A LONGITUDINAL STUDY RELATING PATIENT CARE OUTCOMES TO NURSE MAGNET DESIGNATION IN UNITED STATES ACADEMIC MEDICAL CENTERS

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A DISSERTATION

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ABSTRACT

The purpose of this investigation is to determine whether the addition of the structural and process elements necessary for an academic medical center to garner its initial Magnet designation is associated with improved patient care. Donabedian’s linear structure-process-outcome theory serves as the framework to empirically assess the relationship between Magnet status and patient care outcomes. The influence of such organizational factors as hospital size, clinical activity, and complexity of care is investigated. Secondary data from the American Nurse Credentialing Center (ANCC) and the University HealthSystem Consortium (UHC) is used as the basis of this empirical study.

This investigation identified two specific nursing-sensitive outcome measures that statistically improved following initial Magnet certification: the rate of pressure ulcers, and the rate of physiologic or metabolic derangements following elective surgical procedures. In the adjusted models, the significant improvement in the rate of pressure ulcers was modified by case mix index.

A time-dependent improvement in five additional outcome measures was also revealed: infection resulting from medical care, post-operative deep vein thrombosis or
pulmonary embolus, post-operative respiratory failure, failure to rescue, and hospital re-admission. In the adjusted models the significant time-dependent improvement for failure to rescue was modified by organizational characteristics representing clinical activity and complexity of care. Similarly, the level of care complexity modified the significant improvement observed for hospital re-admission rate. Time-dependent improvements in rates of infection resulting from medical care and post-operative respiratory failure either held constant or improved with the inclusion of covariates. The rate of post-operative deep vein thrombosis or pulmonary embolus slightly increased in the adjusted model. In-hospital mortality rates resulting from acute myocardial infarction or congestive heart failure, and the rate of post-operative sepsis were not correlated with either time or initial Magnet designation.

Though the initial Magnet designation did result in patient care outcome improvements, the frequency of in-hospital complications of care and adverse events was decreased primarily as a function of time. It is possible that these time-dependent improvements stemmed from a shared predisposition by the hospitals studied to consider nursing a critical component of quality improvement.

Keywords: Magnet, Donabedian, Academic Medical Center, Nursing
DEDICATION

To my loving wife Teri, if were not for her unwavering support, complete understanding, and overwhelmingly positive approach to life, this work would not have come to fruition.

To my mother Joan, who by example instilled within me a lifelong drive toward intellectual and academic growth.
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CHAPTER 1:

INTRODUCTION

Designation of a facility by the American Nurses Credentialing Center as a Nurse Magnet Hospital implies the existence of an organizational structure and nursing processes capable of producing improved patient outcomes following medical and surgical interventions. Structure, as defined by Donabedian, represents the stable set of organizational features. These characteristics are objective and measurable. In relation to the nurse Magnet program they include such things as number of nurses and education level, nurse compensation, and equipment. Process factors are continuously changing and include strategies for management, governance, professional autonomy, patient care, and staff communication. It is through continuously redefining these process factors that a Magnet culture is produced (Upenieks & Abelew, 2006; Upenieks & Sitterding, 2008).

Though the preponderance of research on Magnet hospitals has documented an enriched professional environment for nurses compared with non-Magnet facilities, the true impact of Magnet structural and process characteristics on patient care is uncertain. At present, the direct correlation between the establishment of a nurse Magnet structure and improved patient outcomes is not conclusive. The purpose of this study is to determine whether the achievement of nurse Magnet status is associated with an improvement in the healthcare outcomes produced by individual academic medical centers. By comparing patient care outcome measures before and then after achievement
of nurse Magnet designation for each hospital, the true impact of this change on quality of care at the individual facilities is assessed. This is a unique longitudinal investigation designed to test directly the impact of nurse Magnet designation, and all that comes with it, on patient care outcomes within academic healthcare organizations.

Chapter #1 serves as a general introduction to the dissertation. First, background is provided related to the initiation, development, and maturation of the nurse Magnet certification program over the last 30 years. Next, the research problem is defined, then the program of study and the research questions are articulated. The theoretical framework utilized to answer the research questions and to address the stated problem is explained.

**Background**

A cyclical shortage of nurses has plagued the United States healthcare system since World War II. In the early 1980’s the situation was so pressing that the American Nurses Association (ANA) commissioned a research study specifically to address the recruitment and retention of front line nurses in America’s hospitals (McClure, Poulin, Sovie, & Wandelt, 1983). Using a hospital’s reputation for nurse job satisfaction, nurse feelings of high quality care, as well as effective recruitment and retention of nurses, researchers isolated 41 hospitals. Through regional interviews with nurse executives and staff nurses they generated a list of the structural elements and attributes that were thought responsible for this success. Some of the components recognized as important included leadership by knowledgeable and committed nurse executives, participatory management, autonomy for practicing nurses, integration of nursing best practices, and
commitment to the profession of nursing. These became known as the characteristics of magnetism and these 41 facilities were designated as the original Magnet hospitals (Kramer & Schmalenberg, 2005).

In 1992 the American Nurses Credentialing Center (ANCC) was established and by 1994 it had formalized the Magnet recognition program. Based on the original research in 1983, the ANCC set specific structural criteria necessary for a facility to achieve Magnet recognition. Effective patient care was considered an offshoot of the Magnet structural requirements, not a direct focus of the certification process. These structural elements, the 14 forces of magnetism, were as follows (Kramer & Schmalenberg, 2005):

1. High quality nursing leadership
2. Decentralized, flat organizational structure
3. Participatory management at all levels
4. Nurse friendly personnel policies and programs
5. Nurse responsibility for coordination of patient care delivery mechanisms
6. Quality care delivery as a priority
7. Nurse involvement in quality improvement efforts
8. Resources for nurse consultation and direction regarding patient care
9. Autonomy consistent with professional standards
10. Community outreach involvement
11. Teaching as a component of nurse practice
12. An institutional view of nursing as essential to patient care
13. Mutual respect between all disciplines involved in care of the patient
14. Opportunities for professional development

A hospital that sought Magnet certification was required to submit an application, internally document the existence of the 14 forces, and undergo a 2-3 day onsite evaluation. If Magnet designation was achieved, it was conferred for only a 4-year period at which time a similar but even more rigorous evaluation was required for continued certification.

Though the process remains much the same today, in 2005, sensing the need to bring the structural requirements more in line with present day and create a template for future refinement, the Commission on Magnet Recognition studied 147 Magnet facilities and utilized 164 sources of evidence. From this they isolated 7 domains in which most of the 14 forces of magnetism fell:

1. Leadership
2. Resource utilization and development
3. Nursing model
4. Safe and ethical practice
5. Autonomous practice
6. Research
7. Quality processes

Realizing that the Magnet designation mechanism had concentrated predominantly on structure of an organization, not the most critical issue or the one that would lead to a culture of patient care excellence and innovation, the Commission on Magnetism added an eighth domain emphasizing patient care outcomes. A new model
for Magnet certification was subsequently adopted in 2008 incorporating these 8 domains into 5 components (Wolf, Triolo, & Ponte, 2008):

1. Transformational leadership
2. Structured empowerment
3. Exemplary professional nursing practice
4. New knowledge, innovations and improvements
5. Empirical quality results

Transformational leadership, structural empowerment, and exemplary professional nursing are heavily weighted in the evaluation of a hospital seeking its first Magnet designation. Those facilities applying for re-certification, ones that presumably have the desired structures and processes in place, are judged more heavily on the creation of new knowledge, nursing innovation and improvement in care as reflected by empirical patient care results compared against benchmark data for best practice. Whereas the past process for Magnet designation emphasized structure and process evaluation, assuming that the natural end result would be improved patient care, the current method focuses on a hospital’s ability to contribute to the profession of nursing in the future, and to provide and document improved patient care outcomes in the present.

**Statement of the Problem**

The problem addressed in this dissertation is whether the structural and resulting process virtues associated with nurse Magnet designation translate to improved outcomes for patients undergoing medical and surgical treatment within Magnet certified academic medical centers. Though the relationship between Magnet structure and nurse outcome
has been thoroughly researched, the direct impact of Magnet structure and resulting processes on patient-level outcomes has yet to be defined.

At the time of the nurse Magnet program’s inception in the early 1994, Magnet hospitals were chosen based strictly on their ability to create the favorable nursing work environments needed to support nurse recruitment and retention. Facilities were not certified based on their ability to produce superior or more consistent healthcare outcomes for their patients. The initial focus was squarely on desired nurse outcomes like lower rates of job-related burnout and turnover, and higher nurse-appraised quality of care under the assumption that these characteristics would translate to overall better patient care. As a consequence, the great majority of the research evaluating Magnet designated hospitals was geared toward nurse outcome, not patient outcome. Most of the studies confirmed that nurses working in Magnet hospitals had higher job satisfaction (Aiken, Havens, & Sloane, 2009; Hess, Desroches, Donelan, Norman, & Buerhaus, 2011; Lacey et al., 2007) and those nurses rated the quality of patient care higher than nurses working in non-Magnet facilities (Kramer, Maguire, & Brewer, 2011).

In contrast, empirical research focused on patient care outcomes in Magnet hospitals is relatively scarce and the results are inconsistent. For example, two studies found that mortality rates were lower in Magnet hospitals (Aiken, Sloane, Lake, Sochalski, & Weber, 1999; Aiken, Smith, & Lake, 1994) and two others found they were no better than in non-Magnet hospitals (Goode, Blegen, Park, Vaughn, & Spetz, 2011; Hickey, Gauvreau, Connor, Sporing, & Jenkins, 2010). This inconsistency may emanate from two primary factors. Early cross-sectional studies lacked the ability to control adequately for underlying patient variability and severity of illness. Additionally, the
global outcome measures utilized, like mortality, were general, impacted by a variety of factors apart from those being investigated. As the ability to control for patient and disease variation improved, and as nursing-sensitive outcome measures were employed, the magnitude of the differences found between Magnet and non-Magnet facilities diminished in some studies.

**Purpose**

The purpose of this study is to determine whether the addition of the structural and process elements necessary for a hospital to garner its initial Magnet designation are associated with improved patient care outcomes. Both global and nursing-sensitive outcome variables for academic medical center members of the University HealthSystem Consortium (UHC) are recorded at defined times before and after initial nurse Magnet designation. The longitudinal change in values is determined for each facility then compared and contrasted in relation to size, clinical activity, and complexity of patient care provided.

**Research Questions**

In accordance with the purpose of this investigation, the following four primary questions were posed:

1. Is there a significant longitudinal change in global or nursing-sensitive outcome measures after attainment of initial nurse Magnet designation within United States academic medical centers?
   
   a. Which outcome measures are most sensitive to the organizational structure and nursing processes required for successful nurse Magnet designation?
2. Does hospital size impact the changes noted in patient care outcomes following initial nurse Magnet designation?

3. Does the level of a hospital’s clinical activity impact the changes noted in patient care outcomes following initial nurse Magnet designation?

4. Does the level of disease severity and the complexity of care provided by a hospital impact the changes noted in patient care outcomes following initial nurse Magnet designation?

**Theoretical Framework**

This investigation of whether the instillation of the structural changes required for attainment of Magnet status translates to improvement in healthcare quality in academic medical centers is based on Donabedian’s linear structure-process-outcome (SPO) theory (Donabedian, 1966). His premise was that structure, process, and outcome are causally related. Supportive structural characteristics (i.e. the number and skill of the professional staff) increase the likelihood of effective processes both at the patient care level (i.e. direct nursing interventions) and at the nursing function level (i.e. autonomy and self-governance) which subsequently increase the probability of improved outcomes for patients and nurses respectively (Kramer & Schmalenberg, 2005; Sidani, Doran, & Mitchell, 2004). The presence of necessary structural elements, though most easily assessed and quantified, does not guarantee improvement in care quality. Quality is best assessed based either on the actual care processes or on the ultimate care outcomes produced. The relationship between structure and process, and structure and outcome is typically poorly defined (Donabedian, 1966).
In his article *Evaluating the Quality of Medical Care* (Donabedian, 1966), Donabedian details the advantages of considering outcome as a dimension of quality in medicine, stating that concrete outcomes of care are rarely questioned. He mentions however, that sometimes chosen outcomes may be so irrelevant or so heavily influenced by other outside factors (like severity of disease) as to be of little value in assessing quality improvement efforts. Though process measurements may be more relevant in some cases, they are often more difficult to define and can be less concrete and stable. In this investigation of the impact of nurse Magnet certification on quality of care, patient outcome was chosen as the ultimate causal result of the studied structural alteration. Relevant nursing-sensitive dependent outcome variables and additional confounding variables were included in an attempt to address potential weaknesses of this approach.

Though the linear Donabedian SPO framework was employed as the basis for this research, the complexity of the interactions was considered. Sidani et al. emphasized the influence and interaction of patient and healthcare professional characteristics with typical organizational characteristics (like staff mix and nursing hours per day) on the processes of care and the resulting outcomes (Sidani et al., 2004). Diverging somewhat from the classic SPO theory, these investigators, along with Mitchell and her co-authors (Mitchell, Ferketich, & Jennings, 1998), emphasized the complex, sometimes non-linear and dynamic system in which healthcare is rendered.

**Significance**

In these challenging times, as healthcare resources must stretch to cover an additional 32 million lives, it is critical to support only those value-added programs that
ultimately are proven to improve the safety, quality, and effectiveness of patient care.
The process of Magnet designation often requires a complete cultural transformation of
the healthcare environment over a period of 4-5 years (Upenieks & Sitterding, 2008). In
addition to the extensive non-monetary resources directed toward this effort, Wagner
estimated that in 2004 dollars the total direct costs surpassed $50,000 (Wagner, 2004).
Given the demands, re-certification may be even more resource intensive.

If Magnet hospitals provide safer and more effective care as determined by global
and especially nursing-sensitive patient outcome measures a clear moral and business
case can be made for the pursuit of Magnet designation as well as for the ongoing support
of the core nurse-centered culture and environment. Understanding this cause and effect
will allow more thoughtful allocation of healthcare resources. Additionally, the decision
process will be aided by the knowledge of which hospital characteristics result in more
dramatic patient outcome improvements following Magnet designation and which
specific patient outcome measures are most impacted. Those facilities destined to gain
less from the transformation may choose to direct their resources elsewhere.
CHAPTER 2:

LITERATURE REVIEW

Introduction

Donabedian’s structure-process-outcome paradigm, as applied to the organizational characteristics resulting from nurse Magnet designation, may be considered to imply two outcomes. One result is the production of an improved nursing environment that many consider critical to the provision of high quality patient care. Another outcome that impacts healthcare quality more directly is a decrease in complications or adverse events related to care. This outcome stands as the ultimate manifestation of both structure and process working in tandem in the setting of a conducive nursing environment.

Nurses in United States’ hospitals are the primary on-site caregivers. Among other duties, they are responsible for patient surveillance and proactive treatment when clinical decline is recognized. They must not only diagnose medical deterioration but also immediately respond through direct action and through effective communication with co-workers and physicians. At the time the original Magnet facilities were so designated, hospitals were experiencing a profound nursing shortage (Janiszewski Goodin, 2003; Murray, 2002). Nurse recruitment and retention were critical issues. It was recognized that in a select group of U.S. hospitals the nursing workforce was highly
stable, satisfied and productive. Profiling these ideal nursing environments led to the characterization and recognition of the initial 41 Magnet hospitals under the assumption that attracting and maintaining committed nurses was an effective means of assuring high quality patient care.

Though the focus at that time was squarely on recruiting and retaining nurses, not improving the quality of patient care, some early research had begun to document the relationship between hospital characteristics (such as adequate nurse staffing and nurse skill level) and patient care outcomes. After the 1996 publication of *Nursing Staff in Hospitals and Nursing Homes: Is It Adequate?* By The Institute of Medicine (Wunderlich, Sloan, & Davis, 1996) a significant body of work was produced that supported the underlying contention that positive nursing features improve patient outcome. The initial Magnet research was conducted based on this premise. A number of studies focused on the impact of organizational characteristics on nurse outcomes assuming these directly correlated with patient outcomes. Until very recently few investigators assessed patient outcomes as the critical, more direct end product of Magnet structure and process.

**The Influence of Nurse Staffing and Education on Patient Care Outcomes**

Despite the relative paucity of research relating Magnet structure and all its components directly to patient care outcomes, there is a substantial body of literature correlating the level of nurse staffing, and nurse education with these outcomes. The correlation expressed in early reports was typically only a by-product of the results obtained as other aspects of hospital structure and process were researched. Most
investigations provide a consistent message; there exists an inverse relationship between these nursing care characteristics and mortality and failure-to-rescue rates, and to a lesser degree, more specific complications of care or adverse events. The evidence basis for this relationship is weakened by the retrospective, cross-sectional design of most of these studies, the utilization of hospital-level staffing data and the lack of a unit-level focus, and the likely presence of omitted yet impactful variables. Despite this, in 2007 Kane and co-authors published an Agency for Healthcare Research and Quality (AHRQ) commissioned meta-analysis concluding that there exists “a statistically and clinically significant association between RN staffing and adjusted odds ratio of hospital related mortality, failure to rescue, and other patient outcomes” (Kane, Shamliyan, Mueller, Duval, & Wilt, 2007, p. 1202). The authors were unable to attribute causality.

In a study published in 1994, Aiken utilized a multivariate matched sampling procedure and reported on the relationship between RN staffing and skill level, and 30-day case mix adjusted Medicare mortality rates in 39 Magnet hospitals compared with 195 non-Magnet control hospitals (Aiken et al., 1994). The Magnet hospitals had a 4.6% lower adjusted mortality rate than the control institutions. Though the authors clearly focused on the impact of what they termed “the organization of nursing care” (Aiken et al., 1994, p. 784), the Magnet hospitals exhibited a higher nurse to patient ratio (1.6 versus 1.2) and a greater ratio of RN staff to total nurses (0.8 versus 0.6).

Similarly, in two studies focused on post-surgical patients Silber et al. noted an inverse relationship between RN staffing and mortality, as well as failure to rescue. In their first study, the authors measured the relative contributions of patient and hospital characteristics on variations in patient care outcomes following simple general surgery
procedures (Silber, Rosenbaum, & Ross, 1995). They found that patient characteristics most strongly predicted variations in rates of in-hospital death, serious complications after admission, and death following those complications however nurse staffing did predict mortality and failure to rescue rates to some degree. Interestingly, there was no correlation between patient outcomes and hospital characteristics. In their second publication, designed to determine the relative value of the involvement of the anesthesiologist in the provision of anesthesia services for Medicare patients undergoing orthopedic or general surgery procedures, the single most important hospital factor leading to lower mortality and lower failure to rescue rates was a higher registered nurse to bed ratio (Silber et al., 2000).

In an investigation designed to evaluate reasons for regional variation in Medicare hospital mortality, Manheim et al. found that a small but significant decrease in severity-adjusted Medicare mortality rates could be attributed to hospital characteristics, one of which was increased numbers of RN’s (Manheim, Feinglass, Shortell, & Hughes, 1992). The authors attributed the majority of the variation to regional differences.

The Institute of Medicine’s (IOM) report Nursing Staff in Hospitals and Nursing Homes: Is It Adequate? Released in 1996 (Wunderlich, Sloan, & Davis, 1996) called attention to the need to better understand the impact of nursing staff levels and nurse skill mixes on the quality of patient care rendered. The report emphasized that there did not yet exist an empirical basis for linking nurse staffing and skill with patient care outcomes. Prior to publication of this report, most studies that addressed nursing characteristics did so in an indirect manner, as an offshoot of another research question. The IOM’s call to action stimulated new studies focused specifically on this issue. A number of
investigators performed studies documenting a significant association between overall nurse staffing level and improved patient outcome (Aiken, Clarke, Sloane, Sochalski, & Silber, 2002; Aiken et al., 1999; Kovner & Gergen, 1998; Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2002; Sovie & Jawad, 2001; Stone et al., 2007; Whitman, Kim, Davidson, Wolf, & Wang, 2002). The improvements were most often demonstrable in rates of mortality and failure to rescue and least apparent in avoidance of adverse events and complications (Lankshear, Sheldon, & Maynard, 2005; Mark, Harless, McCue, & Xu, 2004).

Aiken and co-authors linked data obtained from staff nurse surveys, discharge data for patients who underwent general, vascular or orthopedic surgery, and administrative data from 168 Pennsylvania acute care general hospitals to determine the relationship between nurse staffing and risk-adjusted 30 day mortality and failure to rescue rates (Aiken et al., 2002). Though their ability to derive conclusions was necessarily compromised by the fact that pooled, hospital-level staffing data was not associated with patient data, they did report a significant inverse relationship between nurse staffing and these two outcome measures. A patient’s risk of dying within 30 days of discharge was estimated to be 7% higher for each additional patient per nurse. Others determined that this association with improved patient outcomes was not linear but rather curvilinear in terms of both increased nurse numbers (Mark et al., 2004) and percentage of nurses (Blegen & Vaughn, 1998). Kane and co-authors determined that as the number of nurses increased there were diminishing marginal returns (Kane et al., 2007).

Studies from nursing literature comparing performance of nurses with a baccalaureate degree (BSN) to those nurses with an associate degree or a diploma found
that nurses with a BSN were more likely to demonstrate professional behaviors critical to
effective nursing care like communication and complex problem solving (DeBack &
Mentkowski, 1986; Johnson, 1988). Several retrospective cross-sectional studies have
noted the value of nursing skill, as determined by education level achieved, in providing
quality patient care (Aiken, Clarke, Cheung, Sloane, & Silber, 2003; Blegen & Vaughn,
1998; Estabrooks, Midodzi, Cummings, Ricker, & Giovannetti, 2005; Hall, Doran, &
Pink, 2004; Lichtig, Knauf, & Milholland, 1999; Needleman et al., 2002; Person et al.,
2004; Tourangeau et al., 2007; Tourangeau, Giovannetti, Tu, & Wood, 2002). Utilizing
the same combination of survey, administrative, and discharge data from their previous
study (Aiken et al., 2002). Aiken et al. reported that a 10% increase in the ratio of nurses
educated at the baccalaureate level translated to a 5% decrease in 30 day mortality and
failure to rescue (Aiken et al., 2003). The authors emphasized that absolute nurse
numbers represented only one important structural component needed for quality care.
Educational background and resulting skill level were also critical to patient outcome.
This point was again emphasized by Aiken and co-authors in a third publication based on
a similar but unique and much larger collection of administrative, nurse survey, and
discharge data (Kendall-Gallagher, Aiken, Sloane, & Cimiotti, 2011). In this study the
authors sought to determine whether nurse specialty certification impacted mortality or
failure to rescue rates. They found that the presence of nurses with additional
certification was associated with improved outcomes but only if the nurse also had a
baccalaureate education.

Though the relationship between nurse education and improved patient outcome
is well supported in the literature, a similar role for nurse experience has not been
demonstrated. In fact, Aiken and co-authors have repeatedly shown that 30-day mortality and failure to rescue rates do not vary with nurse experience (Aiken et al., 2003; Kendall-Gallagher et al., 2011). In their words “the conventional wisdom that nurses’ experience is more important than their educational preparation may be incorrect” (Aiken et al., 2003, p. 1622).

Lankshear and co-authors published a systematic qualitative review of research linking staffing level and education level of nurses to mortality, failure-to-rescue, complications of patient care, adverse events, and patient satisfaction (Lankshear et al., 2005). They emphasized that like those studies just discussed, the majority of authors utilized large diverse databases, making their results more readily generalizable but less precise. Data detailing nurse staffing included not only nurse caregivers but also nurse administrators. Typically, no distinction was offered. Additionally, hospital-wide rather than unit-specific staffing numbers were utilized, potentially incorrectly estimating the impact of nursing in some units. Inadequate adjustment for case mix severity markedly impacted results, typically overestimating the influence of nursing on outcome (Aiken et al., 2002). Finally, most studies adjusted only minimally for hospital characteristics, failed to include data on other caregivers who impact variation in patient outcomes, and assumed quality of care was static, all of which contribute to omitted variable bias (Aiken et al., 2003; Aiken et al., 2002; Kovner & Gergen, 1998).

By allowing hospitals to serve as their own controls, two longitudinal studies better addressed the issue of omitted variable bias. Mark and co-authors confirmed findings by other authors and provided clear evidence that increasing nurse staffing is likely to reduce mortality but may or may not lessen the incidence of complications
(Mark et al., 2004). However Unruh et al. found an association between licensed nurse staffing and nursing-sensitive complications and adverse events like falls, decubitus ulcers, atelectasis, and urinary tract infections (Unruh, 2003).

Similar to the conclusions of Kane and co-authors (Kane et al., 2007), Lankshear noted a consistent array of results despite weaknesses and variability in the studies evaluated. Nurse staffing was inversely correlated with mortality and failure to rescue. A similar but less consistent inverse correlation was noted between nurse staffing and complications of care. The lack of consistency was attributed to poorer reporting of complications compared with mortality and failure to rescue. This pattern of results was noted to be more prominent in relation to RN staffing levels compared with LPN staffing levels.

In the final assessment, the body of research tying nurse staffing and nurse education to improved patient care outcomes does not establish definitive causality but it is highly suggestive. The consistent message is that greater levels of nurse staffing, especially if the nurses are educated at the baccalaureate or masters level, translates to improved patient care outcomes. The degree of marginal improvement is dependent on the staffing level.

**Organizational Structure and Nurse Outcomes**

Three factors led to a concentration of research efforts designed to determine nurse outcomes in Magnet hospitals:

1. The initial and underlying Magnet focus on nurse recruitment and retention.
2. The general belief in the critical importance of nursing to the provision of quality patient care.

3. The documented beneficial relationship between the nursing characteristics and patient care outcomes.

Aiken et al. listed the common organizational features in the original 41 Magnet hospitals “that promoted and sustained nursing practice, including flat organizational structures, unit-based decision making processes, influential nurse executives, and investments in the education and expertise of nurses” (Aiken, Havens, & Sloane, 2000). Through nurse survey instruments, these authors compared 7 facilities designated by the ANCC in the 1990’s as Magnet hospitals with 13 of the original Magnet hospitals in an unmatched manner to determine whether the more recently designated hospitals embodied the same organizational attributes as those originally designated (Aiken et al., 2000, p. 27). The results indicated not only maintenance of these attributes but also improvement in burnout rates, job satisfaction, and nurse rating of care quality for the ANCC certified group.

A survey study of more than 3,000 registered nurses in 11 states utilized a validated instrument, the Individual Workload Perception Scale (IWPS), to assess workload, satisfaction and intent to stay for nursing staff in Magnet, Magnet-aspiring (documented intent to pursue Magnet status), and non-Magnet hospitals (Lacey et al., 2007). Mean scores on all subscales of the IWPS were significantly higher for Magnet hospitals than for the others. Magnet-aspiring hospitals had better mean scores than non-Magnet hospitals. The authors concluded that the ANCC’s Magnet designation process had achieved its goal of creating the needed practice environment for nursing.
Kelly et al. utilized 2006-2007 survey data from 26,276 nurses working in 567 hospitals located in four states to compare work environments in 46 Magnet hospitals with those in 521 non-Magnet hospitals (Kelly et al., 2011). Work environment was specifically assessed using the validated Practice Environment Scale of the Nursing Workforce Index (PES-NWI) (Eileen T Lake, 2002). Magnet facilities were found to have a greater nurse to patient ratio and a more educated nursing staff. Nurses working in Magnet hospitals were 18% less likely to be dissatisfied with their jobs and 13% less likely to express burnout. These authors confirmed the findings noted in several other investigations, Magnet hospitals present a significantly better work environment for nurses compared with non-Magnet hospitals (Aiken, Buchan, Ball, & Rafferty, 2008; Hess et al., 2011; Eileen T Lake & Friese, 2006; Ulrich, Buerhaus, Donelan, Norman, & Dittus, 2007).

In one of these studies conducted by Ulrich et al., the work environment was better in the hospitals actively seeking Magnet designation than in those hospitals already designated (Ulrich et al., 2007). The authors stressed that maintaining the comparative advantage for Magnet hospitals was challenging. They posed the question “How long do the positive results of attaining Magnet recognition last?” and emphasized that in order to answer this question, longitudinal studies were required (Ulrich et al., 2007, p. 219). Hess and co-investigators reported the results of the 2010 National Survey of Registered Nurses (Hess et al., 2011). They also found that Magnet designation, along with the process of achieving that designation, improved nurse work environments. However, in terms of career satisfaction, relationships with physicians and other nurses, and opportunities to influence decisions about patient care the distinction made between
environments within Magnet, Magnet in-process and non-Magnet facilities was not significant. The authors considered that potentially the five Magnet model components; transformational leadership, exemplary professional practice, structural empowerment, new knowledge, innovation and improvement, and empirical quality results had permeated professional organizations or other outside bodies thereby influencing even non-Magnet facilities. To this point, in his review of the trends seen through review and assessment of the biennial 2002-2008 National Survey of Registered Nurses, Buerhaus stated that nursing environments in general were steadily improving (Buerhaus, DesRoches, Donelan, & Hess, 2009).

A subset of studies assessed the work environment in Magnet hospitals but found no significant advantage over non-Magnet hospitals. One such study utilized survey data from 837 nurses practicing in 171 general acute care hospitals (14 of which were Magnet hospitals) in 2 states (Trinkoff et al., 2010). A variety of measures of nurse practice environment were utilized including questions related to “autonomy, support, perceived patient safety culture, and job satisfaction, along with items from the Nursing Work Index Revised (NWI-R), the Job Content Questionnaire support domain, the Patient Safety Center of Inquiry Culture Survey, and the Hospital Survey on Patient Safety Culture” (Trinkoff et al., 2010, p. 311). Though nurses did report workplace differences between Magnet and non-Magnet hospitals those differences were minor.

**Organizational Structure and Patient Care Outcomes**

The majority of the research cited above provides evidence that improvement in nursing workforce factors is associated with better patient outcomes and that these
workforce attributes are enhanced in Magnet designated hospitals. Despite the seemingly self-evident connection between achievement of nurse Magnet structure and improved patient outcomes, only recently have investigators begun to attempt measurement of patient outcomes as a function of hospital Magnet status.

The two primary exceptions are studies that evaluated mortality rates in original Magnet hospitals. In the first study, 39 of the 41 original Magnet hospitals were compared with 195 non-Magnet hospitals (Aiken et al., 1994). Multivariate matched sampling allowed for control of most organizational differences between the two groups of hospitals. However, the authors found that the Magnet hospitals did differ significantly from their matched control facilities based on a higher proportion of registered nurses to total nursing personnel, and to a lesser degree, based on an increased nurse to patient ratio. A more thorough comparison of the groups along other nursing organizational dimensions was not possible due to data limitations. Following predicted mortality adjustments, Magnet hospitals were noted to have a 4.6% lower 30-day mortality rate for Medicare patients than non-Magnet hospitals. In the second study, 30 day mortality for patients with AIDS was less if the patient was treated in either a dedicated AIDS unit or a Magnet hospital (Aiken et al., 1999).

Carlton utilized secondary data to assess patient outcomes and to determine whether the rates of hospital-acquired complications were different for Magnet, Magnet-aspiring and non-Magnet hospitals (Carlton, 2009). He included data on 779 hospitals from 5 states (predominantly California), 8% of which were Magnet facilities and 2% of which were Magnet-aspiring hospitals. Results varied based on the outcome measured. Magnet hospitals were noted to have statistically lower rates of central nervous system
disorders, pneumonia, urinary tract infections, and pressure ulcers. By contrast, non-Magnet hospitals had statistically lower rates of deep vein thrombosis and pulmonary embolism, failure to rescue, pulmonary failure, sepsis, and surgical wound infections.

A report examined the rate of nosocomial infections in critical care units using data derived from the National Database of Nursing Quality Indicators (NDNQI) (Scott 2010). The author found that despite Magnet designated hospitals having a higher percentage of nurses with a baccalaureate level education, more total nursing hours per patient day and higher job satisfaction scores, there was no significant difference in hospital-acquired infection rates. Lake et al. also utilized NDNQI data and included 108 Magnet hospitals and 528 non-Magnet hospitals (Lake, Shang, Klaus, & Dunton, 2010). They chose patient falls as the outcome variable of interest due to its inclusion as a nursing care performance indicator by the National Quality Forum (NQF). The authors found a 5% lower fall rate in Magnet facilities compared with non-Magnet hospitals.

Hickey and co-authors evaluated pediatric mortality following congenital heart surgery at Magnet and non-Magnet facilities (Hickey et al., 2010). Chief nursing officer verified staffing data was obtained from the National Association of Children’s Hospitals and Related Institutions and combined with 2005-2006 patient data garnered from the Pediatric Health Information System representing 38 children’s hospitals. Intensive care unit worked nursing hours differed widely among the institutions studied and nursing skill mix was significantly higher for non-Magnet institutions. Despite such variation in nursing characteristics these differences were not associated with mortality rate. Magnet designation did not correlate with lower risk-adjusted mortality rates.
Two recent studies exemplify the inconsistent findings noted when patient outcomes are evaluated as a function of Magnet status. Goode and co-authors employed hospital level data from adult acute care facilities that were members of the University HealthSystem Consortium (Goode et al., 2011). They quantified nurse staffing characteristics, separating out productive versus non-productive worked hours. The rates of risk-adjusted patient outcomes known to reflect the quality of nursing care and consistent with patient safety indicators and inpatient quality indicators developed by the AHRQ were utilized. These variables included in-hospital mortality rates for congestive heart failure as well as for myocardial infarctions, failure to rescue, hospital-acquired pressure ulcers, infections resulting from medical care, post-operative sepsis, and length of stay. A statistically significant increased number of nursing hours per patient day on general wards was noted for non-Magnet facilities and a statistically significant greater nursing skill mix was also seen for non-Magnet hospitals both on the general wards and in the intensive care units. Importantly, except for the rate of pressure ulcers, non-Magnet hospitals generated significantly better patient outcomes, including lower rates of infections, post-operative sepsis, and post-operative metabolic derangement. There was no statistically significant difference in mortality or failure to rescue rates between the two groups of hospitals. When multivariate analysis was used and other variables known to impact patient outcome were included, like nursing characteristics, the only significantly higher complication rates in Magnet hospitals were for post-operative sepsis and post-operative metabolic derangement.

In what seemed like a direct response to Goode’s study, McHugh et al. investigated risk-adjusted 30 day mortality and failure to rescue rates in Magnet and non-
Magnet hospitals (McHugh et al., 2012). The authors linked data from 3 sources: surveys sent to more than 100,000 registered nurses in 4 states (nursing-related measures), the annual American Hospital Association survey (structural characteristics of adult general acute care hospitals), and hospital discharge data for patients ages 21-85 who underwent orthopedic, general or vascular surgery (patient care outcomes). Hospital characteristics differed for the two groups of hospitals, and based on the Practice Environment Scale of the Nursing Work Index (PES-NWI) Magnet hospitals presented a better work environment for nurses. Education level was significantly higher and nurse staffing showed a non-significant trend favoring Magnet hospitals. Though these nursing characteristics clearly impacted mortality, controlling for nursing and hospital differences, the surgical patients treated in Magnet hospitals still had 14% lower odds of mortality and 12% lower odds of failure to rescue. The authors point to a “Magnet advantage in patient outcomes beyond measurable features of nursing” (McHugh et al., 2012, p. 6).

The existence of a “Magnet advantage” in the avoidance or effective treatment of adverse events and patient care complications is not clear based on the published research to date. The studies cited above reached varying conclusions. Though it seems clear that hospitals designated as Magnet facilities present a better work environment for nurses and that nurse characteristics are key drivers of quality patient care, the direct association of Magnet structure, and the so called “Magnet advantage,” with improved patient outcomes over and above greater nurse staffing and skill level has not been proven.
CHAPTER 3: METHODS

Introduction

This chapter details the research methods utilized to empirically answer the research questions. The research objectives are re-stated. Hypotheses are outlined based on conclusions drawn from the literature review. The data utilized in the analysis is fully described and the variables are defined. Finally, the research design and data analysis are discussed.

Research Objectives

The primary purpose of this investigation is to determine whether the adoption of the structural and process elements that lie at the core of nurse Magnet designation translate into improved patient-level outcomes in a relatively homogeneous group of academic medical centers. In accordance with this purpose, the following four primary research questions were posed:

1. Is there a significant longitudinal change in global or nursing-sensitive outcome measures after attainment of initial nurse Magnet designation within United States academic medical centers?

   a. Which outcome measures are most sensitive to the organizational structure and nursing processes required for successful nurse Magnet designation?
2. Does hospital size impact the changes noted in patient care outcomes following initial nurse Magnet designation?

3. Does the level of a hospital’s clinical activity impact the changes noted in patient care outcomes following initial nurse Magnet designation?

4. Does the level of disease severity and the complexity of care provided by a hospital impact the changes noted in patient care outcomes following initial nurse Magnet designation?

**Hypotheses**

Nurses are the primary care givers; they are responsible for surveillance and proactive intervention. They function as in-hospital advocates for patients. It makes intuitive sense that nursing excellence is a critical ingredient either directly or indirectly for the attainment of high quality patient outcomes. Though authors are not unanimous, the majority of the empirical studies to date support this supposition. Similarly, it seems plausible that more and better nurses would be attracted to institutions that establish a nursing structure based on transformational nurse leaders who empower staff nurses and establish environments that support nursing goals and professional growth. Except for a small subset of studies, the literature supports this assumption as well.

Empirical investigations tying nursing structure directly to patient outcome are fewer in number and their conclusions less definitive. Results vary based on the outcome measure evaluated. In the current literature, global patient outcome measures, like mortality and failure to rescue, are more often shown to be influenced by the structures and processes linked with nurse Magnet facilities. This may be a product of cross
sectional pooled data without the sensitivity and precision provided by a discrete hospital or unit focus. In Goode’s study performed on academic medical center members of the UHC comparing Magnet with non-Magnet facilities, mortality from acute MI’s or CHF was not statistically different yet differences were found when nursing-sensitive outcome measures were investigated (Goode et al., 2011).

In this current longitudinal analysis of specified UHC member institutions, the impact of nurse Magnet certification on global outcomes is likely to be low and the impact on nursing-sensitive outcome measures is expected to be much greater in comparison with the majority of published studies.

Hypothesis 1.0: There is no statistical improvement in global outcome measures associated with initial Magnet designation in academic medical centers.

Hypothesis 1.1: Nursing-sensitive outcome measures are significantly improved following initial nurse Magnet designation in academic medical centers.

Several authors of contemporary studies have found little difference between the nursing environments within Magnet versus non-Magnet hospitals (Buerhaus et al., 2009; Hess et al., 2011; Trinkoff et al., 2010). They have suggested that much of the Magnet structure and process has permeated the professional organizations and regulatory bodies resulting in Magnet-like environments and a steady improvement in patient care and therefore a steady decline in complications of care and adverse events.

Hypothesis 1.2: Patient care outcome measures improve over time in academic medical centers that strive for and achieve nurse Magnet designation.
Multiple investigators have shown that the total volume of (surgical) services provided in a given hospital is inversely related to mortality rates for those or similar services and procedures. Though some authors attribute this relationship to individual physician volumes (Sloan, Perrin, & Valvona, 1986), most consider it a hospital-level finding (Kelly & Hellinger, 1986). By necessity, increased service volumes may result in the development of care processes that are more efficient and provide more consistently positive patient care outcomes.

Though greater clinical activity within a given hospital appears advantageous, a number of investigators have shown that the absolute size of a hospital, as determined by bed number or number of hospital admissions, is not associated with better patient outcome. In fact, hospital size has been positively correlated with increased mortality rates in several studies (Flood, Scott, & Ewy, 1984a, 1984b; Kelly & Hellinger, 1986; Luft, Bunker, & Enthoven, 1979; Sloan et al., 1986). As of yet, no information has been produced to suggest that a hospital’s clinical activity or size impacts changes in patient outcome measures that result from the installation of the structures and processes required for nurse Magnet designation.

Despite this lack of empiric support, busy hospitals may possess less margin for improvement whereas large hospitals might be more likely to demonstrate gains in patient care outcome following the establishment of nurse Magnet systems. Because the largest facilities tend to be the busiest, the two organizational characteristics taken together may obscure these influences.
It seems plausible that improvements in the structure and process of care through nurse Magnet designation will more dramatically impact facilities caring for sicker patients and patients requiring more complex care. Simply put, there may be more to gain in the treatment of this patient population. However, patient-specific disease severity, modeled as case mix index, is known to be the most influential variable when assessing outcomes of care. It seems most probable that the nursing care enhancements brought about by nurse Magnet designation will be overwhelmed by the many challenges associated with care of critically ill patients and in that way obscure the improvement in outcome that might otherwise have been appreciated. Neither potential association has been investigated relative to initial nurse Magnet certification.

Hypothesis 2.0: Improvement in patient care outcome measures following initial nurse Magnet designation in academic medical centers is not modified when hospital size, clinical activity, and complexity of care are considered together as confounding variables.

Hypothesis 2.1: Improvement in patient care outcome measures following initial nurse Magnet designation in academic medical centers is modified by hospital size.

Hypothesis 2.2: Improvement in patient care outcome measures following initial nurse Magnet designation in academic medical centers is modified by the level of clinical activity.
Hypothesis 2.3: Improvement in patient care outcome measures following initial nurse Magnet designation in academic medical centers is modified by complexity of care.

**Description of the Data**

The hospital-level data utilized in this investigation was acquired from two secondary sources, the American Nurses Credentialing Center (ANCC) and the University Health Consortium (UHC). The databases were merged to isolate one study group, UHC member Magnet designated hospitals.

*American Nurses Credentialing Center*

The American Nurses Credentialing Center (ANCC) is a subsidiary of the American Nurses Association (ANA). The ANCC functions as the credentialing body for the nurse Magnet program. Its goals are “to promote quality in a setting that supports professional practice, identify excellence in the delivery of nursing services to patients, and disseminate best practices in nursing services.” ([http://www.nursecredentialing.org/Magnet/ProgramOverview](http://www.nursecredentialing.org/Magnet/ProgramOverview)). The list of Magnet designated hospitals and their date of initial certification was garnered from the website ([http://www.nursecredentialing.org/FindaMagnetHospital.aspx](http://www.nursecredentialing.org/FindaMagnetHospital.aspx)) and recorded.

*University Health System Consortium*

The University Health System Consortium (UHC) is a member organization composed of 119 academic medical centers and 293 of their affiliated hospitals. The member institutions self-report data quarterly in the following areas: clinical, operational,
financial, and supply chain. This information is available for comparative analysis by group members following protocol submission and approvals.

Specific hospital characteristics related to rural versus urban setting, teaching status, size, clinical activity, and complexity of patient disease and care were identified from the 2013 UHC database for the Magnet hospitals studied. This included the following variables:

1. Rural versus urban location
2. American Association of Medical Colleges (AAMC) teaching hospital status
3. Staffed bed number
4. Rate of In-patient discharge per staffed bed
5. Centers for Medicare & Medicaid Services case mix index (CMI)
6. Number of surgical Intensive Care Unit admissions
7. Number of solid organ transplant procedures
8. Number of open-heart surgical cases
9. Number of surgical procedures required for the treatment of traumatic injuries

Patient care outcome data was recorded for each study hospital from 2002 through 2012. Specifically, in-hospital morbidity, complications of care and adverse outcome occurrences, as well as hospital re-admissions were recorded before and after initial Magnet designation was granted. Ten outcome measures were chosen for three primary reasons. First, specific variables were incorporated based on their inclusion in relevant past research studies. Second, outcome measures were chosen based on previously described sensitivity to the quality of in-hospital nursing services as determined by their
presence as National Quality Forum consensus standards for nursing-sensitive care indicators or AHRQ patient safety or quality indicators. Third, variables had to be consistently reported by UHC member institutions and accessible over the study period.

These outcome variables were categorized into four global and six nursing-sensitive measures. Global variables were defined as those that represented not just the quality of nursing care but also the overall excellence of care within the facility. Though nursing services were thought to directly impact these measures on occasion, more often the impact was considered to be indirect. Nursing-sensitive patient care outcome measures were so defined based on their ability to more precisely measure the performance of nursing relative to the delivery of quality in-hospital health care and to be utilized effectively to guide nursing-related quality improvement efforts (Needleman, Kurtzman & Kizer, 2007). The following ten outcome variables were recorded for patients 18 years of age and older. Values were expressed as rates per quarter:

**Global Outcome Variables**

1. In-hospital mortality from acute myocardial infarction – AHRQ Quality Indicator
2. In-hospital mortality from congestive heart failure – AHRQ Quality Indicator
3. Failure to rescue – AHRQ Patient Safety Indicator
4. Re-admission

**Nursing-Sensitive Outcome Variables**

5. Pressure ulcer – AHRQ Patient Safety Indicator
6. Infection due to medical care / CVC bloodstream infection – AHRQ Patient Safety Indicator

7. Post-operative deep vein thrombosis / pulmonary embolus – AHRQ Patient Safety Indicator

8. Post-operative sepsis – AHRQ Patient Safety Indicator

9. Post-operative physio-metabolic derangement – AHRQ Patient Safety Indicator

10. Post-operative respiratory failure – AHRQ Patient Safety Indicator

Variable Definitions

Organizational Variables

Magnet designation – binary variable. The ANCC awards Magnet designation to a select group of hospitals on the basis of nursing excellence, innovation in nursing care, and quality patient care. There are currently 395 Magnet designated facilities. For the purposes of this study, nurse Magnet hospitals are those facilities currently recognized on the ANCC listing. Hospitals were recorded as either Magnet designated or non-Magnet facilities and their date of initial certification recorded.

Rural versus urban – binary variable. Facilities were categorized as urban based on a service population of 50,000 or greater.

Teaching status – binary variable. Teaching hospitals were so designated by the Association of American Medical Colleges.
**Staffed bed number – continuous variable.** The number of hospital beds being utilized for direct patient care represents the size of the facility. It is a hospital characteristic that has been found to impact quality of care (Estabrooks et al., 2005).

**In-patient discharges per staffed bed – continuous variable.** The number of medical and surgical patients discharged from the facility divided by the number of staffed beds. This variable represents the level of clinical activity in each facility.

**Case mix index – continuous variable.** The Case Mix Index (CMI) is assigned by the Centers for Medicare & Medicaid Services (CMS) based on Medicare Severity-Diagnosis Related Groups (MS-DRG’s). It represents complexity of care through diagnoses, age, procedures performed, the presence of co-morbidities and/or complications, discharge status, and gender. By characterizing the population of patients treated, Case Mix Index provides an estimate of the relative cost or resources required for care.

**Surgical intensive care unit admissions – continuous variable.** This variable represents the number of patients that require admission to an intensive care unit following surgery. It serves as a marker for patient disease severity and for the complexity of surgical care provided.

**Solid organ transplants – continuous variable.** Solid organ transplant number was determined based on the following five International Classification of Diseases (ICD-9) procedure codes: 1) 37.5 and 37.51 (heart), 2) 55.6.x (kidney), 3) 50.5.x (liver), 4) 33.5 and 33.6 (lung), and 5) 52.8.x (pancreas). Solid organ transplant number serves as a marker for patient disease severity and for the complexity of surgical care provided.
Open-heart surgical cases – continuous variable. This variable includes all surgical cases defined by the ICD-9 procedure code 39.61 (extracorporeal circulation auxiliary to open-heart surgery). The number of open-heart surgical cases serves as a marker for patient disease severity and for the complexity of surgical care provided.

Trauma surgical cases – continuous variable. The number of trauma surgical cases is based on a scheme adopted by the National Trauma Databank under the auspices of the American College of Surgeons. It includes all surgical cases associated with any trauma diagnosis code (ICD-9 codes 800-959.xx) but excluding isolated injuries defined by the ICD-9 code ranges 905-909.9, 910-924.9, and 930-939.9. The number of such trauma-related surgical procedures serves as a marker for patient injury severity and for the complexity of surgical care provided.

Patient Care Outcome Measures

In-hospital mortality rate from acute myocardial infarction – continuous variable. (http://www.qualityindicators.ahrq.gov/Downloads/Modules/IQI/V31/iqi_guide_v31.pdf)

This was considered a global outcome variable. Decreased mortality rate for acute myocardial infarction (MI) has been linked to better processes of care. The numerator of this variable represents the number of deaths in the hospital caused by an acute myocardial infarction and meeting the inclusion and exclusion criteria for the denominator. The denominator includes all patients with a principle diagnosis code of heart failure. The exclusion criteria include:

1. Transfers from another short-term hospital
2. Major Diagnostic Category (MDC) 14 (pregnancy, childbirth, and puerperium)

*In-hospital mortality rate from congestive heart failure – continuous variable.*

(http://www.qualityindicators.ahrq.gov/Downloads/Modules/IQI/V31/iqi_guide_v31.pdf)

This was considered a global outcome variable. The numerator represents the number of deaths in the hospital attributable to congestive heart failure (CHF) and meeting the inclusion and exclusion criteria for the denominator. The denominator includes all patients with a principle diagnosis of heart failure. The exclusion criteria include:

1. Transfers from another short-term hospital
2. MDC 14 (pregnancy, childbirth, and puerperium)

*Failure to rescue rate – continuous variable.*  (http://www.qualityindicators.ahrq.gov/downloads/modules/psi/v30/psi_technical_specs_v30.pdf)

This global outcome variable is a measure of hospital quality that focuses on a facility’s ability to respond to complications or adverse events and avoid patient death. Failure to rescue represents effectiveness of patient monitoring as well as actions taken once early complications are recognized. Because failure to rescue is less influenced by patient factors than complication rates or mortality, it has been found to be less sensitive to errors in patient disease severity resulting from poor accounting (Silber, Williams, & Krakauer, 1992; Silber, Rosenbaum, & Ross, 1995; Silber, Romano, Rosen, Wang, Even-Shosham, & Volpp, 2007). The numerator includes all discharges with the disposition of deceased and meeting the inclusion and exclusion criteria of the denominator. The denominator includes all patients with potential complications of care (e.g., pneumonia, DVT/PE,
sepsis, acute renal failure, shock/cardiac arrest, or GI hemorrhage/acute ulcer). Exclusion criteria include the following as well as exclusions specific to each diagnosis:

1. An age of 75 years and older
2. Transferred to or from an acute care facility
3. Admitted from a long-term care facility

_Re-admission – continuous variable._ This was considered a global outcome variable, not specific to nursing care. The numerator represents the number of patients discharged from the hospital and readmitted within 30 days. The denominator includes the total number of admissions eligible for readmission. Exclusion criteria include:

1. Death on index admission
2. Obstetrics service line
3. Chemotherapy and radiation therapy
4. Rehabilitation
5. Dialysis
6. Mental diseases and alcohol/drug use


This nursing-sensitive outcome variable includes all discharges with an ICD-9-CM code for decubitus or pressure ulcer in any secondary diagnosis field. The denominator includes all adult medical and surgical discharges defined by specific DRG’s. Exclusions are as follows:

1. Length of stay of less than 5 days
2. Principal diagnosis of pressure ulcer or secondary diagnosis present on admission
3. MDC 9 (skin, subcutaneous tissue, and breast)
4. MDC 14 (pregnancy, childbirth, and puerperium)
5. Any diagnosis of hemiplegia, paraplegia, or quadriplegia
6. Any diagnosis of spina bifida or anoxic brain damage
7. ICD-9-CM procedure code for debridement or pedicle graft before or on the same day as the major operating room procedure (surgical cases only)
8. Any diagnosis of stage I or stage II pressure ulcer
9. Transfer from an acute care hospital (different facility)
10. Transfer from a skilled nursing facility, intermediate care facility, or long-term facility
11. Transfer from another health care facility

_Infection rate due to medical care / CVC bloodstream infection – continuous variable._ (http://www.qualityindicators.ahrq.gov/downloads/modules/psi/v30/psi_technical_specs_v30.pdf)

This nursing-sensitive outcome variable details the number of patient discharges with selected infections defined by specific ICD-9 codes in any secondary diagnosis field. For discharges prior to October 1, 2007, hospital-associated infection diagnosis codes (999.3 and 996.62) were used. For discharges after October 1, 2007, central venous catheter-related blood stream infection diagnosis codes were added. The denominator includes all adult medical and surgical discharges defined by specific DRG’s. Exclusion criteria include:
1. A principal diagnosis of selected infections (as defined by the numerator) or secondary diagnosis present on admission

2. Length of stay less than 2 days

3. Any diagnosis or procedure code for an immunocompromised state

4. Any diagnosis code for cancer or an immunocompromised state

*Post-operative deep vein thrombosis / pulmonary embolus rate – continuous variable.*


For this nursing-sensitive outcome variable the numerator includes the number of discharges with ICD-9-CM codes for deep vein thrombosis (DVT) or pulmonary embolism (PE) in any secondary diagnosis field. The denominator includes all adult medical and surgical discharges defined by specific DRG’s and an ICD-9 code for an operating room procedure. Exclusions are as follows:

1. A principal diagnosis of deep vein thrombosis or pulmonary embolism or secondary diagnosis present on admission

2. A procedure for interruption of vena cava is the only operating room procedure

3. A procedure for interruption of vena cava occurs before or on the same day as the first operating room procedure.

4. MDC 14 (pregnancy, childbirth, and puerperium)
**Post-operative sepsis rate – continuous variable.**


For this nursing-sensitive outcome variable, the numerator includes the number of elective surgery discharges with ICD-9 codes for sepsis in any secondary diagnosis category. The denominator includes all elective surgical discharges defined by specific DRG’s and an ICD-9 code for an operating room procedure. Exclusion criteria include:

1. A principal diagnosis of sepsis or secondary diagnosis of present on admission
2. A principal diagnosis of infection or secondary diagnosis of present on admission
3. Any code for immunocompromised state or cancer
4. MDC 14 (pregnancy, childbirth, and puerperium)
5. Length of stay of less than 4 days

**Post-operative physio-metabolic derangement rate – continuous variable.**


This was considered a nursing-sensitive outcome variable. The numerator includes the number of discharges following elective surgical cases with ICD-9 codes for physiologic and metabolic derangements in any secondary diagnosis field or with ICD-9 codes for acute renal failure in any secondary diagnosis field and with an ICD-9 procedure code for dialysis. The denominator includes all elective surgical discharges defined by specific DRG’s and an ICD-9 code for an operating room procedure. Exclusion criteria include:
1. A principal diagnosis or secondary diagnosis present on admission of physiologic and metabolic derangements

2. A principal diagnosis code for chronic renal failure

3. The presence of acute renal failure and a procedure code for dialysis before or on the same day as the first operating room procedure

4. Ketoacidosis, hyperosmolarity, or other coma and a principal diagnosis or secondary diagnosis present on admission of diabetes

5. Acute renal failure and a principal diagnosis or secondary diagnosis present on admission of acute myocardial infarction, cardiac arrhythmia, cardiac arrest, shock, hemorrhage, gastrointestinal hemorrhage, or chronic renal failure

6. MDC 14 (pregnancy, childbirth and the puerperium)

7. MDC 4 (diseases and disorders of the respiratory system)

8. MDC 5 (diseases and disorders of the circulatory system)

Post-operative respiratory failure rate – continuous variable.


This was considered a nursing-sensitive outcome variable. The numerator includes the number of elective surgical discharges with ICD-9 codes for acute respiratory failure in any secondary diagnosis field or discharges with ICD-9 codes for the following:

1. Mechanical Ventilation for 96 consecutive hours after the first major operating room procedure
2. Mechanical Ventilation for less than 96 consecutive hours (or undetermined) two or more days after the first major operating room procedure

3. Reintubation – one or more days after the first major operating room procedure

The denominator includes all elective surgical discharges defined by specific DRG’s and an ICD-9 code for an operating room procedure. Exclusion criteria include:

1. A principal diagnosis of acute respiratory failure or secondary diagnosis present on admission

2. Any diagnosis code of neuromuscular disorder

3. If a procedure for tracheostomy is the only operating room procedure or takes place before the first operating room procedure.

4. When an esophageal resection procedure occurs

5. When a lung cancer procedure occurs

6. When a procedure for the nose, mouth and pharynx occurs

7. When a procedure for tracheostomy occurs before the first operating room procedure.

8. Any diagnosis code of craniofacial anomalies with a procedure code for laryngeal or pharyngeal surgery or a procedure on the face

9. Any diagnosis code of degenerative neurological disorder

10. MDC 14 (pregnancy, childbirth, and puerperium)

11. MDC 4 (diseases/disorders of respiratory system)

12. MDC 5 (diseases/disorders of circulatory system)
Research Design

The following section details the research design for this investigation. The sampling frame and data collection procedures are discussed first followed by statements defining the data analysis methods.

Sampling Frame

The initial study hospitals were obtained from the University HealthSystem Consortium’s active member directory. This relatively homogeneous list of facilities included current member organizations within the United States that were either academic medical centers or their affiliates. Self-reported data for all these facilities was available through 2012. This sample of hospitals was distilled to those UHC member hospitals that were currently designated as nurse Magnet facilities.

This compilation of current UHC nurse Magnet hospitals was cross-referenced with the American Nurses Credentialing Center (ANCC) website to determine the date of initial Magnet designation for each facility. In order to assure two years of outcome data for all facilities after their Magnet designation, those hospitals initially certified after 2010 were eliminated from the study group.

Ten patient outcomes variables were defined based on literature review or previously described sensitivity to the quality of in-hospital nursing care. Because of both internal UHC changes in data reporting as well as coding alterations, these 10 outcome measures were available for all study institutions beginning for the year 2002 and thereafter. The longitudinal design of this study necessitated not only two years of patient care outcome data after designation but also at least two years of data before the
designation year. As a consequence, hospitals that were Magnet certified prior to 2004 were eliminated. This left a study cohort composed of 25 UHC member facilities initially certified as Magnet hospitals from 2004 through 2010.

**Data Collection Procedures**

The date of Magnet certification was arbitrarily chosen to be between the quarter ending March 31st and that ending June 30th of the designation year. Quarterly data reported March 31 was considered to be before Magnet certification. In order to maximize the information available, quarterly data reported June 30th was considered to be after certification. Organizational information was collected at that time of Magnet designation to characterize each facility in terms of rural versus urban location, teaching status, and hospital size. Clinical activity and complexity of patient care data were obtained quarterly over the study period. Additionally, patient care outcome data was extracted quarterly to gauge each hospitals provision of quality care over time. Twenty to 24 quarters of self-reported longitudinal data submitted to the UHC was collected for all 25 individual hospitals. The collection included nine to 13 quarters of data before Magnet designation and 11 quarters of data after designation for each facility. All this secondary UHC data was cleaned, coded, de-identified, and unique measures calculated as required. The data was merged into a new file for statistical analysis and kept confidential.

**Data Analysis**

Generalized Estimating Equations (GEE) were used for these repeated measures data to estimate over time the effect of Magnet designation on global and nursing-
sensitive patient outcome measures within academic medical centers. This model was also used to determine the impact of organizational characteristics on this Magnet effect. Three organizational characteristics were investigated: 1) hospital size, 2) clinical activity level, and 3) complexity of the care provided.

*Magnet Status* served as the independent categorical variable with the 10 continuous patient outcome measures serving as dependent variables. Global patient outcome variables included: *In-hospital Mortality from Acute MI, In-hospital mortality from CHF, Failure to Rescue, and Re-admission*. Nursing-sensitive patient outcome variables included: *Pressure Ulcer, Infection Due to Medical Care / CVC Bloodstream Infection, Post-operative DVT / PE, Post-operative Sepsis, Post-operative Physiometabolic Derangement, and Post-operative Respiratory Failure*.

Only one of the 25 facilities was a rural, non-teaching medical center. As a result, the binary variables urban versus rural and teaching versus non-teaching were not specifically considered in the covariate analysis. The covariates that were tested included: *Staffed Bed number, In-patient Discharge per Staffed Bed, Medicare CMI, Surgical ICU Admissions, Solid Organ Transplants, Open-Heart Surgical Cases, and Trauma-related Surgical Cases.*
CHAPTER 4:

ANALYSIS AND PRESENTATION OF FINDINGS

Introduction

This chapter provides the statistical analysis of the data and presents the research findings. Descriptive statistics are utilized to describe the study hospitals and to characterize the outcome data. The results of data analysis are detailed and utilized to address the stated hypotheses as well as answer the four research questions.

Sampling Methodology

In 2013, at the time data was collected for this research, there were 412 member hospitals in the UHC, 51 of which were Magnet certified. UHC patient-level outcome data desired was not obtainable prior to 2002 and was available through 2010. As a consequence 12 of these 51 facilities, initially Magnet certified prior to 2003 or after 2010, were eliminated. An additional nine facilities were removed from the study group due to inconsistent data reporting. The remaining 30 institutions included UHC member hospitals that were initially designated as Magnet facilities by the ANCC from 2003 through 2010, were still Magnet certified as of 2013, and provided consistent data before and after initial Magnet certification.

The date of Magnet certification was arbitrarily chosen to be between the quarter ending March 31st and that ending June 30th of the designation year. Quarterly data
reported March 31 was considered to be before Magnet certification and quarterly data reported June 30th was considered to be after certification. All 30 hospitals presented at least five quarters of data prior to Magnet certification and 11 quarters of data after certification. Twenty-five of the 30 hospitals had at least nine quarters of data available prior to the date of certification. The final study group was limited to those 25 facilities with at least nine quarters of data before and 11 quarters of data after in order to adequately compare patient outcomes before and after initial Magnet designation. Nineteen of these 25 study hospitals had an additional 4 quarters of data available prior to initial Magnet certification making 13 quarters of data before and 11 quarters of data after Magnet certification. This extra data was included in the analysis. For the purposes of this analysis, time is measured in terms of quarters from quarter 0, the time of Magnet status designation.

**Missing Data**

After removing the most extreme 1% of the outliers within the dataset there were a total of 5,454 outcome data points available with 306 missing values (5.61%). Three outcome variables had more than 10% missing values: *Pressure Ulcer* (12.06%), *Post-operative Sepsis* (12.28), and *Post-operative Physio-metabolic Derangement* (17.79). Missing values were excluded pairwise.

**Discussion of Combined Variables**

Three organizational characteristics were thought capable of influencing the impact of Magnet certification on patient care outcomes; facility size, clinical activity, and complexity of patient disease and care. The number of staffed beds was utilized to
represent facility size. In order to differentiate facilities based on clinical activity apart from size, a variable termed In-patient Discharges per Staffed Bed was computed by dividing the number of in-patient discharges per quarter by the number of staffed beds.

*Case Mix Index (CMI)* as well as an additional computed variable, *Operative Care Complexity*, signified complexity of disease and care. Summing the values for surgical ICU admissions, solid organ transplants, open-heart procedures, and trauma-related surgical cases for each individual hospital per quarter generated *Operative Care Complexity*.

**Descriptive Statistics**

The initial 51 Magnet certified UHC member hospitals that were isolated from both secondary data sources included only four rural or non-teaching facilities. Once the study group was decreased to 25 facilities based on data availability before and after Magnet designation, there remained only one non-teaching hospital that was located in a rural setting. That facility provided data 13 quarters before and 11 quarters after Magnet certification. The remaining 24 facilities were all major academic medical centers, dedicated to medical education, and located within an urban environment. The data collected included the timeframe January 1, 2002 through December 31, 2010.

The data from the study group characterizing the institutions (Table 1) and measuring the outcome of patient care (Table 2) was analyzed for descriptive statistics (IBM, SPSS, version 22). Where values were normally distributed means and standard deviations are reported. Representative descriptive statistics are presented per quarter.
with quarter 0 representing the second quarter of the Magnet designation year (ending June 30).

The 25 study hospitals were characterized further based on size, clinical activity, and complexity of care. These characteristics were represented by the following continuous variables with no missing values: Staffed Beds, In-Patient Discharges per Staffed Bed, Medicare CMI, and Operative Care Complexity (Surgical ICU Admissions + Solid Organ Transplants + Open-Heart Cases + Trauma-related Surgical Cases).

The median value for the number of staffed hospital beds was 599 (min = 246, max = 1171) and the mean number of in-patient discharges per quarter was 7733.90 (sd = 2571.76, min = 3422, max = 15577), both substantially greater than the national average. In order to better assess clinical activity independent of size, the number of in-patient discharges per staffed bed per quarter was computed. The mean was 12.46 (sd = 2.26, min = 7, max = 18). As might be expected for these academic centers, they were on the whole large and busy patient care sites.

The variable CMI represented complexity of care by considering such things as principle and secondary diagnoses, age, procedures performed, co-morbidities, complications, discharge status, and gender. By characterizing the population of patients treated, case mix index provided an estimate of the relative cost or resources required for care. The quarterly CMI values for the 25 study hospitals from 2002 through 2010 had a mean value of 1.5992 (sd = 0.1842, range = 0.8669). In 2006 the national average for unadjusted CMI was 1.3161 (http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/Acute-Inpatient-Files-for-Download-
and in 2012 that value increased to 1.4167. This steady increase reflects the need to expend more resources to care for patients today compared with years prior. An overall unadjusted CMI of 1.5992 for this study group exceeds the national average even in 2012.

The number of surgical ICU admissions, solid organ transplants, open-heart procedures, and trauma-related surgical cases were summed to generate the values for the variable Operative Care Complexity. The mean value was 1164.83 (sd = 518.84, min = 77, max = 3319).

Ten continuous outcome variables were considered to assess the impact of Magnet certification on patient care. Four of these dependent variables were considered global outcome measures. They have been traditionally used to represent quality of care but are less specific measurements of patient care outcomes as they relate directly to nursing: In-hospital Mortality from Acute MI, In-hospital Mortality from CHF, Failure to Rescue, and Re-admission. The remaining six nursing sensitive outcome variables included: Pressure Ulcer, Infection Due to Medical Care / CVC Bloodstream Infection, Post-operative DVT / PE, Post-operative Sepsis, Post-operative Physio-metabolic Derangement, and Post-operative Respiratory Failure. Though these data also approximated a normal distribution, as was noted for the global outcome variables, mildly positive skewness was observed to varying degrees.
Results and Findings

Based on the four research questions listed here, two primary and five secondary hypotheses were proposed:

1. Is there a significant longitudinal change in global or nursing-sensitive outcome measures after attainment of initial nurse Magnet designation within United States academic medical centers?
   a. Which outcome measures are sensitive to the organizational structure and nursing processes required for successful nurse Magnet designation?

2. Does hospital size impact the changes noted in patient care outcomes following initial nurse Magnet designation?

3. Does the level of a hospital’s clinical activity impact the changes noted in patient care outcomes following initial nurse Magnet designation?

4. Does the level of disease severity and the complexity of care provided by a hospital impact the changes noted in patient care outcomes following initial nurse Magnet designation?

The research findings are listed here and examined in accordance with the proposed hypotheses. All analyses were conducted with SAS version 9.3 (SAS Institute Inc., Cary, New Jersey). Tests of interaction were evaluated at a 0.10 level of significance. All other tests of significance, including paired t-tests for before-after magnet status comparisons and regression coefficient tests of significance were evaluated at a 0.05 level of significance.
Impact of Magnet Certification and Time on Patient Outcomes (Hypotheses 1.0- 1.2)

A paired-samples t-test was conducted as a raw comparison of the values of the ten outcome variables at two time points; four quarters before and after (Table 3), and eight quarters before and after initial Magnet certification (Table 4). The null hypothesis asserted that the differences in mean values before-after Magnet designation were 0. At both time point comparisons a significant decrease in the rate of re-admissions (one year before-after p = 0.0075, two years before-after p = 0.0152), the occurrence of pressure ulcers (one year before-after p = 0.011, two years before-after p < 0.0001), and rates of infection as a complication of medical care (one year before-after p = 0.0226, two years before-after p = 0.0001) were noted. The null hypothesis was rejected for all three variables. Additionally, the two years before-after comparison revealed a significant decrease in the rate of deep vein thrombosis and pulmonary emboli (p = 0.0024), and physiological or metabolic derangement (p = 0.0033). The results of these two paired time point comparisons suggested that the further away from time 0 (the point at which Magnet status is conferred) the compared data points were spaced, the higher the likelihood that significant differences in paired outcome measures would be present.

In order to provide a visual representation of the outcome data over time, a linear regression analysis using time as the predictor variable was performed for each patient outcome measure in all 25 study hospitals. Profile plots were generated with time 0 again representing the second quarter, the time point that Magnet status was attained. (Figures 1-10) The multiple grey simple linear regression lines illustrate the individual outcome data trends over time for each hospital. The red line is a simple smoothed regression line designed to illustrate the overall trend for each outcome variable for all study hospitals.
considered together. The profile plots reveal three general trends: 1) no apparent change, 2) a general decrease over time, and 3) a precipitous improvement in the outcome measure beginning at approximately time 0. Visual time 0 improvements were noted for Pressure Ulcer, Infection due to Medical Care / CVC Bloodstream Infection, Post-operative Physio-metabolic Derangement, Post-operative Respiratory Failure, and to a lesser degree Post-operative DVT/PE. Especially Pressure Ulcer and Infection due to Medical Care / CVC Bloodstream Infection measures demonstrated apparent improvement after Magnet status certification both in t-test pairwise comparisons and in the linear regression analysis over time.

Utilizing generalized linear estimating equations the following linear model was fit:

\[ Y = \beta_0 + \beta_1 \times x_1 + \beta_2 \times x_2 + \beta_3 \times x_1 \times x_2, \]  

where

\[ x_1 = \text{quarter}, \]  

\[ x_2 = \text{Magnet status} \begin{cases} 
0 & \text{if quarter} < 0 \\
1 & \text{if quarter} \geq 0 
\end{cases} \]

Employing generalized estimating equations to fit the linear models that follow allowed clear correlation of measurements made on the same hospital at various quarters over time. An autoregressive correlation structure was incorporated to account for these repeated measures over time on the same hospital. For each model, the outcome variable was assumed to follow an approximately normal distribution conditional on the values of the independent predictor variables.
In the models below, $\beta_3$ was first tested to determine whether it was statistically significantly different from 0. This was a test of whether the slope of a fitted regression line differed before magnet status versus after magnet status. If this interaction was significant, then this indicated a change in the direction of the outcome trend before versus after magnet status and the change in effects was described.

If the interaction term ($\beta_3$) was not statistically significant, the term was removed and the model re-run with only terms for quarter ($\beta_1 * x_1$) and Magnet status ($\beta_2 * x_2$) included:

$$Y = \beta_0 + \beta_1 * x_1 + \beta_2 * x_2$$

In this model $\beta_2$ was tested for a statistically significant difference from 0. If $\beta_2$ was different from 0, then there was a jump (either up or down) in the value of the outcome variable when hospitals achieved initial Magnet certification. If $\beta_2$ was not significant, the model was run a third time, including only the term for quarter. Here $\beta_1$ was tested for a statistically significant difference from 0. This equation allowed determination of whether the value of the outcome variable in question changed over time, independent of Magnet status. If $\beta_1$ was significant, there existed a clear trend over time. A negative slope would indicate a decreasing trend for the measurement in question over time.

In the first set of results that follow, simple models are presented for each outcome variable. Tables are included for outcome variables that demonstrated significant findings.

*In-hospital Mortality from Acute MI* – There was no significant interaction between quarter and Magnet status, thus the observed trend over time was not significantly different before versus after Magnet status was obtained. Models
considering only main effects for quarter and Magnet status indicated no significant change in hospital mortality before and after achieving magnet status. Further, there was no significant change over time.

*In-hospital Mortality from CHF* – There was no significant interaction between quarter and Magnet status, thus the observed trend over time was not significantly different before versus after Magnet status. Models considering only main effects for quarter and Magnet status indicated no significant change in hospital mortality before and after achieving Magnet status. Further, there was no significant change over time.

*Failure to Rescue* – There was no significant interaction between quarter and Magnet status, thus the observed trend over time was not significantly different before versus after Magnet status. Models considering only main effects for quarter and Magnet status indicated no significant change in failure to rescue before and after achieving magnet status. However, as noted in Table 5 there was a significant mean reduction over time ($p = 0.047$). The rate of failure to rescue decreased 0.0020 per quarter.

*Re-admission* – There was no significant interaction between quarter and Magnet status, thus the observed trend over time was not significantly different before versus after Magnet status. Models considering only main effects for quarter and Magnet status indicated no significant change in hospital readmission before and after achieving Magnet status. However, as noted in Table 6 there was a significant mean reduction over time ($p = 0.047$). The rate of hospital re-admission decreased 0.0629 per quarter.

*Pressure Ulcer* – An interaction between quarter and Magnet status was observed to be statistically significant at the $p < 0.10$ level (Table 7). This indicated that the observed trend over time (the slope of the regression line) before achieving Magnet status
was statistically significantly different from the slope of the regression line after achieving Magnet status. More simply, the downward trend observed before achieving Magnet status was more severe following achieving magnet status. Prior to the achievement of Magnet status, the pressure ulcer rate was noted to decrease by 0.0004 occurrences per quarter. After Magnet designation the quarterly decrease became 0.0011.

*Infection Due to Medical Care* – There was no significant interaction between quarter and Magnet status, thus the observed trend over time was not significantly different before versus after Magnet status. Models considering only main effects for quarter and Magnet status indicated no significant change in failure to rescue before and after achieving Magnet status. However, as noted in Table 8 there was a significant mean reduction over time ($p < 0.0001$). The rate of infection due to medical care decreased 0.0001 per quarter.

*Post-operative DVT/PE* – There was no significant interaction between quarter and Magnet status, thus the observed trend over time was not significantly different before versus after magnet status. Models considering only main effects for quarter and Magnet status indicated no significant change in the occurrence of DVT’s and PE’s before and after achieving Magnet status. However, as demonstrated in Table 9 there was a significant mean reduction over time ($p < 0.0001$). The rate of DVT’s and PE’s decreased 0.0007 per quarter.

*Post-operative Sepsis* – There was no significant interaction between quarter and Magnet status, thus the observed trend over time was not significantly different before versus after Magnet status. Models considering only main effects for quarter and Magnet
status indicated no significant change in in-hospital mortality before and after achieving Magnet status. Further, there was no significant change over time.

*Post-operative Physio-metabolic Derangement* – An interaction between quarter and Magnet status was seen that was statistically significant at the p < 0.10 level (Table 10). This indicated that the observed trend over time (the slope of the regression line) before achieving Magnet status was statistically significantly different from the slope of the regression line after achieving Magnet status. The flat trend observed before achieving Magnet status was a downward trend after achieving Magnet status. Prior to the achievement of Magnet status, the rate of post-operative physiologic and metabolic derangements did not change with time. After Magnet designation the quarterly decrease was noted to be 0.0001.

*Post-operative Respiratory Failure* – There was no significant interaction between quarter and Magnet status, thus the observed trend over time was not significantly different before versus after Magnet status. Models considering only main effects for quarter and Magnet status indicated no significant change in hospital readmission before and after achieving Magnet status. However, as noted in Table 11 there was a significant mean reduction over time (p = 0.01). The rate of post-operative respiratory failure decreased 0.0002 per quarter.

In summary, paired-samples t-tests revealed significant differences in the means for *Pressure Ulcer*, *Infection Due to Medical Care / CVC Bloodstream Infection*, and *Readmission* at one and two years before-after Magnet designation. *Post-operative DVT/PE*, and *Post-operative Physio-metabolic Derangement* values were significantly different only for the two year before-after comparison. Linear regression profile plots
demonstrate an apparent improvement around the time Magnet status was conferred especially for Pressure Ulcer, Infection Due to Medical Care / CVC Bloodstream Infection, Post-operative Physio-metabolic Derangement, and Post-operative Respiratory Failure. Finally, analyses using generalized linear estimating equations revealed a significant impact of the Magnet status and time product on the occurrence of Pressure Ulcer, and Post-operative Physio-metabolic Derangement. A significant improvement over time was noted for Failure to Rescue, Re-admission, Infection Due to Medical Care / CVC Bloodstream Infection, Post-operative DVT/PE, and Post-operative Respiratory Failure. Neither time nor Magnet status resulted in significant improvements in morbidity due to acute MI or CHF, or post-operative sepsis.

Influence of Hospital Characteristics on Patient Outcomes (Hypotheses 2.0-2.3)

Similar to the process just described, utilizing generalized linear estimating equations the following linear model was fit:

\[ Y = \beta_0 + \beta_1 * x_1 + \beta_2 * x_2 + \beta_3 * x_1 x_2 + \beta_4 * x_4 + \beta_5 * x_5 + \beta_6 * x_6 + \beta_7 * x_7, \]

where

\[ x_1 = \text{quarter}, \]

\[ x_2 = \text{Magnet status} \begin{cases} 0 \text{ if quarter < 0} \\ 1 \text{ if quarter } \geq 0 \end{cases} \]

\[ x_4 = \text{Staffed bed number}, \]

\[ x_5 = \text{In-patient Discharges per Staffed Bed}, \]

\[ x_6 = \text{Case Mix Index (CMI)}, \]

\[ x_7 = \text{Operative Care Complexity}. \]
An autoregressive correlation structure was incorporated into the model to account for these repeated measures over time on the same hospital. Models were run for each outcome variable with all four covariates included and then with each covariate included individually. In the results and tables that follow, simple models are presented for each outcome variable.

Adjusted models incorporating all covariates together or individually did not change the previously stated findings regarding significance for seven outcome variables: *In-hospital Mortality from Acute MI, In-hospital Mortality from CHF, Infection Due to Medical Care / CVC Bloodstream Infection, Post-operative DVT/PE, Post-operative Sepsis, Post-operative Physio-metabolic Derangement*, and *Post-operative Respiratory Failure*.

For *In-hospital Mortality from Acute MI, In-hospital Mortality from CHF*, and *Post-operative Sepsis* there were no significant interactions between quarter and Magnet status. Models considering only main effects for quarter and Magnet status indicated no significant change for these three outcome variables before and after achieving magnet status. Further, there was no significant change over time.

Analyses for *Infection Due to Medical Care / CVC Bloodstream Infection, Post-operative DVT/PE*, and *Post-operative Respiratory Failure* continued to reveal no significant interaction between quarter and Magnet status. Models considering only main effects for quarter and Magnet status indicated no significant change. However, there remained a significant mean reduction in these measures over time (Tables 12-14). The rate of quarterly decline in infections resulting from medical care doubled from 0.0001 to 0.0002 with the inclusion of case mix index or all covariates into the model. The rate of
post-operative DVT’s or PE’s slightly increased after the addition of all the covariates together or individually from a decline of 0.0007 per quarter to a decline of 0.0004. Finally, the rate of drop for post-operative respiratory failure per quarter increased from 0.0002 to 0.0003 when case mix index was introduced as a covariate.

Models run for Failure to Rescue and Re-admission without the addition of covariates revealed only a significant mean change over time. When the same analysis was performed for Failure to Rescue with the inclusion of all covariates or In-patient Discharges per Staffed Bed and Operative Care Complexity individually, mean reduction over time became non-significant (Table 15). A very slight increased rate of decline per quarter for failure to rescue was noted when case mix index was considered (0.0021 compared with 0.002). Models run for Re-admission with the inclusion of all covariates or Operative Care Complexity and CMI individually similarly resulted in a non-significant effect of time on mean outcome values for this variable (Table 16). The rate of quarterly decline before introduction of staffed bed number and number of discharges per staffed bed into the model was 0.0629. After inclusion of these covariates the rates increased to 0.0669 and 0.0631 respectively.

Previous unadjusted models based on generalized linear estimating equations for Pressure Ulcer and Post-operative Physio-metabolic Derangement revealed a statistically significant interaction between quarter and Magnet status. This indicated that the observed trend over time before achieving Magnet status was statistically significantly different from the slope of the regression line after achieving Magnet status. With the addition of one covariate to the model, CMI, the significance of the interaction between quarter and Magnet status was eliminated for Pressure Ulcer. However, even with this
covariate included there was a significant mean time-dependent decrease in the rate of pressure ulcers per quarter equal to 0.0006 (Table 17). The significant interaction between quarter and magnet status for Post-operative Physio-metabolic Derangement was not modified in the adjusted models (Table 18).
CHAPTER 5:
DISCUSSION AND CONCLUSIONS

Introduction

This chapter reviews the pertinent findings derived from this investigation and applies them to the stated research problem:

Do the structural and resulting process virtues associated with nurse Magnet designation translate to improved outcomes for patients undergoing medical and surgical treatment within Magnet-certified academic medical centers?

Specifically, the research questions emanating from this problem statement are answered by addressing the primary and secondary hypotheses. Based on the scholarly knowledge generated from this original research, conclusions and recommendations are advanced. Limitations of this study are discussed, as are suggestions for future research. A final summary concludes Chapter 5.

Explanation of Findings and Conclusions by Hypothesis

Hypothesis 1.0: There is no statistical improvement in global outcome measures associated with initial Magnet designation in academic medical centers.

There exists significant evidence in the literature that high functioning nursing environments and nurse Magnet certification translate to decreases in global patient outcome measures like mortality and failure to rescue. Many of the supportive studies rely on large volumes of cross sectional, secondary data that lack unit or even hospital
focus and may not properly control for severity of disease, complexity of care, and a variety of other confounding variables.

The longitudinal investigation presented here supports Hypothesis 1.0. Profile Plots revealed no substantial trend toward improvement for the four global outcome variables considered. Paired-samples t-tests showed no change in before-after measurements for three of the four variables. Finally, the GEE analysis indicated that for this homogeneous study group composed of 25 academic medical center members of the University HealthSystem Consortium global outcome measures were not significantly changed as a consequence of initial Magnet designation.

Donabedian considered patient care outcomes to be stable, concrete and rarely questioned representations of quality in medicine. He also cautioned that chosen outcomes are only valuable if they are relevant and minimally influenced by other outside factors. Global outcomes measures like mortality lack the needed sensitivity and specificity to assess improvements in nursing care resulting from an intervention such as nurse Magnet designation. Failure to rescue rates, often considered nursing-sensitive, track patient deaths due to unsuccessful treatment, emergency, or complication. Clearly, nursing plays a role in patient rescue, but are those efforts a primary reason for success or failure?

In a well-controlled longitudinal study like the one presented here, lack of improvement in these global outcome measures cannot be utilized as evidence to argue against the impact of Magnet certification on patient care quality. Similarly, demonstration of decreased morbidity, failure to rescue, and re-admission noted by other
authors cannot be assumed to be the direct result of Magnet nursing. Assessment of specific quality improvement efforts in nursing care is facilitated by the measurement of complications and adverse events more easily traced directly to nursing excellence.

_Hypothesis 1.1: Nursing-sensitive outcome measures are significantly improved following initial nurse Magnet designation in academic medical centers._

As determined by the American Nurses Association: “Patient outcomes that are determined to be nursing sensitive are those that improve if there is a greater quantity or quality of nursing care.”

(https://www.nursingworld.org/MainMenuCategories/ThePracticeofProfessionalNursing/PatientSafetyQuality/Research-Measurement/The-National-Database/Nursing-Sensitive-Indicators_1). Though decreased numbers of in-hospital complications of care have been shown in relation to nursing quality and Magnet certification, the impact on specific nursing-sensitive outcome measures has been less consistently demonstrated compared to global measures. This may be a direct result of data collection methods and the related weaknesses previously detailed. In this longitudinal investigation of 25 specific hospitals it was expected that more sensitive measures for nursing care would show improvement with a direct nursing intervention.

The paired-samples t-tests and the linear regression profile plots seemed to indicate a trend toward improvement in several nursing-sensitive variables. In some cases, as with _Post-operative DVT / PE_ (Figure 7), there appeared to be a slow steady decline over time. In other cases, like _Pressure Ulcer_ (Figure 5), there seemed to be a more precipitous improvement around time 0, the time at which Magnet certification was
obtained. Only *Post-operative Sepsis* showed no trend toward improvement on its profile plot. Though considered a nursing-sensitive measure in this study, a comprehensive literature review by Needleman and co-authors noted there was not consistent or sufficient evidence to label sepsis a nursing-sensitive measure (Needleman et al., 2007).

Only two nursing-sensitive patient care measures, *Pressure Ulcer* and *Post-operative Physio-metabolic Derangement*, showed a statistically significant rate decline after Magnet designation was obtained. For *Pressure Ulcer*, the significant improvement noted was lost when the organizational variable *Medicare CMI* was controlled. Improvement with time remained significant. It seems intuitive that an increase in severity of patient illness and complexity of care could overcome the interval improvements garnered through better nursing treatment. As an example, the frequent positional changes needed to avoid ulcer development in sick, obtunded and long-term patients are more likely to be overlooked in caring for these individuals. Hypothesis 1.1 is supported in part.

There was a positive but non-significant decrease in multiple nursing-sensitive complications of care rates but this improvement was not associated with Magnet designation. Rather the trend, where noted, seemed a function of time alone. Improvement was correlated with Magnet certification only for *Pressure Ulcer* and *Post-operative Physio-metabolic Derangement*. Using similar UHC quarterly member data to compare AHRQ nursing-sensitive safety and quality measures between Magnet and non-Magnet member hospitals, Goode and co-authors (Goode et al., 2011) demonstrated a decrease only in pressure ulcer rate for the Magnet certified members. They did not
assess physio-metabolic derangement but could find no other measurable improvements in the chosen indicators.

Hypothesis 1.2: Patient care outcome measures improve over time in academic medical centers that strive for and achieve nurse Magnet designation.

It has been suggested that nursing-sensitive patient outcome measures may improve over time simply because the structures, processes and overall environment associated with the nurse Magnet movement have become ingrained into the vocation through professional societies and regulatory agencies (Buerhaus et al., 2009; Hess et al., 2011). Especially those institutions that actively seek Magnet certification seem predisposed to embrace the concepts and the culture whether actually Magnet designated or not (Ulrich et al., 2007).

The analyses performed here did reveal time-dependent statistically significant improvements in multiple outcome variables. For Failure to Rescue the significance was modified by inclusion of organizational characteristics representing the level of clinical activity and the complexity of care provided. The significant decline in Re-admission rate was modified by the disease severity and level of care complexity. Hypothesis 1.2 is supported in part.

In regard to the global outcome measures, morbidity did not change as a function of time and though failure to rescue and re-admission did improve, they were subject to modification by variables representing the medical complexity of the patient and of their care. As might be expected, these global measures were impacted by factors other than the nursing improvements that were taking place over time.
Hypothesis 2.0: Improvement in patient care outcome measures following initial nurse Magnet designation in academic medical centers is not modified when hospital size, clinical activity, and complexity of care are considered together as confounding variables.

Whereas clinically busier hospitals are associated with lower mortality rates, larger facilities have been found not to benefit patient outcome. Increased complexity of care, if not controlled, would be likely to result in more complications and poorer outcomes for hospitalized patients.

Introduction of the four covariates for size, clinical activity and complexity of care into the general estimating equation models together did not impact the results significantly. The slope of the regression line for rate of pressure ulcers and post-operative physio-metabolic derangement remained significantly different after compared with before Magnet certification. It seems when taken together these organizational characteristics do not impact patient outcome variable changes attributed to Magnet status. Likely, the positive and negative influences of these hospital characteristics cancel one another when considered together. Hypothesis 2.0 is supported.

Hypothesis 2.1: Improvement in patient care outcome measures following initial nurse Magnet designation in academic medical centers is modified by hospital size.

The study population was composed of 25 large academic medical centers with a median staffed bed number of 599 (min = 246, max =1171). Introduction of size as an individual covariate in the models did not alter the analysis results significantly. Perhaps
a more heterogeneous study group would show a difference as might be expected based on the literature. Hypothesis 2.1 is not supported by the data.

**Hypothesis 2.2:** Improvement in patient care outcome measures following initial nurse Magnet designation in academic medical centers is modified by the level of clinical activity.

Busier hospitals might experience less interval improvement in quality of care by virtue of their fine-tuned patient care processes. However, in this study the level of clinical activity as represented by the number of in-patient discharges per staffed bed did not impact the affect Magnet status had on improved outcome. However, introduction of this covariate did modify the significant effect on time-dependent improvement in failure to rescue rate.

The minimal impact of clinical activity as a confounder may be a function of the homogeneous population of study hospitals. The variation in activity level was naturally restricted. Hypothesis 2.2 is not supported.

**Hypothesis 2.3:** Improvement in patient care outcome measures following initial nurse Magnet designation in academic medical centers is modified by complexity of care.

Two variables were utilized to represent complexity of care: CMI, and the composite variable Operative Care Complexity. When introduced into the models as an independent covariate, CMI, had a significant impact on the improved pressure ulcer rate associated with Magnet certification. The reason for this modification likely relates to the care of sick, often incoherent and long-term patients represented by an increased case mix index. In order to avoid the development of pressure ulcers in these individuals,
nurses must perform frequent positional changes for the patient. Nursing staff, as they concentrate on providing the care needed to keep the patient alive, might more easily overlook such an activity. This outcome measure, perhaps like no other, is extremely dependent on regular nursing intervention. Hypothesis 2.3 is supported in part.

**Study Limitations**

There are a number of limitations directly related to the data utilized in this investigation. The analyses relied entirely on secondary data that was subject to collection and processing error. Though the data was hospital based, it was not specifically unit or patient-focused. All organizational characterization and patient outcome data was self-reported by individual hospitals to the University HealthSystem Consortium sometimes resulting in missing or unreliable data points. In many cases outcome measures were reported as rates without specific numerators and denominators preventing Poisson regression. The assumption of normality for these outcome measures may not be completely satisfied. In the final analysis, the accuracy of data reporting, input, and processing could not be verified. Incomplete or obviously inaccurate reporting of quarterly institutional data did limit the size of the study group.

At different time points from 2002 to 2012 coding and reporting changes occurred. For example, present on admission was instituted in 2009. Prior to that time, the number of patient falls and trauma resulting from hospitalization, one commonly reported nursing-sensitive patient outcome measure could not accurately be distinguished from traumatic injuries that were not related to in-hospital patient care. As a result, this potential patient outcome was excluded.
The design of this study was not experimental in nature. Control groups were not employed. Though the longitudinal nature of the study held constant many variables, some variables within individual facilities likely changed over time. Potentially inappropriate assumptions were made that organizational characteristics remained constant. Critical factors like nurse staffing could have changed during a facility’s Magnet journey.

Confounding variables could not be fully considered. It is very possible that unrecognized or unavailable covariates, not included in the statistical models, would have altered the findings. For example, the inability to adequately measure the impact of time-dependent changes in professional nursing standards and innovations in care most certainly impacted the results. Additionally, in the analyses time was re-scaled such that actual calendar effects cannot be determined.

Initial Magnet designation is geared toward assessment of a facility’s nursing leadership, structured empowerment, and professional nursing practices rather than demonstration of the creation of new knowledge or empirically demonstrated improvements in patient care quality. As such, correlating improved patient care outcome with initial Magnet certification may be flawed. Re-certification, which does concentrate on a hospital’s patient care results, may reveal a more profound before-after improvement in patient care outcome measures.

Finally, the results of this investigation are not widely generalizable for several reasons. First, the study population is exceedingly homogeneous. Second, this study represents a snapshot in time from 2002 until 2010. Third, the number of Magnet facilities studied is but a small fraction of the total number of Magnet designated
hospitals in the United States. The time-dependent improvement in multiple patient care outcome variables may be a direct reflection of the limited timeframe and the narrow study population composed only of academic medical centers, all dedicated to pursuing and obtaining nurse Magnet certification.

**Future Research**

By presenting a longitudinal analysis of patient outcome measures as a function of time and initial nurse Magnet designation, this investigation represents a unique and valuable contribution to the literature. Though it addressed specific research questions in part, it left many questions unanswered. Significantly more insight is needed in relation to the contribution of a culture of nursing excellence, as represented by nurse Magnet designation, to patient care quality. Is there a linear relationship between such a structure and quality improvement in United States medical centers?

Addition of a control group, UHC member institutions that have chosen not to seek Magnet designation, would help clarify the apparent time-dependent improvements in patient outcome measures. Certainly the inclusion of more study hospitals in both Magnet and non-Magnet groups over a longer period of time would potentially provide enough data to reach more definitive conclusions. Using Magnet re-certification as the independent variable might better assess the impact of this nursing effort on patient care outcomes. Finally, expanding this longitudinal assessment to other non-academic facilities in this country would make the findings more generalizable.

There is some indication that following the achievement of Magnet designation, institutions may lose focus and thereby experience resurgence in patient care complications. An evaluation that compares nursing-sensitive patient care outcomes at
the time of Magnet certification to those same measures at least two or three years later might provide an answer. Because hospitals must recertify every four years if they wish to remain Magnet designated, and because the time to prepare for the recertification is at least one or two years, the study would likely need to be limited to those medical centers that chose not to recertify.

Summary

This research study reviewed the literature outlining the impact of nurse Magnet designation on nursing environment and the effect of that environment on patient care outcomes. The limited data available relating Magnet designation directly to patient care outcome measures was also discussed. The overriding purpose of this investigation was to determine whether the addition of the structural and process elements necessary for an academic medical center to garner its initial Magnet designation is associated with improved patient care. Donabedian’s linear structure-process-outcome theory served as the framework to empirically assess the relationship between Magnet status and patient care outcomes. The influence of such organizational factors as hospital size, clinical activity, and complexity of care on this relationship was investigated. Secondary data from the American Nurse Credentialing Center (ANCC) and the University HealthSystem Consortium (UHC) was used as the basis of this empirical study. Specifically, organizational and patient outcome data, self-reported by member institutions of the UHC, served to populate the analyses.

Using generalized estimating equations, this investigation identified two specific in-patient nursing-sensitive outcome measures that statistically improved following initial Magnet certification: the rate of pressure ulcers, and the rate of physiologic or metabolic
derangement following elective surgical procedures. In the adjusted models, the significant improvement in the rate of pressure ulcers was modified by case mix index.

A time-dependent improvement in five additional outcome measures was also revealed: infection resulting from medical care, post-operative deep vein thrombosis or pulmonary embolus, post-operative respiratory failure, failure to rescue, and hospital re-admission. In the adjusted models the significant time-dependent improvement for failure to rescue was modified by organizational characteristics representing clinical activity and complexity of care. Similarly, the level of care complexity modified the significant improvement observed for hospital re-admission rate. Time-dependent improvements in rates of infection resulting from medical care and post-operative respiratory failure either held constant or slightly improved with the inclusion of covariates. The rate of post-operative deep vein thrombosis or pulmonary embolus slightly increased in the adjusted model.

In-hospital mortality resulting from acute myocardial infarction or congestive heart failure and the rate of post-operative sepsis were not impacted by either time or initial Magnet designation.

Though the initial Magnet designation did result in patient care outcome improvements, the frequency of in-hospital complications of care and adverse events was decreased primarily as a function of time in this homogeneous study population. It is possible that these time-dependent improvements stemmed from a shared predisposition to focus on nursing as a critical component of quality improvement. A beneficial Magnet culture may have been present independent of actual nurse Magnet status.
Table 1.  
Quarterly Descriptives – Organizational Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>-13</th>
<th>-10</th>
<th>-5</th>
<th>0</th>
<th>5</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staffed Bed #</td>
<td>599 (246 - 974)</td>
<td>599 (246 - 974)</td>
<td>599 (246 - 1171)</td>
<td>599 (246 - 1171)</td>
<td>599 (246 - 1171)</td>
<td>599 (246 - 1171)</td>
</tr>
<tr>
<td>Inpatient Discharge #</td>
<td>7206.74 ± 1860.60</td>
<td>7349.95 ± 1876.88</td>
<td>7450.56 ± 2397.47</td>
<td>7836.40 ± 2672.18</td>
<td>8244.24 ± 2824.92</td>
<td>8109.48 ± 3067.28</td>
</tr>
<tr>
<td>Inpatient Discharge # Per Bed</td>
<td>11.53 ± 2.34</td>
<td>11.76 ± 2.24</td>
<td>12.13 ± 2.35</td>
<td>12.70 ± 2.461</td>
<td>13.26 ± 2.19</td>
<td>12.85 ± 2.04</td>
</tr>
<tr>
<td>CMI</td>
<td>1.5591 ± 0.1606</td>
<td>1.5803 ± 0.1638</td>
<td>1.5708 ± 0.1873</td>
<td>1.6041 ± 0.1855</td>
<td>1.6217 ± 0.1934</td>
<td>1.6693 ± 0.1932</td>
</tr>
<tr>
<td>ICU Case # - Surgical</td>
<td>677.74 ± 174.03</td>
<td>704.63 ± 203.24</td>
<td>644.72 ± 262.169</td>
<td>757.48 ± 325.95</td>
<td>870.32 ± 463.18</td>
<td>813.72 ± 406.79</td>
</tr>
<tr>
<td>Transplant # - Surgical</td>
<td>43.21 ± 29.186</td>
<td>46.37 ± 33.65</td>
<td>45.64 ± 32.50</td>
<td>54.32 ± 37.114</td>
<td>54.80 ± 39.16</td>
<td>53.00 ± 34.38</td>
</tr>
<tr>
<td>Open Heart # - Surgical</td>
<td>102.58 ± 36.27</td>
<td>107.47 ± 35.93</td>
<td>112.64 ± 44.20</td>
<td>126.64 ± 65.03</td>
<td>122.68 ± 69.62</td>
<td>125.84 ± 67.81</td>
</tr>
<tr>
<td>Trauma # - Surgical</td>
<td>228.68 ± 112.14</td>
<td>274.00 ± 154.44</td>
<td>226.12 ± 129.24</td>
<td>269.64 ± 166.82</td>
<td>302.24 ± 186.68</td>
<td>267.44 ± 153.08</td>
</tr>
<tr>
<td>Operative Care Complexity</td>
<td>1049.21 ± 294.14</td>
<td>1132.47 ± 366.41</td>
<td>1029.12 ± 407.42</td>
<td>1208.08 ± 519.85</td>
<td>1350.04 ± 687.17</td>
<td>1260.00 ± 600.42</td>
</tr>
</tbody>
</table>

0 = Magnet designation (quarter ending June 30<sup>th</sup>)
Table 2. Quarterly Descriptives – Outcome Variables

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>-13</th>
<th>-10</th>
<th>-5</th>
<th>0</th>
<th>5</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-hospital Mortality- Acute MI</td>
<td>.0742 ± .0305</td>
<td>.0649 ± .0265</td>
<td>.07885 ± .0331</td>
<td>.0541 ± .0222</td>
<td>.0612 ± .0304</td>
<td>.0593 ± .0397</td>
</tr>
<tr>
<td>In-hospital Mortality- CHF</td>
<td>.0402 ± .0149</td>
<td>.0353 ± .0162</td>
<td>.0454 ± .0192</td>
<td>.0337 ± .0182</td>
<td>.0378 ± .0191</td>
<td>.0335 ± .0150</td>
</tr>
<tr>
<td>Failure To Rescue</td>
<td>.1211 ± .0506</td>
<td>.0840 ± .0526</td>
<td>.0940 ± .0689</td>
<td>.0795 ± .0655</td>
<td>.0871 ± .0848</td>
<td>.0698 ± .0816</td>
</tr>
<tr>
<td>Re-admission</td>
<td>958.11 ± 306.342</td>
<td>993.47 ± 306.511</td>
<td>1001.20 ± 386.79</td>
<td>1097.6 ± 403.73</td>
<td>1109.17 ± 347.55</td>
<td>1108.21 ± 397.512</td>
</tr>
<tr>
<td>Pressure Ulcer</td>
<td>.0185 ± .0077</td>
<td>.0161 ± .0077</td>
<td>.0163 ± .0109</td>
<td>.0125 ± .0101</td>
<td>.0084 ± .0097</td>
<td>.0027 ± .0034</td>
</tr>
<tr>
<td>Infection Due To Medical Care/ CVC</td>
<td>.0049 ± .0023</td>
<td>.0041 ± .0023</td>
<td>.0034 ± .0022</td>
<td>.0027 ± .0020</td>
<td>.0021 ± .0018</td>
<td>.0012 ± .0010</td>
</tr>
<tr>
<td>Post-operative DVT/PE</td>
<td>.0154 ± .0060</td>
<td>.0125 ± .0059</td>
<td>.0143 ± .0088</td>
<td>.0125 ± .0078</td>
<td>.0109 ± .0073</td>
<td>.0066 ± .0036</td>
</tr>
<tr>
<td>Post-operative Sepsis</td>
<td>.0096 ± .0072</td>
<td>.0073 ± .0066</td>
<td>.0084 ± .0075</td>
<td>.0082 ± .0092</td>
<td>.0100 ± .0109</td>
<td>.0055 ± .0068</td>
</tr>
<tr>
<td>Post-operative Physio-metabolic</td>
<td>.0014 ± .0007</td>
<td>.0023 ± .0019</td>
<td>.0022 ± .0016</td>
<td>.0019 ± .0017</td>
<td>.0013 ± .0012</td>
<td>.0008 ± .0012</td>
</tr>
<tr>
<td>Derangement</td>
<td>.0122 ± .0058</td>
<td>.0099 ± .0062</td>
<td>.0102 ± .0072</td>
<td>.0104 ± .0075</td>
<td>.0071 ± .0069</td>
<td>.0059 ± .0063</td>
</tr>
</tbody>
</table>

0 = Magnet designation (quarter ending June 30th)
Table 3. 
Paired-samples t-test: 4 Quarters Before-After

<table>
<thead>
<tr>
<th>Outcome</th>
<th>4 Quarters Before (quarter -4), mean ± sd</th>
<th>4 Quarters After (quarter +4), mean ± sd</th>
<th>Mean Change: before -after (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-hospital Mortality - Acute MI</td>
<td>0.06061 ± .02872</td>
<td>0.05942 ± .03572</td>
<td>0.00118 (-.0171, .0194)</td>
<td>0.8948</td>
</tr>
<tr>
<td>In-hospital Mortality - CHF</td>
<td>0.03541 ± .01905</td>
<td>0.03542 ± .01647</td>
<td>-.00002 (-.00834, .00831)</td>
<td>0.9968</td>
</tr>
<tr>
<td>Failure To Rescue</td>
<td>.8278 ± .5902</td>
<td>.07711 ± .06673</td>
<td>.00567 (-.375, .0488)</td>
<td>0.7884</td>
</tr>
<tr>
<td>Re-admission</td>
<td>7.88605 ± 21.66205</td>
<td>7.16672 ± 1.14806</td>
<td>.7193 (.2112, 1.2274)</td>
<td>0.0075 *</td>
</tr>
<tr>
<td>Pressure Ulcer</td>
<td>.01251 ± .00910</td>
<td>.00827 ± .00858</td>
<td>.00582 (.00150, .0101)</td>
<td>0.011 *</td>
</tr>
<tr>
<td>Infection Due To Medical Care/ CVC Bloodstream Infection</td>
<td>.00346 ± .00219</td>
<td>.00224 ± .00197</td>
<td>.0010 (.00015, .00181)</td>
<td>0.0226 *</td>
</tr>
<tr>
<td>Post-operative DVT/ PE</td>
<td>.01417 ± .00843</td>
<td>.01070 ± .00677</td>
<td>.00347 (.00065, .00760)</td>
<td>0.0953</td>
</tr>
<tr>
<td>Post-operative Sepsis</td>
<td>.01045 ± .00719</td>
<td>.00655 ± .00699</td>
<td>.00404 (.00083, .00890)</td>
<td>0.0988</td>
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<tr>
<td>Post-operative Physio-metabolic Derangement</td>
<td>.00194± .00117</td>
<td>.00114 ± .00134</td>
<td>.00084 (.2112, 1.2274)</td>
<td>0.0908</td>
</tr>
<tr>
<td>Post-operative Respiratory Failure</td>
<td>.01212 ± .00850</td>
<td>.00762 ± .00755</td>
<td>.00323 (-.00179, .00826)</td>
<td>0.1951</td>
</tr>
</tbody>
</table>

*p < 0.05
Table 4.
Paired- samples t-test: 8 Quarters Before-After

<table>
<thead>
<tr>
<th>Outcome</th>
<th>8 Quarters Before (quarter -8), mean ± sd</th>
<th>8 Quarters After (quarter +8), mean ± sd</th>
<th>Mean Change: before-after (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-hospital Mortality-Acute MI</td>
<td>.06507 ± .03040</td>
<td>.05389 ± .02992</td>
<td>.0112 (-.00664, .0290)</td>
<td>0.2076</td>
</tr>
<tr>
<td>In-hospital Mortality-CHF</td>
<td>.03322 ± .01277</td>
<td>.03793 ± .01422</td>
<td>-.00468 (-.0149, .00723)</td>
<td>0.4791</td>
</tr>
<tr>
<td>Failure To Rescue</td>
<td>.08869 ± .06112</td>
<td>.05775 ± .07366</td>
<td>.0309 (-.0186, .0805)</td>
<td>0.2096</td>
</tr>
<tr>
<td>Re-admission</td>
<td>7.60611 ± 1.43651</td>
<td>7.13447 ± 1.05699</td>
<td>.4716 (.0995, .8438)</td>
<td>0.0152</td>
</tr>
<tr>
<td>Pressure Ulcer</td>
<td>.01428 ± .00880</td>
<td>.00508 ± .00815</td>
<td>.00966 (.00555, .0138)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Infection Due To Medical Care/ CVC Bloodstream Infection</td>
<td>.00343 ± .00220</td>
<td>.00152 ± .00159</td>
<td>.00209 (.00115, .00303)</td>
<td>0.0001</td>
</tr>
<tr>
<td>Post-operative DVT/ PE</td>
<td>.01365 ± .00711</td>
<td>.00702 ± .00548</td>
<td>.00662 (.00260, .0106)</td>
<td>0.0024</td>
</tr>
<tr>
<td>Post-operative Sepsis</td>
<td>.00717 ± .00659</td>
<td>.00517 ± .00810</td>
<td>.00267 (-.000332, .00867)</td>
<td>0.3602</td>
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<tr>
<td>Post-operative Physiometabolic Derangement</td>
<td>.00187 ± .00154</td>
<td>.00069 ± .000618</td>
<td>.00149 (.00057, .00240)</td>
<td>0.0033</td>
</tr>
<tr>
<td>Post-operative Respiratory Failure</td>
<td>.00940 ± .00633</td>
<td>.00619 ± .00749</td>
<td>.00265 (-.00217, .00748)</td>
<td>0.2669</td>
</tr>
</tbody>
</table>

*p < 0.05
Table 5.
Analysis of GEE Parameter Estimates: Failure to Rescue

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>95% Confidence Limits</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.0822</td>
<td>0.0732, 0.0913</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>quarter</td>
<td>-0.002</td>
<td>-0.0041, 0.0000</td>
<td>0.047 *</td>
</tr>
</tbody>
</table>

*p < 0.05

Table 6.
Analysis Of GEE Parameter Estimates: Re-admission

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>95% Confidence Limits</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>7.6609</td>
<td>7.0949, 8.2269</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>quarter</td>
<td>-0.0629</td>
<td>-0.1248, -0.0009</td>
<td>0.0466*</td>
</tr>
</tbody>
</table>

*p < 0.05

Table 7.
Analysis Of GEE Parameter Estimates: Pressure Ulcer

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>95% Confidence Limits</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.0126</td>
<td>0.0076, 1.0177</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>quarter</td>
<td>-0.0004</td>
<td>-0.0008, 0.0000</td>
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*p < 0.1
### Table 8.
*Analysis of GEE Parameter Estimates: Infection*

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*p < 0.05

### Table 9.
*Analysis of GEE Parameter Estimates: Post-operative DVT/PE*

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*p < 0.05

### Table 10.
*Analysis of GEE Parameter Estimates: Post-operative Physio-metabolic Derangement*

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Table 11.

*Analysis of GEE Parameter Estimates: Respiratory Failure*

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Table 12.
*Adjusted Analysis of GEE Estimates: Infection Due to Medical Care/ CVC Bloodstream Infection*

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<th>Operative Care Complexity</th>
<th>All Covariates</th>
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Table 13.
*Adjusted Analysis of GEE Estimates: Post-operative DVT / PE*

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Table 14.  
\textit{Adjusted Analysis of GEE Estimates: Post-operative Respiratory Failure}

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* p < 0.05
### Table 15.
*Adjusted Analysis of GEE Estimates: Failure to Rescue*

#### Empirical Standard Error Estimates

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* * p < 0.05
Table 16.
Adjusted Analysis of GEE Estimates: Re-admission

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* p < 0.05
Table 17.
*Adjusted Analysis of GEE Estimates: Pressure Ulcer*

**Empirical Standard Error Estimates**

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* p < 0.05
** p < 0.1
Table 18.
*Adjusted Analysis of GEE Estimates: Post-operative Physio-metabolic Derangement*

**Empirical Standard Error Estimates**

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<tr>
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Table 19.
Explanation of Findings and Conclusions by Hypothesis

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</tbody>
</table>

- Hospital Mortality- Acute MI: Supported, Not Supported
- Hospital Mortality- CHF: Supported, Not Supported
- Failure To Rescue: Supported, Supported
- Re-admission: Supported, Supported
- Pressure Ulcer: Supported, Supported, Supported, Not Supported, Not Supported, Supported
- Infection Due To Medical Care / CVC Bloodstream Infection: Not Supported, Supported
- Post-op DVT/ PE: Not Supported, Supported
- Post-op Sepsis: Not Supported, Not Supported
- Post-op Physiometabolic Derangement: Supported, Supported, Supported, Not Supported, Not Supported, Not Supported
- Post-op Respiratory Failure: Not Supported, Supported
Figure 1.
Profile Plot: In-hospital Mortality-Acute MI

0 = Magnet designation (quarter ending June 30th)
Figure 2.
Profile Plot: In-hospital Mortality-CHF

In-hospital Mortality - CHF

0 = Magnet designation (quarter ending June 30th)
Figure 3.
Profile Plot: Failure to Rescue

0 = Magnet designation (quarter ending June 30th)
Figure 4.
Profile Plot: Hospital Re-admission

0 = Magnet designation (quarter ending June 30th)
Figure 5.  
Profile Plot: Pressure Ulcer

0 = Magnet designation (quarter ending June 30th)
Figure 6.
Profile Plot: Infection Due to Medical Care

0 = Magnet designation (quarter ending June 30th)
Figure 7.
Profile Plot: Post-operative DVT/PE

0 = Magnet designation (quarter ending June 30th)
Figure 8.
Profile Plot: Post-operative Sepsis

0 = Magnet designation (quarter ending June 30th)
Figure 9.
Profile Plot: Post-operative Physio-metabolic Derangement

0 = Magnet designation (quarter ending June 30th)
Figure 10.
Profile Plot: Post-operative Respiratory Failure

0 = Magnet designation (quarter ending June 30th)
REFERENCES


APPENDIX A

INTERNAL REVIEW BOARD APPROVAL

DATE: May 6, 2013

MEMORANDUM

TO: Thomas R. Hunt, MD
   Principal Investigator

FROM: Cari Oliver, CIP
   Assistant Director
   Office of the Institutional Review Board (OIRB)

RE: Request for Determination—Human Subjects Research
   IRB Protocol #2013042006—Patient Care Outcomes as a Function of Nurse
   Magnet Designation in Academic Medical Centers

A member of the Office of the IRB has reviewed your application for Designation of Not Human
Subjects Research for above referenced proposal.

The reviewer has determined that this proposal is not subject to FDA regulations and is not Human Subjects Research. Note that any changes to the project should be resubmitted to the
Office of the IRB for determination.

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