patients' families to initiate the RRT through the nurse and another facility was starting to involve families in the RRT process. Nurses are the most likely group to activate RRTs (Galhotra, Scholle et al., 2006; Salamonson et al., 2006). Family activation of RRTs was not specifically addressed in the research literature reviewed, but family and consumer involvement in rapid response systems are beginning to appear in journal articles (Dean et al., 2008; Greenhouse, Kuzminsky, Martin, & Merryman, 2006; Van Voorhis & Willis, 2009).

Similar to hospitals in the literature review, most RRT calls in the sample hospitals were communicated by the hospital operator through the hospital pager system and overhead page (Bellomo et al., 2004; Chan et al., 2008; DeVita et al., 2004; Foraida et al., 2003; Galhotra, DeVita et al., 2006; Schmid, 2007). The unit staff at some of the sample facilities was also contacting the RRT directly by overhead page or through the pager system. Some facilities were notifying the RRT through wireless phones. New communication devices like smart phones may replace older pager systems in the future. The evaluation of PSI#4 (*Death among surgical inpatients*) rates (n=7) was of particular interest to this study. None of the studies in the research literature review measured this indicator.

Figure 9: Overall Effectiveness in Supporting Nursing Care (n=38)



CNOs rated the overall effectiveness of the RRT on three different outcomes: support of nursing care (n=38), decreasing patient complications (n=38), and saving patient lives (n=37). Effectiveness ratings of excellent or good were predominant across all three outcomes: support of nursing care (100%), saving patient lives (97%), and decreasing patient complications (92%). Nursing research echoes the perceived value of

RRTs in supporting nurses at the bedside shown in Figure 9 (Donaldson et al., 2009; Jolley et al., 2007; Salamonson et al., 2006).

Research Question 5

What are hospital rates for PSI#4 (Death among surgical inpatients with treatable serious complications)?

a. *What is the annual PSI#4 rate by hospital for 2003-2008?*

b. *What is the regional PSI#4 rate?*

Annual hospital PSI#4 (*Death among surgical inpatients*) rates for survey participants (n=35) ranged from 0.00 to 846.36. Variations in annual PSI#4 rate means are influenced by the non-normal distribution of the data. Less variation is seen in annual PSI#4 median rates over time. Both means and medians for 2008 were lower than means and medians for 2003, which suggests a downward trend in PSI#4 rates for the region.

Only one national statistic was found during an Internet search for “death among surgical inpatients.” Based on 2006 Medicare data, the national mean for risk-adjusted PSI#4 (*Death among surgical inpatients*) rates for Medicare patients was 150 (Centers for Medicare and Medicaid Services, [CMS], 2009). In comparison, the average PSI#4 rate from 2003 to 2008 in the current study was 154 and the annual rate for 2008 was 137. The CMS measure was restricted to Medicare patients aged 60 to 90 and was based on discharge data from a sample of 2875 hospitals, which makes comparing the regional PSI#4 (*Death among surgical inpatients*) rates for the current study difficult.

PSI#4 (*Death among surgical inpatients*) rates for individual hospitals with zero values occurred 24 times over six years. A zero value could occur if there were no patient deaths that met the PSI#4 inclusion and exclusion criteria (numerator) even though there were patients with avoidable complications included in the operational definition (denominator) (pneumonia, DVT/PE, sepsis, shock/cardiac arrest, or GI hemorrhage/acute ulcer) (AHRQ, 2008). A zero value in the numerator would represent a true PSI#4 (*Death among surgical inpatients*) rate of 0.00. On the other hand a zero value could also occur if no patients with avoidable complications were discharged during the measurement period (denominator). A zero value in denominator would not represent a true PSI#4 rate of 0.00, but rather would be not applicable to the measure. PSI#4 rates with zero values in the denominator were excluded in the data analysis.

The conceptual model for the study provided a foundation for exploring structure, process, and outcome components related to research variables among sample hospitals. Evidence from the research literature included in the model guided survey development and suggested conceptual relationships among hospital characteristics, RRT characteristics, overall RRT effectiveness ratings, and PSI#4 (*Death among surgical inpatients*) or FTR. The researcher organized, described, and analyzed survey responses submitted by hospital CNOs and PSI#4 (*Death among surgical inpatients*) data using the SPO framework. Due to study limitations, relationships among study variables could not be analyzed using correlational or inferential statistics, but data trends seemed to show that as RRTs increased in number throughout the Hospital Council membership, overall death rates as measured by PSI#4 (*Death among surgical inpatients*) decreased. These data trends strengthen the recommendation for additional research to support preliminary findings and further explore these conceptual relationships.

Limitations of the Findings

The study was primarily limited by the small sample size (n=39). Masking the identities of participants controlled for researcher bias, but made putting findings into perspective difficult. Restricted access to PSI#4 (*Death among surgical inpatients*) data for the researcher made interpretation complicated. The retrospective nature of the PSI#4 data and the self-reported survey data were both recognized limitations. The focus on hospitals in one geographic region of one state limited generalizability of findings to other regions in the state or country.

Conclusions

1. The hospitals represented by the survey results and linked administrative data were representative of the Hospital Council population of hospitals in size.
2. The hospitals represented by the survey results implemented RRTs predominantly led by an ICU RN with a RT member that may be activated by a wide range of hospital staff and family members.
3. The hospitals represented by the survey results used evidence-based criteria for RRT activation.
4. RRTs increased in number and there was a downward trend in the regional mean and median PSI#4 (*Death among surgical inpatients*) rates from 2003 to 2008. Differences in means and medians were not statistically significant for this sample, but could be clinically significant.
5. Nurse administrators viewed RRTs as effectively supporting nursing care.

Implications and Recommendations

The implications of this study for nursing policy relate to RRT adoption and standards setting. Although study data did not show statistically significant differences among PSI#4 (*Death among surgical inpatients*) rates among Hospital Council members as RRT implementation increased from 2003-2008, there was a slight trend downward in regional rates. Survey data also indicated that RRTs were perceived as supportive to nursing care. RRTs should never be adopted as a substitute for adequate nurse staffing; however, the availability of critical care expertise at the bedside could be a valuable resource for staff nurses. Nurse administrators should conduct cost-benefit analyses to determine financial advantages of both existing and future RRTs to the organization. Evidence-based activation criteria or common performance measures may be helpful during RRT policy development.

This study provided descriptions of common RRT structures and processes in a large metropolitan area that may provide benchmark data, best practices, and evaluation criteria for assessing the efficacy of existing or future RRTs. Findings may guide education and training of health care workers and students about the importance of early detection of deteriorating patient conditions in preventing adverse events. Nursing and medical students must be prepared with basic assessment techniques and communication skills to recognize and report subtle deviations from expected norms. Health care workers must be oriented to policies, procedures, and systems designed to detect physiological decline, mobilize resources, and save patient lives. Periodic reeducation and/or review of assessment skills, high-risk physiological findings, and available resources serve to keep care providers alert, prepared, and supported.

This study provided a first look at RRTs using the newly revised patient safety indicator, *Death among surgical inpatients with treatable serious complications*. Similar research with a larger sample size with adequate power to support statistical analysis of differences in PSI#4 (*Death among surgical inpatients*) rates over time will help us explore and identify relationships among hospital characteristics, RRT characteristics, and this specific patient safety measure. Future research that includes hospital nursing characteristics, like staffing data, could explore relationships between staffing levels, RRT activations, and PSI#4 rates. Outcomes research comparing PSI#4 rates with related objective outcomes, such as, mortality or length of stay, could help evaluate the effectiveness of RRTs. Research that examines PSI#4 by the five complication subcodes could help identify the effectiveness of RRTs in rescuing patients with specific complications. Research that compares process data for PSI#4 for patient who had an RRT intervention with those who did not have an RRT intervention could provide more evidence for effectiveness based on patient outcomes. Survey research aimed at staff nurse perceptions of RRT effectiveness and processes may answer questions related to RRT utilization. The more research data available to nurses at the bedside and in the boardroom, the better informed nursing policy, practice, and education decisions will be. Better decisions translate to better structures, processes, and, ultimately, better patient outcomes.

Appendix A: Operational Definitions for Research Study

<table>
<tr><th>Measure</th><th>Operational Definition</th><th>Data Source</th></tr>
<tr><td>RRT penetration</td><td>Percentage of hospitals in the sample answering “yes” to survey item #5 (shown below) arranged by the month and year implementation began (response to survey item #6):

Does your facility currently have a fully implemented Rapid Response Team (RRT) as defined above*?

*“Rapid response teams, also referred to as medical emergency teams, resemble code teams in that they are staffed by health care professionals with critical care expertise, often including a physician, a nurse, and a respiratory therapist. However, unlike a code team, a rapid response team is summoned before a code occurs.” (Berwick et al., 2006)</td><td>Research Survey</td></tr>
<tr><td>PSI#4 (Death among surgical inpatients) rate</td><td>Total number of patient deaths per 1000 patient discharges each year from all sample hospitals that met the following criteria from January 2003 through December 31, 2007:
<table>
<tr><td>Numerator</td><td colspan="2">Discharge status of death</td></tr>
<tr><td>Denominator</td><td>Inclusion</td><td>Exclusion</td></tr>
<tr><td></td><td>1) Secondary diagnosis codes of:
- Acute Renal Failure
- Sepsis
- Pneumonia
- GI hemorrhage/ Acute Ulcer
- Shock/Cardiac Arrest (and selected procedure codes)
- DVT/PE</td><td>1) Patients age 17 years and younger; age 75 years and older; OR
2) MDC 15; OR
3) Patients transferred to an acute care facility; OR
4) Patients transferred from an acute care facility; OR
5) Patients transferred from a long-term care facility
6) Exclusion for each complication of care</td></tr>
</table></td><td>Hospital discharge data submitted to THCIC</td></tr>
</table>

Measure	Operational Definition	Data Source
Hospital characteristic: Size	Number of inpatient beds	TDSHS Annual Hospital Survey
Hospital characteristic: Profit status	Response to survey item #1: Profit status ☐ Public ☐ Non profit ☐ For profit	Research Survey
Hospital characteristic: Technology status	Response to survey item #2: Technology status ☐ Open heart surgery ☐ Transplant program	Research Survey
Hospital characteristic: Teaching status	Response to survey item #3: Teaching status ☐ Non-teaching ☐ Minor teaching ☐ Major teaching	Research Survey
RRT process: RRT separate	Number of hospitals in the sample answering “yes” to survey item #6: Is your RRT separate from your Code Blue or cardiopulmonary arrest team? ☐ Yes ☐ No [Please explain how you differentiate between a RRT call and a cardiopulmonary arrest call]	Research Survey
RRT process: Written guidelines	Number of hospitals in the sample answering “yes” to survey item #7: Do you have written guidelines for activation of the RRT? ☐ Yes ☐ No [Go to question #9] ☐ Guideline development in progress	Research Survey
RRT process: Calling criteria	Response(s) to survey item #8: If you checked yes or guidelines in development in Item #7, do your guidelines include RRT activation or calling criteria based on the following? [Check all that apply.] ☐ A staff member is worried about the patient ☐ Acute and persistent declining pulse oximetry	Research Survey

Measure Operational	Definition	Data Source
	☐ Acute and persistent change in heart rate ☐ Acute and persistent change in systolic blood pressure ☐ Acute and persistent change in respiratory rate ☐ New onset chest pain suggestive of ischemia ☐ Acute and persistent change in conscious state (including agitated delirium) ☐ Other (describe):	
RRT composition	Response(s) to survey item #9: Who are the RRT members? ☐ Physician ☐ ICU RN ☐ Respiratory Therapist ☐ Other (describe):	Research Survey
RRT leader	Response to survey item #11: Who is the team leader? ☐ Physician ☐ ICU RN ☐ Respiratory Therapist ☐ Other (describe):	Research Survey
RRT effectiveness	Response(s) to survey item #15: How do you rate the overall effectiveness of the RRT in your facility on the following criteria?	Research Survey

	Excellent	Good	Fair	Poor
Supports nursing care	❍	❍	❍	❍
Decreases patient complications	❍	❍	❍	❍
Saves patient lives	❍	❍	❍	❍

Describe your rating:

Appendix B: Publications of failure to rescue research (in chronological order)

Study/Purpose/Design	Subjects/Setting	Operational definition	Major findings
Silber et al. (1992). Compare death rate, adverse occurrence rate, & failure rate as identifying hospital quality Descriptive, correlational	5972 Medicare patients undergoing elective cholecystectomy or TURP (MedisGroups National Comparative Database) Acute care, surgical	# deaths in pts with adverse occurrence/ # of pts with adverse occurrence	FTR was associated more with hospital characteristics & was less influenced by patient characteristics.
Silber et al. (1997). Assess the relationship among hospital quality assessment rankings based on adjusted mortality, complication, and FTR rates Descriptive, correlational	74,647 adult general surgery patients in the 1991-1992 MedisGroups National Comparative Database in the MDC 6, 7, & 9 (GI; heptobilliary, excluding liver transplant; breast biopsy & mastectomy) Acute care hospitals	FTR = in-hospital death following a complication (clinical finding or event that was 1) present during or after surgery, or present on day 3 or later (except cardiac emergencies which could occur at any time), or present in association with a diagnostic or therapeutic procedure at anytime during hospitalization, and 2) was serious enough to have a potentially adverse effect on the patient's outcome. (Listed 26 complications.)	High correlation between death and failure rate rankings, r=0.90 (*P*<0.001). Conclusion = complication rate is poor measure of quality.

Study/Purpose/Design	Subjects/Setting	Operational definition	Major findings
Silber et al. (2000). Compare surgical patient outcomes for patients anesthetized by an anesthesiologist and those NOT cared for by an anesthesiologist Descriptive, correlational	Medicare patients undergoing general surgical or orthopedic procedures from 245 hospitals (1991-1994 claims data) Acute care, Pennsylvania	FTR=30 day death rate after a complication or without a recorded complication/ 1000 with complications FR = D/(C + D|noC) or the number of patients who died (D) divided by the number of patients with complications (C) + the number of patients who died without complications noted in the claims data (D|no C)	30-day mortality and FTR rates were lower when care given by anesthesiologists.
Needleman et al. (February, 2001) Analyze the relationship between nurse staffing and 14 outcomes potentially sensitive to nursing Secondary analysis of hospital patient discharge data (outcomes) & financial reports or hospital staffing surveys (nurse staffing) using multiple regression analysis	1997 administrative data from: 1) 799 hospitals from 11 states 2) 256 California hospitals 3) Nat'l sample of 3,357 hospitals Acute care, medical & surgical	Death among patients with shock, sepsis, pneumonia, DVT/PE or GI bleeding	FTR rate among surgical patients was sensitive to nurse staffing (19.69%)

Study/Purpose/Design	Subjects /Setting	Operational definition	Major findings
Needleman et al. (2002) Examine the relationship between patient outcomes and nurse staffing Regression analyses of hospital administrative data	Discharge data from 799 hospitals in 11 states (5,075,969 adult medical pts + 1,104,659 adult surgical pts) Acute care hospitals in 11 states	FTR = death of a patient with one of five life-threatening complications (pneumonia, shock or cardiac arrest, UGI bleeding, sepsis, or DVT	More nursing hours per patient day was associated with lower rates of FTR (*P*=0.008)
Silber et al. (2002). Compare outcomes for surgical patients under the care of a board certified anesthesiologist with patients whose care was provided by anesthesiologist without certification Descriptive, correlational	Medicare patients undergoing general surgical or orthopedic procedures from 245 hospitals (1991-1994 claims data) Acute care hospitals in Pennsylvania	FTR=30 day death rate after a complication or without a recorded complication/ 1000 with complications FR = D/(C + D|noC) or the number of patiens who died (D) divided by the number of patients with complications (C) + the number of patients who died withough complications noted in the claims data (D|no C)	FTR rates were higher when care was provided by noncertified midcareer anesthesiologists (death 1.13 [95% confidence interval, 1.00, 1.26], P < 0.04; failure to rescue 1.13 [95% confidence interval, 1.01, 1.27], P < 0.04).
Aiken et al. (2002). Determine the association between patient-to-nurse ratio and patient mortality, FTR among surgical patients, and factors related to nurse retention. Cross-sectional analysis of	232,342 adult general surgical patients 168 non-federal acute care hospitals in Pennsylvania	FTR = deaths following complications (39 different clinical events identified by ICD-9 codes in secondary dx & procedure fields.	High ratios were associated with high mortality and FTR rates and burnout and job dissatisfaction.

Study/Purpose/Design	Subjects/Setting	Operational definition	Major findings
patient discharge data and nurse survey data from April 1998 to November 1999			
Romano et al. (2003). To establish face and consensual PSI validity; develop national profile of patient safety Face validation - expert coding consultant; Consensual validation - expert panels of clinicians	1995-2000 Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample (NIS).	AHRQ definition	PSIs are useful in measuring patient safety. FTR rates were essentially the same across all races/ethnicities, hospital profit statuses, and teaching statuses; rural hospitals had slightly lower rates
Aiken et al. (2003). Examine whether RN education is associated with risk-adjusted mortality and FTR Cross-sectional analysis of patient discharge data and nurse survey data from April 1998 to November 1999	232,342 adult general surgical patients 168 non-federal acute care hospitals in Pennsylvania	FTR = deaths within 30 days of admission due to complications (39 clinical events identified by ICD-9 codes in the secondary dx and procedure fields.	Hospitals with higher proportions of RNs at BSN or higher level had lower FTR rates.

Study/Purpose/Design	Subjects /Setting	Operational definition	Major findings
Boyle (2004). Explore relationships between organizational characteristics and outcomes at the unit level. Exploratory, cross-sectional	6 months of patient discharges (N=11,496) RNs (N=390) 944 bed acute care hospital in the Northeast	FTR = death following adverse event	Higher degrees of nurse-perceived autonomy & collaboration were associated with decreased FTR rates and UTIs.
Halm et al. (2005). Replicate the Aiken et al (2002) study Cross-sectional analysis	2709 general, orthopedic, and vascular surgery patients, and 140 staff nurses in a large Midwestern institution. Acute care hospital in Minnesota	FTR as defined by Aiken et al.	Staffing was not a significant predictor of mortality or FTR, emotional exhaustion or job dissatisfaction.
Rosen et al. (2005). Apply the AHRQ PSI software to VA administrative data to identify PSI events and rates; examine PSI construct validity Descriptive, correlational	Veterans discharged from October 1, 2000, to September 30, 2001 (Fiscal year 2001) in the continental US VA hospitals in continental US, acute care	AHRQ definition	PSIs may be useful in the VA.

Study/Purpose/Design	Subjects/Setting	Operational definition	Major findings
Rosen et al. (2006). Describe PSI incidence in the VA; examine national PSI trends; assess if hospital and baseline safety-related performance predict future performance Descriptive, correlational	Veterans discharged from October 1, 2000 to September 30, 2004 acute care, 108 VA hospitals	AHRQ definition	FTR rates decreased over time; PSIs appropriate for VA
Jiang et al. (2006). Compare AHA Annual Survey of Hospitals nurse staffing data with the California Office for Statewide Health Planning and Development (OSHPD) for 3 patient outcomes: FTR, decubitus ulcer, & mortality Descriptive, cross-sectional	Discharge data 372 general acute care, non-federal California hospitals 372 nonfederal, acute care hospitals in California	AHRQ definition	State data was significantly associated with all three patient outcomes; AHA data only associated with decubitus ulcer; state data on hospital nurse staffing are more complete
Horwitz et al. (2007). Test accuracy of the AHRQ FTR algorithm compared to chart review.	2,354 cases from 40 University Health System Consortium Institutions Acute care	AHRQ definition	FTR algorithm misidentified 1/2 of cases, is less accurate for non-surgical cases, & is widely variable across institutions.

Study/Purpose/Design	Subjects /Setting	Operational definition	Major findings
Retrospective chart review results compared to administrative data result			
Kane et al. (March 2007) Assess how nurse-patient ratios and nurse work hours are associated with patient outcomes; identify factors that influence nurse staffing policies, and identify nurse staffing strategies that improved patient outcomes. Meta-analysis	Published observational studies Acute care	FTR = number of deaths in patients who developed an adverse occurrence/the number of patients who developed an adverse occurrence	Higher registered nurse staffing was associated with lower rates of hospital-related mortality, FTR, cardiac arrest, hospital acquired pneumonia, and other adverse events (especially in ICU units and surgical patients).
Friese & Aiken (2008) Explore the incidence of FTR among oncology surgical patients Secondary analysis of hospital claims	24,618 surgical oncology patients in 164 acute care Pennsylvania hospitals from 1998–1999	FTR = "death among surgical patients with treatable serious complications" (p. 779)	Oncology surgical patients have many complications; patients with specific types of cancer have more complications; common complications among patients who died included: atelectasis, hypokalemia, and dehydration (FTR?)
Kutney-Lee & Aiken (2008) Compare surgical patient outcomes (including FTR) among patients with and without mental illness	9,989 nurses and 228,433 surgical patients from 157 Pennsylvania hospitals	FTR = death after surgical complications	Higher staffing and education level improved patient outcomes

Study/Purpose/Design	Subjects/Setting	Operational definition	Major findings
Cross-sectional data from survey and secondary analysis of administrative data			
Isaac & Jha (2008) Compare AHRQ PSIs (including FTR) with other performance measures	2003 MedPAR (Medicare) data from 4502 acute care hospitals	AHRQ definition	FTR was the only PSI that was consistently related to comparison measures
Friese et al. (2008) To examine the effect of the practice environment (staffing and education) on complications among surgical oncology patients Nurse survey and secondary analysis of cancer registry, claims, and administrative data	25,957 caner patients and random sample of nurses on medical-surgical or critical care units in Pennsylvania hospitals	FTR = "death within 30 days of hospital admission for patients who have experienced a postoperative complication" (p. 1149)	Higher staffing and education improved outcomes
Talsma et al. (2008) Compare FTR cases from administrative data with clinical events through chart review	Chart review of 45 FTR cases from 2002 University of Michigan Health System (UMHS) administrative data warehouse	AHRQ definition	14 of 45 chart reviewed cases should not have been included in the FTR metric

Study/Purpose/Design	Subjects/Setting	Operational definition	Major findings
Exploratory, descriptive			
Bobay et al. (2008) To examine patient level characteristics of FTR cases Retrospective, descriptive. correlational	FTR cases in 5 Midwestern hospitals	AHRQ definition	PSI algorithm overestimated FTR cases; FTR patients showed "significant, but subtle, changes in heart rate, respiratory rate, temperature, serum sodium levels, and urine output" (p. 213)

Appendix C: Publications of rapid response team research (in chronological order)

Study/Purpose/Design	Subjects/Setting	Team definition	Outcome Measures	Major findings
Daffurn et al. (1994) Determine RNs opinions, knowledge, and use of the MET system implemented 2 years prior (in 1989?). Questionnaire (2 pages)	141 nurses on duty on the study date (ICU, high dependency unit and CCU nurses were excluded) Liverpool Hospital, Australia	MET = ICU nurse, resuscitation registrar (MD), medical registrar (MD), ICU registrar (MD)	responses to questionnaire items	Positive attitude toward MET; low awareness of MET availability;
Lee et al. (1995). Describe the utilization of MET and patient outcomes over 12 month period Descriptive, retrospective analysis of MET calls from March 1992-March 1993	Patients requiring MET intervention from March 1992-March 1993 Acute care, Australia	MET = medical & nursing staff trained in principles of resuscitation	1) frequency of MET calls 2) location of MET call 3) reason for MET call 4) time of MET call	1) 522 MET calls recorded 2) 62% from ED, 29% from wards, 9% from ICU 3) resp failure and status epilepticus most common 4) 36% during night shift, 30% on weekends

Study/Purpose/Design	Subjects /Setting	Team definition	Outcome Measures	Major findings
Hourihan et al. (1995). Describe MET utilization Prospective	Inpatients and outpatient who required MET intervention during six months of study (April 1, 1994-October 1, 1994) 460-bed teaching hospital, Australia	MET = medical & nursing staff trained in principles of resuscitation	1) frequency of calls 2) unplanned ICU admission 3) mortality	1) 294 calls (53% from wards) 2) 53 ICU admissions 3) mortality rate for cardiopulmonary arrest = 84%; other medical emergencies = 27% which represented a statistically significant difference (*P*<0.01)
Bristow et al. (2000) Evaluate the effectiveness of a MET in reducing the rates of selected adverse events Prospective cohort comparison	Adult patients admitted to one of 3 hospitals from July 8 to December 31 1996 (1510 adverse events among 50,942 admissions) Acute care, Australia Hospital 1 = MET Hospital 2 & 3 = non MET	MET = consisted of the ICU registrar and senior nurse, and medical registrar.	1) Cardiac arrest 2) Unanticipated admission to ICU 3) Death 4) death without DNR order	The MET hospital had fewer unplanned ICU admissions, no increase in in-hospital arrest rate nor total death rate, lower non-DNR deaths
Cioffi, J. (2000) Explore and describe patient characteristics and process of recognition used by	RNs with 5 or more years of experience and history of calling MET Teaching hospital and peripheral hospital in	Not defined	Analysis of transcripts	Nurses relied on 4 patient characteristics to use "seriously worried" MET criterion: feeling “not right," color, agitation & observations

Study/Purpose/Design	Subjects /Setting	Team definition	Outcome Measures	Major findings
nurses Qualitative, exploratory, descriptive	Sydney, Australia			not changed or marginally changed
Parr et al. (2001) Describe the reasons for, and immediate outcome following MET activation Retrospective analysis of MET calls during 1998 (Jan-Dec)	713 MET calls for 599 in-patients Acute care, Australia	MET = lead by an intensive care registrar and includes the medical registrar, and a senior intensive care Nurse.	1) Reason for call 2) Immediate outcome	Three common criteria for calling MET: 1) fall in GCS 2 (n=155) 2) systolic blood pressure 90 mmHg (n=142) 3) respiratory rate 35 (n=109) MET system criteria help identify patients at risk for who become "acutely unwell" (p. 39)
Buist et al. (2002). Determine if early intervention by MET could decrease the incidence of cardiac arrest and death. Non-randomized, population based before 1996 and after 1999 MET implementation	All patients admitted during two study periods: before MET (1996, n=19,317) and after MET (1999, n=22,847) 300 bed tertiary referral teaching hospital, Australia	MET = two doctors & one senior intensive care nurse	1) Cardiac arrests 2) Deaths from cardiac arrests	Cardiac arrests significantly lower after MET implementation (OR = 0.5, 95% CI 0.35 to 0.73).

Study/Purpose/Design	Subjects /Setting	Team definition	Outcome Measures	Major findings
Foraida et al. (2003). Increase utilization of Condition C team Retrospective.	Patients admitted from January 1999 to December 2001 Urban tertiary care medical complex, Pittsburg, PA (567 beds)	MET = Condition Crisis) team; physicians, nurses, respiratory care	1) STAT pages 2) Sequential STAT pages 3) Condition C pages	4 strategies increased MET utilization; fatal cardiac arrests decreased (P<.0001)
Bellomo et al. (2003). Determine the effect of MET on cardiac arrests & overall hospital mortality Prospective before & after trial	Consecutive patients admitted during 4 month "before" period (n=21,090) and 4 month "after" period (n=20921) Acute care, Australia	MET = duty intensive care fellow, designated ICU nurse, and receiving medical registrar (if available)	1) Cardiac arrest 2) deaths following cardiac arrest 3) post-cardiac arrest bed days 4) overall in-hospital deaths	All outcome measures were significantly lower after MET implementation (P <.0001).
Kenward et al. (2004). Evaluate the activity & impact a MET one year after implementation. Prospective and retrospective group comparison	All adult admissions during two study periods: Before MET = October 1, 1999 to September 30, 2000. After MET = October 1, 2000 to September 30, 2001. 700 bed District General Hospital in Southeast England	Not defined	1) MET activations 2) MET outcomes 3) MET scores 4) MET interventions	1) 136 MET activations 2) 40% (52/130) survived to discharge 3) Patients that died had higher MET scores (P = 0.004) 4) Most common MET intervention = oxygen therapy or respiratory support

Study/Purpose/Design	Subjects /Setting	Team definition	Outcome Measures	Major findings
Priestley et al. (2004). Investigate effect of critical care outreach service on in-hospital mortality and LOS Randomized trial	All adult admissions to 16 surgical, medical and elderly care ward during 32 week study period (N=7450) (2000-2001?) Sixteen adult wards in an 800-bed general hospital in the north of England	CCOT = led by a nurse consultant with a team of experienced nurses providing 24-h cover. Critical care medical support was available when required	1) Mortality 2) LOS	CCOT reduced mortality
Braithwaite et al. (2004). Determine if MET reviews can detect medical errors Retrospective, descriptive via chart review	Patients undergoing MET during 8 month period (May-Dec 2000) 567 bed medical complex comprised of 3 connected hospitals served by the same MET system, Pittsburgh, PA	MET = ICU MD (leader), ICU nurses, floor nurse, anesthetist or critical care MD, respiratory care staff, two other MDs	Medical errors (preventable adverse event) in three categories: 1) Diagnostic 2) Treatment 3) Preventive	67.5% of MET charts reviewed were associated with medical errors. Conclusion: MET review may be used to detect medical errors → identify and modify processes of care that underlie those errors

Study/Purpose/Design	Subjects /Setting	Team definition	Outcome Measures	Major findings
DeVita et al. (2004). Determine how the incidence and outcomes of cardiac arrests have changed following increased use of MET in US hospitals Retrospective analysis of clinical outcomes before and after MET re-implementation	3269 MET responses and 1220 cardiopulmonary arrests over 6.8 years (1996-2002) Urban tertiary care hospital, Pittsburg, PA	MET = groups of healthcare professionals that can be assembled in response to grave clinical deterioration; 8 members including physician, nurses, & a respiratory therapist.	1) MET responses 2) Cardiopulmonary arrests 3) Crises with fatal outcomes	930 arrests - before 290 arrests - after METs may decrease cardiac arrests.
Bellomo et al. (2004). Test the hypothesis that some adverse outcomes are preventable by implementing MET Prospective before & after trial	Surgical patients admitted Acute care, teaching hospital, Australia	MET = duty intensive care fellow, designated ICU nurse, and receiving medical registrar (if available)	1) % patients with adverse outcomes (AO) 2) in-hospital deaths 3) individual AOs 4) mean hospital stay	>50% decrease in the incidence of AOs Decrease in specific AO- respiratory failure (P<.0001) stroke (P=.0026) sepsis (P=.0044) ICU admission (P=.001) death (P=.0178) Decrease in hosp stay (P=.0092)
Hillman et al. (2005). Measure the impact of MET on cardiac arrest, unexpected death, or	23 hospitals in Australia - 11 control & 12 MET hospitals with more than 20,000 estimated admissions every year,	MET system = staff education, introduction of MET calling criteria, increased awareness of the dangers of	1) Cardiac arrest 2) Unplanned ICU admission 3) Unexpected deaths	No significant difference in outcome measures between MET hospitals and control hospitals

Study/Purpose/Design	Subjects /Setting	Team definition	Outcome Measures	Major findings
unplanned ICU admission 6 months after implementation. Cluster-randomized controlled trial	with an ICU and emergency department, and that did not already have a MET, were eligible for participation.) Acute care, Australia	physiological instability, and immediate availability of a MET.		
Jones, Bates et al. (2005). Determine the circadian pattern of MET calls and relate to nursing and MD activities Retrospective, observational	Patients requiring MET intervention from Aug 2000 to Sep 2004 (120,000 consecutive overnight M/S admissions) 400 bed university-affiliated teaching hospital, Melbourne, Australia	MET = (intro in 2000) consists of ICU fellow, ICU nurse, medical fellow	Frequency of MET calls by time of day (in 1/2 hour increments)	1) 2568 MET calls 2) 56% of calls occurred after hours (1800-0800) but not statistically significant 3) MET calls were 1.25 times more likely during the 3 hour span at nursing handover (0700, 1300, 2100) ($P<.001$) 4) Highest MET level = 2000-2030 ($P<.001$)
Jones, Bellomo et al. (2005). Examine the long-term effect of MET on cardiac arrests	All patients admitted during three study periods: before MET, during MET education, 4 years after MET implementation Acute care, Australia	MET = ICU fellow and nurse, as well as the Medical fellow of the receiving unit of the day	Cardiac arrests	MET and education associated with a continued decrease in cardiac arrests

Study/Purpose/Design	Subjects /Setting	Team definition	Outcome Measures	Major findings
Prospective before & after trial				
Galhotra et al. (2006) Study nurses' perceptions about MET re: impact on patient outcomes and nursing work environment Anonymous survey	300 staff nurses employed during survey period mid-January 2005 2 hospital complexes totaling 1249 acute care beds; Pittsburgh, PA	MET = expert critical care professional; including attending critical care physician & other experts (ICU nurses & RTs)	Questionnaire responses	1) Favorable opinion re: MET 2) 93% improved pt care 3) 84% improved nursing work environment
Galhotra et al. (2006). Study the impact of time of day, day of week, and level of patient monitoring on MET activation Retrospective, observational	All patients receiving MET intervention or dxd as having cardiac arrest from Oct 2001 to Mar 2005 730 bed urban tertiary hospital, Pittsburgh, PA	MET = "Condition C" consists of six responders: 1 CCM attending, on CCM fellow, 2 ICU nurses, 2 resp therapists (identical in comp to cardiac arrest team)	1) time of day of event (day or night) 2) day of week of event 3) type of patient monitoring (monitored, unmonitored, ICU)	MET rate higher during day on weekdays; no difference in cardiac arrest rates between days and nights, but higher day time rate on weekdays. Conclusion: More MET events occur during the day; unmonitored units have more diurnal variability than monitored units. ICUs show no diurnal variation in MET rate; hospitals inconsistently apply MET activation criteria

Study/Purpose/Design	Subjects /Setting	Team definition	Outcome Measures	Major findings
Jones et al. (2007). Assess the effect of the MET on long-term mortality in patients undergoing surgery requiring hospital stay > 48 hours Prospective before & after trial	Consecutive patients admitted for major surgery (surgery requiring hospital stay > 48 h) during 4 month control (n=1,116) and 4 month MET phase (n=1,313) Acute care, Australia	MET = duty intensive care fellow, a designated intensive care nurse and the receiving medical fellow	Patient mortality at 1500 days	MET associated with better long-term survival (P=.001)
Offner et al (2007). Test the hypothesis that early evaluation and intervention before patient deterioration would avoid progression to cardiac arrest. Prospective data collection (March - December, 2005)	Patients admitted from March to December 2004 (before MET) and those admitted from March to December 2005 (after MET) Level I trauma center, Denver, CO	RRT = available 24 hours/day, 7 seven days/week and consists of an intensivist, an ICU nurse, and a respiratory therapist	1) RRT activation 2) Cardiac arrest (non-ICU)	1) 76 RRT activations 2) 13 cardiac arrests (compared to 27 the year before RRT initiation) (P= 0.02) 3) 1.4 +/- 0.8 cardiac arrests/10,000 patient days (compared to 4.4 +/- 2.4/10,000 patient days before RRT) (P=0.001) [Mann-Whitney U] RRTs increase benefit of 24/7 in-house physicians

Study/Purpose/Design	Subjects /Setting	Team definition	Outcome Measures	Major findings
Schmid (2007). Describe the pattern and frequency of MET calls on 3 monitored medical cardiology units; Retrospective	MET calls for 6 month period (Jan - Jun 2006) 700 bed academic center, Pittsburgh, PA	MET = not defined	Frequency of MET calls by time of day	Slightly higher frequency of calls during day shift
Cretikos et al. (2007). Evaluate ability of clinical criteria to identify patients at risk for cardiac arrest, unplanned intensive care unit admission, or unexpected death Nested, matched case-control study	Four hundred and fifty cases and 520 controls matched for age, sex, hospital, and hospital ward Seven Australian public hospitals	N/A	Respiratory rate; heart rate, systolic BP, GCS score, seizures, "seriously worried"	High heart rate + high resp rate + low systolic BP + decrease in GSC score = predict cardiac arrest, unplanned ICU admission, & unexpected death; however, still high false positives and unidentified patients at risk.
Jolley et al. (2007) evaluate the efficacy of initiating a RRT at a single facility quasi-experimental	488 bed, not-for-profit teaching medical center in South Carolina	RRT = critical care nurse and respiratory therapist called for change in patient status outside the CCU	1) Codes outside the CCU 2) Mortality rate	1) Fewer codes outside the CCU 2) No change in mortality rate

Appendix D: Survey

Rapid Response Team Practices — A Survey

Participant Information

*** 1. Participant ID:**

No person outside the DFW Hospital Council, including the researcher, will have access to the participant identification data.

Hospital Characteristics

2. Profit Status

- ◯ Public
- ◯ Non Profit
- ◯ For Profit

3. Technology Status

- ◯ High technology (have facilities for open-heart surgery or major organ transplantations, or both)
- ◯ Low technology (do not have facilities for open-heart surgery nor major organ transplantations)

4. Teaching Status

- ◯ Non-Teaching (no post-graduate medical residents or fellows)
- ◯ Minor Teaching (1:4 or smaller trainee-to-bed ratios)
- ◯ Major Teaching (higher than 1:4 trainee-to-bed ratios)

5. Total Number of Adult Medical/Surgical Units (Defined as adult, acute care, in-patient units; excludes intensive care, skilled care, rehabilitation, or maternal-child patient populations)

(Enter numerals)

Rapid Response Team Characteristics

Please use the following definition when responding to the remaining questions.

"Rapid response teams, also referred to as medical emergency teams, resemble code teams in that they are staffed by health care professionals with critical care expertise, often including a physician, a nurse, and a respiratory therapist. However, unlike a code team, a rapid response team is summoned before a code occurs." (Berwick et al., 2006, p. 324)
Rapid response teams strive to:
-Assess and stabilize the patient's condition.
-Assist in organizing information to be communicated to the patient's physician.
-Provide support and education to unit staff members.
-Assist with transferring the patient to a higher level of care if circumstances warrant

Rapid Response Team Practices A Survey

6. Does your facility currently have a formal Rapid Response Team (RRT) as defined above?

- ◯ Yes (Please specify implementation date below)
- ◯ Not currently, but implementation roll-out in progress (please continue with the remainder of the questions)
- ◯ No, but planning for future implementation [Stop here; do not answer the remainder of the questions)]
- ◯ No, and no plans for implementation in the future [Stop here; do not answer the remainder of the questions)]

If yes (MM/YYYY Format)

7. Is your RRT separate from your Code Blue or cardiopulmonary arrest team?

- ◯ Yes
- ◯ No

If no (Please explain how you differentiate between a RRT call and a cardiopulmonary arrest call.)

8. Do you have written guidelines for activation of the RRT?

- ◯ Yes
- ◯ No [Go to Question #10]
- ◯ Guideline development in progress

9. If you checked yes or guidelines in development in Item #8, do your guidelines include RRT activation or calling criteria based on the following? [Check all that apply]

- ☐ A staff member is worried about the patient
- ☐ Acute and persistent declining pulse oximetry
- ☐ Acute and persistent change in heart rate
- ☐ Acute and persistent change in systolic blood pressure
- ☐ Acute and persistent change in respiratory rate
- ☐ New onset chest pain suggestive of ischemia
- ☐ Acute and persistent change in conscious state (including agitated delirium)
- ☐ Other (describe):

10. Who are the RRT members? [Check all that apply]

- ☐ Physician
- ☐ ICU RN
- ☐ Respiratory Therapist
- ☐ Other (describe):

11. Who is the team leader?

- ○ Physician
- ○ ICU RN
- ○ Respiratory Therapist
- ○ Other (describe)

Rapid Response Team Practices A Survey

12. Who can activate the RRT? [Check all that apply]

- [ ] Patient care nurse
- [ ] Treating physician
- [ ] Unlicensed patient care staff
- [ ] Family member
- [ ] Other (describe)

13. How are RRT members notified? [Check all that apply]

- [ ] Overhead page from unit
- [ ] Overhead page from operator
- [ ] Beeper/pager message from unit
- [ ] Beeper/pager message from operator
- [ ] Other (describe)

14. Which performance measures are used to evaluate the RRT? [Check all that apply]

- [ ] Minutes to arrival
- [ ] Number of calls per month
- [ ] Number of cardiac arrests outside the ICU
- [ ] Mortality rate
- [ ] Death rate among surgical patients with treatable severe complications (PSI#4)
- [ ] ICU length of stay
- [ ] Hospital length of stay
- [ ] Other (describe)

15. How do you rate the overall effectiveness of the RRT in your facility on the following three criteria?

	Excellent	Good	Fair	Poor
Supports nursing care	○	○	○	○
Decreases patient complications	○	○	○	○
Saves patient lives	○	○	○	○

Please comment on your ratings:

References

Aday, L. A., Begley, C. E., Lairson, D. R., & Balkrishnan, R. (2004). *Evaluating the heathcare system: Effectiveness, efficiency, and equity* (3rd ed.). Chicago: Health Administration Press.

Agency for Healthcare Research and Quality. (2003). *AHRQ Quality Indicators: Guide to Patient Safety Indicators* (AHRQ Publication No. 03-R203). Rockville, MD: Agency for Healthcare Research and Quality.)

Agency for Healthcare Research and Quality. (2007). AHRQ Quality Indicators: Guide to Patient Safety Indicators (Version 3.1). Retrieved June 25, 2007, from http://www.qualityindicators.ahrq.gov/downloads/psi/psi_guide_v31.pdf

Agency for Healthcare Research and Quality. (2008). AHRQ Quality Indicators: Patient Safety Indicators - Technical Specifications, Version 3.2. Retrieved September 28, 2008, from http://www.qualityindicators.ahrq.gov/downloads/psi/psi_technical_specs_v32.pdf

Agency for Healthcare Research and Quality. (March, 2007). Patient safey indicator rates. Retrieved June 25, 2007, from http://www.qualityindicators.ahrq.gov/downloads/psi/psi_provider_comparative_v31.pdf

Aiken, L. (2002). Comments on the nurse shortage. Tuesday, August 20, 2002. Retrieved 6/17, 2007, from http://www.nursing.upenn.edu/chopr/newsdetail.asp?t=2&id=12

Aiken, L., Clarke, S., Cheung, R., Sloane, D., & Silber, J. (2003). Education levels of hospital nurses and surgical patient mortality. *Journal of the American Medical Association, 290*, 1617-1628.

Aiken, L., Clarke, S., Sloane, D., Sochalski, J., & Silber, J. (2002). Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction. *Journal of the American Medical Association, 288*, 1987-1993.

Aiken, L. H. (n.d.). The unfinished patient safety agenda. *Morbidity & Mortality Rounds on the Web: Perspectives on Safety*. Retrieved June 17, 2007, from http://webmm.ahrq.gov/perspective.aspx?perspectiveID=7

Auerbach, D. I., Buerhaus, P. I., & Staiger, D. O. (2007). Better late than never: workforce supply implications of later entry into nursing. *Health Affairs (Project Hope), 26*(1), 178-185.

Bader, M. K., Neal, B., Johnson, L., Pyle, K., Brewer, J., Luna, M., et al. (2009). Rescue me: Saving the vulnerable non-ICU patient population. *The Joint Commission Journal on Quality Patient Safety, 35*(4), 199-205.

Begun, J., Zimmerman, B., & Dooley, K. (2003). Health care organizations as complex adaptive systems. In S. M. Mick & M. Wyttenback (Eds.), *Advances in Health Care Organization Theory* (pp. 253-288). San Francisco: Jossey-Bass.

Bellomo, R., Goldsmith, D., Uchino, S., Buckmaster, J., Hart, G., Opdam, H., et al. (2004). Prospective controlled trial of effect of medical emergency team on postoperative morbidity and mortality rates. *Critical Care Medicine, 32*, 916-921.

Bellomo, R., Goldsmith, D., Uchino, S., Buckmaster, J., Hart, G. K., Opdam, H., et al. (2003). A prospective before-and-after trial of a medical emergency team. *The Medical Journal of Australia, 179*(6), 283-287.

Berwick, D. M., Calkins, D. R., McCannon, C. J., & Hackbarth, A. D. (2006). The 100,000 Lives Campaign. *Journal of the American Medical Association, 295*, 324-327.

Best, M., & Neuhauser, D. (2004). Avedis Donabedian: Father of quality assurance and poet. *Quality & Safety in Health Care, 13*(6), 472-473.

Bewick, V., Cheek, L., & Ball, J. (2005). Statistics review 14: Logistic regression. *Critical Care (London, England), 9*(1), 112-118.

Blegen, M. A., & Vaughn, T. (1998). A multisite study of nurse staffing and patient occurrences. *Nursing Economic$, 16*(4), 196-203.

Bobay, K. L., Fiorelli, K. L., & Anderson, A. J. (2008). Failure to rescue: A preliminary study of patient-level factors. *Journal of Nursing Care Quality, 23*(3), 211-215.

Boyle, S. (2004). Nursing unit characteristics and patient outcomes. *Nursing Economics, 22*(3), 111.

Braithwaite, R. S., DeVita, M. A., Mahidhara, R., Simmons, R. L., Stuart, S., & Foraida, M. (2004). Use of medical emergency team (MET) responses to detect medical errors. *Quality & Safety in Health Care, 13*(4), 255-259.

Bristow, P. J., Hillman, K. M., Chey, T., Daffurn, K., Jacques, T. C., Norman, S. L., et al. (2000). Rates of in-hospital arrests, deaths and intensive care admissions: The effect of a medical emergency team. *The Medical Journal of Australia, 173*(5), 236-240.

Buerhaus, P. I., Staiger, D. O., & Auerbach, D. I. (2000). Why are shortages of hospital RNs concentrated in specialty care units? *Nursing Economic$, 18*(3), 111-116.

Buist, M. D., Moore, G. E., Bernard, S. A., Waxman, B. P., Anderson, J. N., & Nguyen, T. V. (2002). Effects of a medical emergency team on reduction of incidence of and mortality from unexpected cardiac arrests in hospital: Preliminary study. *BMJ (Clinical Research Ed.), 324*, 387-390.

Burns, N., & Grove, S. K. (2005). *The practice of nursing research: Conduct, critique, and utilization* (5th ed.). St. Louis: Elsevier.

Centers for Medicare and Medicaid Services. (2009). CMS Hospital-Specific Report Dry-Run Version: AHRQ Patient Safety Indicators and Inpatient Quality Indicators. Retrieved September 13, 2009, from http://www.qualitynet.org/

Chan, P. S., Khalid, A., Longmore, L. S., Berg, R. A., Kosiborod, M., & Spertus, J. A. (2008). Hospital-wide code rates and mortality before and after implementation of a rapid response team. *Journal of the American Medical Association, 300*, 2506-2513.

Cho, S.-H., Ketefian, S., Barkauskas, V. H., & Smith, D. G. (2003). The effects of nursing staffing on adverse events, morbidity, mortality, and medical costs. *Nursing Research, 52*, 71-79.

Cioffi, J. (2000). Recognition of patients who require emergency assistance: A descriptive study. *Heart & Lung: The Journal of Critical Care, 29*(4), 262-268.

Clarke, S. P. (2004). Failure to rescue: Lessons from missed opportunities in care. *Nursing Inquiry, 11*(2), 67-71.

Clarke, S. P. (2007). Nurse staffing in acute care settings: Research perspectives and practice implications. *Joint Commission Journal on Quality & Patient Safety, 33*(11), 30-44.

Clarke, S. P., & Aiken, L. H. (2003). Failure to rescue: Needless deaths are prime examples of the need for more nurses at the bedside. *American Journal of Nursing, 103*(1), 42-47.

Comeau, E., & Adkinson, K. (2007). Promoting quality patient care: Reducing inpatient mortality. *Journal of Nursing Care Quality, 22*(1), 43-49.

Correa-de-Araujo, R., Stone, P., & Clarke, S. (2004). Challenges in healthcare systems and women's caregiving roles [conference summary]. [Electronic Version]. *Emerging Infectious Diseases*, *10*, from http://www.cdc.gov/ncidod/EID/vol10no11/04-0622_05.htm

Cretikos, M., Chen, J., Hillman, K., Bellomo, R., Finfer, S., & Flabouris, A. (2007). The objective medical emergency team activation criteria: A case-control study. *Resuscitation, 73*(1), 62-72.

Daffurn, K., Lee, A., Hillman, K. M., Bishop, G. F., & Bauman, A. (1994). Do nurses know when to summon emergency assistance? *Intensive & Critical Care Nursing: The Official Journal of The British Association of Critical Care Nurses, 10*(2), 115-120.

Daly, M. L., Powers, J., Orto, V., Rogers, M., Dickinson, T., Fabris, M., et al. (2007). Innovative solutions: Leading the way. *Dimensions of Critical Care Nursing, 26*(1), 15-20.

Dean, B. S., Decker, M. J., Hupp, D., Urbach, A. H., Lewis, E., & Benes-Stickle, J. (2008). Condition HELP: A pediatric rapid response team triggered by patients and parents. *Journal for Healthcare Quality: Promoting Excellence in Healthcare, 30*(3), 28-31.

DeVita, M., Bellomo, R., Hillman, K., Kellum, J., Rotondi, A., Teres, D., et al. (2006). Findings of the first consensus conference on medical emergency teams. *Critical Care Medicine, 34*, 2463-2478.

DeVita, M. A., Braithwaite, R. S., Mahidhara, R., Stuart, S., Foraida, M., & Simmons, R. L. (2004). Use of medical emergency team responses to reduce hospital cardiopulmonary arrests. *Quality & Safety in Health Care, 13*(4), 251-254.

Donabedian, A. (1966). Evaluating the quality of medical care. Reprinted 2005. *The Milbank Quarterly, 83*, 691-729.

Donabedian, A. (1992). The role of outcomes in quality assessment and assurance. *Quality Review Bulletin, 18*(11), 356-360.

Donaldson, N., Shapiro, S., Scott, M., Foley, M., & Spetz, J. (2009). Leading successful rapid response teams: A multisite implementation evaluation. *The Journal of Nursing Administration, 39*(4), 176-181.

Estabrooks, C., Midodzi, W., Cummings, G., Ricker, K., & Giovannetti, P. (2005). The impact of hospital nursing characteristics on 30-day mortality. *Nursing Research, 54*, 74-84.

Foraida, M. I., DeVita, M. A., Braithwaite, R. S., Stuart, S. A., Brooks, M. M., & Simmons, R. L. (2003). Improving the utilization of medical crisis teams (Condition C) at an urban tertiary care hospital. *Journal of Critical Care, 18*(2), 87-94.

Friese, C. R., & Aiken, L. H. (2008). Failure to rescue in the surgical oncology population: Implications for nursing and quality improvement. *Oncology Nursing Forum, 35*, 779-785.

Friese, C. R., Lake, E. T., Aiken, L. H., Silber, J. H., & Sochalski, J. (2008). Hospital nurse practice environments and outcomes for surgical oncology patients. *Health Services Research, 43*, 1145-1163.

Galhotra, S., DeVita, M. A., Simmons, R. L., & Schmid, A. (2006). Impact of patient monitoring on the diurnal pattern of medical emergency team activation. *Critical Care Medicine, 34*, 1700-1706.

Galhotra, S., Scholle, C. C., Dew, M. A., Mininni, N. C., Clermont, G., & DeVita, M. A. (2006). Medical emergency teams: A strategy for improving patient care and nursing work environments. *Journal of Advanced Nursing, 55*(2), 180-187.

Greenhouse, P. K., Kuzminsky, B., Martin, S. C., & Merryman, T. (2006). Emergency. Calling a condition h(elp): one facility gives patients and families the ability to summon a rapid response team. *American Journal of Nursing, 106*(11), 63-66.

Grover, F. L., Hammermeister, K. E., & Shroyer, A. L. (1995). Quality initiatives and the power of the database: What they are and how they run. *The Annals of Thoracic Surgery, 60*, 1514-1521.

Halm, M., Peterson, M., Kandels, M., Sabo, J., Blalock, M., Braden, R., et al. (2005). Hospital nurse staffing and patient mortality, emotional exhaustion, and job dissatisfaction. *Clinical Nurse Specialist, 19*, 241.

Haraden, C., & Rutherford, P. (2004). Redesign the clinical process to enhance patient care. *AHA News, 40*(22), 7.

HealthGrades. (2004, July). HealthGrades quality study: Patient safety in American hospitals. Retrieved June 21, 2007, from http://www.healthgrades.com/media/english/pdf/hg_patient_safety_study_final.pdf

HealthGrades. (2007, April). HealthGrades quality study: Fourth annual patient safety in American hospitals study. Retrieved June 21, 2007, from http://www.healthgrades.com/media/DMS/pdf/PatientSafetyInAmericanHospitalsStudy2007.pdf

Hillman, K. (2004). Expanding intensive care medicine beyond the intensive care unit. *Critical Care (London, England), 8*(1), 9-10.

Hillman, K., Chen, J., & Brown, D. (2003). A clinical model for health services research: The medical emergency team. *Journal of Critical Care, 18*(3), 195-199.

Hillman, K., Chen, J., Cretikos, M., Bellomo, R., Brown, D., Doig, G., et al. (2005). Introduction of the medical emergency team (MET) system: A cluster-randomised controlled trial. *Lancet, 365*, 2091-2097.

Hillman, K., Parr, M., Flabouris, A., Bishop, G., & Stewart, A. (2001). Redefining in-hospital resuscitation: The concept of the medical emergency team. *Resuscitation, 48*(2), 105-110.

Hinshaw, A. S. (2008). Navigating the perfect storm: Balancing a culture of safety with workforce challenges. *Nursing Research, 57*(1S), S4-10.

Horwitz, L. I., Cuny, J. F., Cerese, J., & Krumholz, H. M. (2007). Failure to rescue: Validation of an algorithm using administrative data. *Medical Care, 45*(4), 283-287.

Hourihan, F., Bishop, G., Hillman, K. M., & Daffurn, K. (1995). The medical emergency team: A new strategy to identify and intervene in high-risk patients. *Clinical Intensive Care, 6*(6), 269 - 272.

Iezzoni, L. (Ed.). (2003). *Risk adjustment for measuring health care outcomes* (3 ed.). Chicago: Health Administration Press.

Institute for Healthcare Improvement. (n.d.). Establish a rapid response team. Retrieved April 21, 2007, from http://www.ihi.org/IHI/Topics/CriticalCare/IntensiveCare/Changes/EstablishaRapidResponseTeam.htm

Institute of Medicine. (2004). *Keeping patients safe: Transforming the work environment of nurses*. Washington, D.C: The National Academies Press.

Isaac, T., & Jha, A. K. (2008). Are patient safety indicators related to widely used measures of hospital quality? *Journal of General Internal Medicine, 23*, 1373-1378.

Jacobs, J. L. (2006). Automated clinical inference and rapid response teams improve patient safety [Electronic Version]. *Patient Safety & Quality Healthcare*, 34-41. Retrieved November/December, from http://www.psqh.com/novdec06/inference.html

Jiang, H., Stocks, C., & Wong, C. (2006). Disparities between two common data sources on hospital nurse staffing. *Journal of Nursing Scholarship, 38*(2), 187-193.

Jolley, J., Bendyk, H., Holaday, B., Lombardozzi, K. A. K., & Harmon, C. (2007). Rapid response teams: Do they make a difference? *Dimensions of Critical Care Nursing, 26*(6), 253-262.

Jones, D., Bates, S., Warrillow, S., Opdam, H., Goldsmith, D., Gutteridge, G., et al. (2005). Circadian pattern of activation of the medical emergency team in a teaching hospital. *Critical Care, 9*(4), 303-306.

Jones, D., Bellomo, R., Bates, S., Warrillow, S., Goldsmith, D., Hart, G., et al. (2005). Long term effect of a medical emergency team on cardiac arrests in a teaching hospital. *Critical Care (London, England), 9*(6), R808-815.

Jones, D., Opdam, H., Egi, M., Goldsmith, D., Bates, S., Gutteridge, G., et al. (2007). Long-term effect of a medical emergency team on mortality in a teaching hospital. *Resuscitation, 74*(2), 235-241.

Kane, R. L., Shamliyan, T. A., Mueller, C., Duval, S., & Wilt, T. J. (2007). The association of registered nurse staffing levels and patient outcomes: systematic review and meta-analysis. *Medical Care, 45*, 1195-1204.

Kenward, G., Castle, N., Hodgetts, T., & Shaikh, L. (2004). Evaluation of a medical emergency team one year after implementation. *Resuscitation, 61*(3), 257-263.

Kirk, T. (2006). Rapid response teams in hospitals: Improving quality of care for patients and quality of the work environment for nursing staff. *Holistic Nursing Practice, 20*(6), 293-298.

Kohn, K. T., Corrigan, J. M., & Donaldson, M. S. (Eds.). (1999). *To err is human: Building a safer health system*. Washington, DC: National Academy Press.

Kutney-Lee, A., & Aiken, L. H. (2008). Effect of nurse staffing and education on the outcomes of surgical patients with comorbid serious mental illness. *Psychiatric Services (Washington, D.C.), 59*, 1466-1469.

Lange, L. L., & Jacox, A. (1993). Using large data bases in nursing and health policy research. *Journal of Professional Nursing, 9*, 204-211.

Lankshear, A. J., Sheldon, T. A., & Maynard, A. (2005). Nurse staffing and healthcare outcomes. *Advances in Nursing Science, 28*(2), 163-174.

Lee, A., Bishop, G., Hillman, K. M., & Daffurn, K. (1995). The Medical Emergency Team. *Anaesthesia and Intensive Care, 23*(2), 183-186.

Mailey, J., Digiovine, B., Baillod, D., Gnam, G., Jordan, J., & Rubinfeld, I. (2006). Reducing hospital standardized mortality rate with early interventions. *Journal of*

Trauma Nursing: The Official Journal of the Society of Trauma Nurses, 13(4), 178-182.

McCarthy, D., & Blumenthal, D. (2006). Stories from the sharp end: Case studies in safety improvement. *The Milbank Quarterly*, *84*(1), 165-200.

Merne Smaldone, A., & Connor, J. A. (2003). The use of large administrative data sets in nursing research. *Applied Nursing Research, 16*, 205-207.

Meyer, G., & Lavin, M. A. (2005). Vigilance: The essence of nursing [Electronic Version]. *Online Journal of Issues in Nursing*, *10*, 38-51. Retrieved October 17, 2008, from www.nursingworld.org/MainMenuCategories/ANAMarketplace/ANAPeriodicals/OJIN/TableofContents/Volume102005/No3Sept05/ArticlePreviousTopic/VigilanceTheEssenceofNursing.aspx

Moriarty, J., Naessens, J., Finnie, D., & Johnson, M. (2005). *Failure to rescue or failure to measure: What's important? No shortcuts to assessing quality. AcademyHealth. Meeting (Boston, MA). Mayo Clinic.* Paper presented at the AcademyHealth: Annual Research Meeting 2005, Boston, MA.

Morse, K. J., Warshawsky, D., Moore, J. M., & Pecora, D. C. (2006). A new role for the ACNP: The rapid response team leader. *Critical Care Nursing Quarterly, 29*(2), 137-146.

Munro, B. H. (2005). *Statistical methods for health care research* (5th ed.). Philadelphia: Lippincott Williams & Wilkins.

Needleman, J., & Buerhaus, P. (2003). Nurse staffing and patient safety: Current knowledge and implications for action. *International Journal for Quality In Health Care, 15*(4), 275-277.

Needleman, J., Buerhaus, P., Mattke, S., Stewart, M., & Zelevinsky, K. (2001). *Nurse staffing and patient outcomes in hospitals: Final report for Health Resources Services Administration* (No. 230-99-0021): Harvard School of Public Health.)

Needleman, J., Buerhaus, P., Mattke, S., Stewart, M., & Zelevinsky, K. (2002). Nurse-staffing levels and the quality of care in hospitals. *New England Journal of Medicine, 346*, 1715-1722.

Needleman, J., & Buerhaus, P. I. (2007). Failure-to-rescue: Comparing definitions to measure quality of care. *Medical Care, 45*, 913-915.

Offner, P. J., Heit, J., & Roberts, R. (2007). Implementation of a rapid response team decreases cardiac arrest outside of the intensive care unit. *The Journal of Trauma, 62*, 1223.

Parr, M., Bishop, G., Hillman, K., Duffurn, K., & Thebridge, C. (1998). Predicting inhospital cardiac arrest. *Resuscitation, 38*(3), 199.

Parr, M. J., Hadfield, J. H., Flabouris, A., Bishop, G., & Hillman, K. (2001). The medical emergency team: 12 month analysis of reasons for activation, immediate outcome and not-for-resuscitation orders. *Resuscitation, 50*(1), 39-44.

Polit, D., & Hungler, B. P. (1999). *Nursing research: Principles and methods* (6 ed.). Philadelphia: Lippincott.

Priestley, G., Watson, W., Rashidian, A., Mozley, C., Russell, D., Wilson, J., et al. (2004). Introducing critical care outreach: A ward-randomised trial of phased introduction in a general hospital. *Intensive Care Medicine, 30*, 1398-1404.

Pryor, D. B., Tolchin, S. F., Hendrich, A., Thomas, C. S., & Tersigni, A. R. (2006). The clinical transformation of Ascension Health: Eliminating all preventable injuries and deaths. *Joint Commission Journal on Quality And Patient Safety / Joint Commission Resources, 32*(6), 299-308.

Ransom, S. B., Joshi, M., & Nash, D. B. (2005). *The Healthcare quality book: Vision, strategy, and tools*. Chicago: Health Administration Press.

Repasky, T., & Pfeil, C. (2005). Experienced critical care nurse-led rapid response teams rescue patients on in-patient units. *Journal of Emergency Nursing, 31*, 376-379.

Robeznieks, A. (2006). IHI campaign draws more fire. Article questions methodology, rapid-response teams. *Modern Healthcare, 36*(49), 14-15.

Romano, P., Geppert, J., Davies, S., Miller, M., Elixhouser, A., & McDonald, K. (2003). A national profile of patient safety in U.S. Hospitals. *Health Affairs, 22*, 154-166.

Rosen, A., Zhao, S., Rivard, P., Loveland, S., Montez-Rath, M., Elixhauser, A., et al. (2006). Tracking rates of patient safety indicators over time: Lessons from the Veterans Administration. *Medical Care, 44*, 850-861.

Rosen, A. K., Rivard, P., Zhao, S., Loveland, S., Tsilimingras, D., Christiansen, C. L., et al. (2005). Evaluating the patient safety indicators: How well do they perform on Veterans Health Administration data? *Medical Care, 43*, 873-884.

Salamonson, Y., van Heere, B., Everett, B., & Davidson, P. (2006). Voices from the floor: Nurses' perceptions of the medical emergency team. *Intensive and Critical Care Nursing, 22*(3), 138-143.

Saver, C. (2006a). Beyond expectations: Part 1. *Nursing Management, 37*(10), 36-42.

Saver, C. (2006b). Beyond expectations: Part 2. *Nursing Management, 37*(11), 17-23.

Schmid, A. (2007). Frequency and pattern of medical emergency team activation among medical cardiology patient care units. *Critical Care Nursing Quarterly, 30*(1), 81-84.

Scholle, C., & Mininni, N. (2006). Best practice interventions: How a rapid response team saves lives. *Nursing, 36*(1), 36-40.

Shojania, K. G., Showstack, J., & Wachter, R. M. (2001). Assessing hospital quality: A review for clinicians. *Effective Clinical Practice: ECP, 4*(2), 82-90.

Silber, J. H., Kennedy, S. K., Even-Shoshan, O., Chen, W., Koziol, L. F., Showan, A. M., et al. (2000). Anesthesiologist direction and patient outcomes. *Anesthesiology, 93*(1), 152-163.

Silber, J. H., Kennedy, S. K., Even-Shoshan, O., Chen, W., Mosher, R. E., Showan, A. M., et al. (2002). Anesthesiologist board certification and patient outcomes. *Anesthesiology, 96*, 1044-1052.

Silber, J. H., Romano, P. S., Rosen, A. K., Wang, Y., Even-Shoshan, O., & Volpp, K. G. (2007). Failure-to-rescue: Comparing definitions to measure quality of care. *Medical Care, 45*, 918-925.

Silber, J. H., Rosenbaum, P. R., Schwartz, J. S., Ross, R. N., & Williams, S. V. (1995). Evaluation of the complication rate as a measure of quality of care in coronary artery bypass graft surgery. *Journal of the American Medical Association, 274*(4), 317-323.

Silber, J. H., Rosenbaum, P. R., Williams, S. V., Ross, R. N., & Schwartz, J. S. (1997). The relationship between choice of outcome measure and hospital rank in general surgical procedures: Implications for quality assessment. *International Journal for Quality in Health Care, 9*(3), 193-200.

Silber, J. H., Williams, S., Krakauer, H., & Schwartz, J. (1992). Hospital and patient characteristics associated with death after surgery. *Medical Care, 30*, 615-627.

Surgenor, S., Cook, C., Slogic, S., Maloney, L., & Blike, G. (2007). Letter to the Editor: Rapid response team responses. *Journal of the American Medical Association, 297*(2), 154-155.

Talsma, A., Bahl, V., & Campbell, D. A. (2008). Exploratory analyses of the "failure to rescue" measure: Evaluation through medical record review. *Journal of Nursing Care Quality, 23*(3), 202-210.

Talsma, A., Grady, P. A., Feetham, S., Heinrich, J., & Steinwachs, D. M. (2008). The perfect storm: Patient safety and nursing shortages within the context of health policy and evidence-based practice. *Nursing Research, 57*(1S), S15-21.

Tee, A., Calzavacca, P., Licari, E., Goldsmith, D., & Bellomo, R. (2008). Bench-to-bedside review: The MET syndrome--the challenges of researching and adopting medical emergency teams. *Critical Care, 12*(1), 205-205.

Thomas, K., Force, M., Rasmussen, D., Dodd, D., & Whildin, S. (2007). Rapid response team: Challenges, solutions, benefits. *Critical Care Nurse, 27*(1), 20-28.

Van Voorhis, K. T., & Willis, T. S. (2009). Implementing a pediatric rapid response system to improve quality and patient safety. *Pediatric Clinics Of North America, 56*(4), 919-933.

Vogt, W. P. (1999). *Dictionary of statistics and methodology: A nontechnical guide for the social sciences* (2nd ed.). Thousand Oaks: SAGE Publications.

Waltz, C. F., Strickland, O. L., & Lenz, E. R. (2005). *Measurement in nursing and health research* (3 ed.). New York: Springer Publishing Company, Inc.

Whitcomb, J. J., & Blackman, V. S. (2007). Cardiopulmonary resuscitation: How far have we come? *Dimensions of Critical Care Nursing: DCCN, 26*(1), 1.

Whittington, J., Simmonds, T., & Jacobson, D. (2005). Reducing hospital mortality rates (part 2). *IHI Innovation Series white paper* Retrieved July 22, 2007, from http://www.ihi.org/IHI/Results/WhitePapers/ReducingHospitalMortalityRatesPart2.htm

Winters, B. D., Pham, J., & Pronovost, P. J. (2006). Rapid response teams--walk, don't run. *Journal of the American Medical Association, 296*, 1645-1647.

Winters, B. D., Pham, J. C., Hunt, E. A., Guallar, E., Berenholtz, S., & Pronovost, P. J. (2007). Rapid response systems: A systematic review. *Critical Care Medicine, 35*, 1238-1243.

VITA

Jere Thornhill Hammer attended Plano High School, Plano, Texas. In 1974 she entered The University of Texas in Austin, Texas. She received the degree of Bachelor of Science from The University of Texas at Austin in December, 1978. During the following years she was employed as a nurse in Texas, Oklahoma, and Louisiana as a civilian and an Air Force reservist. She received the degree of Master of Science from East Central University in Ada, Oklahoma in May 1992. She received the degree of Master of Science from The University of Texas at Tyler in May 1994. In September, 2004, she entered the Graduate School at The University of Texas at Austin.

Permanent Address: 121 Timberline Drive, Port Lavaca, Texas, 77979

This manuscript was typed by the author.