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Jill Marie Vanak
University of Pennsylvania, vanakj@nursing.upenn.edu

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The Effects of Changes in the Hospital Nursing Workforce and Practice Environment on the Outcomes of Surgical Oncology Patients: A Two-Stage Panel Study

Abstract
ABSTRACT

THE EFFECTS OF CHANGES IN THE HOSPITAL NURSING WORKFORCE AND PRACTICE ENVIRONMENT ON THE OUTCOMES OF SURGICAL ONCOLOGY PATIENTS: A TWO-STAGE PANEL STUDY

Jill M. Vanak

Eileen T. Lake

Prior research has documented that a better educated nursing workforce, higher nurse staffing levels, and better nurse practice environments are significantly associated with improved quality of care and lower patient mortality in multiple patient populations. Most prior research has used cross-sectional data to analyze associations between variables at a single time point. Little research has addressed whether changes in hospital nursing characteristics over time are associated with changes in outcomes. This two-stage panel study, in which cross-sectional samples of patients and nurses in acute care hospitals in Pennsylvania were compared at two time points, provides evidence of the relationship between changes in hospital nursing characteristics and patient outcomes.

The objective of this study was to examine the effects of changes in hospital-level proportion of baccalaureate-prepared nurses, nurse staffing, and the nurse practice environment on changes in rates of failure-to-rescue and 30-day mortality in a surgical oncologic patient population between two points in time. The study was a two-stage panel designed secondary analysis that examined the effect of changes between 1999 and 2006 in nursing characteristics in 135 hospitals on changes in risk-adjusted mortality and failure-to-rescue of 29, 356 adult oncology patients admitted for primary surgical intervention for the purposes of disease management. The study combined information about nursing characteristics from nurse surveys with patient characteristics and outcomes derived from a state cancer registry and hospital discharge abstracts and hospital characteristics drawn from administrative databases. Multivariate regression modeling was employed to jointly assess the effect of changes in the organization of nursing within an institution on outcomes, controlling for both patient and hospital characteristics.

The overall mean percentage of nurses with a baccalaureate degree across hospitals did not change significantly between 1999 and 2006. The mean number of patients per nurse across all hospitals was 5.81 in 1999 and 5.76 in 2006, a non-significant change, with the vast majority of hospitals decreasing or increasing the average number of patients per nurse by less than one patient. Nurse-reported practice environment scores increased significantly during the study period. A number of hospitals had increases in level of nurse education, nurse staffing, and rating of the practice environment over the period, while many others had decreases. Some of the changes in both directions were sizable.

Improvement in nurse staffing was associated with reductions in failure-to-rescue and mortality rates. The addition of one patient to the nurse's average workload resulted in an average increase of 4.34 deaths for every 1,000 patients. For the subset of patients with complications, the addition of one patient to the nurse's average

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workload resulted in an average increase of 13.47 deaths for every 1,000 patients. When controlling for patient characteristics, with every 10% increase in the proportion of nurses with a baccalaureate degree, hospitals had an average reduction of 5.07 deaths for every 1,000 patients. This association was not significant in models that controlled for hospital characteristics. Investments in hospital nursing features including increasing the proportion of baccalaureate-prepared nurses and lowering patient-to-nurse ratios within hospitals may contribute to improvement in outcomes of surgical oncology patients.

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THE EFFECTS OF CHANGES IN THE HOSPITAL NURSING WORKFORCE AND PRACTICE ENVIRONMENT ON THE OUTCOMES OF SURGICAL ONCOLOGY PATIENTS: A TWO-STAGE PANEL STUDY

Jill Marie Vanak

A DISSERTATION

in

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in

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Supervisor of Dissertation

_____

Eileen T. Lake, PhD, RN, FAAN
Associate Professor of Nursing

Graduate Group-Chairperson

_____

Barbara J. Riegel, DNSc, RN, FAAN, FAHA
Professor of Nursing

Dissertation Committee

Ann Kutney-Lee, PhD, RN
Assistant Professor of Nursing

Salimah Meghani, PhD, MBE, RN, FAAN
Associate Professor of Nursing

Kelly Wiltse-Nicely, PhD, MSN, CRNA
Assistant Professor of Nurse Anesthesia

Dedication

To my parents

Your love is like the North Star, you guide me when I'm lost.

In a changing world, you are my constant.

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ABSTRACT

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CHAPTER 1: INTRODUCTION

The Problem

"Cancer begins and ends with people. In the midst of scientific abstraction, it is sometimes possible to forget this one basic fact…" –June Goodfield

Cancer is the second most common cause of death in the United States, exceeded only by heart disease, accounting for nearly 1 in every 4 deaths. (American Cancer Society, 2013). The National Institutes of Health (NIH) estimate that the overall costs of cancer in 2008 (last year available) totaled over 200 billion dollars (Mariotto, Yabroff, Shao, Feuer, & Brown, 2011). A quarter of all American deaths are attributed to cancer, with statistics indicating that 1 in 3 women and 1 in 2 men will develop cancer during their lifetime. (American Cancer Society, 2013).

Efforts to eradicate cancer and demystify the behavior of an illness referred to as "the plague of a generation" (Mukherjee, 2010) have occupied researchers for the past 3000 years. The remarkable progress in the past quarter century has been in the field of cancer biology, including the discovery that cancer represents not one disease but approximately 200 distinct disease processes (Mukherjee, 2010). The knowledge that cancer refers not to one disease process but to unique and separate disease states that share certain commonalities, including the abnormal growth of cells, is not only a scientific breakthrough, but a call to arms for health services researchers. Cancer patients constitute a vulnerable population of individuals whose unique treatment and care requirements warrant study by health services researchers. Advances in the biological

mechanisms surrounding this disease group represent novel work, but the study of cancer and the outcomes of those who are affected by the disease cannot be comprehensively examined without analysis of organizational features and characteristics of the institutions in which they are treated.

It is known that the quality of cancer care varies across hospital organizations (Nattinger, 2003). Due to the paucity of research regarding the causes of variation across hospitals, national quality organizations have urged for an increase in health services research conducted in cancer patient populations (Lipscomb & Snyder, 2002).Given the complexity of health care organizations, the study of methods to improve organizational structure and operation is warranted. The challenge faced by health services researchers is the identification of ways to improve patient care by improving the organizations that provide this care. To date, the health services research work that has been done in this field has focused on surgical procedure volume and individual surgeon volume as factors that contribute to the improvement or worsening of patient outcomes.

Despite growing evidence that nurses play a role in optimizing patient outcomes, research has given little consideration to examining if the organization of nursing care explains, in part, why outcomes for surgical oncology patients with similar risk factors and characteristics are poorer in one hospital than another. Given the known benefits of higher-rated nurse practice environments, lower patient-to-nurse staffing ratios, and an educated nurse workforce on outcomes for a general population of surgical patients, it is appropriate for health services researchers to explore this relationship with a population of oncology patients.

Significance

Cancer patients constitute the fifth largest clinical population in hospitals, but are largely excluded from health services research (The World Health Organization, 2008). Rationale for the exclusion of this population includes a lack of homogeneity between cancer diagnoses and the variation in severity of illness upon diagnosis (National Research Council, 1999). As compared to other populations, the cancer patient is clinically complex in regards to range of comorbidities, length of disease state, treatment effects, and genetic disposition (McCabe et al., 2013). Although deemed a difficult population to study due to the aforementioned reasons, cancer patients, due to their immunocompromised state, are at particularly high risk of developing infection, morbidity, and mortality, and warrant study. Increased burden of illness, high resource utilization, and the chronic nature of the disease provide reasons for inclusion of this population into health outcomes research.

Due to the complex nature of the disease and its management, care of the cancer patient routinely occurs within a hospital. Hospitals are positioned to implement changes that could lead to better care. Researchers must provide the evidence to guide these changes. In 2001, the Institute of Medicine released a report entitled, *Crossing the Quality Chasm*, which identified issues related to quality of care as a systems problem, rather than as an issue of individual competence (Institute of Medicine, 2001). The report posited that health care organizations, such as hospitals, are well poised to effect changes as they represent the link between individual healthcare providers and the larger environment of healthcare (Institute of Medicine, 2001; Hearld, Alexander, Fraser, & Jiang, 2007). Study of the quality of care provided to a cancer patient cannot be

conducted without analyzing the effects of the organizational features of the treating institution on patient outcomes. The organizational structure of a hospital is a complex map composed of departments, personnel, committees, and services. It operates within a hierarchy of personnel, and functions like any large business, with an emphasis not only on patient care but on financial 'bottom line' margins. Major operating divisions of a hospital represent areas of the hospital's functions and include medical, nursing, diagnostic, fiscal, human resource, hotel services, and community relation divisions. In the majority of hospitals, the nursing division compromises the single largest component of the hospital's organization. Nursing is subdivided by the type of patient care delivered in conjunction with medical specialty and patient diagnosis.

The organization of healthcare professionals within the hospital, specifically the nursing workforce, constitutes a structural organization trait that has received scant attention in the study of the patient with a cancer diagnosis. Research on the effects of nursing-specific organizational features on patient outcomes has been done primarily in the context of a general surgical patient population. The majority of studies linking nursing-specific organizational features such as nurses' educational preparation, level of nurse staffing, and the rating of nurse practice environment with patient outcomes have used cross-sectional data in order to report on these associations (Aiken, Clarke, Sloane, Lake, & Cheney, 2008; Needleman & Hassmiller, 2009; Aiken et al., 2012). The level of nurse staffing is the most examined aspect of nursing organization in the existing research, and suggests that decreased rates of mortality and adverse events are associated with better staffing levels (Shekelle, 2013; Aiken, Clarke, Sloane, Sochalski, & Silber, 2002; Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2002). The effects of nurse

education and the nurse practice environment on patient outcomes are understudied. This study's primary aim was not to analyze the effect of nursing-specific organizational features on patient outcomes, but to examine the effect of *changes* in these features on patient outcomes over time. This study fills a void in the literature by providing evidence regarding the effects of changes in hospital organization features, specifically those that focus on the nursing workforce, on the outcomes of failure-to-rescue and 30-day mortality in a population of patients diagnosed with solid tumor carcinomas post-surgical intervention.

Role of the Registered Nurse

No other healthcare provider group offers the same capacity for healthcare delivery as nurses (Armstrong, 2009). Care provided by qualified nurses has the capacity to save lives, prevent complications, save money, and promote wellbeing (Armstrong, 2009). Evaluating the contribution of the nursing profession to the health of a patient is vital analysis at a social and administrative level. As the largest health provider within an institution, omission of analysis of the effect of nursing-specific organizational features on patient outcomes would provide an incomplete review of factors vital to provision of quality care.

The American Nurses Association defines nursing as the "protection, promotion, and optimization of health and abilities, prevention of illness and injury, alleviation of suffering through the diagnosis and treatment of human response, and advocacy in the care of individuals, families, communities, and populations" (American Nurses Association, 2003, p.8). Registered nurses provide direct care to patients through a nursing process that includes assessment, diagnosis, planning, intervention, and

evaluation. In the acute hospital setting, registered nurses act as a “front line defense” or surveillance system for patients, and are an essential component to the timely detection and prevention of complications, adverse events, and untoward treatment effects (Clarke & Aiken, 2003; Kutney-Lee, Lake, & Aiken, 2009). Nurses play a significant role in the provision of highly specialized care to the cancer patient. Knowledge of evidence-based nursing care management and multiple complications is required to care for this population (Rice & Bailey, 2009). The complexity of care for patients with solid tumor malignancies undergoing treatment in the form of surgical intervention requires expert technical competence, clinical judgment, and conceptualization and understanding of the cancer continuum by the nurse (Ezzone, 2004). Nursing interventions and management of hospitalized patients have been described in order to identify the clinical basis for a nursing effect on overall survival and failure-to-rescue in this patient population. Nurses provide complex assessments, patient management, surveillance, hemodynamic monitoring, prevention, and treatment of disease-related and treatment-related toxicities and complications throughout the surgical and post-surgical continuum of care (Ezzone, 2004).

Based on studies conducted in general surgical patient populations that identified superior outcomes for patients cared for in hospitals with better educated nurses, it can be hypothesized that outcomes in the solid tumor cancer patient would improve with the provision of care by better educated nurses. For the purposes of this analysis, better educated nurses are defined as those who obtained a baccalaureate degree as their highest level of education. An aim of this analysis is to determine the effect of changes in the proportion of baccalaureate-prepared nurses within a hospital on outcomes of surgical

oncology patients. It is surmised that those nurses would demonstrate clinical competence and extensive knowledge of the underlying disease processes and treatment effects that occur from the regimens utilized for the purposes of disease remission or curative intent in the surgical oncology patient.

Provision of care to a surgical oncology patient is complex, involving knowledge of underlying disease processes, intervention techniques, and post treatment regimens within the context of the cancer care continuum. Challenges for nurses caring for this patient population include increased patient risk and rate of opportunistic infection and post-surgical complications, documented mortality rates due to treatment-related mortality and the constant communication and continuity of care required throughout each phase of the treatment process. Nurses caring for the cancer patient must be able to address current and forthcoming critical care needs and grasp a complete understanding of the patient as a whole entity with needs both routine and unique. An ability to work effectively with an inter-disciplinary team that functions across the continuum of care is required.

The patient populations examined in this study are those patients with a diagnosis of one of the following types of cancers: head and neck, esophageal, colorectal, pancreatic, lung, ovarian, prostate, and endometrial. All of these cancer diagnoses are classified as solid tumor carcinomas and the majority of these require a surgical procedure as a primary treatment intervention. Inclusion and exclusion criteria for the population of patients chosen for this study is reviewed in a later chapter, but is noted here for the purposes of identifying the importance of the specialized nursing care that is required for a patient with a solid tumor carcinoma who requires surgical intervention.

Nursing care of a cancer patient undergoing a primary surgical intervention as a means of disease prevention, control, or palliation requires an expert level of knowledge in order to engage in the diagnosis, treatment, and care of the patient. The nursing care provided encompasses not only the immediate surgical care that occurs on the operating table, but the pre and post-surgical care of the vulnerable patient. Not only do surgical oncology nurses need to be aware of the development of innovative treatment modalities and the therapeutic agents that require the healthcare professional to be alert to an ever-evolving treatment environment, but he or she must be versed in expected and adverse side effects, symptoms, and complications that occur from said treatment modalities.

Treatment for solid tumor cancers routinely consists of primary surgical intervention, radiation, and numerous cycles of chemotherapy, entailing at minimum, months of dedicated treatment. Cancer patients, specifically those patients undergoing surgical resection, require physical and psychosocial support throughout the length of the inpatient hospital stay and beyond into survivorship. Care received during the acute inpatient period has consequences extending into acute and chronic recovery, with correlation between the number of symptoms experienced and poor functional status and general health being shown (Larsen, Nordstrom, Ljungman, & Gardulf, 2007). Increased symptom distress during surgery has been associated with poor prognosis and may serve as an indicator variable of long-term survival (Molassiotis, Van Den Akker, Milligan, & Goldman, 1997). Nursing interventions and management must address the patient undergoing surgery in a holistic manner, as a number of physical, emotional, and psychosocial stressors are inherent within the treatment process. The notion that nurses perform vital skills that not only improve the quality of patient care but result in

decreased patient deaths is not disputed. Further research into the organizational features that allow for registered nurses to perform to the full scope of their practice and provide the care that prevents complications and saves patient lives is required.

It was an aim of this study to explore the organizational features specific to nursing, including level of nurse education, level of nurse staffing, and rating of the nurse practice environment and how changes in these features affected surgical oncology patient outcomes over time. The impetus for this research study stemmed from previous work by Aiken and colleagues (2008) reporting that nurse leaders have at least three major options for improving patient outcomes: moving towards a more educated nurse workforce, improving the nurse practice environment, and improving nurse staffing (Aiken et al., 2008). This study aimed to develop evidence to support these decisions by analyzing changes in organizational nursing features over time, with an attempt to not only examine how these changes effect patient outcomes but to potentially decipher which of these organizational nursing features, when improved, may lead to the greatest improvement in outcomes. Aiken and colleagues' study (2008) allows one to raise the pertinent question: "If hospital managers changed their recruitment or retention policies to favor bachelor's trained nurses, or put their efforts into improving nurses' environments, or improved nurse staffing levels, would patients benefit? In particular, should managers attempting to optimize patient outcomes choose the latter strategies or the former?" This study contributes new knowledge that will inform health policy makers about the merits of alternative nursing management decisions for health outcomes in a population of patients diagnosed with a solid tumor carcinoma admitted for surgery as a primary disease intervention.

Study Purpose and Specific Aims

Despite the cancer patient's requirement of complex and skilled care, no published study has examined the association between changes in the organization of nursing-specific characteristics and changes in patient outcomes for hospitalized cancer patients undergoing surgical intervention. The objective of this study was to examine whether changes in nursing-specific organizational characteristics including the educational preparation (proportion of nurses with a baccalaureate degree), level of nurse staffing (patient-to-nurse ratio) and rating of the practice environment (Practice Environment Scale of the Nursing Work Index) were associated with changes in surgical oncology patient outcomes, specifically failure-to-rescue and 30-day mortality in a general panel of hospitals. Failure-to-rescue was defined as patient death following the development of at least one of thirty-nine clinical adverse events, such as sepsis and shock (Silber, Romano, Rosen, Wang, Even-Shoshan, & Volpp, 2007).

The use of data at two time points allowed for a panel analysis so that the effects of changes in the nursing-specific organizational characteristics of a hospital on patient outcomes were able to be measured.

The proposed study was a retrospective two-stage panel analysis of secondary data from linked datasets. The following types of data were required for study completion: nurse survey data, patient administrative record data, cancer registry data, and hospital characteristics data. All data pertain to the state of Pennsylvania only.

The study had the following specific aims:

Specific Aim 1:

To describe the changes in hospital nursing characteristics, including nurses' educational level, level of staffing, and nurses' rating of the nurse practice environment, and characteristics of selected surgical oncology patients between 1999 and 2006 in a panel of general hospitals.

Specific Aim 2:

To document how rates of failure-to-rescue and 30-day mortality for selected surgical oncology patients changed in a panel of hospitals between 1999 and 2006, and to analyze whether these changes were associated with changes in nurse educational composition, changes in level of nurse staffing, and changes in nurse practice environment ratings.

Summary

The lack of a systematic and comprehensive examination of nursing workforce characteristics associated with patient outcomes in this population represents a gap in the literature. This study sought to examine the effect of changes in nursing-specific organizational characteristics of a hospital on changes in patient outcomes between the years 1999 and 2006. The longitudinal nature of this analysis provides additional perspective on how nursing care is provided in complex hospital systems over time, and how these changes affect patient outcomes. Evidence that changes in nursing organization are related to improvements as well as the worsening of patient outcomes provides a foundation to support initiatives to improve the organization of nurses in hospitals.

CHAPTER 2: BACKGROUND AND SIGNIFICANCE

Introduction

This study examines the association of changes of nursing-specific organizational characteristics with changes in outcomes for surgical oncology patients, controlling for differences in hospital and patient characteristics between two points in time. This chapter presents the theoretical framework used to guide this study. The innovativeness of the research, including novel concepts that will be added to the field of oncology health services research, is addressed. Literature on the importance of quality cancer care in a surgical oncology patient population, the association between the organization of nursing-specific features within a hospital and patient outcomes, hospital and patient characteristics that predict patient outcomes, and existing health services literature regarding the cancer population is synthesized. The chapter concludes by identifying the gaps in the literature that this study aimed to address.

Theoretical Framework

The conceptual framework used to guide this study is an adapted version of the Quality Health Outcomes Model (QHOM), introduced by the American Academy of Nursing Expert Panel on Quality of Health Care (Mitchell, Ferketich, & Jennings, 1998). The QHOM, adapted from Donabedian's linear model, allows for dynamic relationships with indicators that not only act upon, but also reciprocally affect the various components (Mitchell et al., 1998). Donabedian's model is linear, assuming that structures affect processes, which in turn affect outcomes (Donabedian, 2005). The QHOM suggests a multi-directional relationship between system, patient, intervention, and outcome, positing that interventions do not directly affect outcomes. The model posits that

interventions indirectly affect outcomes as they are mediated by both system and patient characteristics. The QHOM incorporates feedback loops indicating multi-directional relationships between structure, process and outcome variables.

The QHOM was chosen as it can be adapted to represent the complexity of care of the surgical oncology patient in relation to the multiple disease and treatment-related complications he or she may suffer, as well as the number of interdisciplinary interventions and outcomes that occur (Mitchell & Lang, 2004). The QHOM has primarily been used in the description of cross-sectional research studies to represent the dynamic relationship between system, patient, intervention, and outcome at a singular point in time. In the context of this study, the QHOM is used to depict relationships between variables over time.

The QHOM suggests that interventions influence and inform outcomes indirectly through the components of system and patient characteristics. The QHOM fits the current study well because the crux of this study lies in the examination of the relationships between the system, specifically the organization of nursing-specific characteristics, within hospitals, interventions, and patient outcomes. All four constructs are included in the examination of the effect of changes in the organization of nursing characteristics on patient outcomes. Although the bi-directionality of the arrows by Mitchell and colleagues (1998) was implemented to account for the dynamic interrelationships between constructs, for the purposes of this research, the relationship between the listed system, patient characteristics, and patient outcomes is of primary interest and is examined within the context of mediating system and patient characteristics (Mitchell et al., 1998).

This model (see Figure 1) posits that patient outcomes are not directly influenced by the nursing and medical care, or interventions, provided to patients, but are mediated by healthcare system and patient factors. Nursing-specific organizational characteristics including nurse educational composition, level of nurse staffing, and rating of the practice environment, are viewed as an aspect of the system that mediates patient outcomes. For the purposes of this conceptual model, the independent variables for this study, which include changes in level of nurse education, nurse staffing, and rating of the nurse practice environment between two points in time, are categorized as components of the system. It is acknowledged that the care provided by healthcare professionals, including diagnosis, nursing surveillance, monitoring, and treatment are interventions. The purpose of this study however, was to examine the effect of changes in nursing-specific organizational characteristics, or system-wide characteristics, on patient outcomes. The intervention listed in the model is the primary surgical procedure for which the patient population was admitted, as this is a common intervention linking all patients. The effect of interventions on outcomes is not dismissed, but is not directly examined.

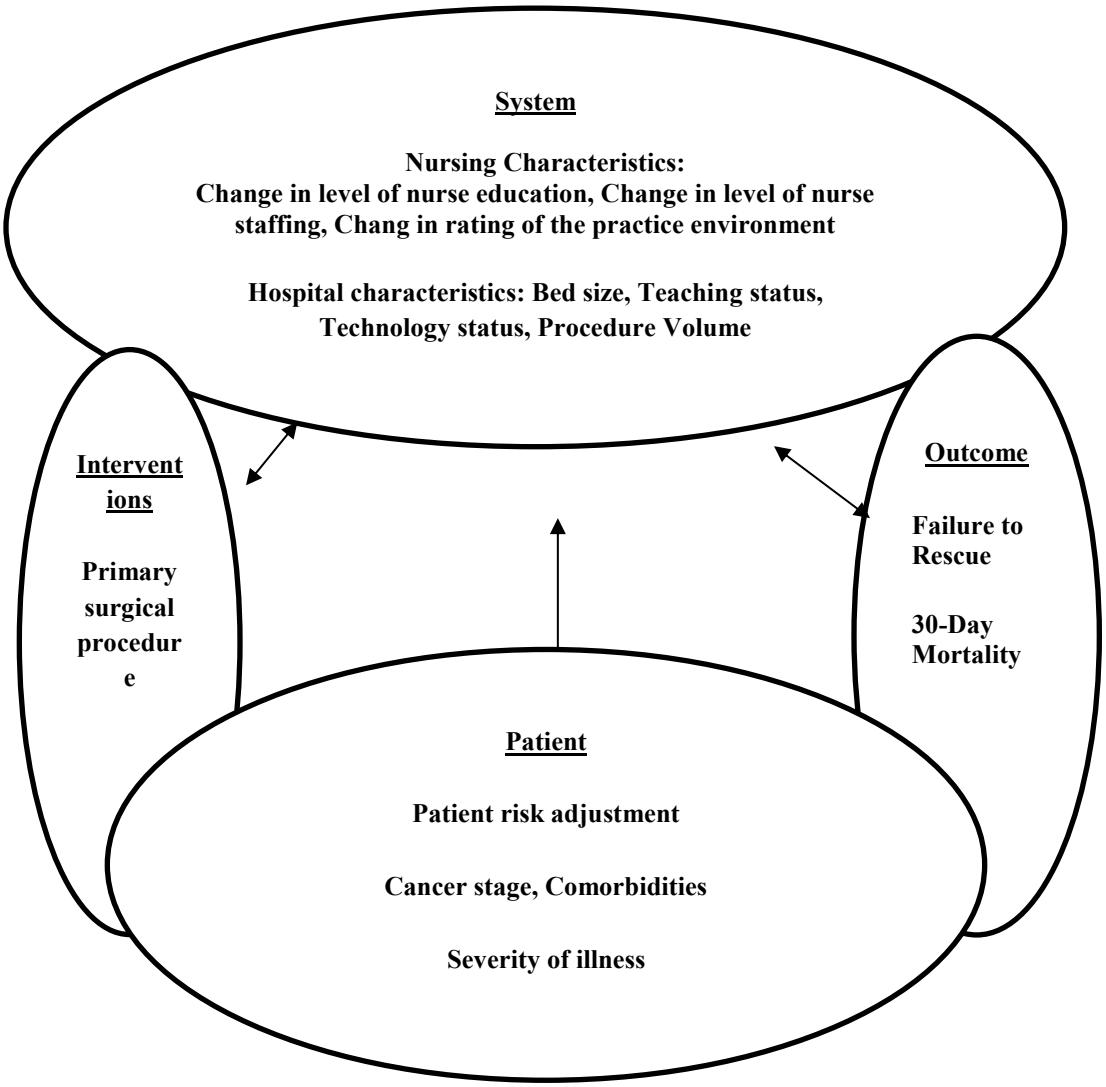
Given the advanced and interdisciplinary nature of modern healthcare, the need for a conceptual framework that allows for dynamic processes to be described is warranted. The QHOM is such a model and can be used to examine care in the hospital setting. The QHOM provides a framework for this study due to its inclusion of facility structural characteristics, client characteristics, processes, and outcomes in a dynamic and non-linear function (Mitchell et al., 1998). Due to the delicate physiologic equilibrium of the patient who presents with an oncologic diagnosis, a view of the linkages among

system, client, intervention and outcomes during the care continuum is needed to guide practice and research.

Figure 1.

Adaptation of the Quality Health Outcomes Model

(Mitchell, Ferketich, & Jennings, 1998)



System

The system component of the framework recognizes the contribution of the structure of an institution and accounts for features of the organization where care and treatment is provided. Examples of system characteristics include the ownership status, bed size, number of medical residents employed, and the type of technology available within the institution or hospital studied. For the purposes of this research, the organization of nurses and nursing characteristics are included within the system construct, as they are viewed as organizational structure components of the healthcare system. The characteristics that this study specifically focuses on include changes in level of nurse education, level of nurse staffing, and rating of the practice environment within individual institutions over time. The nursing characteristics listed under the system component represent these hospital-wide concepts. In this study, the *change* in the nursing-specific organizational characteristics of level of education, level of nurse staffing, and rating of practice environment were considered system components. The author did not view changes in these nursing-specific organizational characteristics as directed interventions, but rather as components that should be attributed to the healthcare system.

The concept of time in this model is represented as changes in nursing-specific organizational characteristics in the system component of the model. Time refers not only to changes that occurred in nursing-specific organizational characteristics over the identified time period, but also to immeasurable changes that developed within the field of oncology, such as the development of improved surgical techniques, within this same period. Data are not available to measure changes in the field of oncology or their impact

in the current study. This represents an inherent limitation of the study, but must be addressed as interpretation of study results must be considered within this context.

Interventions

All patients included in this study shared common interventions, including the performance of a surgical procedure as a primary intervention for disease management, post-operative nursing surveillance, and interventions performed by healthcare providers. Although a multitude of variables are considered interventions, all are not highlighted within the model because they are beyond the scope of this study.

Patient

The patient component of the framework recognizes the contribution of the patient to outcomes, and includes patient demographics, cancer diagnosis, admission severity, cancer stage, comorbidities, and health status. These patient characteristics were included in the patient risk adjustment model.

Outcomes

Mitchell and colleagues (1998) define outcome measures as results of care structures and processes that integrate all aspects of a person's health experience, including social, physical, and physiologic aspects (Mitchell et al., 1998). The outcome component of the framework includes outcomes specific to this study, namely failure-to-rescue and 30-day patient mortality. Patient outcomes may be explained by organizational characteristics including nursing and structure, as well as patient characteristics. It was the intent of this study to determine to what extent changes in nursing-specific organizational characteristics between two points in time contributed to changes in patient outcomes.

Innovation

Research with the use of a two-stage panel design has not been conducted in the study of surgical oncology patient outcomes as related to the organization of nursing-specific characteristics. The results of this study constitute a novel contribution to the field of oncology health services research. While a number of published studies have evaluated the epidemiological trends and patterns of treatment and treatment outcomes in the surgical oncology patient population, none have assessed the impact of changes in nursing-specific organizational characteristics on this population.

Despite considerable evidence that nurses' level of education, level of staffing, and professional practice environment are significantly related to patient outcomes, the evidence has stemmed from cross-sectional data. This has generated enduring uncertainty as to whether efforts to improve these identified nursing-specific organizational characteristics would benefit patients by improving patient outcomes. This study aimed to identify which of these three nursing organization factors had significance to patient outcomes over a period of time, and the degree to which these factors influenced outcomes. The main contribution of this research is the study of these changes and their effects over time. This allows for the establishment of confidence into the temporal relationships between these independent nursing-specific organizational variables. This constitutes a significant contribution to the field of health services research in an oncologic context.

Review of the Literature

Introduction

The associations between changes in nursing-specific organizational characteristics and changes in patient outcomes were examined in this study. This review of the literature identifies existing evidence surrounding each of the components of the QHOM in the context of study variables of interest. The study's contributions to the field of oncology health services research is provided in the context of identified gaps in the literature.

Patient

Surgical Oncology Population Characteristics

"In treating of cancer, we shall remark, that little or no confidence should be placed either in internal….remedies, and that there is nothing, except the total separation of the part affected"—A Dictionary of Practical Surgery, 1836

Patients with a confirmed solid tumor cancer diagnosis admitted to the hospital for surgical intervention for primary disease management were the population of interest in this study. Patients with a diagnosis of one of the following types of solid tumor cancers were included: esophageal, lung, pancreatic, head and neck, prostate, ovarian, endometrial, and colorectal. These cancers were selected based on the reliance of surgical intervention as a standard, critical part of disease management and tumor control. Although each cancer diagnosis listed varies in regards to incidence rate, overall survival, and standard treatment continuum, these oncologic malignancies all represent common cancers that are treated with surgery as the primary treatment modality in the majority of cases, providing a form of homogeneity to the selected population.

Four standard methods of treatment for cancer exist: surgery, chemotherapy, radiation therapy, and immunotherapy/biologic therapy. Surgery is the primary method of treatment of most isolated solid tumor carcinomas, and is the oldest modality of cancer therapy. It is the rare patient with a solid tumor carcinoma whose care does not include a surgical component. It remains a paradigm that more patients are cured by surgery when used as a single treatment, as compared with any other type of cancer therapy (Pollock & Morton, 2000). This treatment method is used not only for curative intent, but also for palliation and prolongation of survival. Localized tumors in early stages of diagnosis may be able to be treated with surgery alone, with curative intent. Treatment for each of the solid tumor cancers varies dependent on patient characteristics, cancer diagnosis, staging, comorbidities, and overall health status.

Surgery, despite its potential curative intent, poses risks to the patient, including immediate operative effects as well as post-surgical complications. Inherent risks from a surgical procedure include complications resulting from anesthesia, the operative process, and immune suppression, amongst others. For a number of cancer diagnoses, the surgical removal of the primary tumor site is imperative for overall survival and/or long-term remission. The avoidance of serious complications in a surgical oncology patient is needed to optimize treatments and increase the odds of survival. Adverse outcomes that result after surgery may result in new comorbidities and complications for this patient population, which have serious consequences on future treatments. Patients often have surgery prior to or in between cycles of chemotherapy, all of which are scheduled at pre-determined intervals to achieve maximum benefit. If delays in time between cycles or in the dosage of systemic therapy able to be administered occur, patient outcomes worsen.

The intensity of radiation therapy and chemotherapy is critical to the effectiveness of cancer management (Budman et al., 1998).

As is noted in the QHOM, optimization of outcomes for patients with solid tumor cancers undergoing surgery for treatment purposes is dependent upon a number of institutional, patient, and structural characteristics. In terms of patient characteristics, specifically the presenting stage of disease, state of overall health, and number of comorbidities mediate a patient's risk for poor outcomes and complications post treatment intervention (Martin, Williams, Haskard, & Dimatteo, 2005). Increased age is associated with an increased risk of both a decline in organ function and with an increase in the number of comorbidities (Mick & Ackerman, 2004). Race appears to play a role in both the incidence rate and mortality associated with cancer burden. Research has shown that African-Americans have the highest odds of death compared to all other groups, and are 33 percent more likely to die from a cancer diagnosis versus their non-Hispanic Caucasian counterparts (American Cancer Society, 2013). Disparities in the cancer burden amongst racial and ethnic minorities represent obstacles to receiving health care services related to cancer prevention and high-quality treatment.

Due to the influence of patient characteristics on outcomes, proper risk-adjustment is necessary to ensure that inherent patient characteristics do not influence relationships between study variables. The presence of co-morbid conditions, age, sex, and race are routinely adjusted for in standard risk-adjustment models employed when studying a population of general surgical patients. Outcome studies relying on administrative data as a primary data source commonly employ one of two risk-adjustment models: the Charlson comorbidity index or the Elixhauser method. A number

of oncologic outcome studies are conducted by investigators within hospitals and are focused on the population within that single-center institution. In cases such as this, the use of clinical data collected from medical record review and/or primary patient data collection is employed in risk-adjustment modeling. The Elixhauser method was chosen for the purposes of risk-adjustment for this study. The Elixhauser method uses 30 co-morbid conditions, treating each as a dichotomous variable in analysis (Elixhauser, Steiner, Harris, & Coffey, 1998). This method has been shown as superior to the Charlson co-morbidity index when studying a medical and surgical patient population (Stukenborg, Wagner, & Connors, 2001), but similar consensus regarding a superior adjustment technique has not been shown within an oncologic patient population. In addition to the Elixhauser method, this study adjusted for age, sex, primary diagnosis, admission status, admission type, disease stage, days from diagnosis to surgical admission, and Medi-qual score. This method of risk-adjustment was validated in prior work done by Friese and colleagues (Friese, Lake, Aiken, Silber, & Sochalski, 2008). In total, 45 variables were included in the risk-adjustment model used for this study.

This secondary analysis accounted for patient characteristics including, but not limited to, age, sex, primary diagnosis, and disease stage, in an effort to differentiate severity of illness amongst patients. In a prospective study, severity of illness would be accounted for with the use of clinical data including relevant laboratory values, cancer-specific variables including treatment regimen and information including actual interventions provided. Distinction between specific treatment interventions (i.e. chemotherapy versus surgery versus radiotherapy), as well as the order in which

treatment regimens were provided to the patient have been identified as important prognostic indicators and would be included in an ideal risk-adjustment procedure.

Continued research is necessary in order to advance the field of cancer nursing and to enhance the nursing profession's impact on patient outcomes. Assessment of the nursing organizational features, specifically the nurse practice environment, level of nurse education, and level of nurse staffing, on patient outcomes while controlling for hospital and patient characteristics over time is lacking in the literature. This research aids in filling this knowledge gap, and reviews the outcomes of patients treated with surgery as a primary intervention for a solid tumor cancer in the years 1999 and 2006. Specifically, the research examines the effects of changes and trends in nursing-specific organizational characteristics over time and their associated effects on changes in the patient outcomes of failure-to-rescue and 30-day mortality.

System

Organizational Structure of Hospitals and Patient Outcomes

The importance of the organizational structure of the healthcare system in which care is provided and its effect on patient outcomes has been demonstrated. Variation in patient mortality has been attributed in part to variation in hospital structural characteristics, namely the teaching status of the institution (Zimmerman et al., 1993). Hospitals with certain structural characteristics, including larger bed size, more physician residents and fellows, and the presence and use of technologically advanced procedures and equipment have traditionally been linked with better outcomes (Wan, 1992; Friese et al., 2008; Ananathakrishnan, McGinley, & Saeian, 2008). This statement becomes muddled when a surgical oncology patient population is introduced, as the majority of

studies focusing on the association of organizational components with patient outcomes have been done with a general surgical patient population. This study built upon a cross-sectional analysis of 1999 Pennsylvania state data in which the effects of nurse education, staffing, and rating of practice environment on patient outcomes were examined. In this earlier study, Friese (2008) identified teaching status as a significant factor in better patient outcomes in a surgical oncology patient population (Friese et al., 2008). The presence of a bone marrow transplant unit, used as a proxy for high technological status of a hospital, as well as bed size, were not significant indicators of better outcomes in models that adjusted for patient and hospital characteristics. This study did not include the presence of a bone marrow transplant unit as a proxy for high technological status of a hospital. Exclusion of this variable was due in part to the fact that this data was not readily available, and that Friese found no significance in prior work. Control for hospital characteristics including bed size, technology status, and teaching status allow for the control of inherent organizational differences. The variables of bed size, technology status, and teaching status do not represent an exhaustive list of variables, but do encompass major organizational characteristics and allow for control of known differences in patient level characteristics that are unable to be directly controlled.

Hospital and Procedure Volume

Associations between hospital volume and acute post-operative outcomes have been well described in the literature. Patients undergoing surgery at high-volume hospitals have lower rates of post-surgical morbidity and mortality than those at lower-volume centers for a number of cancer procedures (Birkmeyer, Sun, Wong, & Stukel, 2007). Confirmation of relationships between hospital volume and operative mortality in

specific types of cancer resection has been shown by a number of large-sample population-based studies (Birkmeyer et al., 2007; Birkmeyer, Dimick, & Birkmeyer, 2004; Hillner & Smith, 1998; Hillner, Smith & Desch, 2000). The number of operations performed in a hospital (i.e. hospital volume), has been associated with outcomes after surgery for cancers of the pancreas, esophagus, prostate, breast, lung, and colon (Hodgson, Zhang, Zaslavsky, Fuchs, Wright, & Ayanian, 2003; Atkins et al., 2004). Better postoperative care and overall survival among patients undergoing surgery at high-volume hospitals has been reported in some studies, but not in others (Hodgson et al., 2003).

More recent studies have extended this evidence by examining the effect of hospital volume on 5-year long-term survival. Although the importance of volume to 5-year survival varied by cancer type, volume-related differences were most significant for esophageal, gastric, pancreatic, and lung cancer surgeries, while the least significant in colon and bladder cancer surgeries (Birkmeyer et al., 2007). Of the studies focusing on the relationship between volume and long-term survival, all found a significant volume-outcome effect for surgical procedures performed for treatment of breast, lung, pancreatic, liver, and rectal cancers (Fong, Gonen, Rubin, Radzyner, & Brennan, 2005; Roohan, Bickell, Baptiste, & Therriault, 1998; Birkmeyer, Finlayson, Tosteson, Sharp, Warshaw, & Fisher, 1999; Bach, Cramer, Schrag, Downey, Gelfand, & Begg, 2001; Simunovic et al., 2000; Schrag, Cramer, Bach, Cohen, Warren, & Begg 2000; Porter & Skibber, 2000). The Leapfrog Group, composed of large U.S. purchasing companies focused on patient safety, has recommended that cancer-related surgeries including esophagectomies and pancreatic duodenectomies be performed in high volume

institutions (Birkmeyer, Birkmeyer, Wennberg, & Young, 2000). Although not included in the Leapfrog Group guidelines, a broader literature review favors hospitals that have a large procedure volume for patients undergoing tumor resection for lung, gastrointestinal, and pancreatic cancers in regards to patient outcomes (Bach et al., 2001).

Understanding the relationship between hospital volume, surgical practice, and outcomes is important for solid tumor carcinomas, as prior studies have found that primary surgical management of these diseases has important effects on tumor control and quality of life. Interpretation of the volume-outcome literature in the context of cancer is complicated by inadequate statistical power, sample heterogeneity, limited adjustment for comorbidity, older data, and lack of population-based sampling techniques (van Heek et al., 2005). Hospital volume is accounted for in this research study as a control variable as the study of volume and its role in patient outcomes was not the objective of this study.

The literature supports a volume-outcomes relationship in the surgical oncology patient population, but organizational factors that might explain that relationship or operate independently, such as nursing workforce composition, have not been explored in a comprehensive manner. Strategies for improving care in all hospitals, even those considered low-volume, are necessary for closing the "quality care" gap. Volume-related differences in mortality may be attributed to a number of factors; including differences in the quality of care patients receive post-surgical intervention. Although the volume-outcome relationship cannot be discounted in the study of surgical oncology patients, the association of hospital and surgeon volume alone does not account for outcome variation. The amount of variation explained by the volume-outcomes relationship is difficult to

ascertain, as the underlying association between the two continues to be examined. It is noted that in the field of oncology, there are existing data that support a volume-outcomes relationship for specified surgical procedures with respect to both institutions and surgeons, but the literature is not consistent (Gruen, Pitt, Green, Parkhill, Campbell, & Jolley, 2009; Birkmeyer, Goodney, Stukel, Hillner, & Birkmeyer, 2005; Birkmeyer, Stukel, Siewers, Goodney, Wennberg, & Lucas, 2003; D'Amico, 2007). Research on the importance and effect of type of physician provider has been done, yielding inconclusive results. For example, in the field of ovarian cancer research, studies have documented superior outcomes for those patients treated by a gynecologic oncologist, but this finding is not consistent across studies (du Bois, Rochon, Pfisterer, & Hoskins, 2009). The role of the nurse and of nursing-specific organizational features has not been comprehensively examined within this patient population.

Limitations inherent to the use of hospital volume as a primary measure include non-standardized measures of volume. Researchers have categorized hospital procedure volume into tertiles, quartiles, and deciles. Limited review of the rationale behind such categorization has made the use of a consistent volume metric difficult to adopt. Interpretation of procedure volume data has proved difficult in that some take results of better outcomes in larger volume hospitals as a supporting factor for regionalization, while others require further exploration into this relationship prior to advocating for a seminal change in the organization of healthcare delivery. Subsequently, volume-outcome relationships may reflect differences in the quality of care patients receive post-surgical intervention. Mechanisms underlying relationships between volume and cancer mortality have not been characterized and remain speculative (Birkmeyer et al., 2007;

Glance, Dick, Osler, Li, & Mukamel, 2006).

To date, research focusing on variation across hospitals for cancer patients has centered on the role of surgical procedure volume. A number of studies suggest an inverse relationship between hospital volume of surgical procedure and mortality, but the relative importance of hospital volume in various surgical procedures is unknown (Birkmeyer et al., 2002). The overarching trend in the literature is that better outcomes occur at high-volume centers, and with surgeons who perform a high number of procedures (Hodgson et al., 2003; Flood, Scott, & Ewy, 1984). Volume has been recognized as an "imperfect correlate of quality" (Hewitt & Pettiti, 2001); however, this, among other compelling findings, leads one to consider additional organizational aspects of care associated with disparate outcomes for oncology patients.

In regards to the institutional characteristics that affect patient outcomes, experts attribute variations in care to a number of factors, with the volume of surgical procedures performed per hospital being the most examined. Research has focused on the effect of hospital procedure volume, physician volume, and hospital structure on outcomes, but has not fully determined the contribution of the organization of nurses and nursing-specific organizational characteristics of an institution on outcomes. Lacking in the literature is examination of the healthcare workforce, specifically nursing characteristics, on patient outcomes. The focus on the nursing workforce as an integral variable in determining the variation in patient outcomes at institutions delves deeper into the characteristics, trends, and differences in resource management. Leading medical centers are distinguished by efficient coordination of care, which results in less delay between treatments. Delays with a non-aggressive, slow-growing cancer might not affect the

patient, but a two-week delay in an aggressive cancer can mean the difference between life and death. The nursing workforce within a hospital constitutes the primary care givers and providers for each individual diagnosed and treated for cancer. Research conducted to explain variations in care provided at institutions is not comprehensive without focusing on the nurse and the nursing workforce.

Outcomes

Organization of Nursing within the Hospital: Nurse Education, Nurse Staffing, and Nurse Practice Environment

Research findings link the organization of nursing care to patient outcomes. The earliest research in this area documented lower mortality rates for Medicare patients in hospitals identified by reputation for good nursing care. These select hospitals were branded as Magnet® hospitals, due to their ability to attract and retain registered nurses in a competitive market during a nursing shortage (Lundmark, 2008; McClure, Poulin, Sovie, & Wandelt, 1983; McClure, 2005). Research indicated that Magnet® hospitals were unique in the presence of such measures as: chief nursing executives involved in hospital-level administrative decisions, tuition reimbursement for continuing education, flexible scheduling, and investment in employees (Kramer & Schmalenberg, 1988; Kramer & Schmalenberg, 1988). Identification of Magnet® hospitals being linked to improved outcomes served as a catalyst for research aimed at exploring *why* these institutions experienced superior results. Nursing-specific organizational characteristics including level of nurse education, level of nurse staffing, and nurse rating of the practice environment were among the first to be identified as individual factors related to patient outcomes. These organizational characteristics and the literature that supports their

inclusion into this research study are reviewed below. The aim of this research was to examine the effects of changes in these three nursing-specific organizational characteristics on changes in patient outcomes including failure-to-rescue and 30-day mortality between two points in time.

Nurse Education and Outcomes

As patient needs and care environments become more complex, nurses are required to attain requisite competencies to deliver high-quality care. Core competencies including leadership, system improvement, health policy, research and evidence-based practice, in addition to competency in specific clinical areas are required by nurses. To respond to the increasing demands of patient care, the Institute of Medicine has called for nurses to achieve higher levels of education (Institute of Medicine, 2010). This "call to arms" was expressed after studies showing empiric evidence of improved patient outcomes with a higher-educated nursing workforce was published. It is theorized that units that house hospitalized patients would experience improved patient outcomes with staff that are educated at a higher theoretical level as compared to those who have not received such education.

Nurses educated at the bachelor's level have earned a 4-year academic degree as compared to nurses who have earned a two-year associate's degree or those who have completed a three-year diploma program. Multiple pathways into entry-level practice exist. Stakeholders including academics, nurses, and nursing organizations have debated the qualifications and level of education required for entry into practice for the past half century. It is recognized that a Bachelor's of Science in Nursing (BSN), although not a panacea for all that is expected of nurses, introduces students to a broad range of

competencies in arenas including leadership, quality improvement, and critical thinking. Based on this rationale, the Institute of Medicine (IOM) and Robert Wood Johnson Foundation (RWJF) have created a goal of 80% of registered nurses attaining a baccalaureate degree by the year 2020 (Institute of Medicine, 2010).

The first study to empirically demonstrate the effect of a higher proportion of baccalaureate-prepared nurses on patient outcomes was conducted by Aiken and colleagues (Aiken, Clarke, Cheung, Sloane, & Silber, 2003). Results from this study showed that higher proportions of nurses within hospitals who held a baccalaureate degree were associated with lower surgical mortality and failure-to-rescue rates (Aiken et al., 2003). Specifically, study authors found that in hospitals, a 10% increase in the proportion of nurses holding a BSN degree decreased the risk of both failure-to-rescue and patient mortality by 5% (Aiken et al., 2003). A follow-up study to this seminal work performed by Aiken and colleagues confirmed previous findings published in 2003, with findings indicating that for every 10% increase in the proportion of BSN-prepared nurses in a hospital, risk of death was decreased by 4% (Aiken et al., 2008). A number of follow-up studies to Aiken's 2003 publication have been conducted by both national and international researchers, with the majority confirming initial findings of a firm link between the level of nurse education and patient outcomes (Estabrooks, Midodzi, Cummings, Ricker, & Giovannetti, 2005; McHugh, Brooks Carthon, Sloane, Wu, Kelly, & Aiken, 2012; Tourangeau et al., 2007). Research with a primary focus of examination of the effect of nursing practice environments on outcomes of inpatient surgical patients by Friese subsequently found that level of nurse education was significantly associated

with patient outcomes including decreased failure-to-rescue and 30-day mortality rates (Friese et al., 2008).

The effect of nurse education has served as a mediator in studies examining the effects of both specialty certification and Magnet® status on patient outcomes. Authors of a 2011 study examining the effects of nurse specialty certification on failure-to-rescue and mortality concluded that no effect of specialty certification was seen in the absence of baccalaureate education (Kendall-Gallagher, Aiken, Sloane, & Cimiotti, 2011). Superior outcomes observed in Magnet® hospitals have been attributed, in part, to a higher proportion of baccalaureate-prepared nurses within that institution. Magnet® hospitals are healthcare facilities designated by the American Nurses Credentialing Center (ANCC) as 'models' of patient care due to the demonstration of excellence in more than 35 areas of patient-centered care. A number of studies have examined the link between recognition of Magnet® status to a hospital and its effect on patient outcomes (Boyle, Gajewski, & Miller, 2012; McHugh et al., 2012). In one such study, surgical patients cared for in Magnet® hospitals were shown to have 14% lower odds of 30-day mortality and 12% odds of failure-to-rescue as compared with patients cared for in non-Magnet® hospitals (McHugh et al., 2012). Data show that Magnet® hospitals routinely employ a higher proportion of baccalaureate-prepared nurses as compared to non-Magnet® hospitals, 59% as compared to 34% (American Association of Colleges of Nursing, 2011).

The majority of studies examining the association of level of nurse education on outcomes have used mortality as a primary outcome, but additional outcome variables have recently been assessed. Researchers have found that a higher percentage of

baccalaureate-prepared nurses within hospitals have been associated with superior outcomes including decreased rates of failure-to-rescue, decreased development of preventable complications including decubitis ulcers, deep vein thrombosis, pulmonary embolism, and decreased length of stay (Blegen, Goode, Park, Vaughn, & Spetz, 2013). Advantages of an increased proportion of baccalaureate-prepared nurses within a hospital extend not only to patients and patient outcomes, but to nurses themselves. Studies have shown that baccalaureate-prepared nurses have stronger communication and problem-solving skills, higher proficiency in the ability to implement nursing diagnoses and evaluate nursing interventions, stronger professional-level skills, and higher competency in nursing practice, communication, leadership, professional integration, and research (Johnson, 1988; Giger & Davidhizar, 1990; Phillips, Palmer, Zimmerman, & Mayfield, 2002). The majority of research linking level of nurse education to patient outcomes has been cross-sectional in nature. A novel study integrating the use of longitudinal data that compared repeated cross-sectional samples of patients and nurses in the same acute care hospitals in Pennsylvania at two points in time, found that a 10% increase in the number of nurses holding a baccalaureate degree in nursing within a hospital was associated with a reduction of 2.1 deaths for every 1000 patients (Kutney-Lee et al., 2013). For a subset of patients with complications, the same 10% increase in baccalaureate-prepared nurses was associated with a reduction of 7.47 deaths per 1,000 patients (Kutney-Lee, Sloane, & Aiken, 2013). The use of longitudinal data provides increased evidence to the link between level of nurse education and patient outcomes, enhancing the preliminary argument for causality. This study sought to build upon Kutney-Lee's prior research,

incorporating longitudinal data in the examination of the effect of changes in nursing-specific organizational characteristics on patient outcomes.

Further study regarding the mechanisms that underlie the association between level of nurse education and patient outcomes is required. It is surmised that the development of increased communication skills, professional leadership, and higher competency in nursing practice contribute to this relationship. The role of the nurse as a surveillance system able to observe, intervene, and manage acute changes in patient clinical conditions has been understudied in oncologic research. It has been surmised that patient outcomes can serve as a proxy for the measure of nursing surveillance capabilities. The role of nurse surveillance may prove to be a critical piece in the mediation of patient outcomes that has not been comprehensively explored. Further research regarding the mechanism of action involved in the link between level of nurse education and patient outcomes is warranted. Based on the accumulation of research confirming the link between level of nurse education and patient outcomes, however, movement towards a nursing workforce in which a high proportion of staff are baccalaureate-prepared would appear to result in improved patient outcomes, including decreased rate of failure-to-rescue and mortality.

Nurse Staffing and Outcomes

Given the acuity of the cancer patient, the role of the health services researcher is to decipher what variables improve nursing care and outcomes for this population. Research has shown a correlation between nurse staffing ratios and patient outcomes. As of the year 2007, more than 45 studies exploring the relationship between hospital nurse staffing and patient outcomes have been conducted in the United States (Unruh, 2008).

Literature supports that nurse staffing has a definitive, measurable impact on patient outcomes including length of stay, rate of infection, failure-to-rescue, and mortality. Nurse staffing has been linked to nurse outcomes including medical errors, nurse burnout, and turnover. Seminal evidence in the study of a general surgical population documented that in hospitals with high patient-to-nurse ratios, surgical patients had higher odds of mortality and failure-to-rescue versus those centers with lower staffing ratios (Aiken, Clarke, Sloane, & International Hospital Outcomes Research Consortium, 2002). This study was replicated in the intensive care unit (ICU), confirming that the increase of each patient to a nurse's caseload increased the odds of dying by 9% (Cho, Hwang, & Kim, 2008).

A new systematic review of the literature completed in 2013 indicates that substantial evidence that links low nurse staffing levels to the outcomes of failure-to-rescue as well as inpatient mortality rates exists. From 550 titles, 87 articles were reviewed; including 15 new studies augmenting 2 previous systematic reviews. No studies reported serious harm associated with an increase in nurse staffing. The strongest evidence supporting a causal relationship between higher nurse staffing levels and decreased inpatient mortality is from a longitudinal study in a single institution and a meta-analysis that found a "dose-response" relationship in observational studies of nurse staffing and death (Shekelle, 2013).

The "gold standard" measure in health service outcomes research is mortality, specifically 30-day mortality. Substantial evidence linking better nurse staffing (Aiken et al, 2002; Harless & Mark, 2010; Kovner & Gergen, 1998; Mark, Harless, McCue, & Xu, 2004; Needleman et al., 2002; Unruh, 2003; Kane, Shamliyan, Mueller, Duval, & Wilt,

2007; Liang, Tsay, & Chen, 2012; Lang, Hodge, Olson, Romano, & Kravitz, 2004; Seago, Williamson, & Atwood, 2006; Stanton, 2004), better nurse practice environments (Aiken et al., 2008; Friese & Aiken, 2008), and a higher proportion of BSN educated nurses (Aiken, Cimiotti, Sloane, Smith, Flynn, & Neff, 2011; Aiken et al., 2003; Van den Heede et al., 2009; Unruh, 2003) to patient outcomes exists. The majority of these studies were conducted on medical-surgical patient populations in acute care hospitals. The use of in-hospital mortality as an outcome measure has been used by researchers, with findings noting that the association between nurse staffing and skill mix and in-hospital patient mortality depends on whether the analysis is conducted at the hospital or unit level (Sales et al., 2008). The unit and patient population most often studied in regards to the organization of nursing workforce and patient outcomes is the critical care population. Review of nurse staffing and patient outcomes in a critical care population demonstrates an association of nurse staffing in the intensive care unit with patient outcomes and is consistent with findings in studies of the general acute care population (Penoyer, 2010; Hugonnet, Uckay, & Pittet, 2007; Manojlovich, Antonakos, & Ronis, 2010; Manojlovich & DeCicco, 2007).

It is important to note that the study of staffing ratios has not provided a standardized finding as to what the "appropriate" patient-to-nurse ratio is. Additional study of the effect of nurse staffing on a number of different patient populations will aid in this question. Literature to date has led to a consensus that a range of 4 to 6 patients per nurse in the majority of acute care hospital inpatient units, with no more than one to two patients per nurse in areas of high patient acuity is acceptable (Curtin, 2003). Ratios must vary by unit and patient population however, as they are unique to the needs of varying

patient populations, and must be modified based on patient characteristics, organization characteristics, the provider's level of experience, and the environment in which multi-disciplinary care is delivered.

The majority of research to date has focused on the effect of nurse staffing on a general patient population, limiting the generalizability of findings to an oncologic patient population. Seminal work in the examination of nursing-specific organizational characteristics on outcomes in a surgical oncology patient population includes research by Friese and colleagues. In a study using 1999 Pennsylvania PHC4 inpatient discharge and cancer registry data, Friese showed that significant predictors of 30-day mortality included the poorest category of nurse staffing and unfavorable nurse practice environments. An increased proportion of nurses with a baccalaureate degree or higher was associated with a decreased odds of 30-day mortality. Unfavorable nurse practice environments and nursing education were significant predictors of failure-to-rescue in a surgical oncology patient population (Friese et al., 2008). This study built upon the earlier work completed by Friese and contributes to a growing body of evidence focusing on the effect of nurse staffing on an oncologic patient population. Although similar data from the year 1999 was used for both studies, this study focused on the effect of changes in nursing-specific organizational characteristics on patient outcomes in a surgical oncology population. Notably, effects of nurse staffing on both failure-to-rescue and 30-day mortality were found to be statistically significant, differing from the earlier work of Friese (Friese et al., 2008).

Consensus indicates that staffing levels are an important and often statistically significant independent variable in the study of patient outcomes. A review of existing

literature indicates that lower staffing levels across units are associated with increased risk for poor patient outcomes (Clarke & Donaldson, 2008). Nurse staffing as a variable significant in the study of patient safety, practice, and research has been shown in a plethora of studies, however, aspects of hospital working conditions beyond that of staffing do affect outcomes regardless of nurse staffing levels. Further research using nursing unit level specific data is warranted. The mix of patients at different stages of the cancer continuum requires continuous review of staffing requirements in order to maintain patient safety and improved patient outcomes.

The Nurse Practice Environment and Patient Outcomes

An effective nurse practice environment is central to the care and management of the hospitalized patient. A quality nursing practice environment is defined as a practice environment that has the organizational and human support allocations necessary for safe, competent, and ethical nursing care (Lake, 2007). Research has shown that the quality of care that registered nurses and other healthcare professionals can provide is directly impacted by the quality of the practice environment (Aiken et al., 2002; Aiken et al., 2008). In addition to a link to quality of care and patient outcomes, the quality of the practice environment has been associated with nurse job satisfaction, nurse burnout, productivity, recruitment, and retention of nurses (Brooks & Anderson, 2005).

A professional practice environment supports nurses to function at the highest scope of clinical practice, to work effectively in an interdisciplinary team of caregivers, and to mobilize resources quickly (Lake, 2007). The American Association of Colleges of Nursing's (AACN) Hallmarks of the Professional Practice Environment is a comprehensive set of characteristics that are outlined, identifying what is necessary to

allow nurses to practice to the full range of their education and experience level. The eight hallmarks are: (1) manifest a philosophy of clinical care emphasizing quality, safety, interdisciplinary collaboration, continuity of care, and professional accountability; (2) recognize contributions of nurses' knowledge and expertise to clinical care quality and outcomes; (3) promote executive-level nursing leadership; (4) empower nurses' participation in clinical and organizational decisions; (5) maintain clinical advancement programs based on education, certification, and advanced preparation; (6) support nurses' professional development; (7) create collaborative relationships within the health care provider team; and (8) use technological advances in clinical care and information systems (American Association of Colleges of Nursing, 2011). Creating this type of practice environment within a specialized unit that requires expert care of surgical oncology patients at risk for increased morbidity and mortality throughout the acute treatment process is imperative to improved patient outcomes.

Aiken and colleagues (1994) attributed better outcomes in Magnet® hospitals to a combination of organizational attributes where nurses experienced increased autonomy, control over their practice environment, and a collegial relationship with physician colleagues (Aiken, Smith, & Lake, 1994). Following the research documenting lower Medicare mortality in Magnet® hospitals (Aiken et al., 1994) a similar study examining the outcomes of patients hospitalized in dedicated AIDS units was conducted. Lower mortality and increased patient satisfaction were observed in both Magnet® hospitals and in hospitals with dedicated AIDS units as compared to hospitals where the care of patients with AIDS occurred throughout a variety of hospital units (Aiken, Sloane, Lake, Sochalski, & Weber, 1999; Aiken & Sloane, 1997). These seminal studies on Magnet®

and Magnet®-like institutions are considered the first to establish a link between the nurse practice environment and nurse and patient outcomes (Cheung, Aiken, Clarke, & Sloane, 2008). Research cited above was based on a conceptual framework developed by Aiken and colleagues that hypothesized that the specialization of nurses affected outcomes by improving nurse autonomy, strengthening multi-disciplinary relationships amongst providers, and by granting increased control of institution-wide resources to nurses (Shang, Friese, Wu, & Aiken, 2012; Aiken Clarke, & Sloane, 2000). Aiken and colleagues reported that changes in nurse practice environments required evolution of the inter-professional culture and development of increased autonomy and care management decisions to be given to those providers closest to patients, or nurses (Aiken et al., 2011). As evidenced in previous research conducted within Magnet® hospitals, a number of institutions seeking to improve practice environments have found effective strategies for change within the Magnet® Recognition Program guidelines published by the AACN.

Publication of the Institute of Medicine's *Quality Chasm* report (2001), which cited that both poor nurse staffing and poor nurse practice environments threaten patient safety, spawned additional investigation into components and effects of the practice environment (Institute of Medicine, 2003). Practice environment research has expanded in scope beyond the study of Magnet® hospitals to more broadly describe practice environments as well as to link variation in practice environments to other nursing-specific organizational characteristics such as nurse staffing. It is surmised that practice environments, through the support of professional nursing practice, affect healthcare providers, patients, the use of resources, and the context for which nursing care is delivered. Development of instruments to aid in the measurement and scoring of the

nurse practice environment focused on examination of the link between nurse practice environments and nurse and patient outcomes. The Practice Environment Scale-Nursing Work Index (PES-NWI) is a 31-item instrument used extensively in research since the year 2002, and is meant to ascertain the presence of specific organizational characteristics within an institution. This study reports on the nurse practice environment as an aggregated value of nurse responses to the PES-NWI scale found within both 1999 and 2006 nurse surveys (Lake, 2007).

Relationships between practice environments and both nurse and patient outcomes have been demonstrated in previous studies. Prior research has shown that hospitals with nurse practice environments deemed poor were more inclined to have higher mortality rates as well as higher rates of nurse turnover, job dissatisfaction, and burnout (Lake, 1998; Aiken et al., 2002; Aiken, Xue, Clarke & Sloane, 2007). Conversely, nurses employed in hospitals with a practice environment rated as favorable were less likely to report needlestick injuries (Aiken, Sloane & Klocinski, 1997). A limited number of studies have examined the association between nurse practice environments and outcomes for hospitalized cancer patients. Friese and colleagues (2008) completed the first published study to date linking the nurse practice environment and outcomes for surgical oncology patients (Friese et al., 2008). Findings noted a significant association between the quality of the nurse practice environment and outcomes, including failure-to-rescue and 30-day mortality (Friese et al., 2008). The majority of research in the field of oncology linking nurse practice environments with outcomes has focused on nurse outcomes rather than patient outcomes. This may be due, in part, to calls by the Institute of Medicine and the National Cancer Policy Board to researchers to

engage in research that will provide strategies to increase the number of oncology providers in the workforce (Institute of Medicine, 2009). A shortage of sufficiently trained oncology healthcare providers was identified, and a key strategy to improve numbers of available professionals included policies aimed at retention. Subsequent studies that have reported on nurse outcomes in oncology settings have found significant relationships between unfavorable nurse practice environments and adverse nursing outcomes, including increased rates of emotional exhaustion, job dissatisfaction, and an intent to leave one's current oncology nursing role (Shang et al., 2012). A limited number of studies have identified a link between favorable nurse practice environments and superior nurse outcomes, but these studies have been limited by small sample sizes or a focus on singular, rather than joint, nurse outcomes (Shang et al., 2012). Cross-sectional analysis has remained the main-stay for research examining the association of practice environment on outcomes. Methodology incorporating longitudinal data was conducted in 2012 by Kutney-Lee and colleagues, with findings indicating that in hospitals where the practice environment improved over a period of time, rates of adverse nurse outcomes, including burnout, intention to leave, and job dissatisfaction decreased concurrently (Kutney-Lee, Wu, Sloane, & Aiken, 2013).

Study of the effect of the practice environment on patient outcomes has examined the effect of environment on outcomes in isolation, in conjunction with other nursing-specific organizational characteristics, and as a mediating factor. The three nursing-specific organizational characteristics of level of nurse education, staffing, and practice environment, have each been shown to independently contribute to improved patient outcomes (Aiken et al., 2008). Aiken and colleagues advanced existing research

acknowledging that better staffing, better educated nurses, and better work environments were all shown to independently improve outcomes, by studying the effect of the conditions under which they were associated with patient outcomes (Aiken et al., 2011). Results from this cross-sectional analysis revealed a consistently positive effect of increased proportion of baccalaureate-prepared nurses on patient outcomes, but found that improving patient-to-nurse ratios significantly improved patient outcomes in hospitals with good practice environments, slightly improved them in hospitals with average practice environments, and had no effect in hospitals with poor practice environments (Aiken et al., 2011). Research as to the effect of the nurse practice environment on patient outcomes as a mediating, or conditional variable, is warranted.

It is surmised that favorable practice environments can aid in achieving superior nurse outcomes, including improved retention, nurse well-being, and quality of care. Continued research on the effect of nurse practice environments and their relationship with outcomes for hospitalized oncology patients is warranted. This study aimed to assist in filling this void in the literature by examining the effect of changes in nurses' practice environments and their relationship with outcomes of surgical oncology patients over time.

Oncology Health Services Research

Review of Oncology Health Outcomes Literature

Gaps in the Literature

The major emphasis of cancer research has primarily been on the development, testing, and dissemination of new cancer treatments, with an emerging focus on the prevention and early detection of cancer (Potosky, Riley, Lubitz, Mentnech, & Kessler,

1993). Research into the optimal provision of healthcare to an oncologic patient population has been brought to the forefront by accredited organizations including the National Comprehensive Cancer Network (NCCN) and the American Society of Clinical Oncology (ASCO) amongst others. Recognition that the complete evaluation of cancer care requires application and further development of appropriate methods that incorporate many different areas of research, including clinical trials, clinical practice, and examination of administrative data, has served as the impetus behind the support of outcomes research in the field of oncology. Collaboration between clinicians, economists, and outcomes researchers is necessary if healthcare organizations, providers, and ultimately, patients, are to benefit from current research analysis.

As healthcare costs rise, emphasis has been placed on the study of the outcomes of medical and surgical patients in order to ascertain factors that determine quality and appropriateness of care. Oncology health services research is a field of science that analyzes cancer treatment and outcomes using administrative and clinical databases. The majority of studies to date have focused on defining the role of health insurance in cancer disparities, including studies examining relationships between insurance status, socioeconomic status, and quality of care and cancer outcomes (Lipscomb & Snyder, 2002). Outcomes research involving an oncologic patient population is unique in regards to the complexity of scientific evaluation of cancer care. Healthcare outcomes such as failure-to-rescue and mortality are the end result of a complex interaction between patient, provider, treatment, and the healthcare system as a whole. Marked variations in patient outcomes after surgical oncologic procedures have been attributed to individual surgeon and institution characteristics, namely procedure volume, but a call for a more

comprehensive examination of patient outcomes and influential factors is needed. Cancer research provides a unique arena in which to study the effects of infrastructure, or system, changes associated with surgery, including imaging and diagnostic techniques, radiotherapy, medicines, and organizational aspects of care, such as nursing-specific organizational features of an institution.

Frequent sources of outcome data in the field of oncologic outcomes research include insurance company data and administrative databases. Limitations include a lack of vital patient information contained only in clinical data sources. In answer to this, the Surveillance, Epidemiology, and End Results (SEER) Program, a database created by the National Cancer Institute and the Centers for Medicare and Medicaid, has become the prevalent data source for oncology health services research studies. The SEER Program is a system of population-based tumor registries that collect standardized clinical information on cases diagnosed in separate, geographically defined areas covering approximately 25% of the U.S. population (Potosky et al., 1993). The ability to link the SEER Program database to Medicare data has expanded the database resources that researchers are able to access, providing more complete information regarding patient course of treatment, presence of comorbidity, and subsequent health outcomes and survival information. The advent of state cancer registries and improved data collection by state Departments of Health has allowed for data not included in the SEER Program data registry to be linked to claims data, allowing for additional research databases to be developed (Haggstrom & Doebbeling, 2011; Hillner et al., 1997). To date, the SEER Program database and the SEER-Medicare database have primarily been used in identifying treatment effects for patients with specific cancer diagnoses. The majority of

publications have focused on the breast cancer population, and although clear differences in outcomes and care between patients have been uncovered through these linked databases, generalization of findings has not been proven. A staple of oncology health services research has been review of hospital procedure volume and its effect on patient outcomes with specific oncologic surgeries (Bach et al., 2001; Hillner & Smith, 1998; Schrag et al., 2000). Similar to earlier research regarding the Magnet® status of a hospital, researchers began to focus on patient outcomes in cancer centers designated as National Cancer Institute comprehensive cancer centers (Birkmeyer, et al., 2005). Birkmeyer and colleagues (2005), using Medicare data from 1994-1999 calculated 30-day and 5-year mortality rates for patients undergoing gastrectomies, cystectomies, colectomies, esophagectomies, pulmonary and pancreatic resections. Results indicated that those who had procedures performed in NCI-designated cancer centers had significantly lower odds of 30-day mortality versus those treated in non-NCI centers with a similar number of procedures performed (Birkmeyer et al., 2005). Friese (2005) identified NCI-designated status as a statistically significant indicator of lower odds of death and failure-to-rescue in a surgical oncology patient population extracted from a panel of hospitals in the state of Pennsylvania (Friese, 2005; Friese et al., 2008). Besides the recent work of Friese (2008), no other oncology health services research studies conducted with linked datasets have examined organizational aspects of care, including measures related to the organization of nursing care. Rationale for controlling for hospital characteristics is partly due to known differences in patient level characteristics. Data regarding the difference in patient characteristics between those persons who receive treatment at academic medical centers versus a community setting is needed. Statistics

indicate that 85% of cancer patients are diagnosed and receive initial treatment in community medical centers, yet greater than 50% of patients enrolled in clinical trials receive care at academic or NCI-designated cancer research centers. Additional research into patient preferences is needed in order to decipher which patients are more likely to seek treatment at academic medical centers versus community hospitals. In this study, risk adjustment including hospital characteristics was meant to account for these inherent differences.

This study is unique in regards to its ability to assess changes in nursing-specific organizational characteristics on changes in outcomes related to a hospitalized surgical oncology patient population. Few studies not classified as single-institution studies have been able to simultaneously assess the effects of multiple components of the organization of nursing within an institution on patient outcomes. The ability of the study to adequately control for patient, nursing, and hospital characteristics represents a novel methodological approach in the field of oncologic health services research.

Summary

Variations in rates of post-surgical mortality amongst surgical oncology patients in hospitals indicate that the safety of cancer surgery could be significantly improved. Efforts to improve quality are hindered due to a knowledge gap concerning the underlying mechanisms that cause variations in hospital performance and patient outcomes. The lack of longitudinal studies linking the organization of nursing characteristics and patient outcomes in the existing literature base is evident. Studies that aim to establish a correlation between nursing factors and patient outcomes, providing evidence that improvements in the level of workforce education preparation, the level of

nurse staffing, and the hospital nurse practice environment are associated with reductions in poor patient outcomes over time in a surgical oncology patient population by analyzing hospitals at different points in time is warranted. Development of an improved understanding of clinical mechanisms that underlie the variation in patient outcomes in the surgical oncology population will allow for improvement in evidence-based practice and medical management of cancer patients. Answers to pertinent questions such as "Do high mortality rates in institutions vary because of preventable surgical complications? Do hospitals with high mortality rates have higher failure-to-rescue rates or is there no relationship? Are these outcomes affected by the organization of nurses within the institution?" are ripe with implications for policymakers, healthcare administrators, and providers. This study adds to the current evidence-base of existing knowledge by examining the association between *changes* in nursing-specific organizational features and their relationship with *changes* in failure-to-rescue and 30-day mortality in selected surgical oncology patients cared for in 135 hospitals within the state of Pennsylvania between 1999 and 2006. By both separately and jointly assessing the effect of change in nursing-specific organizational characteristics on patient outcomes over a specified period of time, this study was able to provide additional evidence to the existing literature base regarding the organization of nursing and its effect on outcomes. Factors cannot be examined in isolation, as a number of system, patient, and external level factors can and do effect outcomes. Nurses constitute the largest providers of care within institutions. By failing to examine the organization of nursing within an institution, variation in patient outcomes for an oncologic patient admitted to the hospital for primary surgical intervention cannot be fully explained. The use of the QHOM and the integrative

approach of joint system, patient, and nursing-specific characteristics on examination of patient outcomes in this study allows for dynamic study of the effect of changes in system re-organization over time.

CHAPTER 3: METHODS

Research Design and Methods

This chapter outlines the methodology and design of the study, which sought to understand the relationship between changes in nursing characteristics over a period of time and their associations with changes in patient outcomes in the hospital setting. Rationale for the study design, review of databases, and descriptions of the variables and measures that were used are discussed. A data analysis plan for completion of the study's specific aims is presented.

Overview

A retrospective, two-stage panel design analysis involving the following four data sources from 1999 and 2006 was conducted for this research: nurse survey data, cancer registry data, administrative patient discharge data, and the American Hospital Association (AHA) annual survey data. There were 135 hospitals for which all four sources of data were complete and available at both points in time.

The nurse survey and AHA dataset were accessible to the author as they had been requested and stored securely in the Center for Health Policy and Outcomes Research at the University of Pennsylvania School of Nursing by principal investigators from earlier studies (Aiken et al., 2002; Aiken et al., 2011). The cancer registry and administrative patient discharge data were requested and obtained by the author through the Pennsylvania Department of Health for use in this study. The study was reviewed and approved by the Institutional Review Board (IRB) at the University of Pennsylvania as an expedited review protocol, as all data were secondary in origin.

Data Sources and Study Population

Four data sources were merged to create a database for each survey year to support the study objectives and specific aims. Four data sources were merged by linking a unique hospital identification code contained within each dataset. The unique datasets included in this study include:

1. Nurse survey data:
    a. Pennsylvania Registered Nurse Survey (1999)
    b. Multi-State Nursing Care and Patient Safety survey, a four-state survey of nurses' working conditions from registered nurses (2006)
2. Pennsylvania Cancer Registry data (1999; 2006)
3. Pennsylvania Health Care Cost Containment Council (PHC4) inpatient discharge data (1999; 2006)
4. American Hospital Association (AHA) Annual Survey of Hospitals (1999; 2006)

Nurse Survey Data

Pennsylvania Registered Nurse Survey (1999)

Multi-State Nursing Care and Patient Safety Survey (2006)

The Pennsylvania Registered Nurse Survey developed by researchers within the Center for Health Outcomes and Policy Research at the University of Pennsylvania, was mailed to a random sample of 50% of all licensed registered nurses in the state in the year 1998. Responses were received from 42,329 registered nurse respondents, constituting a final response rate of 52% (Aiken et al., 2002). In 2005, the Multi-State Nursing Care and Patient Safety survey was mailed to a random sample of 40% of all licensed nurses in

Pennsylvania and California, 50% in New Jersey, and 25% in Florida (Aiken et al., 2011). The sampling frame consisted of state licensure lists for the year 2006. Nurses were surveyed by mail at their home residences. The response rate was 39%, with a follow up random sample-survey of non-respondents from Pennsylvania and California, which received a response rate of 91%, and found no response bias (Smith, 2008).

Approximately one-third of the respondents on both surveys worked as staff nurses in general acute care hospitals, comprising our analytic sample. There were, on average, 82 and 47 respondents from each of the 135 hospitals in 1999 and 2006, respectively. Responses from both survey years were used to measure staffing of registered nurses, rating of the professional nurse practice environment, and characteristics of the nurse workforce within each hospital, including highest degree earned in the field of nursing.

"Nurses" refers exclusively to registered nurses (RNs). The sample was drawn from a list of all RNs that was obtained from the state RN licensing board. The sampling frame included all licensed nurses who held an active RN license and had a mailing address in the state. State boards do not collect information on employment status of nurses (e.g. whether and where they work); therefore, in order to ensure a sufficient number of responses from nurses practicing in all hospitals, large samples were drawn. In 2005, surveys were mailed with an accompanying cover letter explaining the purpose of the survey, its voluntary nature, and the protection of anonymity. A postcard reminder was sent out two weeks later to non-respondents to encourage their participation. A follow-up mailing was sent to all remaining non-respondents, followed by a second reminder postcard to all non-respondents.

The survey contained skip options to enable respondents to proceed page by page regardless of their place of work, position, or role. Major categories of questions in the survey included: 1) characteristics of the respondent's present position, work experience, and demographic information; 2) the Practice Environment Scale of the Nursing Work Index (PES-NWI) 3) details about the last shift worked, including number and care needs of patients, non-nursing tasks performed, and necessary nursing care left undone; 4) nurse assessments of quality of nursing care and patient readiness for discharge; 5) nurse job outcomes (e.g., burnout, needlestick injuries, job satisfaction, intent to stay); and 6) frequency of patient adverse events.

To obtain measures of nurse practice environments and the process and quality of care in hospitals, it was critical to link each survey from a hospital staff nurse to the specific institution where she or he works. Respondents who worked in hospitals identified the hospital where they were employed (or worked most often, in cases where they had more than one employing institution in the state) using a code from a list of hospitals in the state. An insert printed on different-colored paper listing all acute care general hospitals in the state along with code numbers was provided in the 1999 Pennsylvania Registered Nurse Survey, while in 2006, the acute care general hospitals in the states along with code numbers were provided on the survey itself. Both surveys obtained information regarding nurses' working conditions and patient safety, with the intent of conducting analysis that would inform policy decisions on a range of topics related to the effect of nursing characteristics on both nurse and patient outcomes. The surveys included questions regarding demographic information, such as sex and race.

Two specific tools were contained in each survey: the Maslach Burnout Inventory-Human Services Survey and the Practice Environment Scale of the Nursing Work Index.

Administrative data

American Hospital Association's (AHA) Annual Survey of Hospitals

The American Hospital Association (AHA) is an organization that promotes the quality provision of healthcare by both hospitals and healthcare networks. Promotion of quality is completed through efforts including the provision of information related to healthcare and health administration to healthcare providers and the public. More than 5600 organizations and 41,000 individuals are members of the AHA (American Hospital Association-AHA, 2013). The AHA Annual Survey Database is a compilation of data from the AHA Annual Survey, and contains a "snap-shot" of hospital-specific data on approximately 6500 hospitals in the United States. The database contains as many as 1000 fields of information including data on organizational structure, personnel, hospital facilities and services, and hospital financial performance. This study used variables contained within the AHA database as control variables, specifically those variables identifying total number of beds, technology status, and teaching status of a hospital.

Patient data

Pennsylvania Health Care Cost Containment Council (PHC4) Data

The Pennsylvania Health Care Cost Containment Council (PHC4) is an independent state agency responsible for addressing the issues of escalating health costs, ensuring the quality of healthcare, and increasing access for all citizens regardless of one's ability to pay (Pennsylvania Health Care Cost Containment Council-PHC4, 2013). The PHC4 collects inpatient discharge records from all hospitals within the state of

Pennsylvania. Over 70 fields of data are available through the PHC4 database, including clinical information such as diagnosis-related group (DRG) codes, admission source and type, length of stay, hospital charges, and patient origin information. State law to collect and disseminate health care data using guidelines set forth by the Centers for Medicare and Medicaid Services (CMS) mandates the PHC4. This data, obtained from the UB-92 (Uniform Billing Form), are submitted quarterly to the Pennsylvania Health Care Cost Containment Council, an independent state agency formed under Pennsylvania statute (Act 89 of 1986, as amended by Act 3 of 2009) in order to address rapidly growing health care costs, by hospitals within the state of Pennsylvania via magnetic media as directed under Section 912, Data Submission Requirements, of Act 89. The data include patient demographic information, hospital charges, diagnosis and procedure codes including ICD-9-CM (International Classification of Diseases, Ninth Revision, Clinical Modification) and DRG (Diagnosis Related Group) codes (PHC4, 2013).

Pennsylvania Cancer Registry Data

The Pennsylvania Cancer Registry (PCR) is a statewide data system responsible for collecting information on all new cases of cancer diagnosed or treated in the state of Pennsylvania. The PCR is a subset of the National Program of Cancer Registries (NPCR) administered by the Centers for Disease Control and Prevention (CDC). Reporting to the PCR is mandated by the Pennsylvania Cancer Control, Prevention, and Research Act of 1980 and the Pennsylvania Department of Health's regulations concerning Reporting of Communicable and Noncommunicable Diseases. Cancer data are collected through a number of means, including through hospital reporting, death certificates, and through data exchange when Pennsylvania residents are diagnosed or treated in other states.

Information collected on each case includes patient demographics and medical information about the cancer type, extent of disease, and initial course of treatment provided.

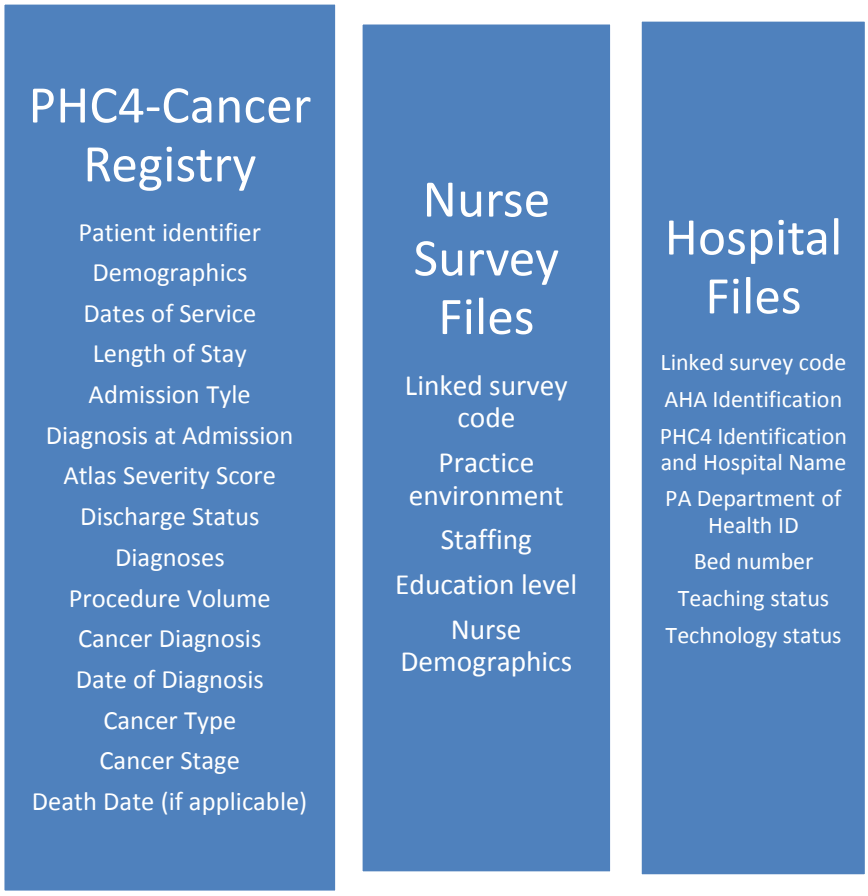
Data Linkage Procedure

Linkage of the databases occurred in a step-wise process. The PHC4 and Pennsylvania Cancer Registry data were required to be linked by the offices of the Pennsylvania Department of Health. Upon completion of linkage, the dataset was de-identified and sent to the requesting study author. The second part of the data linkage occurred on-site at the Center for Health Outcomes and Policy Research at the University of Pennsylvania School of Nursing. Procedural linkage steps are outlined below:

Figure 3-1: Data Linkage Procedure

Step 1: External linkage of PHC4 and PA Cancer Registry Databases (completed by staff at the Pennsylvania Department of Health)

Step 2: Internal linkage of databases



Data for individual patients was obtained from linked Pennsylvania Health Care Cost Containment (PHC4) and Pennsylvania Cancer Registry datasets for the years 1998-1999 and 2005-2006. These data files included the following information: facility identification, patient demographic characteristics, admission information, principal International Classification of Diseases of Oncology, Second and Third Revision (ICD-O-2; ICD-O-3) diagnosis codes, principal and secondary International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis and procedure codes, up to eight secondary diagnoses and procedure codes, cancer stage at diagnosis, date of cancer diagnosis, and whether the patient was alive or dead at discharge.

Patient outcomes of interest included failure-to-rescue, defined as patient death following the development of a condition that could have theoretically been remedied but was not, and mortality within thirty days of hospital admission. Death record files were linked to the patient discharge records so that deaths occurring outside of the hospital setting were able to be recorded. Replicating the approach of Silber and colleagues (2007), failure-to-rescue was noted if a patient died following the development of at least one of thirty-nine clinical adverse events, such as sepsis and shock (Silber, Romano, Rosen, Wang, Even-Shoshan, & Volpp, 2007).

The eight cancer categories were selected with assistance from a published manual by the Surveillance, Epidemiology, and End Results (SEER) program. The manual details how to group ICD-02 (for 1999 data) and ICD-03 (for 2006 data) into meaningful cancer sites. This approach was used to identify patients with the cancer diagnoses listed above (Friese & Aiken, 2008; Seiffert, 1993; Young, Roffers, Gloeckler, Firitz, & Hurlbut, 2000). ICD cancer site codes used in the 1999 data were updated to ICD-O-3 groupings for the 2006 data, as the upgrade to ICD-O-3 classification categories was instituted by SEER in 2001. Cross-matched tables provided by SEER were used to ensure that the diagnosis codes from both 1999 and 2006 identified the same patient populations. Both clinical expert consultation and a comprehensive review of coding manuals were used to identify the ICD-9 surgical procedure codes and diagnoses, as reported in claims data that were relevant to the patient population (Friese et al., 2008; Berger, Feig, & Fuhrman, 1995; Pennsylvania Department of Health, 2002; Pennsylvania Department of Health, 2012). Those surgical procedure codes used for inclusion criteria into the study were those directly related to or pertaining to a surgery relevant to the

treatment of the specified cancer. For example, patients were included in the study only if a secondary ICD-9 code indicated a surgical intervention specifically related to the primary ICD-O-3 diagnosis (i.e. resection of pancreatic tumor), and were excluded if the secondary ICD-9 code indicated a procedure not specifically related to the primary diagnosis (i.e. tonsillectomy for a patient with a diagnosis of ovarian cancer). It was the author's intent to study outcomes for patients with an identified cancer diagnosis who underwent a surgical procedure directly related to that diagnosis. Refer to the appendix for a list of included secondary ICD-9 codes that constituted patient inclusion into the study. A finalized table of all cancer diagnoses (identified by ICDO-02, ICD-O-03 codes), ICD-9 coded diagnoses and procedures, and medical records coding for verification was compiled and is included in an appendix in this work. There were more than 29,000 patients meeting inclusion criteria in both years in the linked PHC4 and Pennsylvania Cancer Registry dataset.

Due to the nature of treatment required for an oncologic diagnosis, it is common for patients to experience multiple planned and unplanned admissions to a hospital over the course of a year. Therefore, multiple patient records may exist in the database due to multiple discharges. If a patient had multiple admission records that indicated a surgical procedure was performed, the hospitalization at which the primary surgical intervention occurred was chosen as the index admission. Patient-level outcomes of failure-to-rescue and mortality were aggregated to produce risk-adjusted rates for each hospital in each year that accounted for differences in the characteristics of included patients.

Sample

The inclusion and exclusion criteria for each sample and the sampling methods used are reviewed below.

Hospitals

Hospitals included in this study were non-federal acute care institutions. Hospitals with fewer than 10 eligible nurse respondents per year were excluded from the sample. This follows precedent set by research performed by Aiken and colleagues (2003), which indicated that reliability of the survey measures with at least 10 nurses per hospital was supported through empirical work (Aiken et al., 2003). Hospitals were included in the study sample if hospital identifier code, structural variables and patient outcomes of interest were identified as present in both 1999 and 2006. The 135 hospitals in the sample represented approximately 78 percent of all acute care hospitals in the state of Pennsylvania in 2006.

Nurses

The inclusion and exclusion criteria listed for nurses applied to both study years. To be included in the study, nurses had to be employed in a non-federal acute care hospital. Nurses who did not identify employment as a staff nurse working on an inpatient unit were excluded from study analysis. Survey respondents who identified their primary unit of employment as an outpatient unit or long-term care unit were excluded from the study. Nurses aged less than 18 years old were excluded from study analysis. Rationale for the inclusion of nurses providing direct patient care is based on the theory that this group of nurses had the most frequent interaction with patients and was in a prominent position to report patient safety measures. Based on the criteria above, the

final sample of nurses in this study included 17,844 nurses in both study years: 11,370 registered nurses in the year 1999 and 6,474 registered nurses in the year 2006.

Patients

Patients aged 18 and above with an International Classification of Diseases of Oncology (ICD-O-3) diagnosis code of one of eight solid tumor cancers were selected for inclusion into this study. No upper limit for patient age was set, and all patients meeting criteria who were over the age of 18 were included. Rationale for inclusion of all patients over the age of 18 with no upper limit criteria reflects full use of available data. The 8 solid tumor cancer categories included in this study were: prostate, head and neck, endometrial, ovarian, lung, esophageal, colorectal, and pancreatic cancers. Patients were included in the population sample if they had one of the eight listed ICD-O-02 or ICD-O-03 diagnoses as their primary diagnosis code, and had a specified surgical intervention related to the disease state listed as a primary or secondary procedure code.

The eight ICD-O-3 diagnostic codes selected for this study are consistent with the patient population studied by Friese (2005), thus allowing for comparison of results with the study he conducted with 1999 data (Friese, 2005). Patients with a diagnosis of breast cancer were excluded from this study, as a minimal amount of inpatient care is associated with their operative procedures. The exclusion of patients with breast cancer as a primary diagnosis was consistent with the patient population studied by Friese. Children under the age of 18 were excluded from the study.

Comorbidities were identified by examination of the eight secondary diagnosis fields in the PHC4 claims data using ICD-9 codes. Differential risk in the patient population was accounted for, in part, by the use of the comorbid conditions identified by

the Elixhauser method (Elixhauser et al., 1998). The Elixhauser comorbidity model has been shown to outperform other risk adjustment methods and uses an extensive list of 30 comorbid conditions (Stukenborg et al., 2001). This study adapted the traditional Elixhauser model to include 29 comorbid conditions outlined by Elixhauser (1998), but excluded the presence of a solid tumor as a comorbid condition due to multicollinearity with the population of patients being studied (Elixhauser et al., 1998).

Measurement

Variables and Instruments

The primary independent variables explored in this study included the change in level of nurse education, level of nurse staffing, and rating of the nurse practice environment between 1999 and 2006. Variables were created from measures collected from nurse respondents to both surveys. Change in level of nursing education, nurse staffing, and nurse rating of the practice environment were measured as both categorical and continuous variables. Modeling with categorical variables produced similar results to modeling with the use of continuous variables. For ease of interpretation and consistency, variables were represented as continuous throughout the study.

Independent Variables

Nursing-Specific Organizational Characteristics

Nurse Education and the Change in Nurse Education from 1999-2006:

Nurse education was measured by calculating the percentage of respondents in each hospital whose highest degree in nursing was a Bachelor's of Science in Nursing, or baccalaureate (BSN) degree. This variable was measured from the staff nurse's response to the survey question, "what is the highest nursing degree you have"? The 1999 Pennsylvania Registered Nurse Survey and the 2006 Multi-State Nursing Care and Patient Safety Survey asked respondents to identify the highest nursing degree obtained. The 2006 survey asked respondents to identify the highest degree in any other field obtained, however only responses for the question related to nursing and contained in both surveys were included in this analysis. In an effort to aid interpretation of results, only those nurses indicating that a BSN was the highest degree obtained were included in

this variable calculation. Nurses who reported having an advanced degree, either a Master's or Doctorate degree, were excluded from this study.

Individual values were aggregated to a hospital level mean of the percentage of nurses with a BSN within both survey years. The change in level of nurse education from 1999 to 2006 was measured as both a continuous and as a categorical variable. Regression analyses used the change in nurse education measured as a continuous measure. The change in hospital percentage of nurses with a BSN degree from 1999 to 2006 was calculated. Hospitals were categorized based on these differences. Hospitals that increased or decreased the percentage of nurses with a BSN by greater than 5% from 1999 to 2006 were classified as "improved" or "worsened or declined," respectively. Hospitals experiencing percentage changes between -5% and 5% were classified as "stable". The 5% cut point was selected because preliminary data indicated that this was roughly.5 of a standard deviation (SD) and this extent of change was considered sizable.

Nurse Practice Environment and the Change in Nurse Practice Environment from 1999-2006:

The nurse practice environment was measured using the Practice Environment Scale of the Nursing Work Index (PES-NWI). In 2002, Lake revised the original NWI using a five-stage approach shortening it from 66 to 31 items. The PES-NWI contains 31 items and asks nurses to indicate the degree to which various organizational features are present in their practice setting (Lake, 2002). Exploratory factor analysis resulted in five subscales used to characterize nurse practice environments: nurse participation in hospital affairs (9 items), nursing foundations for quality care (10 items), nurse manager ability, leadership, and support of nurses (5 items), staffing and resource adequacy (4

items), and collegial nurse-physician relations (3 items) (Lake, 2002). Each item in the PES-NWI is scored with a Likert scale, with the following answers: "Strongly Disagree", "Somewhat Disagree", "Somewhat Agree", and "Strongly Agree".

Each item is scored to reflect agreement that the characteristic is present (1=strong disagreement, 4=strong agreement). Published internal consistency coefficients (Cronbach's alphas) for these subscales range from .71 to .84. The PES-NWI has been used in multiple studies and settings and is considered a highly reliable and valid measure of nursing practice environment (Warshawky & Havens, 2011). Evidence of the predictive validity of the PES-NWI has been demonstrated (Aiken et al., 2008; Friese et al., 2008; Lake & Friese, 2006). The PES-NWI is able to distinguish hospitals with different organizational forms (Lake & Friese, 2006) and is sensitive to changes in organizations over time (Aiken, Buchan, Ball, & Rafferty, 2008; Aiken, Havens, & Sloane, 2000; Aiken & Poghosyan, 2009). The validity of the PES-NWI to differentiate hospital nurse practice environments has been demonstrated in previous research (Lake & Friese, 2006). Content validity was supported by four of the subscales matching the domains of core questions from the original Magnet® hospital interviews. Construct validity was demonstrated by the ability of the tool to discriminate between nurses working in Magnet® versus non-Magnet® hospitals. Refer to the appendix for a complete listing of the PES-NWI and subscales.

Subscale scores were calculated by averaging individual nurse responses to items on each subscale. Nurse scores were averaged for each hospital and aggregated to indicate one hospital-level mean. A composite PES-NWI score was calculated for each hospital in both 1999 and 2006 by taking the average of four of the five PES-NWI

subscales, excluding the staffing and resource adequacy subscale, omitted due to its correlation with the staffing measure used in this analysis. Three methods were used to categorize hospitals into “improved” “stable” and “worsened or declined” nurse practice environments: by PES-NWI score cut points, by identifying categories of hospitals according to PES-NWI composite score rank based on 1999 data, and by .5 of a standard deviation of 1999 composite data. For the latter methods, which identified categories relative to the 1999 sample, hospitals were classified as “improved” if their PES-NWI composite score fell in the top range, “stable” if the score fell in the middle two groups and “worsened or declined” if the score fell in the bottom range. The same method was repeated using .5 SD from 1999 composite score data. Using the PES-NWI score cut point method, hospitals were classified into four categories: 0-2.5 (poor), 2.5-3 (good), and 3-4 (excellent). Those hospitals that shifted into better categories from 1999-2006 were deemed “improved”, those that shifted into worse by a category deemed “worsened”, and those that experienced no change in category deemed “no improvement”.

Cronbach’s alphas for each subscale ranged from .88 (Nursing participation in hospital affairs) to 0.90 (Collegial nurse-physician relationships and Staffing and resource adequacy) in 1999 indicating strong reliability of the measure in this sample. Cronbach’s alphas for each subscale for the year 2006 ranged from .92 (Nursing manager ability, leadership and support, Nursing participation in hospital affairs, Nursing foundations for quality care) to .93 (Collegial nurse-physician relationships and Staffing and resource adequacy) indicating strong reliability of the measure in this sample. The composite score for each survey year was calculated with and without the staffing

resource and adequacy subscale (SRA) as this subscale was highly correlated with the direct staffing measure. The mean composite score with staffing and resource adequacy (2.49) was slightly lower than the composite without the staffing and resource adequacy subscale (2.57) in 1999. This trend was evident in 2006 with the mean composite score with staffing and resource adequacy (2.60) being slightly lower than the composite without the staffing and resource adequacy subscale (2.65).

Table 3-1: *Practice Environment Scale-Nursing Work Index (PES-NWI) Subscale Scores (1999) n=11408*

	Number of items	Number of RN respondents (n)	Cronbach's alpha	Mean (SD)	Median	Range
Nurse Manager Ability, Leadership, and Support	4	N=11264	0.90	2.37 (0.83)	1.75	1-4
Nurse Participation in Hospital Affairs	9	N=11247	0.89	2.33 (0.62)	2.38	1-4
Nurse Foundations for Quality of Care	9	N=11241	0.89	2.83 (0.55)	2.89	1-4
Nurse/physician Relationships	3	N=11234	0.91	2.78 (0.65)	3.00	1-4
Staffing and Resource Adequacy	4	N=11266	0.91	2.19 (0.79)	2.25	1-4
Composite score (with SRA)		N=11233	0.88	2.51 (0.50)	2.51	1-4
Composite score (without SRA)		N=11266	0.87	2.58(0.54)	2.59	1-4

Scale scores range from 1-4 with a higher numeric score representing rating of a more positive practice environment

Table 3-2: *Practice Environment Scale-Nursing Work Index (PES-NWI) Subscale Scores (2006) n=6460*

	Number of items	Number of RN respondents (n)	Cronbach's alpha	Mean (SD)	Median	Range
Nurse Manager Ability, Leadership, and Support	4	N=6379	0.92	2.47 (0.80)	2.50	1-4
Nurse Participation in Hospital Affairs	9	N=6365	0.92	2.58 (0.65)	2.57	1-4
Nurse Foundations for Quality of Care	9	N=6372	0.92	2.92 (0.54)	2.88	1-4
Nurse/physician Relationships	3	N=6375	0.93	2.88 (0.69)	3.00	1-4
Staffing and Resource Adequacy	4	N=6377	0.93	2.43 (0.76)	2.50	1-4
Composite score (with SRA)		N=6382	0.90	2.65 (0.55)	2.64	1-4
Composite score (without SRA)		N=6381	0.90	2.71 (0.55)	2.71	1-4

Scale scores range from 1-4 with a higher numeric score representing rating of a more positive practice environment

Tables 3-3 and 3-4 illustrate the intraclass correlation coefficients (ICC) for the aggregated nursing measures in hospitals with 10 nurse respondents or greater per each survey year. All measures had ICCs greater than 0.6. The use of ICC (2) is reported in the table below, as it is the "estimated reliability of the hospital mean" (Estabrook, 2005). The ICC(2) measures the likelihood of obtaining similar mean scores if additional sub-groups were drawn repeatedly from the same population within each hospital. Values for ICC (2) greater than 0.6 justify the aggregation of nursing data to the hospital level.

Table 3-3: *Intraclass correlation coefficients (2, 1) of Nursing Measures in Hospitals with 10 Nurse Respondents or more in 1999*

Nurse Education	0.83
Nurse Staffing	0.83
Practice Environment Scale (NWI4)	0.87
Practice Environment Scale (NWI5)	0.88
Nurse Manager Ability, Leadership, & Support	0.82
Nurse Participation in Hospital Affairs	0.92
Nurse Foundations for Quality of Care	0.88
Collegial Nurse/Physician Relations	0.73
Staffing and Resource Adequacy	0.87

Table 3-4: *Intraclass correlation coefficients (2, 1) of Nursing Measures in Hospitals with 10 Nurse Respondents or more in 2006*

Nurse Education	0.75
Nurse Staffing	0.78
Practice Environment Scale (NWI4)	0.88
Practice Environment Scale (NWI5)	0.88
Nurse Manager Ability, Leadership, & Support	0.78
Nurse Participation in Hospital Affairs	0.94
Nurse Foundations for Quality of Care	0.87
Collegial Nurse/Physician Relations	0.73
Staffing and Resource Adequacy	0.82

Nursing staffing and the Change in Nurse staffing from 1999-2006:

The nurse staffing measure was derived from a question on both surveys asking nurses to identify the number of patients they had individually cared for during their last shift. The predictive validity of this method of using nurse reports to measure hospital staffing levels has been demonstrated previously (Aiken et al., 2008; Aiken et al., 2002).

Nurses who reported caring for less than 1 patient or greater than 20 patients in a shift were excluded from analysis. This exclusion criterion was based on previous work (Aiken et al., 2002; Aiken et al., 2003). Respondents were excluded if they reported caring for less than one patient per shift in an effort to exclude those nurses not providing direct patient care. Respondents were excluded if they reported caring for greater than 20 patients as this high of a patient care assignment is unlikely and may have reflected a charge nurse role. Individual values were aggregated to a hospital level mean, with the result being one average value for the number of patients cared for on the last shift by nurses within that hospital. Analyses were conducted with the change in staffing measure as both a continuous and categorical variable. Hospitals with an increase of more than 0.5 patients per nurse were classified as "worsened". Hospitals with a decrease of more than 0.5 patients per nurse were classified as "improved", while those hospitals with difference values between -.5 and .5 were categorized as "no change". The .5 patient per nurse cut point was selected for ease of interpretation and consistency with previous work (Kutney-Lee, et al, 2012).

Outcome Variables

The patient outcomes of interest in this study were failure-to-rescue and 30-day mortality. Outcome measures were obtained from PHC4 inpatient discharge files linked

to existing death records. All outcome variables were measured as binary variables, while risk-adjusted changes in outcome variables were measured as continuous values.

Failure-to-rescue (FTR), Hospital level risk-adjusted FTR, and the change: Failure-to-rescue (FTR) is defined as death in a patient who has suffered a complication while in the hospital after surgery using Silber's definition of FTR (Silber & Rosenbaum, 1995; Clarke & Aiken, 2003). Following the approach of Silber and colleagues, a patient death was classified as involving a failure-to-rescue if a patient died after experiencing one of 39 identified complications, such as shock, pneumonia, and sepsis (Silber et al., 2007). Complications were identified using diagnosis and procedure codes for each discharge record. Surgical FTR has been well-tested and has excellent psychometric and empirical properties for assessing the impact of provider characteristics including nursing on patient outcomes (Silber & Rosenbaum, 1995; Silber & Rosenbaum, 1997; Aiken et al., 2002; Aiken et al., 2008). Individual FTR values were aggregated to produce risk-adjusted rates for individual hospitals in both study years. The change in failure-to-rescue in surgical oncology patients from the years 1999 to 2006 was calculated using an absolute difference model. Analyses were conducted with failure-to-rescue represented as a rate change.

Patient mortality, Hospital level risk-adjusted mortality, and the change:

A patient outcome of primary interest was 30-day mortality. Mortality was measured independent of whether death occurred in the hospital or after patient discharge. Individual patient mortality was aggregated to the hospital level and was used to calculate a risk-adjusted mortality rate for each hospital in 1999 and 2006. The change in mortality in surgical oncology patients from the years 1999 to 2006 was calculated

using an absolute difference model. Analyses were conducted with patient mortality represented as a rate change.

Control Variables

Hospital characteristics

Structural characteristics of hospitals in both 1999 and 2006 were derived primarily from the American Hospital Association's (AHA) Annual Survey. The technology status of a hospital was categorized by the capacity of the facility to perform organ transplants and/or open heart procedures. Technology status of a hospital was treated as a categorical variable (high/low technology status). Teaching status was defined by the number of medical residents and fellows per hospital bed. Hospitals were classified as: non-teaching, minor teaching (<1:4 trainee to bed ratio), and major teaching (>1:4 trainee to bed ratio. Hospital size was measured as the number of beds in the hospital and classified according to the following: small (<=100 beds), medium (101-250 beds), and large (>=251 beds).

Structural measures theorized to influence the quality of care provided to a cancer patient but not included in the AHA Annual survey included hospital surgical procedure volume. No uniform calculation to measure hospital procedure volume exists. Consistent with Friese (2008), quartiles of total procedure volume were identified and assigned to each hospital (0-3). Ranking the hospitals by quartiles of procedure volumes is a direct approach and one that leads to ease of interpretation (Arozullah, Henderson, Khuri, & Daley, 2003; Hewitt & Petitti, 2001; Hodgson et al., 2003). Procedure volume was treated as a control variable in this study. The structural variables included in this study include:

Table 3-5: Hospital Structural Variables

Hospital Variable	Categories
Teaching status	Non-teaching Minor Major
Bed size	≤ 100 beds 101-250 beds >251 beds
Technology status	High Low
Hospital Procedure Volume	0-3 (Lowest to Highest Quartile)

Patient Characteristics

Patient Demographics Patient-level demographic information was derived from the Pennsylvania state PHC4 administrative hospital inpatient discharge data files. These data included age, sex, and race/ethnicity. Age was treated as a continuous variable, while sex and race/ethnicity were treated as categorical variables.

Admission Status There were two admission variables included in the data, admission status (emergent or scheduled) and admission source (i.e. patient transferred from another hospital (yes/no) or emergency department (yes/no)).

Patient comorbidities Patient comorbidities included a list of twenty-nine clinically significant diseases or disorders, including hypertension and diabetes, as defined by Elixhauser and colleagues (Elixhauser et al., 1998). The presence of a solid

tumor was excluded due to collinearity with the patient population being studied. Comorbidities were identified by performing a review of the index admission medical record. For each comorbidity, a dummy variable was created in order to measure the presence of the condition in a patient.

Acute Physiology of the Patient Included in the PHC4 dataset is a measure known as the Atlas severity score, calculated by MediQual for each patient (Brewster, Karlin, Hyde, Jacobs, Bradbury, & Chae, 1985). MediQual is a clinical information management business that is recognized as an authority on risk-adjustment methodology. In a contractual agreement with Cardinal Information Corporation (CIC)-MediQual, hospitals are required to use CIC-MediQual's Atlas™ Severity of Illness System to abstract patient severity information. The Admission Severity Group (ASG) scores generated by this system are submitted for a select group of acute care inpatient records covering approximately 75 percent of acute care hospital discharges. Upon receipt of the data, media verification is performed to assure data has been submitted in a readable format. The data verification process continues with extensive quality assurance checks and matching of admission severity scores to inpatient records (PHC4, 2013). All hospitals were required to submit these data in the study years of 1998-1999 as well as 2005-2006 in a standardized format known as MediQual's Atlas Outcomes Severity of Illness System. MediQual's group developed risk-adjustment model uses in-hospital mortality as the predicted event and outcome of interest (Steen, Brewster, Bradbury, Estabrook, & Young, 1993). The risk-adjustment models used to develop the severity score are based on clinical information including physical examination results, laboratory values, radiology reports and various procedural information obtained during the first 48

hours of a patient's hospital admission to assess baseline illness severity. The result is a 5-point scale, ranging from 0 to 4. A score of zero indicates no probability of an in-hospital death. A score of four indicates a "maximal" likelihood of in-hospital death, or a statistical probability of greater than .5. Categorical variables were created for the reported Atlas Score. A total of 14, 406 and 12, 632 patient records had an accompanying Atlas Score in the years 1999 and 2006, respectively. Sensitivity analyses were completed in order to assess the effect of the Atlas Score on risk-adjustment.

Cancer Specific Variables

Cancer specific variables made available through the Pennsylvania Cancer Registry data included: primary cancer site, stage of cancer, laterality, method of diagnostic confirmation, and length of the disease (defined as time from initial diagnosis to admission for primary surgical intervention). These variables were included in the patient risk-adjustment model used by Friese to account for the severity of disease (Friese et al., 2008). This constituted a novel contribution to the existing cancer health services literature in that prior studies in this field had not had measures to describe the stage and extent of disease. Studies of associations between organizational features of nursing and patient outcomes have commonly lacked disease-specific information as a part of the risk-adjustment modeling techniques used. The use of disease-specific information is found commonly in single-institution based studies where the study authors have access to clinical information. To date, the use of disease-specific information for studies involving large, administrative datasets has been resigned to the use of SEER data. Friese's work constituted novel use of disease-specific information in the use of risk-adjustment modeling for surgical patients with a solid tumor diagnosis.

In this study, cancer site was treated as a categorical variable, as each patient included in analyses was assigned one of eight previously identified principal diagnosis codes. Cancer stage was defined as both a categorical and dichotomous variable. Categorically, cancer stage was assigned according to SEER summary stage classification as either localized, regional by direct extension, regional by node involvement, regional by both direct extension and by node involvement, or systemic disease (Young et al., 2000). Cancer stage was defined as a dichotomous variable if regional or systemic disease was reported. The length of disease was specified as a continuous variable, measured in days. The date of reported cancer diagnosis was subtracted from the date of reported index admission for primary surgical intervention. For those calculations yielding a negative result, these values were recorded as zero and classified as de novo diagnoses occurring on day of admission. It is hypothesized that negative values were obtained when a delay, or lag, in reporting dates to the cancer registry occurred.

Risk-Adjustment Modeling

When comparing outcome rates for two different patient samples, risk-adjustment is used to yield comparable rates accounting for differences in risk profiles across the samples. (Shaughnessy & Hittle, 2002). The use of risk-adjustment allows observed outcome rates at the hospital level to be altered so that they reflect the mean illness severity of the average study hospital's patient case mix severity. The method of risk-adjustment selected allowed for the creation of an expected rate of the patient outcomes (failure-to-rescue and 30-day mortality) for an individual hospital based on that hospital's patient population and their severity of illness. This expected outcome was then

compared to the actual observed rate of the outcome within each hospital. Calculation of risk-adjusted rates for failure-to-rescue and 30-day mortality was completed in five steps:

1) The observed outcome rate for the hospital was calculated for all eligible patients receiving care from the hospital during the study year:

Hospital $_{obs}$ = *(number of patients achieving outcome)/(number of patients eligible for outcome)*

2) For each of the same patients, a predicted outcome probability was calculated based on a statistical risk model using identified independent variables including cancer stage and patient's condition at hospital admission

3) Predicted outcome probabilities were averaged across all of the patients cared for over the identified study time period, to yield a predicted outcome rate for the hospital:

Hospital $_{pred}$ =*(sum of predicted probability)/(number of patients eligible for outcome)*

4) The hospital rate is risk-adjusted using the following formula:

Adjusted outcome rate = (Outcome $_{obs}$ – Outcome $_{exp}$)/(total number of patients eligible for outcome)/1000 to calculate a risk-adjusted rate per 1000 patients.

Risk-adjustment of both outcomes for patient characteristics and comorbidities was accomplished by using variables including age, sex, admission type, transfer status, and surgical ICD-O-3 diagnosis group in addition to a set of twenty-nine comorbidities identified by Elixhauser and colleagues (Elixhauser et al., 1998). It also included cancer-specific variables including cancer stage, site of primary cancer, diagnostic confirmation method, laterality, and days from diagnosis to primary surgical intervention. The clinical severity measure of initial Medi-Qual score, calculated within the first 48 hours of

admission, was included in the risk-adjustment model. All measurable, prognostically important patient risk factors that existed on index admission were used for purposes of risk-adjustment. Adjustment for hospital characteristics and interventions provided to the patient prior to and after surgery were not adjusted for, which represents an inherent limitation. The hospital characteristics of bed size, technology status, and teaching status were control variables in this analysis. Control of hospital characteristics allowed for

A hospital-level risk-adjusted rate was calculated for each outcome variable for each survey year. The rate of change for these variables was then calculated using a difference model, subtracting 1999 risk-adjusted outcome rates from 2006 risk-adjusted outcomes rates. Finally, hospitals were classified as having increased, remained the same, or decreased the respective outcome rates across the two years. Rate changes greater than .5 SD of the hospital-level observed rate distribution in 1999 were considered sufficient to classify as increases or decreases.

Table 3-6: Hospital-level variables

Type	***Variable***	***Definition***	***Variable Type***	***Database***
Predictors	Level of Nurse Staffing	Hospital level (mean)	Continuous	PA Registered Nurse survey (1999); Multi-State Nurse survey (2006)
	Change in level of nursing staffing	Absolute difference	Continuous Categorical	PA Registered Nurse survey (1999); Multi-State Nurse survey (2006)
	Level of nurse education	Hospital level (proportion of RNs with BSN as highest degree)	Continuous	PA Registered Nurse survey (1999); Multi-State Nurse survey (2006)
	Change in level of nurse education	Absolute difference	Continuous Categorical	PA Registered Nurse survey (1999); Multi-State Nurse survey (2006)
	Rating of nurse practice environment	Hospital level composite score (PES-NWI)	Categorical	PA Registered Nurse survey (1999); Multi-State Nurse survey (2006)
	Change in rating of nurse practice environment	Absolute difference	Continuous Categorical	PA Registered Nurse survey (1999); Multi-State Nurse survey (2006)
Risk Variables	Patient demographics	Age, sex, race, Primary diagnosis ICD-02/ICD-03 codes	Dichotomous, continuous, categorical	PHC4/PA Cancer Registry
	Patient comorbidities	Elixhauser comorbidities	Dichotomous Binary	PHC4 database
	Cancer Type	One of eight previously selected ICD-O-02 or ICD-O-03 diagnoses	Categorical	PA Cancer Registry
	Cancer Stage	0=Localized 1=Metastases	Categorical	PA Cancer Registry
	Days from Diagnosis to Surgery	Calculated from difference in day of diagnosis from day of surgical admission date	Continuous	PA Cancer Registry
Controls	Bed size	Total number of hospital beds (<100, 101-250, >250)	Categorical	AHA
	Technology Status	0=Low 1=High	Categorical Binary	AHA
	Teaching Status	0=None 1=Minor 2=Major	Categorical	AHA
	Hospital Volume	0=<25 1=25-50 2=51-75 3=>76	Categorical	PHC4/PA Cancer Registry
Outcomes	Failure to Rescue rate	Death occurring due to one of 39 specified adverse	Continuous	PHC4/PA Cancer Registry

		events		
	Change in FTR rate	Absolute difference	Continuous	PHC4/PA Cancer Registry
	30-day mortality rate	Death within 30 days of admission (in-hospital or post-discharge)	Continuous	PHC4/PA Cancer Registry
	Change in mortality rate	Absolute difference	Continuous	PHC4/PA Cancer Registry

Plan for Data Analysis

The characteristics of patients, nurses, and hospitals in the 1999 and 2006 samples were examined. The extent of changes across hospitals in terms of nurse-reported level of education, staffing levels, and practice environment between the years 1999 and 2006 were measured.

A two-period fixed effects difference model was employed to estimate changes in the risk-adjusted outcome rates related to changes in the independent variables (Allison, 2005). Nurse education was reported in percentages so that the coefficient could be interpreted as the change in patient outcomes associated with an increase in the percentage of nurses with a baccalaureate degree. STATA version 12.0 was used to analyze data.

Analysis Procedures

The Pennsylvania Registered Nurse Survey (1999) and the Multi-State Nursing Care and Patient Safety Survey (2006) were received in a STATA 12.0 file from secured files within the Center for Health Outcomes and Policy Research at the School of Nursing at the University of Pennsylvania. Combined PHC4 and Pennsylvania Cancer Registry data were received in SAS format and converted to STATA. After data conversion, a systematic audit was conducted to ensure the absence of patient record duplication for the same admission. STATA 12.0 was used for the integrated dataset management and all analysis procedures.

Specific Aim 1:

To describe the changes in hospital nursing characteristics, including nurses' educational level, level of staffing, and nurses' rating of the nurse practice

environment, and characteristics of selected surgical oncology patients between 1999 and 2006 in a panel of general hospitals.

Descriptive statistics were calculated for all patient, nurse, and hospital characteristics in both years and compared for statistically significant differences across the years (statistical significance set at $p < .05$). The use of bivariate methods including cross-tabulation and the use of chi-square tests were performed for categorical variables in order to test "goodness of fit" between the observed and expected output. Means, medians, and standard deviations were calculated for continuous variables. Correlations were completed to assess for multicollinearity. Data were examined for missing values. The changes in nursing organizational characteristics were specified as both continuous and categorical variables as described earlier. The distributions of these variables were displayed in tables and bar charts.

Specific Aim 2:

To document how rates of failure-to-rescue and 30-day mortality for selected surgical oncology patients changed in a panel of hospitals between 1999 and 2006, and to analyze whether these changes were associated with the effects of changes in nurse educational composition, changes in level of nurse staffing, and changes in nurse practice environments.

Analysis of Aim 2 took place at the hospital level. Multivariate linear regression models and a two-period fixed effects difference model were used in order to accomplish

Aim 2. Multivariate linear regression models were used, adjusting for patient and hospital characteristics using the general form:

$$Y_1 = alpha + betax_1 + error_1$$

The dependent variable, y, represents a continuous variable. In this equation, y is the *change*, or difference in the hospital risk-adjusted outcome rate between 1999 and 2006. X refers to the vector of variable representing the independent variables (i.e. change in the level of nurse education, nurse practice environment, and level of staffing), alpha is the model intercept and e is the error term.

A two-period fixed effects difference model was employed to examine the relationship between patient outcomes and changes in nursing organization factors (Allison, 2005). Our primary variables of interest were: the change in the level of nurse education of nurses employed in those hospitals, the change in the level of nurse staffing, and the change in the nurse practice environment in those hospitals between 1999 and 2006. A fixed effects model controls for unobserved heterogeneity that is assumed to be constant over time and correlated with the independent variables. Examples include hospital location, geography, and potentially, the patient population that is primarily seen within the institution. The two-period fixed effects difference model does not, however, control for unobserved heterogeneity that is not assumed to be constant over time. Examples include advances in technology and surgical technique characteristics that cannot be controlled for in this study. This represents a study limitation.

Hospital characteristics considered invariant to time based on preliminary analysis for this study include the control variables of bed size, technology status, and teaching status. Both the 1999 and 2006 values of the above variables will be included in the

model. The inclusion of both 1999 and 2006 time-invariant hospital characteristics was due to differing effects of the variables at the two time points studied.

Regression models were used to estimate the effects of the change in the level of nurse education of nurses employed in those hospitals, the change in the level of nurse staffing, and the change in the nurse practice environment of hospitals on the two patient outcomes (failure-to-rescue and 30-day mortality) of interest. Regression models using continuous difference variables only are presented in this study. Organization of change variables as both categorical and continuous types was done, but for ease of interpretation the regression models using variables as a continuous measure only are presented. For analyses of patient outcomes, controlled variables included variables in the risk-adjustment model, specifically patient demographic characteristics, hospital admission type, hospital admission source, and patient comorbidities. The control variables of hospital bed size, teaching status, and technology status were included in analyses.

Calculation of risk-adjusted outcome rates for failure to rescue and 30-day mortality was completed for each hospital in each year. The rate of change in outcome variables between years was calculated with the use of a difference-in-difference model as described below.

This study used panel data, where the same cross sectional units (i=1,…n) are observed twice: t=1 and t=2. In a cross-sectional model, the following model would be used:

$$y_{it} = \beta_0 + \beta_1 x_{it} + v_{it}$$

With two time periods, the formula must allow for a difference intercept, where d2 is a dummy variable for all observations that occur in time period two (t=2):

$$y_{it} = \beta_0 + \delta_0 d2_t + \beta_1 x_{it} + \alpha_i + u_{it}$$

Analysis is based on the fact that observations across time are not independent and are correlated. In the model above, i=1,…n are the cross-sectional units (hospitals) and t=1, 2 is the time index. Alpha in this model is a unit-specific effect (fixed effect for unobserved heterogeneity) that is implemented to capture all unobserved time-invariant factors that affect the outcome. If an unobserved unit-specific effect is to be correlated with the regressors, estimating the model will occur with the use of this format:

For a cross-sectional unit *i* we have

$$y_{i1} = \beta_0 + \beta_1 x_{i1} + \alpha_i + u_{i1}$$
$$y_{i2} = \beta_0 + \delta_0 + \beta_1 x_{i2} + \alpha_i + u_{i2}$$

If we subtract line 1 from line 2 we will get a first-difference equation:

$$(y_{i2} - y_{i1}) = \delta_0 + \beta_1 (x_{i2} - x_{i1}) + (u_{i2} - u_{i1})$$
$$\Delta y_i = \delta_0 + \beta_1 \Delta x_i + \Delta u_i, \quad i = 1,..n$$

Where Δ denotes change in variables from t=1 to t=2. The unobserved effect is "differenced away" from the model.

With a two-period panel data design, differencing results in creating one cross-sectional equation where the variables are differenced over time. Ordinary least squared regression can be used for this model assuming that the error term is not correlated with the regressors.

	1999	2006	Difference
1999	Y_{t1}	Y_{t2}	$\Delta Y_t = Y_{t2} - Y_{t1}$
2006	Y_{c1}	Y_{c2}	$\Delta Y_c = Y_{c2} - Y_{c1}$
Difference			$\Delta\Delta Y \Delta Y_t - \Delta Y_c$

Strengths and Limitations

Strengths to the study include the ability to measure multiple nursing-specific organizational characteristics not commonly examined due to lack of data availability. The data used were representative of a large fraction of hospitals from a large state in the United States. The unique nurse survey data in a large sample of hospitals that does not represent a "convenience" sample or a voluntary sample constitutes a major strength of this study. However, this study relied on nurse survey data from only one state, which limited the representativeness and generalizability of the study results. The data were available for two time points, which permitted the measurement of changes in key hospital organizational features and the effects of these changes. The use of more than two points in time would have strengthened this study and would provide stronger support for a causality argument. Through the use of validated secondary datasets, five distinct data sets were merged to formulate an innovative research database that revealed how much hospitals changed in a seven-year time period and whether such changes were associated with changes in surgical oncology patient outcomes.

In evaluating patient outcomes using administrative data, problems with completeness and consistency of the coding of complications and comorbidities exists (Iezzoni, 2003). Limitations include the inability to link specific nurses with specific patients, or measure independent and dependent variables at the unit level. This is not considered to be a major limitation since multiple nurses, often from different units, care for a single patient over a hospital stay. The study design was longitudinal, which enhances a causal perspective rather than associations based on cross-sectional designs. The study sample was limited to surgical oncology patients with one of eight solid tumor

diagnoses. It is theorized that the effect of a workforce comprised of more highly educated nurses, increased nurse staffing levels, and improved nurse practice environments would affect outcomes of additional patient populations (Kutney-Lee et al., 2013). The inability to control for improved technologies and quality improvement initiatives introduced into the health system from 1999 to 2006 represented a limitation as these innovations could not be measured. This research will serve as a step towards empirically evaluating the influence of nursing on cancer patient outcomes and may serve as a foundation from which future research involving panel data may be compared.

Data Integrity

The de-identification of all data was completed prior to study analysis. This research study, which included hospitals, nurses, and patients in the state of Pennsylvania, was based on hospital survey data, de-identified nurse survey data, and de-identified linked PHC4 and Pennsylvania Cancer Registry data. Linkage of the PHC4 and Pennsylvania Cancer Registry data containing patient identifiers was performed by administrators in the Pennsylvania Health Cost and Containment center and shipped directly to the Center for Health Outcomes and Policy Research Center at the University of Pennsylvania School of Nursing after de-identification. The nurse survey data were de-identified and the nurse respondents' confidentiality maintained. The datasets were stored on a University of Pennsylvania password protected server, maintained by the University of Pennsylvania School of Nursing Office of Technology and Information Services (OTIS). OTIS maintained the security of the server within the institution, completing nightly backup as well as weekly backup of data stored off site. OTIS maintains responsibility to maintain a secure firewall, antiviral software, patches, and additional

software updates, all of which are employed on a regular basis. All data used for this study were housed and analyzed on a secure computing server located in the School of Nursing at the University of Pennsylvania. Data analysis was completed on the author's individual computer, located within the School of Nursing at the University of Pennsylvania. The computer was both password protected as well as located within a locked office space within the School of Nursing. During periods of analysis, all printed data were kept within this locked office space and then discarded into a secure and locked waste receptacle. Printed data included analyses and STATA output that were printed as a hard copy for review with statisticians and support staff. No printed materials or electronic data were transferred outside of the School of Nursing via the internet, email, or any other mode of communication.

Protection of Human Subjects

The Pennsylvania State Registered Nurse Survey and the Multi-State Nursing Outcomes and Patient Safety Survey study protocols were previously reviewed and approved by the Institutional Review Board (IRB) at the University of Pennsylvania. Individual IRB expedited approval was sought and received prior to beginning this study. Expedited review was appropriate as there was limited risk involved for the patients on whom this data was collected, as all data were de-identified. No direct contact with human subjects was made during this study. A main risk for participants in the study was the potential for linkage of particular patient data to a particular hospital, nurse, or patient outcome. To safeguard against this risk, all patient data were de-identified prior to receipt by the author.

The Health Insurance Portability and Accountability Act (HIPAA) of 1996 defines de-identified data as data removed of: names, geographic subdivisions smaller than at a state level, all dates except for year, telephone numbers, fax numbers, electronic email addresses, social security numbers, medical record numbers, health plan beneficiary numbers, account numbers, certificate/license numbers, vehicle identifiers, vehicle serial numbers, device identifiers and serial numbers, web universal resources (URLs), internet protocol (IP) address numbers, biometric identifiers, full face photographic images, and comparable images. The data were received in de-identified form and did not fall under HIPAA regulations as defined by the federal government and the University of Pennsylvania Institutional Review Board (University of Pennsylvania IRB, 2013).

There were no direct benefits to the participants involved in this study. It is the intent of the author to use results from this study to generate knowledge to inform institution-wide policies, which may or may not impact nurses and patients who participated in this study.

CHAPTER 4: RESULTS

Introduction

The purposes of this study were to document the nature and size of changes in hospital nursing organizational features (nurse education, staffing level, and practice environment) over a seven-year period and to examine the associations between changes in these features and changes in outcomes of a select population of adult surgical oncology patients (failure-to-rescue and 30-day mortality). A retrospective, two-stage panel design study involving nurse survey, cancer registry, administrative inpatient discharge, and American Hospital Association Annual Survey data for the years 1999 and 2006 was implemented to address the proposed aims. The changes in nursing-specific organizational features from 1999 to 2006 were measured at the hospital level by aggregation of nurse survey reports to reflect the hospital level values of nurse education, nurse staffing, and the rating of the nurse practice environment. Changes in patient outcomes, including failure-to-rescue and 30-day mortality, were analyzed at the hospital level. Following a description of the study sample and a review of the process used to obtain the sample, the proposed aims of the study are listed. A brief synopsis of each study aim and evidence supporting how the aim was met is provided. Text, figures, and graphs are displayed to showcase analysis. Finally, a summary of results and evidence generated from aim analysis is presented.

The sample inclusion and exclusion criteria identified a priori were applied to the available nurse and hospital data, resulting in an analytic dataset composed of 17,844 registered nurses and 29, 356 patients, in 135 hospitals. Visual diagrams that identify how final samples of registered nurses, patients, and hospitals were obtained for this study are presented on the following pages in Figures 4-1 through 4-3.

Figure 4-1: Final sample of registered nurse respondents

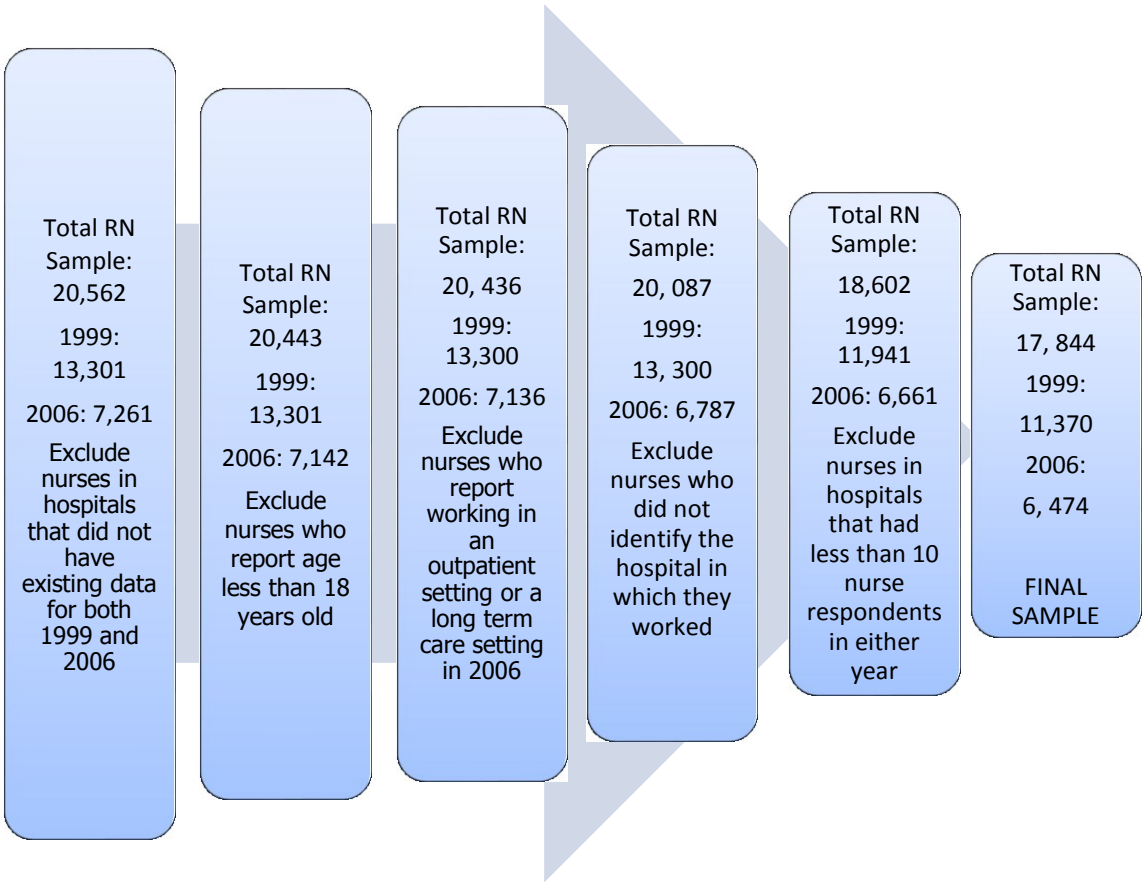


Figure 4-3: Final sample of study patients

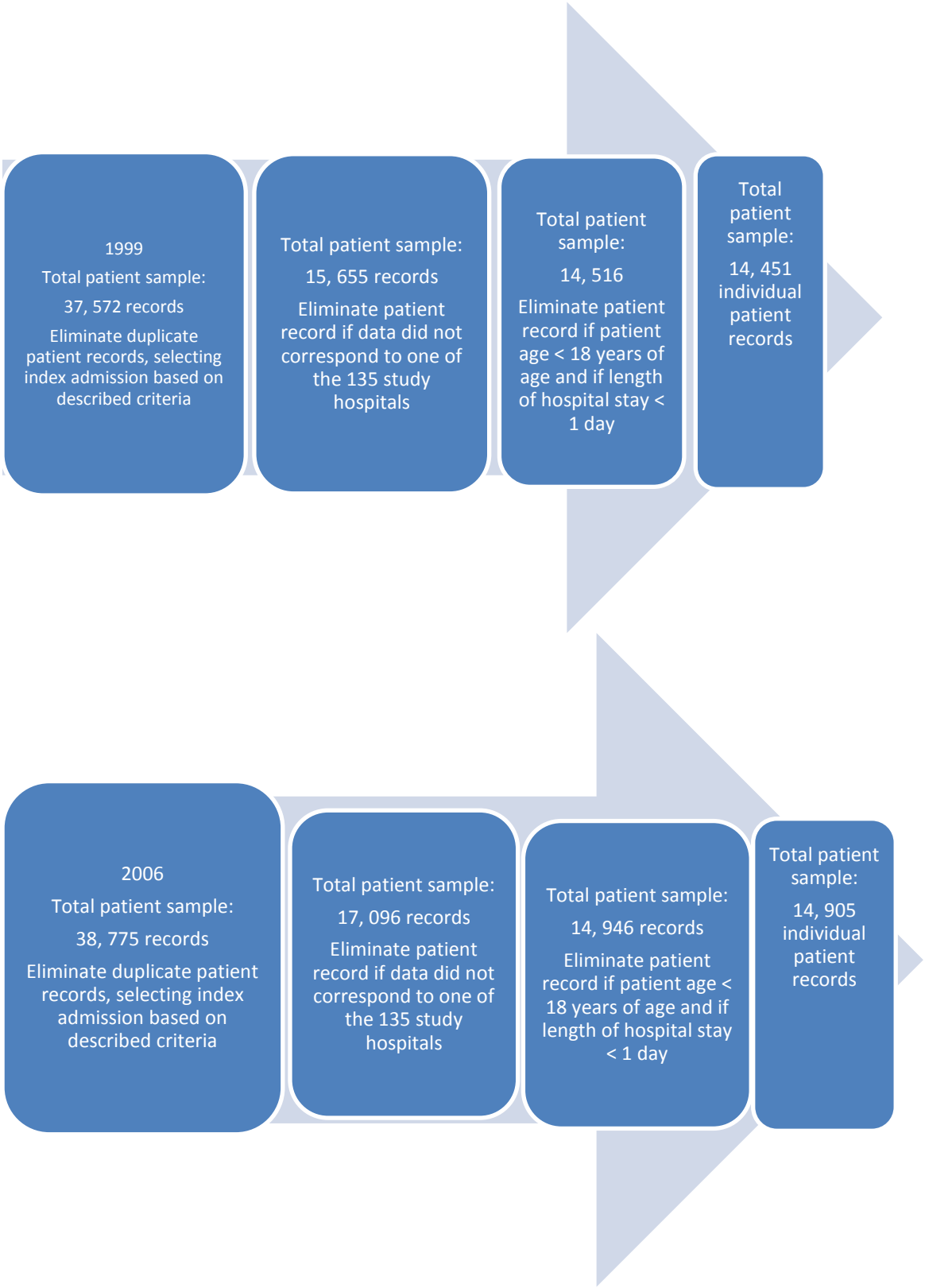
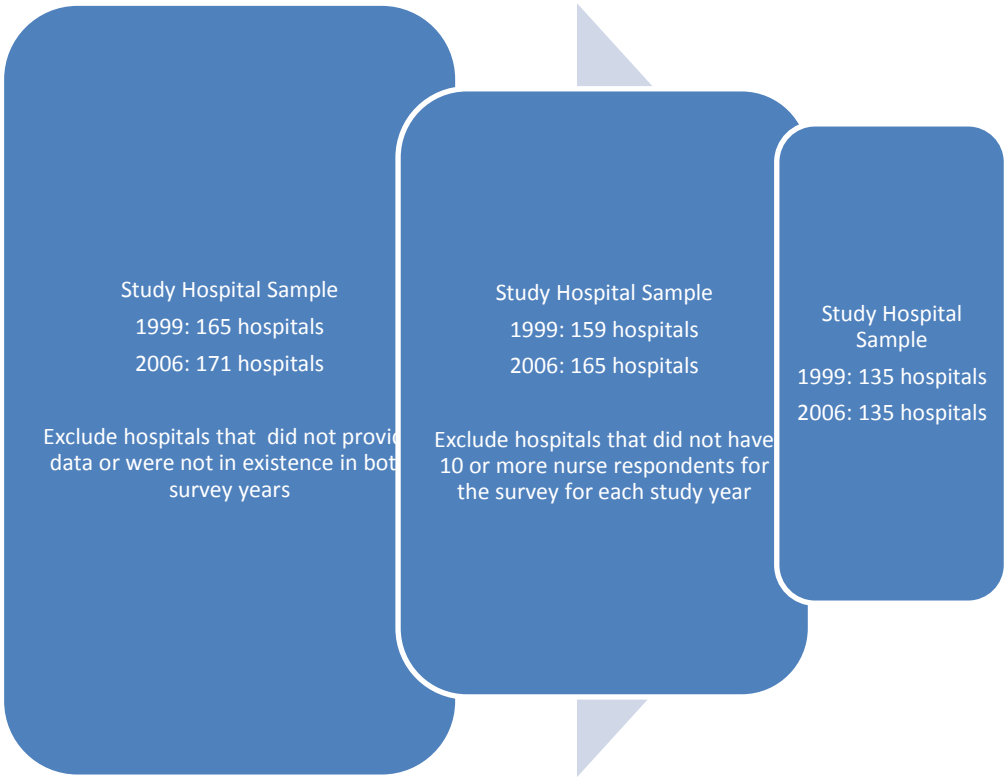


Figure 4-2: Final sample of study hospitals



Specific Aim 1:

To describe the changes in hospital nursing characteristics, including nurses' educational level, level of staffing, and nurses' rating of the nurse practice environment, and characteristics of selected surgical oncology patients between 1999 and 2006 in a panel of general hospitals.

The aim of the study was to demonstrate how surgical oncology patient outcomes changed in a set of 135 hospitals within the state of Pennsylvania between 1999 and 2006, as well as how these outcomes may have been influenced by a change in level of nurse education, level of nurse staffing, and rating of the nurse practice environment between these years. In order to accomplish this aim, descriptive statistics were calculated for all patient, nurse, and hospital characteristics in both years and compared for statistically significant differences across the years (statistical significance set at $p < .05$). Means, medians, and standard deviations were calculated for continuous variables. Correlations were completed to assess for multicollinearity between independent variables. Changes in nursing-specific organizational characteristics across the study time period were graphed to show the number of hospitals that worsened, experienced no change, or improved in measures of varying degree between 1999 and 2006.

Sample Characteristics: Registered Nurses and Hospitals

The final study sample included 135 hospitals, 17,844 registered nurses, and 29,356 patients. The characteristics of the 17, 844 nurses in the study are presented in Table 4-1. The number of respondents ranged from 10-394 per hospital in 1999 and 10-224 per hospital in 2006, with an average of 84.2 respondents in 1999 and 47.9 respondents in 2006. A total of 11, 370 nurse respondents were included in the 1999 sample, while a total of 6, 474 respondents were included in the 2006 sample. The majority of nurse respondents were non-Hispanic, white, and female. Information

regarding race and type of unit on which the nurse worked for the majority of his or her employment is not available for the year 1999. This information was not requested in the Pennsylvania Registered Nurse Survey (1999), but was included in the 2006 survey version.

Nurse demographic characteristics were similar in both years in regards to gender, with the majority of respondents identifying as female (93% in 1999, 94% in 2006). Change between study years is shown in categories including age, years of experience, and attainment of a Bachelor's of Science in Nursing degree. The mean age of nurses increased by four years over the study period (39.6 years in 1999 and 43.8 years in 2006), which coincides with national trends towards an aging nursing workforce. In line with this trend, the mean years of experience of the average nurse increased by three years (14 years of experience in 1999 and 17 years in 2006). The percentage of respondents who held a baccalaureate degree in nursing increased by 2% (34% in 1999 to 36% in 2006) during the study period. These percentages are indicative of the mean percentage of baccalaureate-prepared nurses when including those nurses with a higher degree, such as a master's or doctorate degree, in the sample. As previously indicated, for the purposes of this study, these nurses were coded as 'missing' in order to clearly define the predictor variable of change in level of nurse education within a hospital as a change amongst those nurses with a baccalaureate as the highest obtained degree. When omitting those nurses coded as 'missing', the mean percentage of baccalaureate-prepared nurses at the nurse-level similarly increases by 2% between study years, but with slightly higher values (37% in 1999 to 39% in 2006).

Table 4-1: Characteristics of Registered Nurses in Study Hospitals in 1999 and 2006 (n=17844)

Nurse Characteristics	*1999 (n=11370)*	*2006 (n=6474)*
Nurses (n)	N=11370	N=6474
Female (%)	10,527 (93)	6,098 (94)
Male (%)	675 (6)	366 (6)
Missing (%)	169 (1.6)	10 (0.2)
Age, mean	39.6	43.8
Age, range	Range 20-92	Range 21-72
Missing	183 (1.6)	64 (1.0)
Years experience, mean	14	17
Years experience, range	Range 0-82	Range .5-51
Missing	235 (2.1)	109 (1.7)
BSN, n (%)		
Yes	3836 (34)	2318 (36)
No	6634 (58)	3668 (57)
Missing (including higher degrees)	900 (8)	488 (8)
BSN, mean (bsnonly)	.37 (37)	.39 (39)
Race, n (%)		
White	***	6091 (94)
Filipino		64 (1)
Asian		65 (1)
Black/African American		125 (2)
American Indian		3 (.05)
Mixed Race		26 (0.4)
Other Race		47 (0.7)
Missing		53 (0.8)
Unit Type		
Float Pool	***	69 (1)
Medical/Surgical		692 (11)
Pediatric		97 (2)
ICU Adult		717 (11)
ICU Pediatric		24 (0.4)
ICU Neonatal		161 (3)
Intermediate Care		167 (3)
Telemetry		325 (5)
Oncology		93 (2)
Emergency Room		363 (6)
Transitional Care		79 (1)
Behavioral/Psychiatric		143 (2)
Nursery/Postpartum		194 (3)
Labor/Delivery		219 (3)
Operating Room		247 (4)
Recovery Room		196 (3)
Missing		2,688 (42)

Hospital characteristics including bed size, technology status, and teaching status are displayed for 134 of the 135 study hospitals in Table 4-2. The omission of one hospital is due to missing hospital characteristic data. As compared to 1999, more hospitals in 2006 had the capability to perform high technology procedures, had a greater number of beds, and were affiliated with a medical school.

Table 4-2: Pennsylvania's Hospital Characteristics in 1999 and 2006 (n=134)

Hospital Characteristics	1999 (n=134)	2006 (n=134)
Bed Size, n (%)		
Small (<100)	24 (18)	19 (14)
Medium (100-250)	77 (58)	72 (54)
Large (>250)	33 (25)	43 (32)
Technology, n (%)		
Low	89 (66)	74 (55)
High	45 (34)	60 (45)
Teaching Status, n (%)		
Non-teaching	81 (60)	63 (47)
Minor teaching	36 (27)	52 (39)
Major teaching	17 (13)	19 (14)

Note: Hospital characteristics are from the American Hospital Association Annual survey. Percentages may not add up to 100 due to rounding totals.

Table 4-3 includes hospital-level descriptive statistics including mean, median, standard deviation, and range for nursing-specific organizational characteristics. Statistics are provided for practice environment scores based on both PES-NWI composite scores (one with the staffing and resource adequacy subscale (NWI5) and one with the staffing and resource adequacy subscale omitted (NWI4)). Results from the table indicate that, on average, nursing-specific organizational characteristics improved within hospitals between 1999 and 2006. The results from these tables are presented in separate sections below to accompany results presented in figures.

The mean proportion of baccalaureate-prepared nurses within hospitals increased from 33% (range of 6-74% in individual hospitals) in 1999 to 34% (range of 0-79% in individual hospitals) in 2006. Nurse staffing, defined as the number of patients assigned to each nurse during his or her last shift, improved over the study period, from a mean of 5.81 patients per nurse in 1999 to 5.76 patients in 2006. A significant increase in the mean practice environment score for both PES-NWI composite scales was shown. The PES-NWI composite score including all five subscales increased from 2.49 to 2.60, while the PES-NWI score omitting the staffing and resource subscale increased from 2.57 to 2.65 during the same period. Nursing-specific organizational characteristics between study years were tested for statistical difference. Rating of the nurse practice environment was found to be statistically different between study years, as expected from the data presented below. The two nursing-specific organizational variables of nurse education and nurse staffing were not shown to be statistically different between 1999 and 2006.

Table 4-3: Descriptive Statistics for Nursing-Specific Organizational Variables at the Hospital Level, N=135

Nursing Variable	**Mean**	**Median**	**SD**	**Range**
Level of Nurse Education				
1999 (h_bsnonly99)	0.33	0.31	0.13	0.06-0.74
2006 (h_bsnonly06)	0.34	0.33	0.14	0.00-0.79
Level of Nurse Staffing				
1999 (h_patsyou99)	5.81	5.61	1.18	3.70-9.27
2006 (h_patsyou06)	5.76	5.56	1.22	3.30-10.50
Nurse Work Environment (NWI5)				
1999 (h_nwi599)	2.49	2.48	0.17	2.11-2.89
2006 (h_nwi506)	2.60	2.60	0.22	2.05-3.18
Nurse Work Environment (NWI4)				
1999 (h_nwi499)	2.57	2.55	0.16	2.17-2.93
2006 (h_nwi406)	2.65	2.66	0.22	2.04-3.25
Nurse Work Environment Subscales				
Staffing and Resource Adequacy				
1999	2.19	2.18	0.25	1.58-2.87
2006	2.40	2.40	0.28	1.79-3.09
Collegial Nurse/Physician Relations				
1999	2.77	2.79	0.15	2.26-3.12
2006	2.85	2.88	0.20	2.29-3.31
Nurse Manager Ability/Nurse Leadership	2.38	2.37	0.22	1.81-2.97
1999	2.42	2.43	0.28	1.61-3.06
2006				
Nurse Participation in Hospital Affairs	2.32	2.33	0.23	1.74-2.95
1999	2.47	2.48	0.33	1.75-3.40
2006				
Nursing Foundations for Quality Care	2.81	2.82	0.18	2.20-3.22
1999	2.85	2.85	0.21	2.15-3.40
2006				

Table 4-4 includes descriptive statistics for the *changes* in hospital-level nursing characteristics between study years. Results from the table indicate that, on average, nursing-specific organizational characteristics improved within hospitals between 1999 and 2006.

Hospitals increased the percentage of baccalaureate-educated inpatient staff nurses between study years by an average of 1.1%. The range of change between time points was expansive, with one hospital decreasing the number of baccalaureate-educated nurses by 24% while another hospital increased the number of baccalaureate-educated nurses by 36% within the same time period. A mean decrease of .06 patients per nurse between study years is shown, noting an expansive range at the individual hospital level (-4.11, or an average of 4 less patients per nurse to 3.47, an average of 3.5 patients more per nurse). Change in the practice environment is congruent with data shown in Table 4-3. Marked improvement in both versions of the PES-NWI composite scale is shown, with a mean change value of 0.11 when including all five practice environment subscales, and a mean change value of 0.08 when omitting the staffing and resource adequacy subscale.

Table 4-4: Descriptive Statistics for Changes in Nursing Variables between 1999 and 2006 at the Hospital Level, N=135

Change in Nursing Variable	**Mean**	**Median**	**SD**	**Range**
Change in Level of Nurse Education	0.01	0.02	0.11	-0.24-0.36
Change in Level of Nurse Staffing	-0.06	-0.09	1.19	-4.11-3.47
Change in Nurse Work Environment (NWI5) (H_nwi506-H_nwi599)	0.11	0.10	0.20	-0.41-0.61
Change in Nurse Work Environment (NWI4) (H_nwi406-H_nwi499)	0.08	0.08	0.20	-0.39-0.57

Table 4-5 presents a distribution of study hospitals across categories of nursing-specific organizational measures for both years. Based on nurse response, the majority of hospitals (64.4% in 1999 and 60% in 2006) employed between 25-50% of baccalaureate-prepared nurses. This supports evidence in Table 4-3 and 4-4 that showed mean values of the proportion of baccalaureate-prepared nurses within hospitals to be 33% in 1999 and 34% in 2006. The majority of hospitals (39.3%) in 1999 had nurse respondents reporting care of greater than 6 patients per nurse per shift. The majority of hospitals (42.9%), however, had nurse respondents reporting an average of between 5 and 6 patients per nurse in 2006, indicating a decreasing trend in the number of patients per nurse over the study period. Practice environment between study years shows marked change between study years. While the majority of hospitals in 1999 (50) had a mean nurse practice environment score between 2-2.49, the majority of hospitals in 2006 (43) had a mean nurse practice environment above 3.0. This represents a marked increase in rating of the nurse practice environment by nurse respondents between study years.

Table 4-5: Distribution of Hospitals Across Categories of Nursing Variables: (N = 135)

Hospital Level Nursing Characteristics	***1999*** ***N=135***		***2006*** ***N=135***	
Nurse Education (mean proportion of nurses with a bachelor's degree) **Note omission of those RNs with higher than a BSN*		N (%)		N (%)
	<25%	34 (25.4%)	<25%	36 (26.6%)
	25-50%	87 (64.4%)	25-50%	81 (60%)
	50-75%	14 (10.2%)	50-75%	17 (12.6%)
	>75%	0 (0%)	>75%	1 (.01%)
Nurse Staffing (mean patients per nurse)	<5 pts/RN	38 (28.2%)	<5 pts	35 (25.9%)
	5-6 pts/RN	44 (32.6%)	5-6 pts	58 (42.9%)
	>6 pts/RN	53 (39.3%)	>6 pts	42 (31.1%)
Practice Environment (PES-NWI tool) NWI4	1-1.99	18 (13%)	1-1.99	15 (11%)
	2-2.49	34 (25%)	2-2.49	40 (30%)
	2.5-2.99	50 (37%)	2.5-2.99	37 (27%)
	> 3	33 (24%)	> 3	43 (32%)

*Percentages may not add up to 100 due to rounding errors
*Practice environment uses h_nwi499 and h_ nwi406 variables at the hospital level for characteristics

Nurse Education

Figure 4-4 displays the hospital-level distribution of the fraction of registered nurses within hospitals who held a baccalaureate degree in nursing as their highest degree in both 1999 and 2006. As indicated by the data presented above, the range of the number of baccalaureate-prepared nurses within individual hospitals is more expansive in 2006 (0-79%) as compared to 1999 (6-74%). As described, the majority of hospitals in both study years have a proportion of baccalaureate-prepared nurses between 25-50%. The mean value of baccalaureate-prepared nurses within hospitals appears to marginally increase from 1999 to 2006. This appears to be due, in part, to the increased range of values in 2006. Figure 4-5 displays the hospital level distribution of the change in the percentage of baccalaureate-educated nurses within hospitals between study years. The change in proportion of baccalaureate-prepared nurses within a hospital ranged from -24% to 36% between study years. This expanse indicates variability amongst hospitals. As indicated in Figure 4-5, the majority of hospitals appear to have decreased or increased the proportion of baccalaureate-prepared nurses within their institution by a value of approximately 0-7%. The figure indicates that the greatest number of hospitals (approximately 30), increased the proportion of baccalaureate-prepared nurses within the institution by 2-8%. The second largest majority of hospitals (approximately 25), appear to have decreased the proportion of baccalaureate-prepared nurses within the institution by 2-8%. This data coincides with a mean value for change between years of 1.1% in the proportion of baccalaureate-prepared nurses within institutions.

Figure 4-4: Hospital level distribution of fraction of nurse respondents within hospitals with a BSN degree in 1999 and 2006

Figure 4-5: Hospital level distribution of the change in percentage of BSN educated nurses within study hospitals 1999-2006

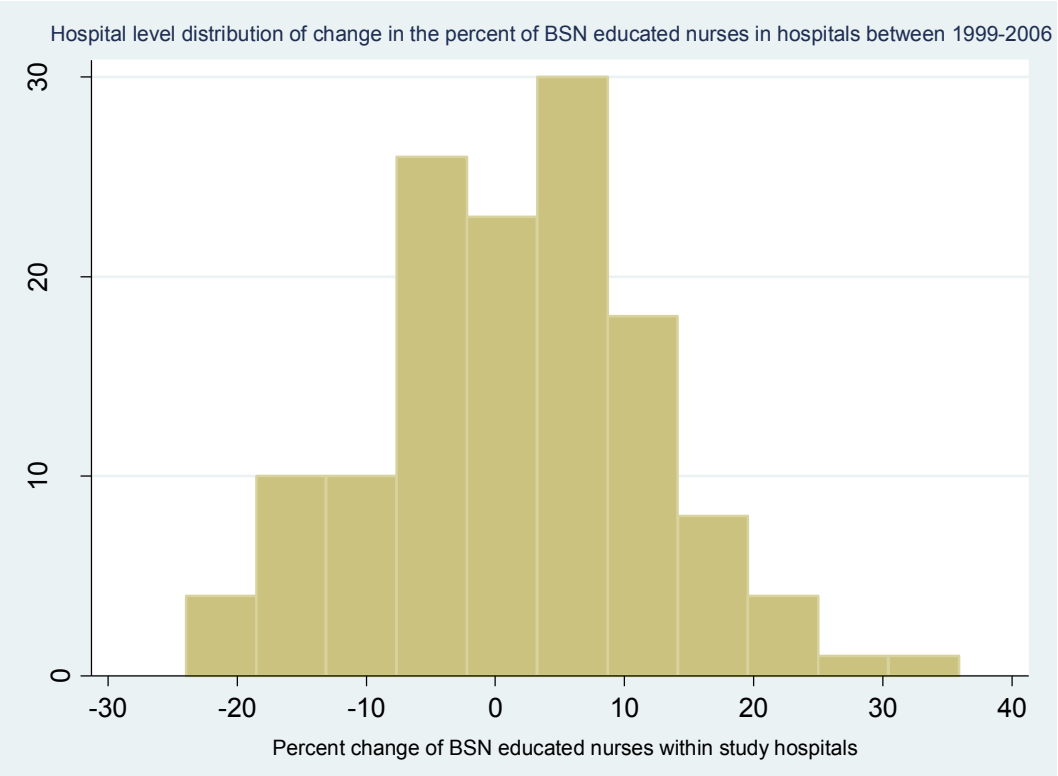
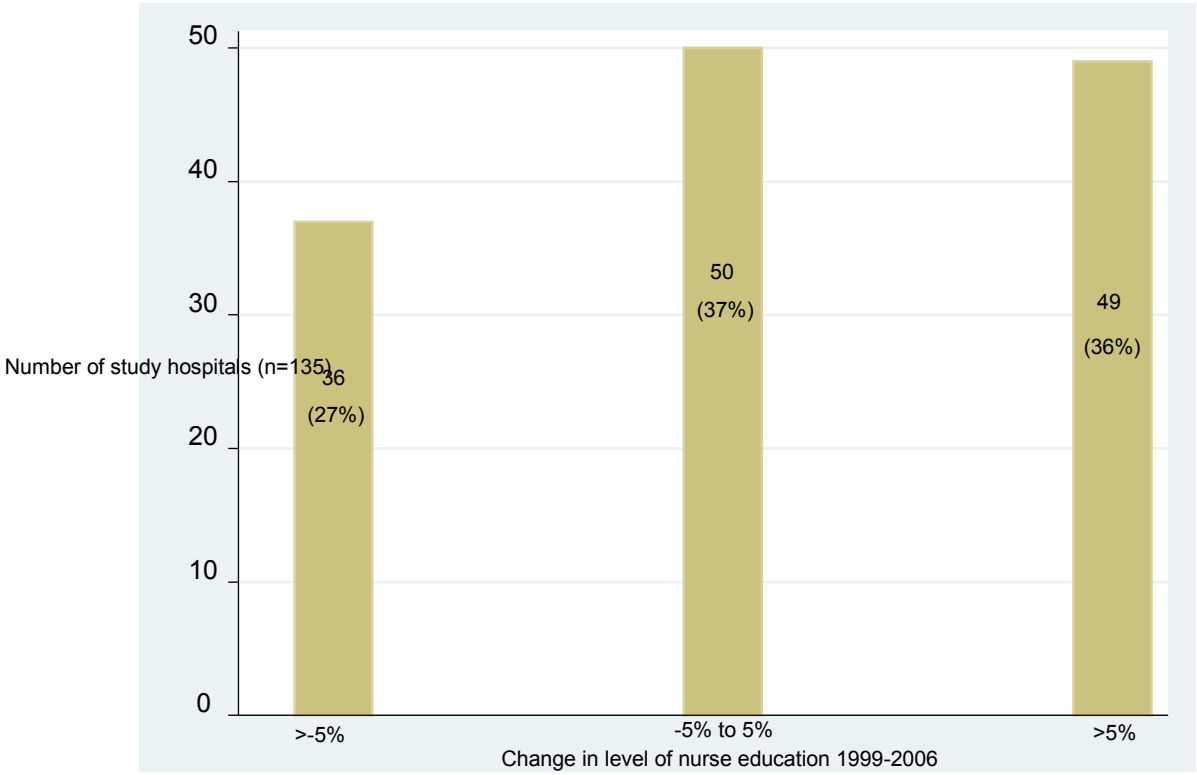


Figure 4-6 displays the hospital level distribution of the change in percentage of baccalaureate-prepared nurses within study hospitals. Based on previously described methodology, hospitals were categorized as “worsened or declined” “stable” and “improved” in regards to nursing education based on the change value between 1999 and 2006. “Worsened or declined” hospitals were those hospitals that decreased their proportion of baccalaureate-educated nurses by greater than 5% during the study period. “Improved” hospitals were those that increased their proportion of baccalaureate-educated nurses by greater than 5% during the study period. “Stable” hospitals were those institutions that experienced a change between -5 and 5% in their proportion of baccalaureate-prepared nurses within the same time period. As evidenced below, the “stable” and “improved” categories are approximately equivalent in regards to the number of hospitals within each (50 hospitals in “stable”, 49 hospitals in “improved”). There were 36 hospitals categorized as “worsened or declined” due to a decrease of greater than 5% in the percentage of baccalaureate-prepared nurses.

Figure 4-6: Hospital level distribution of the change in percentage of BSN educated nurses within study hospitals 1999-2006



Nurse Staffing

Figure 4-7 displays the hospital-level distribution of the mean number of patients cared for per nurse in 1999 and 2006. The hospital-level mean number of patients per nurse was 5.81 in 1999 and 5.76 in 2006 (Table 4-3). The range of the mean patients per nurse at the hospital level was expansive, ranging from 3.7 to 9.27 in 1999 and 3.3 to 10.5 in 2006 (Table 4-3). The mean change was a 0.06 decrease in patients per nurse (range -4.1 to 3.5 (Table 4-4)). Between the years 1999 and 2006, the majority of the study hospitals either maintained their current standard of staffing (38%) or improved their level of staffing by decreasing the nurse-to-patient ratio by greater than one-half of a patient (35%) over the study time period.

Figure 4-8 displays the hospital level distribution of the change in nurse staffing levels within hospitals between study years. The change in the number of patients cared for per nurse within a hospital ranged from -4.11 to 3.46. This range indicates variability amongst hospitals. The mean value of change between study years was -0.06, indicating a marginal decrease in the number of patients per nurse cared for between study years. As indicated in Figure 4-8, the majority of hospitals appear to have decreased or increased the average number of patients per nurse by a value of approximately 0-1 patients. The figure indicates that the greatest number of hospitals (approximately 43), decreased the average number of patients per nurse by 0-1. Variability among changes in nurse staffing appears less expansive than the variability seen amongst hospitals in regards to proportion of baccalaureate-prepared nurses employed within an institution.

For the nurse staffing variable, a total of 582 respondents (3.3% of the sample) were considered out of range and recoded as missing for this variable. A total of 439

nurses in the 1999 sample reported caring for < 1 patient/shift or > 20 patients/shift and were coded as missing. This represented 3.8% of the 1999 sample. A total of 143 nurses in the 2006 sample reported caring for < 1 patient/shift or > 20 patients/shift and were coded as missing. This represented 2.2% of the 2006 sample.

Figure 4-7: Hospital level distribution of the number of patients cared for by registered nurses within each study hospital on last shift in 1999 and 2006

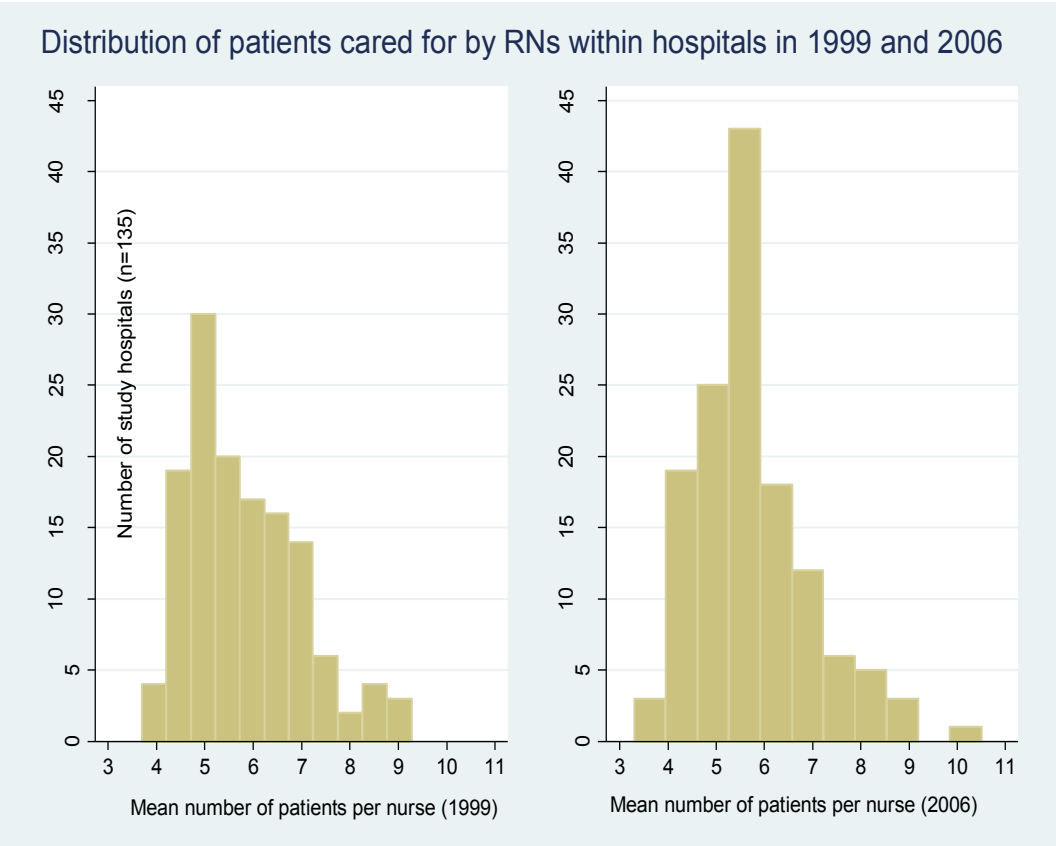


Figure 4-8: Hospital level distribution of the change in nurse staffing levels within study hospitals1999-2006

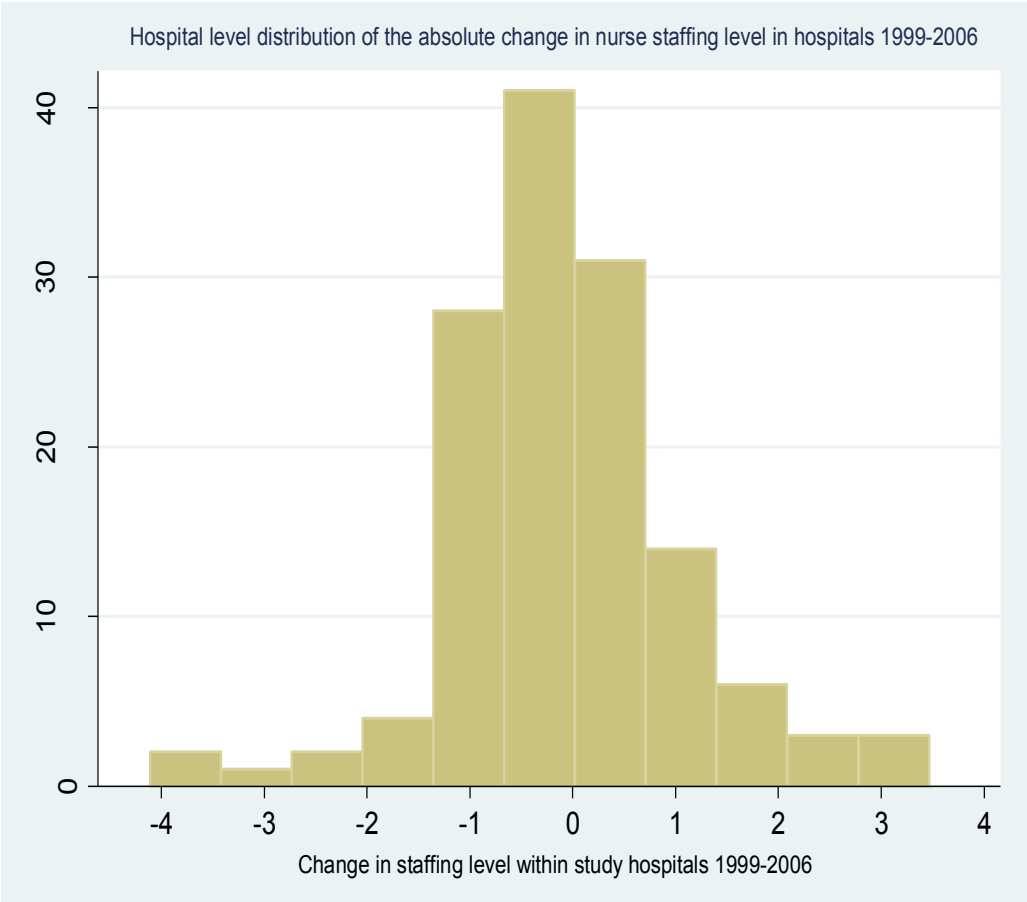
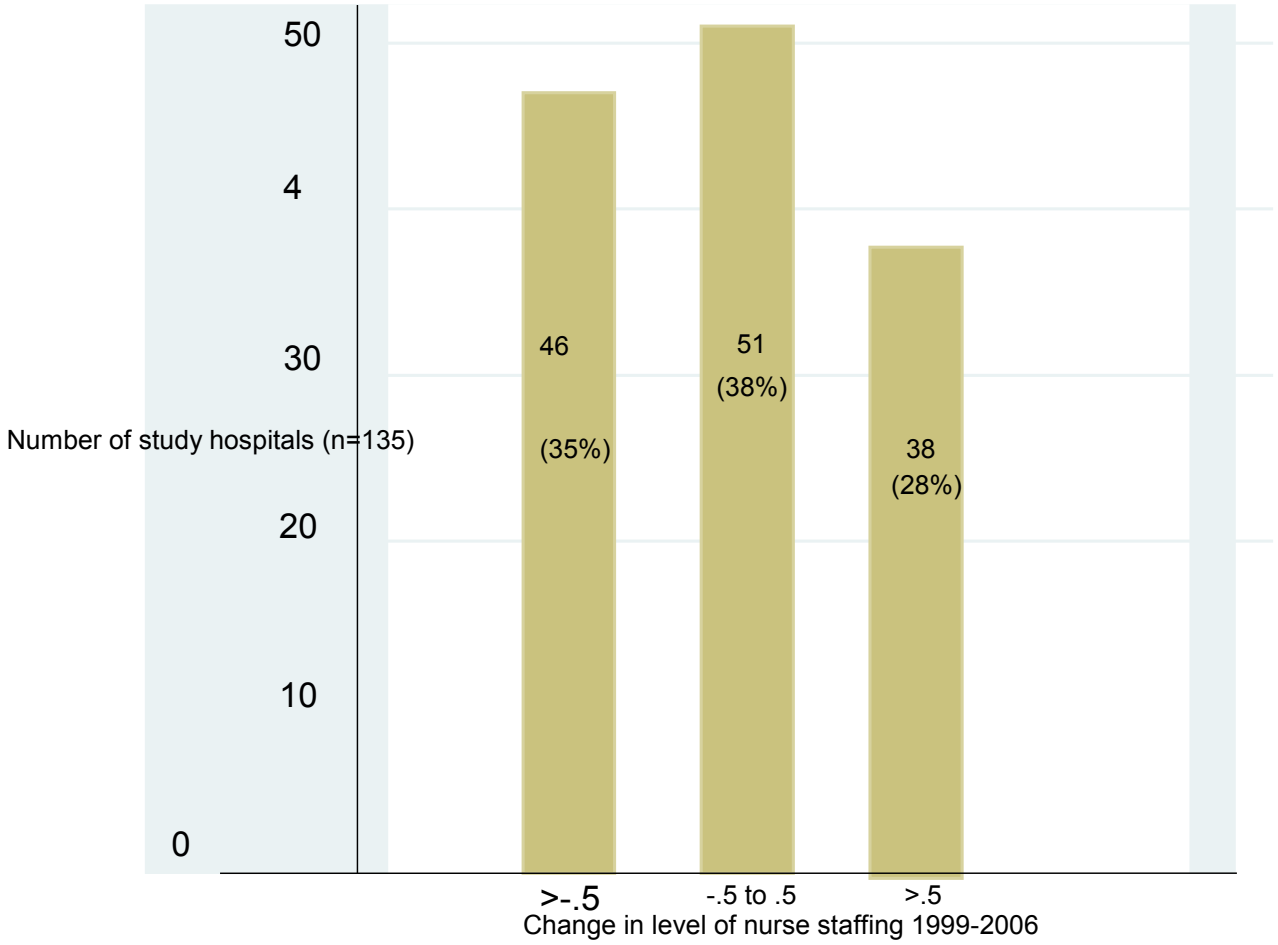


Figure 4-9 displays the hospital level distribution of the change in the level of nurse staffing within study hospitals. Based on previously described methodology, hospitals were categorized as "worsened or declined "stable" and "improved" in regards to nurse staffing based on the change value between 1999 and 2006. "Worsened or declined" hospitals were those hospitals that increased the number of patients per nurse by greater than one-half (0.5) patients during the study period. "Improved" hospitals were those that decreased the number of patients per nurse by greater than 0.5 patients during the study period. "Stable" hospitals were those institutions that experienced a change between -0.5 and 0.5 in the number of patients per nurse within the same time period. As evidenced below, the largest group of hospitals (n = 51, 38%) had no appreciable change in staffing (i.e., a change value between -0.5 and 0.5 between 1999 and 2006). Slightly fewer hospitals (n = 46, 35%) had improved staffing in 2006 (i.e., a greater than 0.5 decrease in the number of patients cared for per nurse). The fewest hospitals (n = 38, 28%) had worsened staffing (i.e., a greater than 0.5 increase in the number of patients cared for per nurse).

Figure 4-9: Hospital level distribution of the change in nurse staffing level within study hospitals 1999-2006



Nurse Practice Environment

PES-NWI5 Composite Score

Figure 4-10 displays the hospital-level distribution of the mean composite score of the PES-NWI in1999 and 2006. The composite mean value increased 0.11 points from 1999 to 2006. Values in 1999 (mean=2.49, median=2.48, range 2.11-2.89) as compared to values in 2006 (mean=2.60, median=2.60, range 2.05-3.18) indicate that responses were increasingly positive in regards to the practice environment scale using all five subscales in the sample of hospitals in 2006 as compared to 1999. The range of scores in the year 2006 is more expansive than the range seen in 1999.

Figure 4-11 displays the hospital level distribution of the change in the composite score from 1999 to 2006. The mean value for this change variable is .11. The change in composite score within hospitals ranged from -0.41-0.61.

Figure 4-10: Hospital level distribution of NWI5 scores within study hospitals in 1999 and 2006

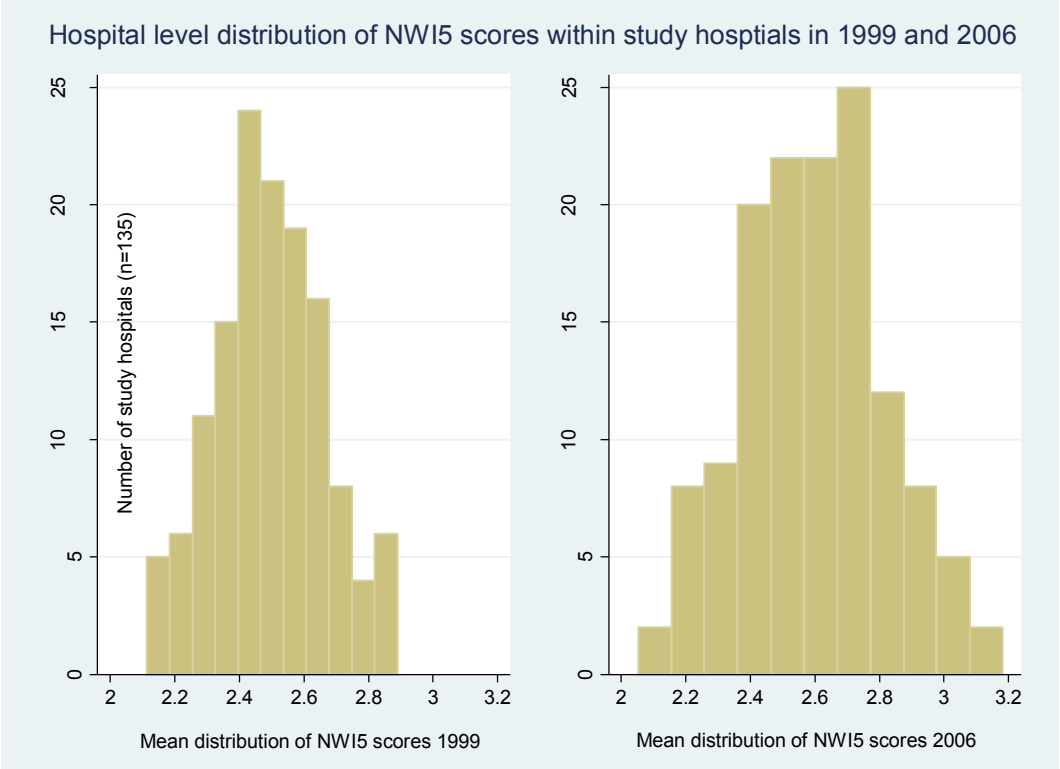
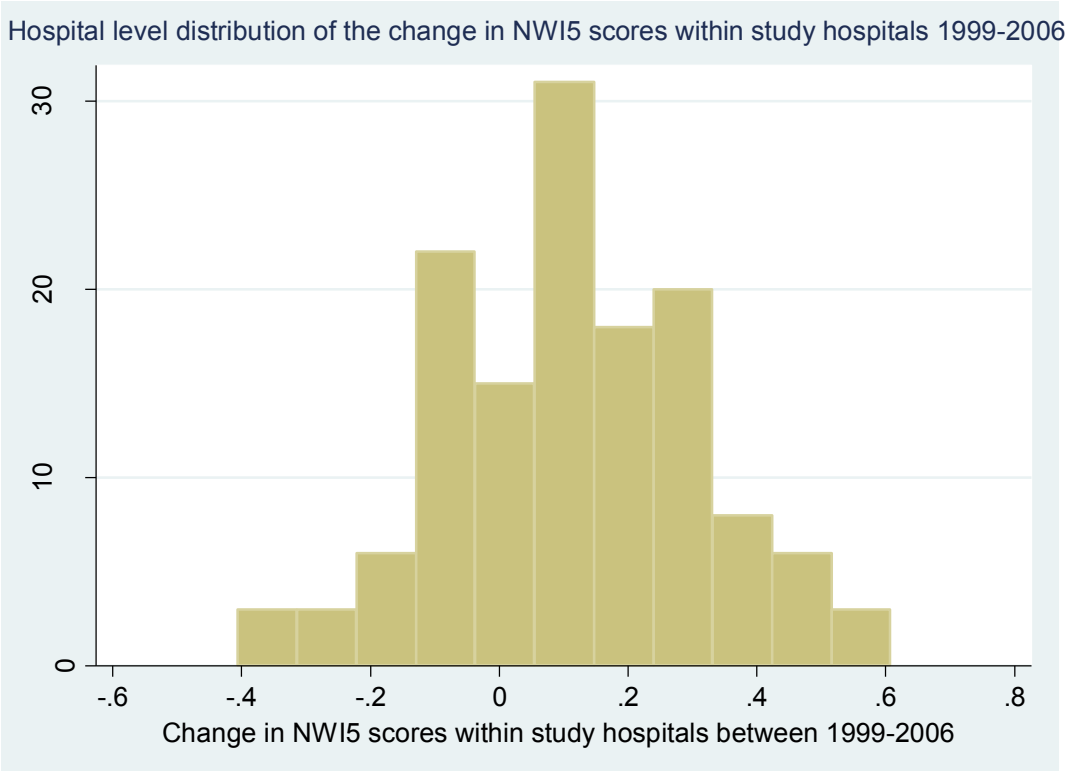


Figure 4-11: Hospital level distribution of the change in NWI5 scores within study hospitals 1999-2006



PES-NWI4 Composite Score

Figure 4-12 displays the hospital-level distribution of the mean composite score of the PES-NWI, omitting the staffing and resource adequacy subscale, for 1999 and 2006. The staffing and resource adequacy subscale was omitted due to high correlation with the direct staffing measure used. PES-NWI composite scores with and without the staffing and resource adequacy subscale are reviewed in an effort to provide comparative statistics. For the four-subscale composite score, the mean value increased from 1999 to 2006. Values in 1999 (mean=2.57, median=2.55, range 2.17-2.93) as compared to values in 2006 (mean=2.65, median=2.66, range 2.04-3.25) indicate that responses were increasingly positive in regards to the practice environment scale using four of the five subscales in the sample of hospitals in 2006 versus 1999. Comparison between study years indicates a major upward shift of scores from 1999 to 2006.

Figure 4-13 displays the hospital level distribution of the change in the composite score from 1999 to 2006. The mean value for this change variable was .08, which represents a considerable shift in change value between study years. The change in composite score within hospitals ranged from-0.39-0.57.

Figure 4-12: Hospital level distribution of NWI4 scores within study hospitals in 1999 and 2006

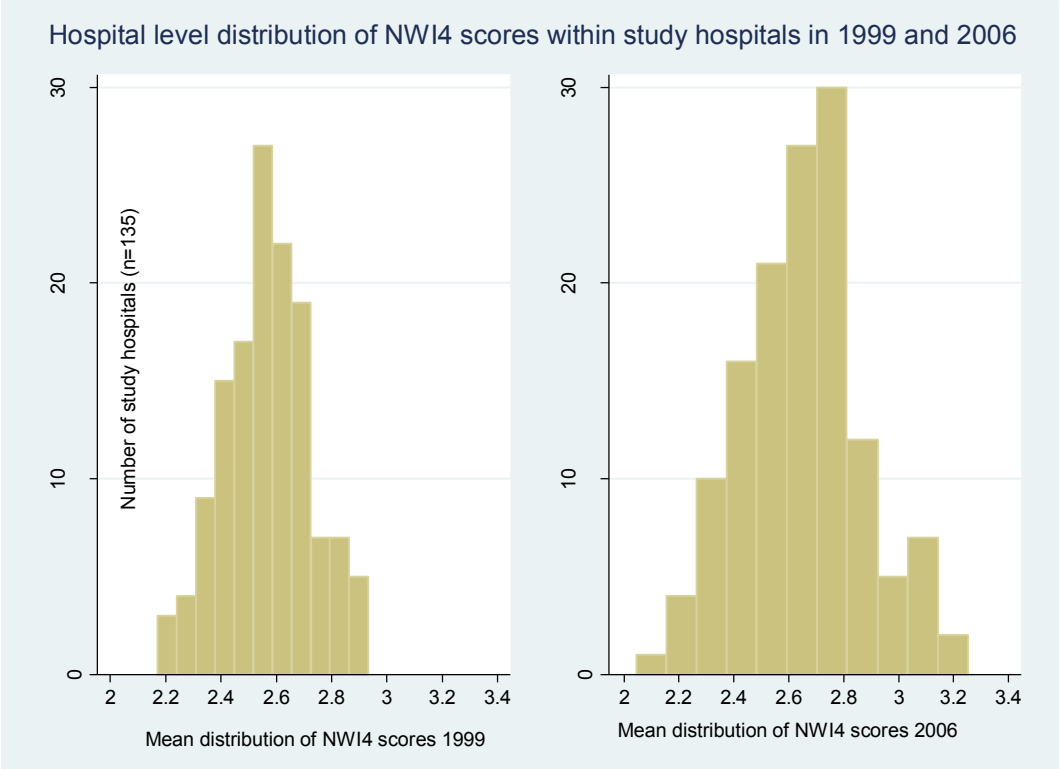
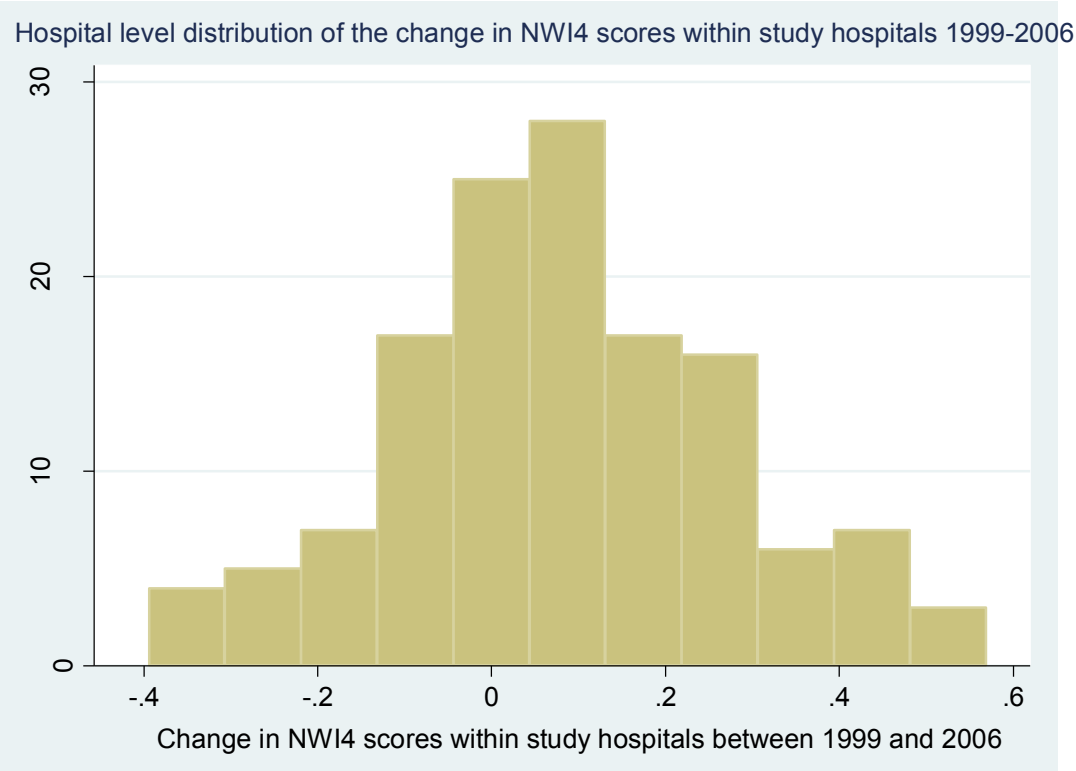


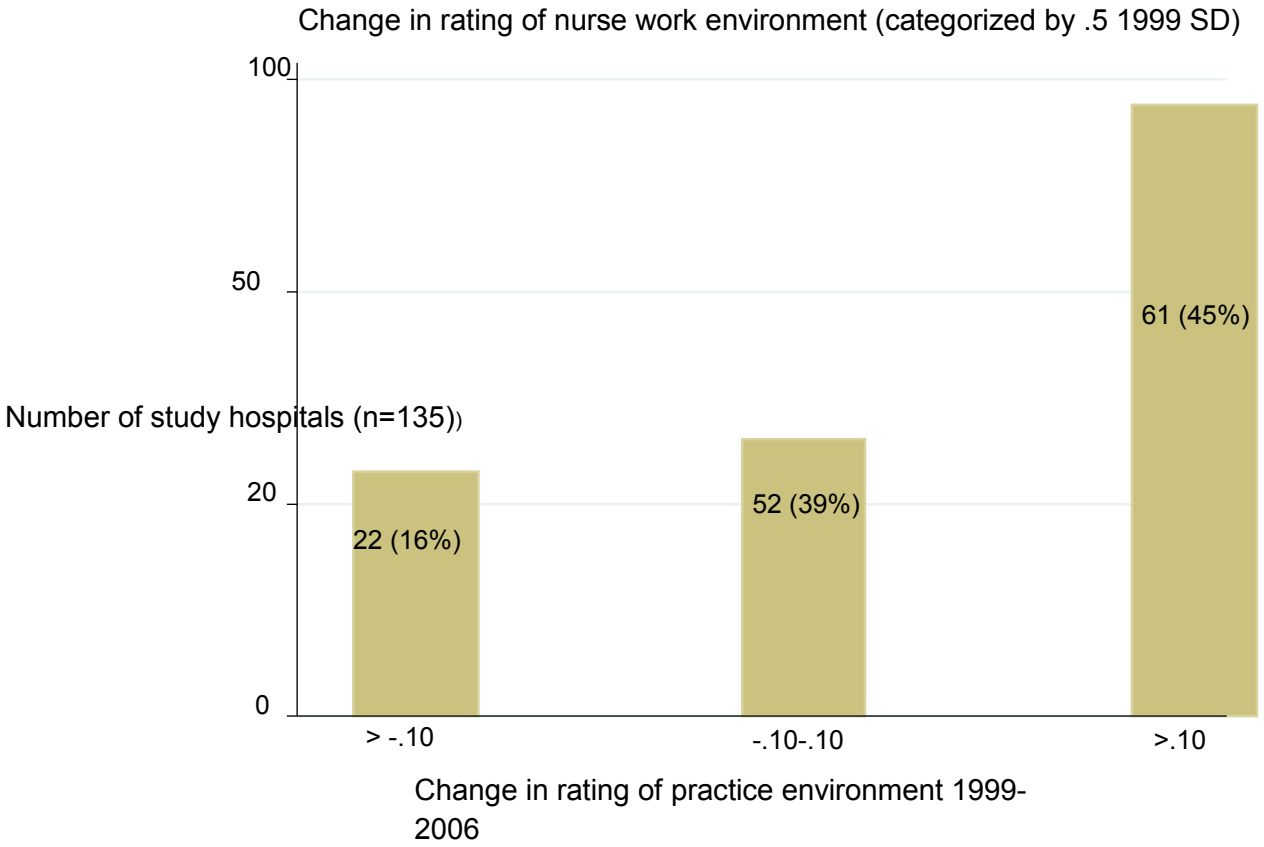
Figure 4-13: Hospital level distribution of the change in NWI4 scores within study hospitals 1999-2006



Change for hospital level NWI4 composite scores between years was specified into a categorical variable based on a .5 of a standard deviation change from 1999 nursing-work index composite scores. The standard deviation of the nursing work-index composite score in 1999 was 0.17, as observed in Table 4-3. One-half of a standard deviation would be measured at approximately 0.085. For ease of interpretation, use of 0.10 as a categorical measure was employed, and is referred to as one-half of one standard deviation.

Twenty-two hospitals (16%) had more than one-half of a standard deviation decrease (> -.10) in rating of the nurse practice environment between the years 1999 and 2006, 61 hospitals (45%) had greater than a .5 (> .10) standard deviation increase in the rating of the practice environment, while 52 hospitals (39%) had no appreciable change in the rating of the practice environment.

Figure 4-14: Hospital level distribution of the change in rating of the nurse practice environment level within study hospitals by .5 SD (.10) from 1999 data 1999-2006 (PES-NWI with exclusion of staffing and resource adequacy subscale)



Nursing Practice Environment Subscales

Staffing Resource and Adequacy Subscale

Figure 4-15 is a graphical display of hospital level distributions of the staffing and resource adequacy (SRA) subscale scores for 1999 and 2006. The SRA subscale mean and median increased from 1999 to 2006. Values in 1999 as compared to values in 2006 indicate that responses were increasingly positive in regards to the staffing and resource adequacy component of the practice environment in the sample of hospitals in 2006 versus 1999.

Figure 4-16 displays the hospital level distribution of the change in SRA subscale scores from 1999 to 2006. The mean value for this change variable was 0.21. This result indicates a positive change in the staffing and resource adequacy subscale over the study period, especially in light of the nurse staffing variable, which basically showed no to little change over this same time period. Further exploration into the staffing and resource adequacy subscale and its correlation with the nurse staffing variable is warranted. Future research exploring the individual subscales of the PES-NWI and how these subscales have changed over time would enhance findings from this study.

Figure 4-15: Comparison of hospital level distribution of staffing and resource adequacy subscale scores in 1999 and 2006

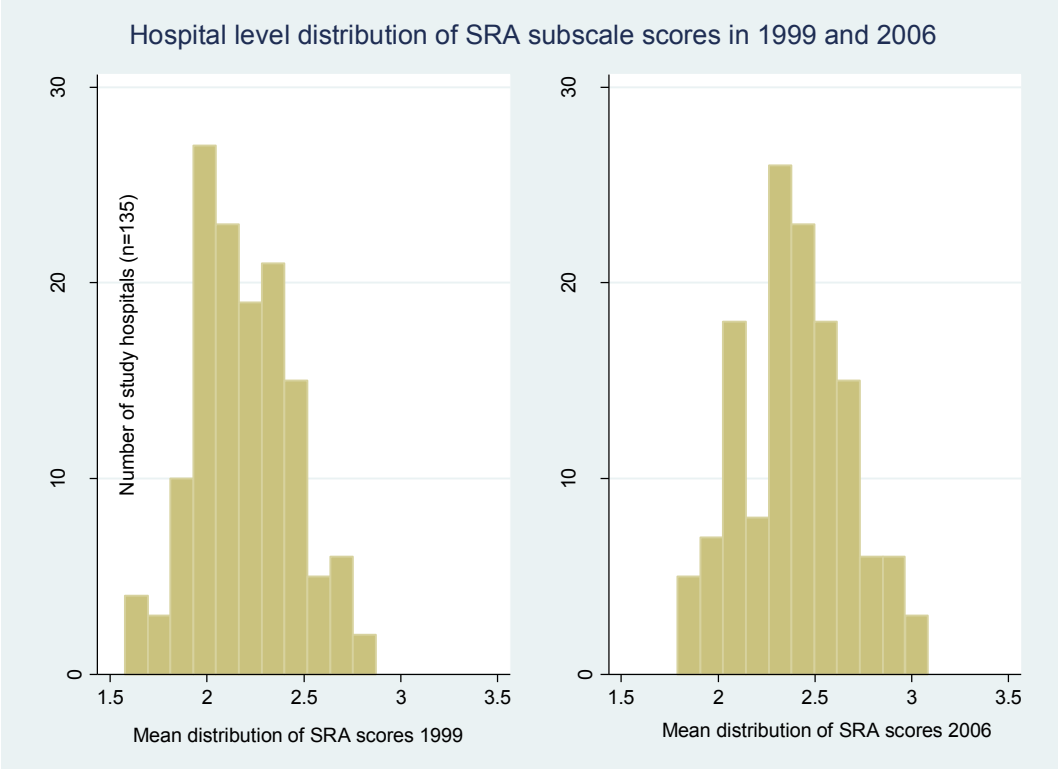
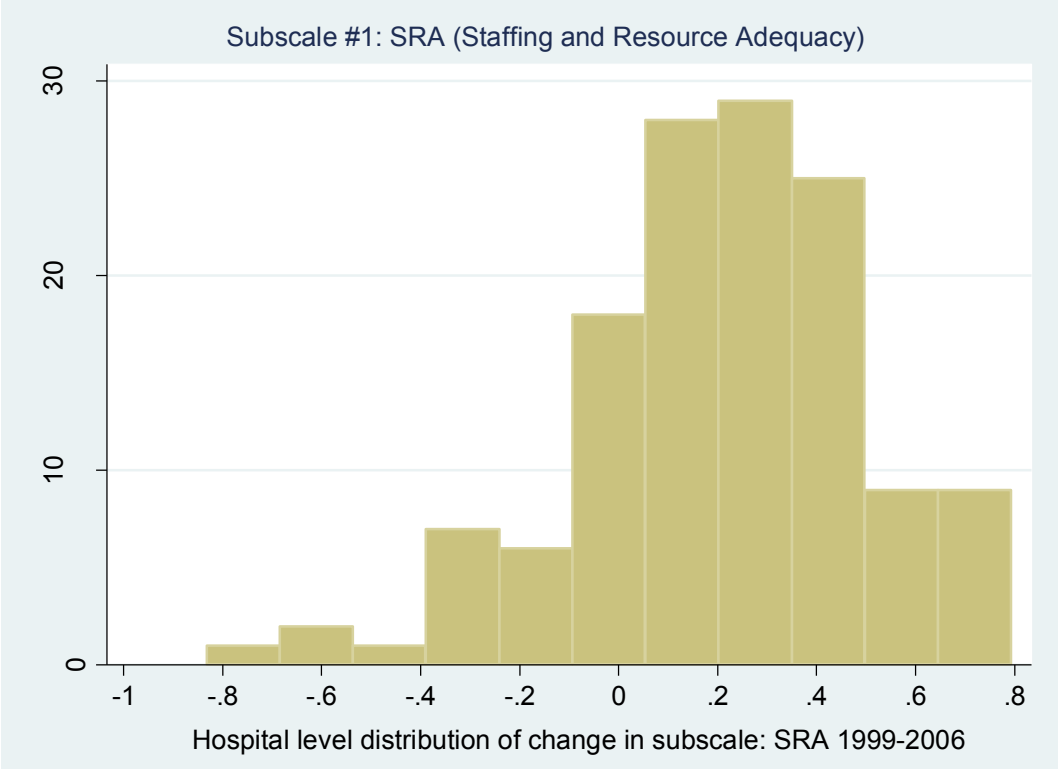


Figure 4-16: Hospital level change in staffing and resource adequacy subscale scores from 1999-2006



Collegial Nurse/Physician Relations

Figure 4-17 displays the hospital level distribution of the collegial nurse/physician relations (NPRELATE) subscale scores for 1999 and 2006. The NPRELATE subscale mean and median increased from 1999 to 2006. Values in 1999 as compared to values in 2006 indicate that responses were increasingly positive in regards to the rating of collegial nurse/physician relations component of the practice environment in the sample of hospitals in 2006 versus 1999.

Figure 4-18 displays the hospital level distribution of the change in NPRELATE subscale scores from 1999 to 2006. The mean value for this change variable was 0.08.

Figure 4-17: Comparison of hospital level distribution of collegial nurse/physician relations subscale scores in 1999 and 2006

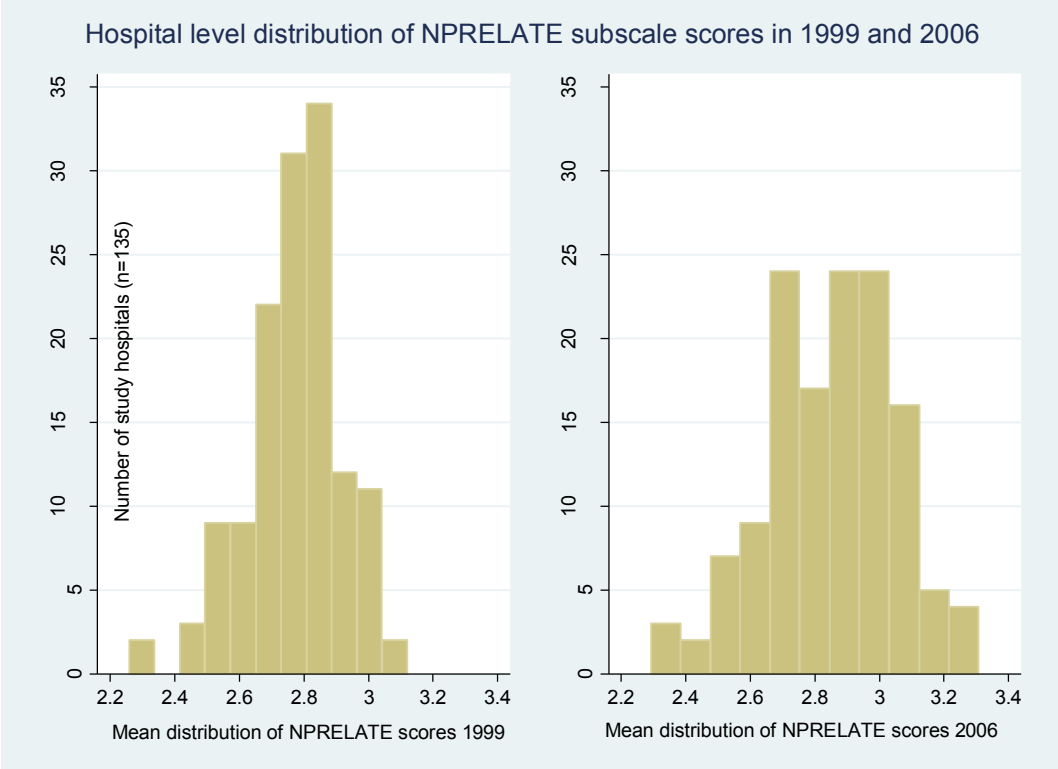
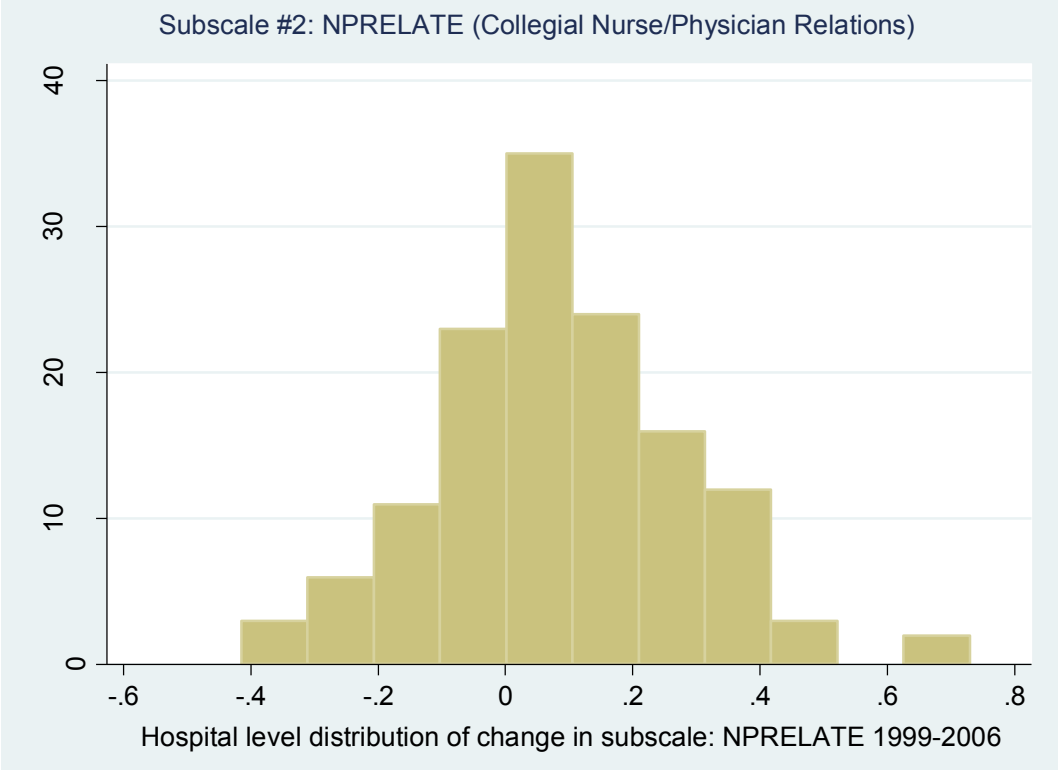


Figure 4-18: Hospital level change in collegial nurse/physician relations subscale scores from 1999-2006



Nurse Manager Ability, Leadership and Support of Nurses

Figure 4-19 is a graphical display of hospital level distributions of the nursing management and leadership (MNALS) subscale scores for 1999 and 2006. The MNALS subscale mean and median increased from 1999 to 2006. Values in 1999 as compared to values in 2006 indicate that responses were more positive in regards to the nursing management and leadership component of the practice environment in the sample of hospitals in 2006 versus 1999.

Figure 4-20 displays the hospital level distribution of the change in MNALS subscale scores from 1999 to 2006. The mean value for this change variable was 0.04.

Figure 4-19: Comparison of hospital level distribution of nurse manager ability, leadership and support of nurses subscale scores in 1999 and 2006

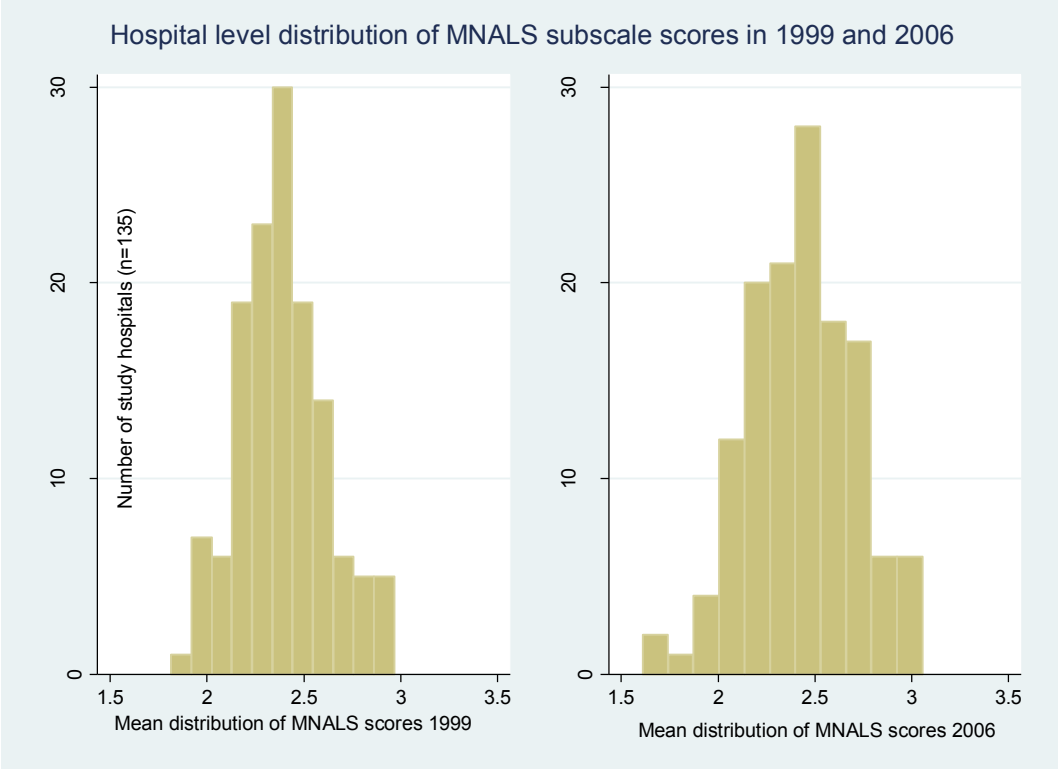
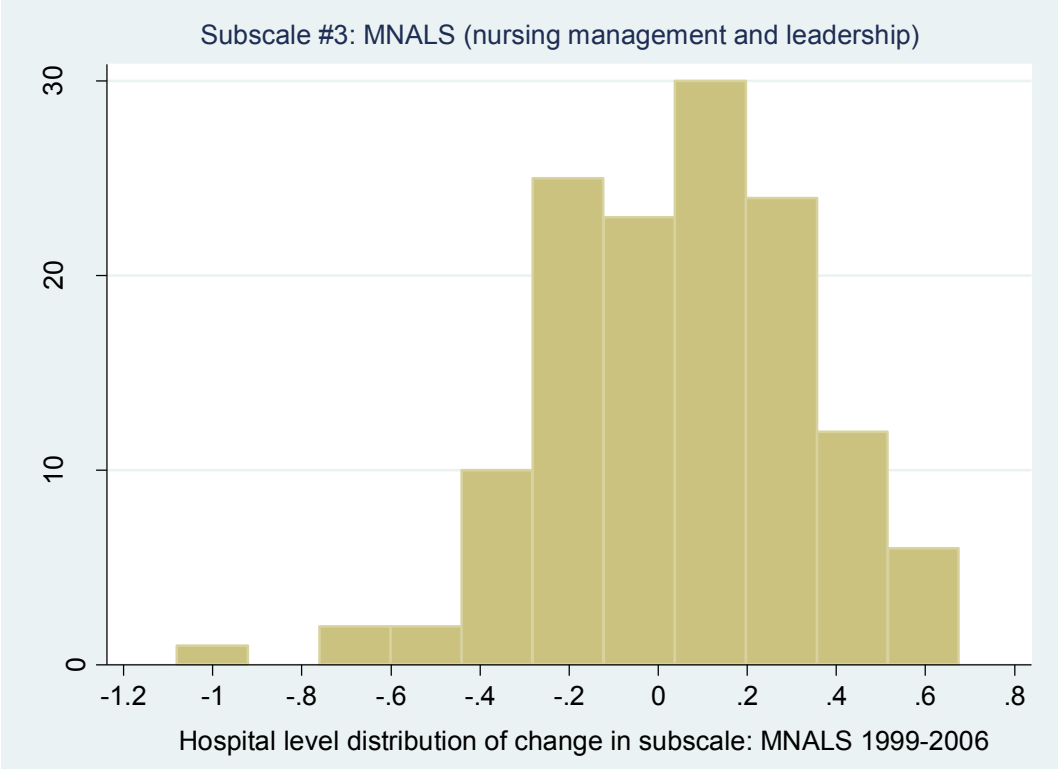


Figure 4-20: Hospital level change in nurse manager ability, leadership and support of nurses subscale scores from 1999-2006



Nurse Participation in Hospital Affairs

Figure 4-21 is a graphical display of hospital level distributions of the nurse participation in hospital affairs (AFFAIRS) subscale score for 1999 and 2006. The AFFAIRS subscale mean and median increased from 1999 to 2006. Values in 1999 as compared to values in 2006 indicate that responses were more positive in regards to the nurse participation in hospital affairs component of the practice environment in the sample of hospitals in 2006 versus 1999.

Figure 4-22 displays the hospital level distribution of the change in AFFAIRS subscale scores from 1999 to 2006. The mean value for this change variable was 0.15.

Figure 4-21: Comparison of hospital level distribution of nurse participation in hospital affairs subscale scores in 1999 and 2006

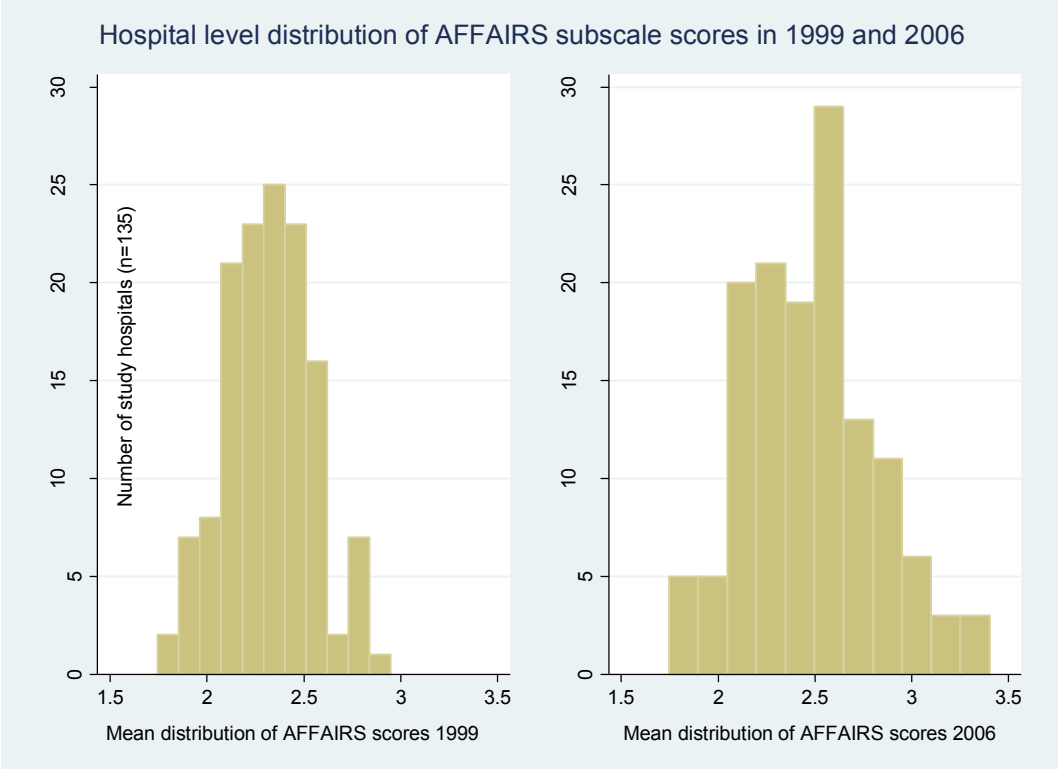
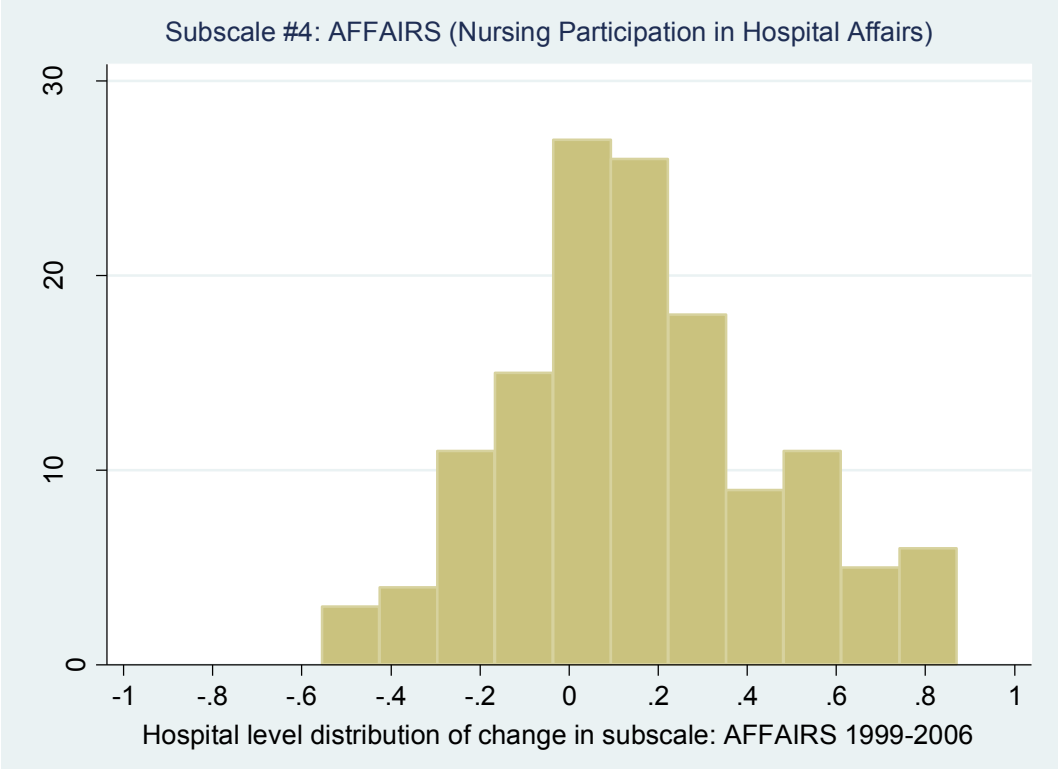


Figure 4-22: Hospital level change in nurse participation in hospital affairs subscale scores from 1999-2006



Nursing Foundations for Quality of Care

Figure 4-23 is a graphical display of hospital level distributions of the nursing foundations for quality of care subscale scores for 1999 and 2006. The FOUNDTNS subscale mean and median increased from 1999 to 2006. Values in 1999 as compared to values in 2006 indicate that responses were increasingly positive in regards to the nursing foundations for quality of care component of the practice environment in the sample of hospitals in 2006 versus 1999.

Figure 4-24 displays the hospital level distribution of the change in FOUNDTNS subscale scores from 1999 to 2006. The mean value for this change variable was 0.04.

Figure 4-23: Comparison of hospital level distribution of nursing foundations for quality of care subscale scores in 1999 and 2006

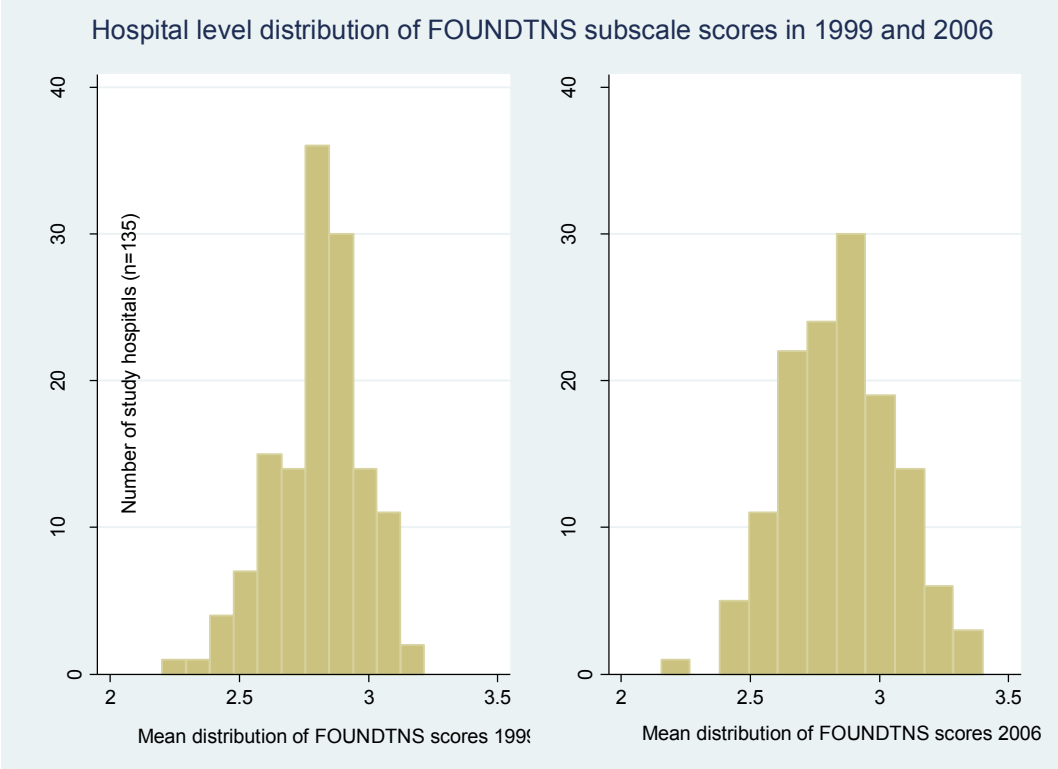
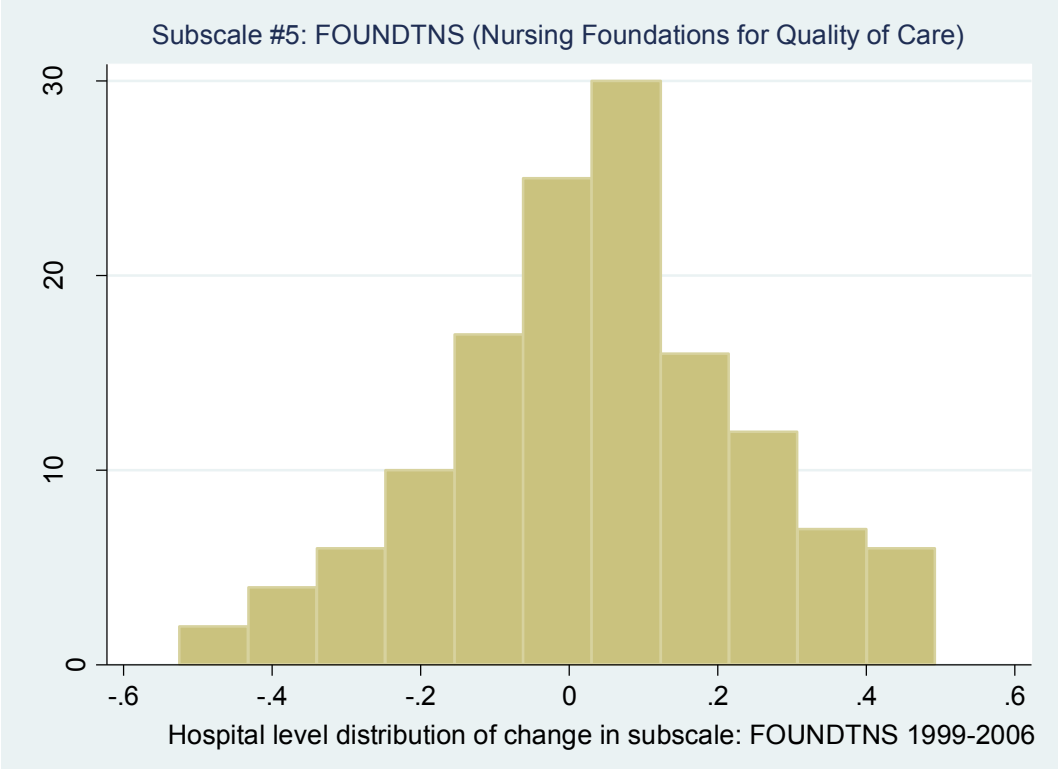


Figure 4-24: Hospital level change in nursing foundations for quality of care subscale scores from 1999-2006



Of the 5 PES-NWI subscales, all had a mean change in a positive direction from 1999 to 2006. Subscales of the PES-NWI reflect at the individual level, what is evidenced in regards to the composite nurse practice environment score. Rating of all individual nurse practice environment subscales increased from 1999 to 2006. The largest rating increases were seen in the staffing and resource adequacy subscale (mean change of .21) and the nurse participation in hospital affairs subscale (mean change of .15). The nursing foundations for quality of care subscale was scored highest in both study years, and remained relatively stable throughout the study period, with a mean change of 0.04.

A Pearson product-moment correlation coefficient was computed to assess the relationship and potential for multicollinearity between the independent study variables in both 1999 and 2006. Spearman correlations were computed to account for non-parametric data. Results between analyses were consistent; therefore, the Pearson correlation coefficients for each year only are reported. Tables 4-6 and 4-7 display the correlation matrix of all independent variables in the study for study years 1999 and 2006, respectively.

Results from 1999 data (Table 4-6) indicate that nurse staffing (patients-per-nurse) and nurse education were negatively correlated (coefficient=-.34, p=.0000), as was nurse staffing with hospital characteristics including technology status, bed size, and teaching status. Staffing was positively correlated with the nursing practice environment (coefficient=.15, p<.05), however the subscales of staffing and resource adequacy and nursing foundations of quality care were negatively correlated with staffing (coefficient=-.33, p=.0000; coefficient=-.19, p<.05). Results are interpreted as such that hospitals with more patients per nurse had a less educated workforce, or, as the level of nurse staffing within a hospital worsens, so did the level of nurse education within the institution. The individual subscales of the PES-NWI were significantly correlated with the composite practice environment scale. The subscale of staffing and resource adequacy is negatively correlated (coefficient=-0.33, p=.0000) with nurse staffing, which is in direct correlation to data shown in 2006. This negative correlation between nurse staffing and the practice environment is interpreted as "as nurse staffing worsens, the staffing and resource adequacy subscale of the nurse practice environment worsens". The Pearson correlations shown below represent comparison at the cross-sectional level.

Table 4-6: *Pearson Correlations between Nursing-Specific Organizational Characteristics and Hospital Characteristics in Study Hospitals n=134(1999)*

Variables	1	2	3	3a	3b	3c	3d	3e	4	5
1.Nurse Staffing	---									
2.Education	-.35***	---								
3.Practice Environment	.21*	0.15	---							
a.Staffing and resource adequacy	-.33***	.06	.71***	---						
b. Nurse-Physician Relationships	-.20*	0.21*	.60***	.38***	---					
c. Nurse Management/Leadership	-.17	0.06	.87***	.70***	.42***	---				
d. Nursing Foundations	-.19*	0.11	.85***	.66***	.36***	.63***	----			
e. Nurse Participation in Hospital Affairs	-.13	-.10	.89***	.55***	.36***	.67***	.75***	---		
4.High Technology	-.36***	.44***	-.03	-.09	0.06	-.11	-.02	-.03	---	
5. Teaching Status	-.37***	.50***	-.01	-.07	0.08	-.05	.01	-.01	.59***	---
6. Bed size	-.24**	.48***	-.10	-.16	-.07	-.20*	-.08	-.07	.66***	.54***

***p<.0001, **p<.01, *p<.05*

Results from 2006 data (Table 4-7) differ from results of the correlation matrix performed for 1999 data. Results from 2006 data indicate significant correlation between all nursing and hospital characteristics. Correlation between variables occurs in the proposed direction, indicating that as the nursing-specific organizational variables of nurse staffing, level of education, and practice environment worsened, so did all other characteristics. Nurse staffing (patients-per-nurse) and nurse education were negatively correlated (coefficient= -.34, p=.0000), as was nurse staffing with hospital characteristics including technology status, bed size, and teaching status. Staffing was negatively correlated with the nursing practice environment (coefficient= -.26, p<.01). Results are interpreted as such that hospitals with more patients per nurse had a less educated workforce, or, as the level of nurse staffing within a hospital worsens, so did the level of nurse education within the institution. In this analysis, nurse staffing was negatively correlated with the nurse practice environment, as well as with all five practice environment subscales. The individual subscales of the PES-NWI were significantly correlated with the composite practice environment scale. The subscale of staffing and resource adequacy is negatively correlated (coefficient= -0.35, p=.0000) with nurse staffing, which is in direct opposition to the correlation shown with 1999 data. Data below indicate that nursing and hospital characteristics were correlated, following the same directional trends, for the year 2006.

Table 4-7: *Pearson Correlations between Nursing-Specific Organizational Characteristics and Hospital Characteristics in Study Hospitals n=134 (2006)*

Variables	1	2	3	3a	3b	3c	3d	3e	4
1.Nurse Staffing	---								
2.Education	-.34***	---							
3.Practice Environment	-.26**	.24**	---						
a.Staffing and resource adequacy	-.35***	.19*	.74***	---					
b. Nurse-Physician Relationships	-.15	.19*	.70***	.54***	---				
c. Nurse Management/Leadership	-.23**	.21*	.87***	.68***	.48***	---			
d. Nursing Foundations	-.23**	.17*	.92***	.69***	.54***	.75***	----		
e. Nurse Participation in Hospital Affairs	-.25**	.23*	.92***	.63***	.51***	.72***	.86***	---	
4.High Technology	-.36***	.39***	.22*	.01	.07	.11	.23**	.29***	---
5. Teaching Status	-.34***	.32***	.08	-.03	.03	-.01	.11	.13	.43***
6. Bed size	-.23**	.31***	.09	-.07	.04	-.06	.16	.15	.63***

***p<.001, **p<.01, *p<.05*

Table 4-8 displays Pearson correlations between changes in all nursing-specific organizational variables. Unlike the correlation matrices outlined prior (Table 4-6 and Table 4-7), which detail relationships between variables at a cross-sectional level, this matrix displays correlations between changes in variables. There is no statistically significant correlation between changes in nursing-specific organizational characteristics with the exception of level of nurse staffing and the staffing and resource adequacy subscale of the nurse practice environment. The matrix displays a statistically significant negative correlation between changes in level of nurse staffing and the staffing and resource adequacy subscale, which would be expected given that when the number of patients-to-nurses per shift increases, rating of the staffing scale is expected to worsen. Additional correlations, though not significant, do 'trend' in the proposed direction. Changes in nurse staffing are inversely correlated with both changes in nurse education and with changes in the composite practice environment variable. This correlation provides data that warrants further examination. The lack of statistical significance between changes in all independent variables indicates that hospitals that invested in changing one of the three nursing-specific organizational characteristics studied did not necessarily invest in the others. It is plausible that resources within a hospital were allocated to one performance improvement initiative, and not all three. It is possible that focusing on change in one nursing-specific organizational characteristic will not affect others. These findings must be examined and discussed by policy makers prior to making recommendations and offering guidance to hospital administrators who wish to improve the state of the nursing workforce within their institution.

Table 4-8: *Pearson Correlations between the Changes in Nursing-Specific Organizational Characteristics in Study Hospitals n=135*

Variables	1	2	3	3a	3b	3c	3d
1.Nurse Staffing	---						
2.Education	-.09	---					
3.Practice Environment	-.16	.04	---				
a.Staffing and resource adequacy	-.37***	.11	.68***	---			
b. Nurse-Physician Relationships	-.13	.16	.48***	.42***	---		
c. Nurse Management/Leadership	-.12	-.01	.86***	.59***	.23**	---	
d. Nursing Foundations	-.12	.04	.85***	.64***	.27**	.66***	----
e. Nurse Participation in Hospital Affairs	-.13	-.04	.87***	.53***	.22*	.68***	.72***

***p<.001, **p<.01, *p<.05*

Sample Characteristics: Patients

The final study sample included 135 hospitals, 17,844 registered nurses, and 29,356 patients. The characteristics of the 29, 356 patients in the study are presented in Table 4-13. A total of 14, 950 unique patients were included in the 1999 sample, while a total of 14, 451 unique patients were included in the 2006 sample. Primary patient clinical characteristics and demographic information is displayed in Table 4-9. The majority of patients in both years were male (62% in 1999 and 61% in 2006). The average age of patients was 67.5 in 1999 and 66.8 in 2006. The majority of patients sampled in 1999 were between 71 and 80 years old (30.2%) while the majority of patients in 2006 were between 61 and 70 years old (28%). The majority of patients in each study year self-identified as Caucasian (91.6% in 1999 and 89.9% in 2006). Demographic data regarding race appeared consistent across study years when omitting the category labeled as "unknown". A category labeled as "unknown" was included in both 1999 and 2006 PHC4 data, however the number of patients listed as "unknown" in 1999 was 2, 505 as compared to 474 in 2006. This indicates improved coding for demographic information, specifically race, during the seven-year study period. For purposes of comparison, the "unknown" category was omitted from view in Table 4-9, allowing for parsimonious comparison of patient data.

Table 4-9: Characteristics of the Patient Sample in Study Hospitals, 1999 and 2006 (n=29, 356)

Patient Characteristics	*1999 (n=14,905)*	*2006 (n=14,451)*
Individuals in the sample (n)	N=14,905	N=14,451
Sex, no. (%)		
Male	9,230 (62.0)	8, 827 (61.1)
Female	5,675 (38.1)	5, 624 (38.9)
Missing	0	0
Age		
Mean (SD)	67.5 (12.06)	66.8 (12.45)
Range	18-102	18-101
Missing	0	0
Age Categories, no. (%)		
18-20	14 (0.1)	9 (0.1)
20-30	54 (0.4)	62 (0.4)
31-40	251 (1.7)	210 (1.5)
41-50	1036 (7)	1074 (7.4)
51-60	2620 (17.6)	3199 (22.1)
61-70	4424 (29.7)	4035 (28.0)
71-80	4505(30.2)	3777 (26.1)
81-90	1829(12.3)	1905 (13.2)
> 90	172 (1.2)	180 (1.2)
Race, n (%)	N=12,400	N=13, 977
White	11,369 (91.6)	12,567 (89.9)
Asian/Pacific Islander	30 (0.2)	69 (0.5)
Black/African American	925 (6.2)	1,206 (8.3)
Native American/Eskimo	2 (0.01)	6 (0.04)
Other Race	73 (0.49)	129 (0.9)
Missing	1 (0.01)	0 (0)

Table 4-10 displays clinical characteristics of the patient sample from data in the PHC4 database, including patient admission source, admission type, and the MediQual Atlas Admission Severity of Illness Score assigned to a patient within 48 hours upon hospital admission. This score describes the risk of in-hospital mortality as derived from 250 key clinical finding on admission (Iezzoni,1997). Patient severity decreased from 1999 to 2006 as measured by the MediQual Atlas Score. Due to its reliance on clinical data, it is not uncommon for the MediQual Atlas Score variable to include a larger percentage of missing data versus those variables that are available in administrative data alone, and contain no clinical information. MediQual Atlas Score data for a total of 859 (5.8%) patients in 1999 and 1,854 (12.8%) patients in 2006 were coded as missing. Missing data were omitted for purposes of reporting on variable distribution below. A subset analysis of the variable with missing data included and without missing data included revealed similar results in risk-adjustment modeling.

While the majority of patients in both years were scored in the moderate category (41.9% in 1999 and 34.3% in 2006), less patients were categorized with a severe or maximal score in the year 2006, while a significantly larger percentage of patients were categorized as having no risk of death upon admission to the hospital (9.5% in 1999 and 23.4% in 2006). This indicates that the patient population in 2006 was coded as less severe or “less sick” upon admission for primary surgical intervention for a solid tumor cancer diagnosis. Rationale for the decreased severity of patient conditions upon admission is not able to be confirmed based on study data, but it is surmised that improved diagnostic and staging techniques for this patient population aided in earlier diagnosis and admission for surgical procedures. With improved diagnostic and staging

techniques, solid tumors can be recognized earlier, and surgical intervention can be scheduled for treatment prior to the cancer metastasizing into an advanced stage. Approximately three-quarters of study patients in both years were admitted on an elective basis by physician referral. The majority of patients in both years (64.8% in 1999 and 56.2% in 2006) were discharged to home with no additional home care services prescribed, however this number did decrease by approximately 7% between study years. Subsequently, the number of patients discharged to home care with provision of home health services increased by 8% between study years. This represents a significant change in the 'culture of care' provided to surgical oncologic patients during this seven-year period. The use of visiting nurse and home care services for interventions such as fluid and electrolyte management, administration of intravenous antibiotics, and monitoring for signs and symptoms of infection moved out of the inpatient unit and into the home environment during this period. The use of external resources to administer care in a setting other than on an inpatient unit is evidenced by this shift in the provision of care. The average length of stay remained relatively constant, averaging 7.95 days in 1999 to 8.0 days in 2006. The primary method of payment in both study years (approximately 55%) was Medicare coverage.

Table 4-10: Characteristics of the Patient Sample in Study Hospitals, 1999 and 2006 (n=29, 356)

Patient Characteristics	*1999 (n=14,905)*	*2006 (n=14,451)*
Individuals in the sample (n)	N=14,905	N=14,451
Admission Type, n (%)		
Emergency	2,252 (15.1)	2, 247 (15.6)
Urgent	1,812 (12.2)	1, 474 (10.2)
Elective	10,631 (71.3)	10, 729
Missing/Miscoded	210 (1.4)	(74.2)
		1 (0.01)
Admission Source, n (%)		
Physician Referral	11, 473 (77.0)	11, 363
Clinic Referral	777 (5.2)	(78.6)
HMO Referral	450 (3.0)	458 (3.2)
Transfer from a Hospital	117 (0.8)	266 (1.8)
Transfer from a Skilled Nursing Facility (SNF)	70 (0.5)	127 (0.9)
Transfer from another Health Care Facility	84 (0.6)	40 (0.3)
Emergency Room	1, 932 (13.0)	69 (0.5)
Court/Law Enforcement	1 (0.01)	2, 121 (14.7)
Missing	1 (0.01)	1 (0.01)
		4 (0.01)
Discharge Status, n (%)		
Routine discharge (home/self -care)	9, 656 (64.8)	8, 117 (56.2)
Discharged/transferred to short term inpatient care	81 (0.5)	68 (0.5)
Discharged/transferred to SNF with Medicare	1, 461 (9.8)	1, 429 (9.9)
certification	27 (0.2)	18 (0.1)
Discharged/transferred to intermediate care	352 (2.4)	32 (0.2)
facility	2, 881 (19.3)	3, 960 (27.4)
Discharged/transferred to another facility not	5 (0.03)	12 (0.1)
coded	2 (0.01)	N/A
Discharged/transferred to home under care of	N/A	4 (0.03)
home health services	N/A	23 (0.2)
Left against medical advice (AMA)	N/A	201 (1.4)
Discharged/transferred to home with IV care	N/A	117 (0.8)
Discharged/transferred to a federal health care	N/A	4 (0.03)
facility	9 (0.1)	0 (0)
Discharged/transferred to hospital Medicare swing bed		
Hospice-home		60 (0.4)
Hospice-medical facility	N/A	54 (0.4)
Expired	431 (2.9)	352 (2.4)
Length of stay		
Mean (SD)	8.3 (7.95)	7.9 (8.0)
Range	1-375	1-152
Payer Identification/Primary Payer		
Uninsured/Patient self-pay	84 (0.6)	64 (0.4)
Medicare	7969 (53.5)	7983 (56.3)
Medicaid	453 (3.0)	723 (5.0)
Blue Cross	3380 (22.7)	3602 (24.9)
Commercial	2536 (17)	1977 (13.7)
Employer Funded Plan	88 (0.6)	N/A
Other Government	52 (0.4)	81 (0.6)
Other/Unknown	343 (2.3)	19 (0.1)
Missing	0 (0)	2 (0.01)

Major Diagnostic Category		
Nervous System	42 (0.3)	29 (0.2)
Eye	0 (0)	2 (0.01)
Ear, Nose, Mouth, and Throat	822 (5.5)	829 (5.7)
Respiratory System	2, 313 (15.5)	2, 627 (18.2)
Circulatory System	161 (1.1)	135 (0.9)
Digestive System	6, 543 (43.9)	6, 100 (42.2)
Hepatobiliary System and Pancreas	175 (1.2)	294 (2.0)
Musculoskeletal System and Connective Tissue	68 (0.5)	48 (0.3)
Skin, Subcutaneous Tissue and Breast	19 (0.1)	22 (0.2)
Endocrine, Nutritional and Metabolic System	71 (0.5)	124 (0.9)
Kidney and Urinary Tract	279 (1.9)	276 (1.9)
Male Reproductive System	3, 320 (22.3)	3, 039 (21.0)
Female Reproductive System	827 (5.6)	608 (4.2)
Pregnancy, Childbirth, and Puerperium	2 (0.01)	6 (0.04)
Blood and Blood Forming Organs and	12 (0.1)	22 (0.2)
Immunological Disorders	176 (1.2)	199 (1.4)
Myeloproliferative DDs (Poorly Differentiated	29 (0.2)	53 (0.4)
Neoplasms)	3 (0.02)	3 (0.02)
Infectious and Parasitic DDs	0 (0)	0 (0)
Mental Diseases and Disorders	28 (0.2)	26 (0.2)
Alcohol/Drug Use or Induced Mental Disorders	0 (0)	1 (0.01)
Injuries, Poison and Toxic Effect of Drugs	10 (0.1)	5 (0.03)
Burns	0 (0)	0 (0)
Factors Influencing Health Status	5 (0.03)	3 (0.02)
Multiple Significant Trauma		
Human Immunodeficiency Virus Infection		
MediQual Atlas Admission Severity Score (Probability of Death), n (%)		
	1, 338 (9.5)	2, 958 (23.4)
None (0.000-0.001)	3, 966 (28.2)	3, 709 (29.4)
Minimal (0.002-0.011)	6, 246 (44.5)	4, 327 (34.3)
Moderate (0.012-0.057)	2, 416 (17.2)	1, 605 (12.7)
Severe (0.058-0.499)	80 (0.6)	33 (0.3)
Maximal (0.500-1.000)		
Number of procedures per hospital for survey years combined	1-639	3-1210
Range 16-1719	110.4	106.5
Quartile min 16; .25 83; .50 166; .75 260; max 1719		
Mean 217.5		

Table 4-11 displays clinical characteristics of the patient sample from data in the Pennsylvania Cancer Registry database, including SEER summary stage, method of diagnostic confirmation, laterality of tumor site, and days from diagnostic confirmation to surgical admission. These four variables represent patient-specific oncologic data. The majority of patients in both study years (45% in both 1999 and 2006) were classified as having localized disease, defined as a neoplastic process that originates in and is confined to one organ system or general area of the body, without signs of metastasis. The majority of diagnoses were confirmed with positive histology alone (99% in both 1999 and 2006). The majority of patients (77.5% in 1999 and 75.7% in 2006) had diagnosis of disease at one primary site, not involving a paired disease site at time of original diagnosis. The average days from time of diagnosis to admission for primary surgical intervention was 47 days in 1999 and 55 days in 2006. The 8-day increase in number of days from diagnosis to admission for primary surgical intervention between study years speaks to the changes in oncologic practice between this seven-year period. It can be surmised that the earlier diagnosis of individuals would lead to earlier staging of disease, allowing for a greater period of time between diagnosis and surgical intervention as a "less sick" patient would be admitted. In addition, the onset of more plentiful diagnostic techniques over the seven-year study period could attest to this week-long increase in this variable. The addition of more tests to stage a patient's disease could lead to a slight increase in days between diagnosis and intervention.

Table 4-11: Clinical Cancer Characteristics of the Patient Sample in Study Hospitals, 1999 and 2006 (n=29,356)

Patient Characteristics	*1999 (n=14,905)*	*2006 (n=14,451)*
Individuals in the sample (n)	N=14,905	N=14,451
SEER Summary Stage (1977), n (%) SEER Derived ss2000 (2000), n (%) In Situ Localized Regional, direct extension only Regional, regional lymph nodes only Regional, direct extension and regional lymph nodes Regional, NOS Distant Unstaged	 285 (2.0) 6, 782 (45.5) 2, 231 (15.0) 1, 220 (8.2) 1, 597 (10.7) 87 (0.6) 2, 108 (14.1) 595 (4.0)	 325 (2.3) 6, 560 (45.4) 2, 112 (14.6) 1, 386 (9.6) 1, 407 (9.7) 27 (0.2) 2, 382 (16.5) 252 (1.7)
Diagnostic Confirmation, n (%) Positive histology Positive cytology Positive microscopic confirmation, method NOS Positive laboratory test/marker study Direct visualization without microscopic confirmation Radiography and/or other imaging techniques without micr.conf. Clinical diagnosis only (other than previous categories) Unknown; death certificate only	 14, 717 (98.7) 111 (0.74) 6 (0.04) 8 (0.05) 10 (0.07) 26 (0.17) 8 (0.05) 19 (0.13)	 14, 276 (98.8) 112 (0.8) 3 (0.02) 2 (0.01) 7 (0.1) 9 (0.1) 10 (0.1) 32 (0.2)
Laterality, n (%) Not a paired site Right: origin of primary Left: origin of primary Only one side involved, right or left origin unspecified Bilateral involvement at time of diagnosis Paired site, but no information concerning laterality	 11, 548 (77.5) 1, 652 (11.1) 1, 342 (9.0) 6 (0.04) 276 (1.9) 81 (0.5)	 10, 942 (75.7) 1, 781 (12.3) 1, 377 (9.5) 15 (0.1) 243 (1.7) 93 (0.6)
Days from diagnosis to primary surgical intervention	Obs: 14, 609 Range: 0-716 Mean: 47.03 SD: 86.69 Min: 0;.25: 0; .50: 16; .75: 52; Max: 716	Obs: 14, 157 Range: 0-717 Mean: 54.96 SD: 85.81 Min: 0; .25: 1; .50: 27; .75: 68; Max: 717

Table 4-12 describes the primary patient diagnoses by ICD-O3 classification groups. The International Classification of Diseases for Oncology (ICD-O) is a domain specific extension of the International Statistical Classification of Diseases and Related Health Problems for tumor diseases, and is a classification widely used by cancer registries, including the Pennsylvania Cancer Registry. The largest classification group of study patients were those admitted for a surgical intervention for a primary diagnosis of colorectal carcinoma (43.7% of patients in 1999 and 42% of patients in 2006). The second largest clinical classification group consisted of those patients with a prostate carcinoma diagnosis (24.4% in 1999 and 22.9% in 2006). Endometrial carcinoma groups accounted for the fewest number of patients in the study sample (0.44% in both 1999 and 2006). The distribution of primary diagnoses remained consistent between study years.

Table 4-12: Distribution of Patient Primary Diagnoses and Procedures

Primary Diagnoses, Clinical Classification Group ICD-O3	*1999 (n=14,905)*	*2006 (n=14,451)*
HEAD AND NECK ICD-03 CODES INCLUDE THE FOLLOWING: C00.0-C00.9 C01.9 C02.0-C02.9 C03.0, C03.1, C03.9 C04.0, C04.1, C04.8, C04.9 C05.0, C05.1, C05.2, C05.8, C05.9 C06.0, C06.1, C06.2, C06.8, C06.9 C07.9 C08.0, C08.1, C08.8, C08.9 C09.0, C09.1, C09.8, C09.9 C10.0, C10.1, C10.2, C10.3, C10.4, C10.8, C10.9 C11.0, C11.1, C11.2, C11.3, C11.8, C11.9 C12.9 C13.0, C13.1, C13.2, C13.8, C13.9 C14.0, C14.2, C14.8 C30.0, C30.1, C31.0, C31.1, C31.2, C31.3, C31.8, C31.9 C32.0, C32.1, C32.2, C32.3, C32.8, C32.9 C73.9	1097 (7.4)	1141 (7.9)
ESOPHAGUS C15.0, C15.1, C15.2, C15.3, C15.4, C15.5, C15.8, C15.9	217 (1.5)	231 (1.6)
COLON-RECTUM C18.0-C18.9 C19.9 C20.9 C21.0, C21.1, C21.2, C21.8	6525 (43.7)	6071 (42.0)
PANCREAS C25.0, C25.1, C25.2, C25.3, C25.4, C25.7, C25.8, C25.9	157 (1.1)	276 (1.9)
LUNG C34.0, C34.1, C34.2, C34.3, C34.8, C34.9, C33.9	2335 (15.7)	2677 (18.5)
OVARY C569	793 (5.3)	588 (4.1)
PROSTATE C619	3, 636 (24.4)	3, 312 (22.9)
ENDOMETRIUM C54.1	65 (0.44)	64 (0.44)

The distribution of the Elixhauser co-morbid conditions that were used to risk-adjust are displayed in Table 4-13. The table includes the number of study patients with each recorded condition, as well as the number of patients who died within 30 days of hospital admission who were diagnosed with said co-morbidity. The prevalence of co-morbid conditions per study year is listed in Table A in the Appendix. The most common co-morbid conditions in both study years were hypertension, chronic pulmonary disease, and metastatic cancer. The co-morbid condition of metastatic cancer was not omitted from the list of Elixhauser comorbidity variables as it was not noted to exhibit multicollinearity with cancer-specific variables such as SEER stage. Unlike the comorbidity listed as "solid tumor" which was omitted from the variable list due to multicollinearity, presence of a metastatic cancer was included. AIDS/HIV, drug abuse, and chronic peptic ulcer disease were the least common co-morbidities in both study years.

Table 4-13: Co-morbid Conditions of the Patient Sample (n=29, 391)

Elixhauser Co-morbidity	1999 n=14905 (N=total; n=deaths)	2006 n=14451 (N=total; n=deaths)
Congestive Heart Failure	N=933, n=87	N=914, n=75
Valvular Disease	N=703, n=23	N=842, n=23
Pulmonary Circulation Disorders	N=167, n=23	N=186, n=23
Peripheral Vascular Disorders	N=439, n=20	N=427, n=5
Paralysis	N=90, n=2	N=69, n=2
Other Neurological Disorders	N=329, n=24	N=341, n=7
Chronic Pulmonary Disease	N=2796, n=119	N=3171, n=120
Diabetes, uncomplicated	N=1779, n=41	N=1977, n=21
Diabetes, complicated	N=145, n=6	N=206, n=8
Hypothyroidism	N=668, n=10	N=938, n=13
Renal Failure	N=138, n=17	N=574, n=40
Liver Disease	N=157, n=15	N=224, n=5
Peptic Ulcer Disease excluding bleeding	N=9, n=0	N=3, n=0
AIDS/HIV	N=9, n=1	N=8, n=0
Lymphoma	N=53, n=1	N=90, n=6
Metastatic Cancer	N=2195, n=102	N=2408, n=99
Solid Tumor without metastasis**	N=765, n=34	N=796, n=41
Rheumatoid arthritis/collagen vascular diseases	N=159, n=3	N=164, n=3
Coagulopathy	N=191, n=40	N=229, n=23
Obesity	N=276, n=3	N=453, n=2
Weight loss	N=346, n=40	N=476, n=43
Fluid and electrolyte disorders	N=1377, n=120	N=1848, n=103
Blood loss anemia	N=642, n=27	N=554, n=13
Deficiency anemia	N=1125, n=32	N=1532, n=23
Alcohol abuse	N=260, n=14	N=309, n=8
Drug abuse	N=17, n=1	N=63, n=1
Psychoses	N=129, n=4	N=154, n=3
Depression	N=300, n=4	N=631, n=5
Hypertension, complicated and unc.*	N=5206, n=100	N=6530, n=73

*Note: Htn_c and htn coded as one variable
**Omitted solid tumor comorbidity as correlated with patient population

Summary of Specific Aim 1

Specific Aim 1:

To describe the changes in hospital nursing characteristics, including nurses' educational level, level of staffing, and nurses' rating of the nurse practice environment, and characteristics of selected surgical oncology patients between 1999 and 2006 in a panel of general hospitals.

The first specific aim of the study revealed trends and relationships regarding change in level of nurse education, change in level of nurse staffing, and change in the rating of the nurse practice environment between the years 1999 and 2006 from a sample of staff registered nurses employed within one of 135 Pennsylvania study hospitals. Characteristics of a sample of patients admitted to one of the study hospitals for a primary surgical intervention for the treatment of a solid tumor carcinoma were described.

Summary of Specific Aim 1 Results:

- Between the years 1999 and 2006, the majority of hospitals did improve the number of BSN educated nurses working within each of their institutions. The mean estimate is a 1.1% improvement in the number of BSN educated nurses in each institution between study years although individual hospitals varied considerably in regards to change.
- Between the years 1999 and 2006, the majority of hospitals decreased the total number of patients per nurse by .06 of a patient.
- The NWI4 composite mean value increased from 1999 to 2006. Values in 1999 (mean=2.57, median=2.55, range 2.17-2.93) as compared to values in 2006 (mean=2.65, median=2.66, range 2.04-3.25) indicate that responses were increasingly positive in regards to the practice environment scale using four of the

five subscales (excluding the staffing and resource adequacy subscale) in the sample of hospitals in 2006 versus 1999. Comparison of NWI5 composite mean values indicated similar results.

- Of the 5 PES-NWI subscales, all five had a mean that increased between study years, with the subscales of staffing and resource adequacy and nursing participation in hospital affairs yielding the largest positive changes between 1999 and 2006.
- Approximately half of hospitals improved their mean level of BSN educated nurses by greater than 5% (49 hospitals, 36%); while 36 (27%) hospitals decreased their mean level of BSN educated nurses by greater than 5%, and 50 (37%) hospitals did not change their mean level of BSN educated nurses by less than or greater than 5% during the time period.
- Hospitals that improved their level of staffing by decreasing the patients-to-nurse ratio by greater than 0.5 patients between 1999 and 2006 numbered 46 (35%), while hospitals that worsened level of staffing by greater than 0.5 patients per nurse numbered 38 (28%). There were 51 (38%) hospitals that experienced no change in staffing between these two values.
- Change in nurse practice environment was treated as a continuous variable for the composite score that included the staffing and resource adequacy subscale as well as for the score that omitted this variable. The mean value for change over the study period was 0.11 for the composite score containing all five subscales and 0.08 for the score omitting the staffing and resource adequacy scale. Change in practice environment was measured as a continuous variable, as well as a

categorical variable based on a one-half standard deviation from available 1999 practice environment data. One standard deviation for the practice environment composite score for the NWI4 in 1999 was 0.17. For the purposes of this study, one-half of a standard deviation was measured at 0.10. Use of this method showed that the majority of hospitals (61) improved the practice environment between study years, 22 worsened, and 52 experienced no substantial change.

- Patients included in the study were admitted for a primary surgical intervention for one of eight ICD-O diagnosis categories, all of which identify solid tumor diagnoses. The average patient age was 67.5 in 1999 and 66.8 in 2006. The majority of patients in each study year self-identified as Caucasian (91.6% in 1999; 89.9% in 2006). Approximately two-thirds of the patient sample in each year was male.
- The average length of stay per patient remained relatively constant, averaging 7.95 days in 1999 to 8.0 days in 2006. The primary method of payment in both study years (approximately 55%) was Medicare coverage.
- The largest patient classification group in both study years were those admitted with a primary diagnosis of colorectal carcinoma (43.7% of patients in 1999 and 42% of patients in 2006).
- The most common co-morbid conditions in both study years were hypertension, chronic pulmonary disease, and metastatic cancer. AIDS/HIV, drug abuse, and chronic peptic ulcer disease were the least common co-morbidities in both study years.

Specific Aim 2:

To document how rates of failure-to-rescue and 30-day mortality for selected surgical oncology patients changed in a panel of hospitals between 1999 and 2006, and to analyze whether these changes were associated with changes in nurse educational composition, changes in level of nurse staffing, and changes in nurse practice environment ratings.

To address Specific Aim 2, the relationships among the changes in the three nursing-specific organizational variables and changes in each of the patient outcomes were assessed. Linear regression models were used to estimate the effects of the changes in nursing-specific organizational variables on changes in failure-to-rescue and 30-day mortality. Bivariate analyses were performed in order to assess the relationship between changes in each of the nursing-specific organizational characteristics on changes in patient outcomes. Bivariate analyses did not include the use of unadjusted variables, as both outcome measures of failure-to-rescue and 30-day mortality were risk-adjusted prior to analysis. Clustering of patients within hospitals was accounted for when estimation of risk-adjusted failure-to-rescue and 30-day mortality rates for each hospital was completed. Regression models are presented in tables in three columns, as coefficient values from the separate estimation of nursing-specific organizational characteristics adjusted for patient-level characteristics only, from the estimation of nursing-specific organizational characteristics separately adjusted for both patient and hospital level characteristics, and from the estimation of nursing-specific organizational characteristics jointly adjusted for both patient and hospital level characteristics.

Outcome Distribution

The overall distribution of the patient outcomes of failure-to-rescue and death within 30 days of hospital admission are displayed in Table 4-14. Four-hundred thirty-

one (2.9%) patients died within 30 days of hospital admission in 1999, while 352 (2.4%) patients died within 30 days of hospital admission in 2006. Observed rates of failure-to-rescue declined from 1999 to 2006, decreasing from a rate of 7.5% to 6.0% in 2006. A total of 5,710 patients were classified as failure-to-rescue in 1999. This represents approximately 38% of the total patient sample from that year. A total of 5, 889 patients were contained in the failure-to-rescue group in 2006. This represents approximately 41% of the total patient sample from that year. Observed trends indicate that although a higher percentage of patients were classified into the failure-to-rescue group in 2006, mortality rate was improved as compared to 1999 results. Distribution of observed outcomes at the hospital level is displayed in Table 4-15. Mean values for both failure-to-rescue and 30-day mortality are higher in 1999 as compared to 2006.

Table 4-14: Patient-level Outcome Distribution 1999 and 2006

Patient Outcome Variable	Total N	Observed Values	Observed Mean (SD)	Percent (%)
Failure-to-Rescue				
1999	N=5710	N=431	0.07 (0.26)	7.5
2006	N=5880	N=352	0.06 (0.24)	6.0
30-day Mortality				
1999	N=14905	N=431	0.03 (0.17)	2.9
2006	N=14451	N=352	0.02 (0.15)	2.4

Note: Failure-to-rescue defined as number of patients who died given either a documented complication or died within 30 days (ex. 1999: 431/5710)

Table 4-15: Hospital-level Outcome Distribution 1999 and 2006

Patient Outcome Variable	Total N	Observed Mean (SD)
Failure-to-Rescue		
1999	N=56	0.09 (0.29)
2006	N=64	0.03 (0.18)
30-day Mortality		
1999	N=135	0.04 (0.19)
2006	N=135	0.01 (0.12)

Table 4-16 displays the distribution of both failure-to-rescue and 30-day mortality by primary cancer diagnosis. Observed rates of failure-to-rescue and 30-day mortality were highest in those patients with a diagnosis of pancreatic cancer in the year 1999 (12.5% and 6.4% respectively). In the year 2006, observed rates of failure-to-rescue and 30-day mortality were highest in those patients with a diagnosis of esophageal cancer (9.1% and 4.4% respectively). In both years, those patients admitted for a surgical intervention for endometrial cancer had no observed failure-to-rescue or 30-day

mortality. Those patients with a diagnosis of endometrial cancer were included in the analysis despite this result in order to maintain consistency of data between this study and earlier work from Friese (Friese, 2005). Rationale for inclusion of this population included the need for cumulative research in this area of study. The exclusion of this patient population in future research may be warranted.

Table 4-16 highlights the overall decrease in both failure-to-rescue and 30-day mortality rates from 1999 to 2006. The clinical significance of the information contained in Table 4-20 is twofold: 1) The table shows that rates of failure-to-rescue and 30-day mortality in this patient population decreased over the seven-year study period, indicating improvement in patient outcomes, and 2) The table emphasizes that there are disease states that are greater in severity and subsequent risk of patient complications and mortality than others. Rates of failure-to-rescue and 30-day mortality are highest in both study years in those patients with a diagnosis of lung, esophageal, and pancreatic cancer. Disease acuity, aggression, and ability to metastasize to additional organ sites as well as the complex nature of the surgical procedure and treatment intervention delivered must be accounted for when discussing the effects of organizational factors on patient outcomes. Table 4-16 provides context for the reader and is necessary for interpretation of study results. Inherent disease factors and patient characteristics must be accounted for in order to accurately interpret findings on the effects of changes of nursing-specific organizational factors on patient outcomes.

Table 4-16: Patient Outcomes Distribution by Clinical Classification Group (ICD-O3) in 1999 and 2006(listed in descending order by highest to lowest observed 30-day mortality)

1999

Clinical Classification Group	Number (%)	Failure-to-rescue (%)	30-day mortality (%)
PANCREAS	157 (1.05)	10 (12.50)	10 (6.37)
ESOPHAGUS	217 (1.46)	11 (8.59)	11 (5.07)
LUNG	2,335 (15.67)	107 (9.19)	107 (4.58)
COLON-RECTUM	6,525 (43.78)	253 (8.61)	253 (3.88)
OVARY	793 (5.32)	17 (5.69)	17 (2.14)
HEAD AND NECK	1,097 (7.4)	12 (3.38)	12 (1.05)
PROSTATE	3,636 (24.4)	11 (1.63)	11 (0.3)
ENDOMETRIUM	65 (0.44)	0 (0)	0 (0)

2006

Clinical Classification Group	Number (%)	Failure-to-rescue (%)	30-day mortality (%)
ESOPHAGUS	231 (1.60)	12 (9.09)	12 (5.19)
LUNG	2, 677 (18.52)	119 (8.34)	119 (4.45)
PANCREAS	276 (1.91)	12 (8.28)	12 (4.35)
COLON-RECTUM	6, 071 (42.01)	180 (5.95)	180 (2.96)
OVARY	588 (4.07)	9 (3.93)	9 (1.53)
HEAD AND NECK	1, 141 (7.90)	12 (3.38)	12 (1.05)
PROSTATE	3, 312 (22.92)	7 (1.36)	7 (0.21)
ENDOMETRIUM	64 (0.44)	0 (0)	0 (0)

Table 4-17 displays the hospital distribution of the risk-adjusted patient outcomes of failure-to-rescue and death within 30 days of hospital admission. Per risk-adjustment methodology previously outlined, negative values indicate superior outcomes, because fewer patients than expected died, while positive values indicate a worse outcome, because more patients than expected died. For the purposes of this study, risk-adjusted patient outcomes are interpreted per 1,000 surgical patients. Therefore, a risk-adjusted rate of 0 per 1,000 surgical patient discharges would indicate that the number of deaths observed was equal to the expected number of deaths for either 30-day mortality or failure-to-rescue, given the risk characteristic panel for the patient population in that specific hospital. The mean risk-adjusted rate of failure-to-rescue was -61.7 per 1,000 surgical discharges for the year 1999, and -24.2 per 1,000 surgical discharges in 2006. Although on average, failure-to-rescue rates in both 1999 and 2006 were better than expected across study hospitals, the rate of failure-to-rescue did "worsen" between this time period, indicating poorer risk-adjusted outcomes in 2006 as compared to 1999. The mean value for 30-day mortality was -0.45 in 1999 and 3.46 in 2006. This indicates an increase in risk-adjusted 30-day mortality between 1999 and 2006. The median values for risk-adjusted 30-day mortality provide a potentially clearer picture of trends in rates of death over the seven-year period, as they are much closer in value (-1.1 in 1999 and -0.82 in 2006). The values for risk-adjusted patient outcomes followed a relatively normal distribution pattern. Descriptive statistics including mean, medians, and standard deviation values are reported in order to provide a complete analysis of data. Table 4-18 provides descriptive statistics for the changes in the risk-adjusted patient outcomes of failure-to-rescue and 30-day mortality. The mean value for the change in risk-adjusted

failure-to-rescue is 37.43, while the mean value for the change in risk-adjusted 30-day mortality is 3.91.

Table 4-17: Descriptive Statistics for Risk-Adjusted Patient Outcome Variables at the Hospital Level, N=135

Patient Outcome Variable (Risk Adjusted)	**Mean**	**Median**	**SD**	**Range**
Failure-to-Rescue 1999 (RARmodelaltFTR2) 2006 (RARmodealtFTR206)	 -61.67 -24.24	 -59.73 -28.27	 68.38 62.52	 -367.16-125.99 -259.14-198.51
30-day Mortality 1999 (RARmodelaltdeath302) 2006 (RARmodelaltdeath30206)	 -0.45 3.46	 -1.10 -0.82	 22.17 24.18	 -66.97-87.14 -44.66-76.49

NOTE: Negative numbers indicate lower rate of 30-day mortality and FTR (+=poor outcome, -=better outcome)

Table 4-18: Descriptive Statistics for Changes in Risk-Adjusted Patient Outcome Variables at the Hospital Level 1999- 2006, N=135

Change in Outcome Variable (Risk Adjusted)	**Mean**	**Median**	**SD**	**Range**
Change in FTR (RAFTRRATE0699)	37.43	38.49	86.65	-224.12-333.52
Change in 30-day mortality (RADEATH30RATE0699)	3.91	2.03	31.90	-91.48-119.50

Between the years 1999 and 2006, the mean value of the change in risk-adjusted failure-to-rescue indicates that hospitals on average worsened in regards to adjusted FTR rate. This number varied considerably from hospital to hospital with ranges from an adjusted change in FTR rate of -224 to an adjusted change in FTR rate of 333. The risk-adjusted mean for failure-to-rescue shifted from -61.67 to -24.24 in 2006. Figure 4-25 displays the hospital-level distribution of risk-adjusted failure-to-rescue rates within hospitals for each study year. Figure 4-26 displays the hospital-level change in risk-adjusted FTR over the study period. The range of change was expansive. The mean for the change in risk-adjusted death was 37.43.

Figure 4-25: Hospital level distribution of risk-adjusted failure-to-rescue rate within study hospitals in 1999 and 2006

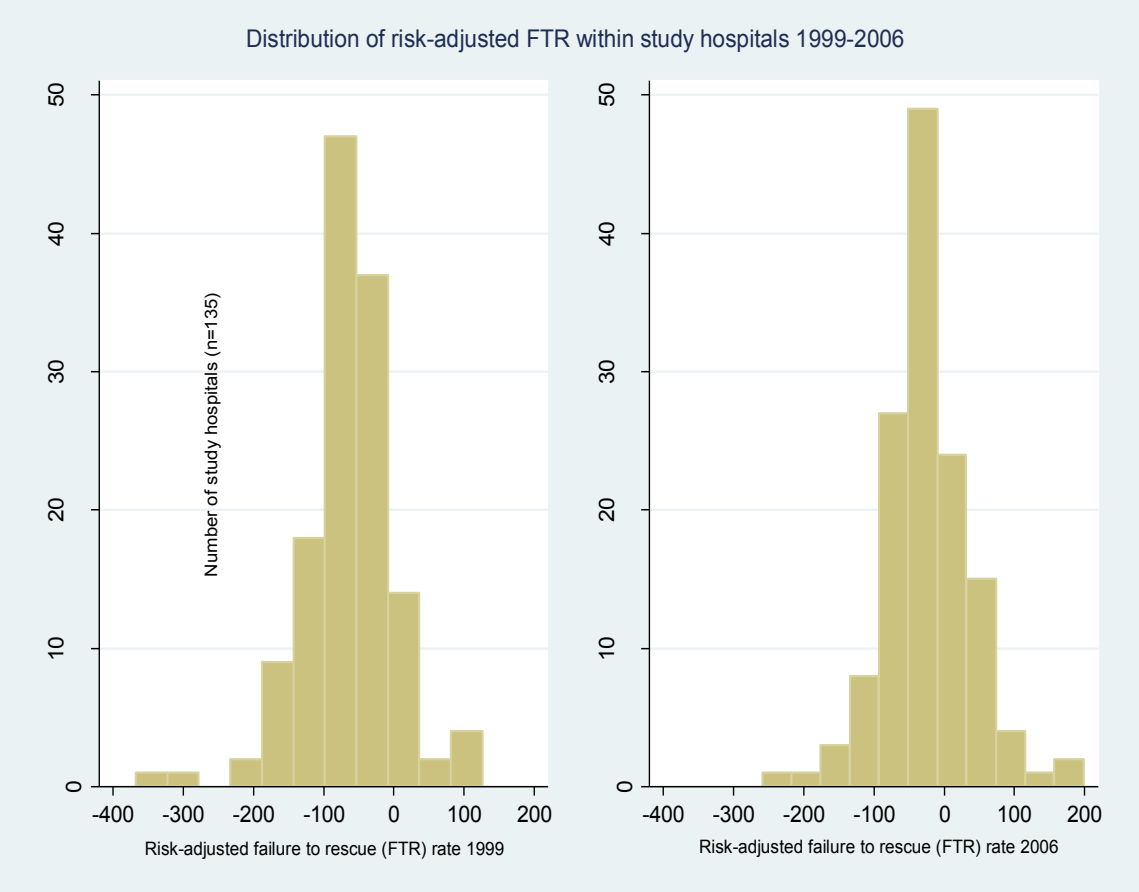
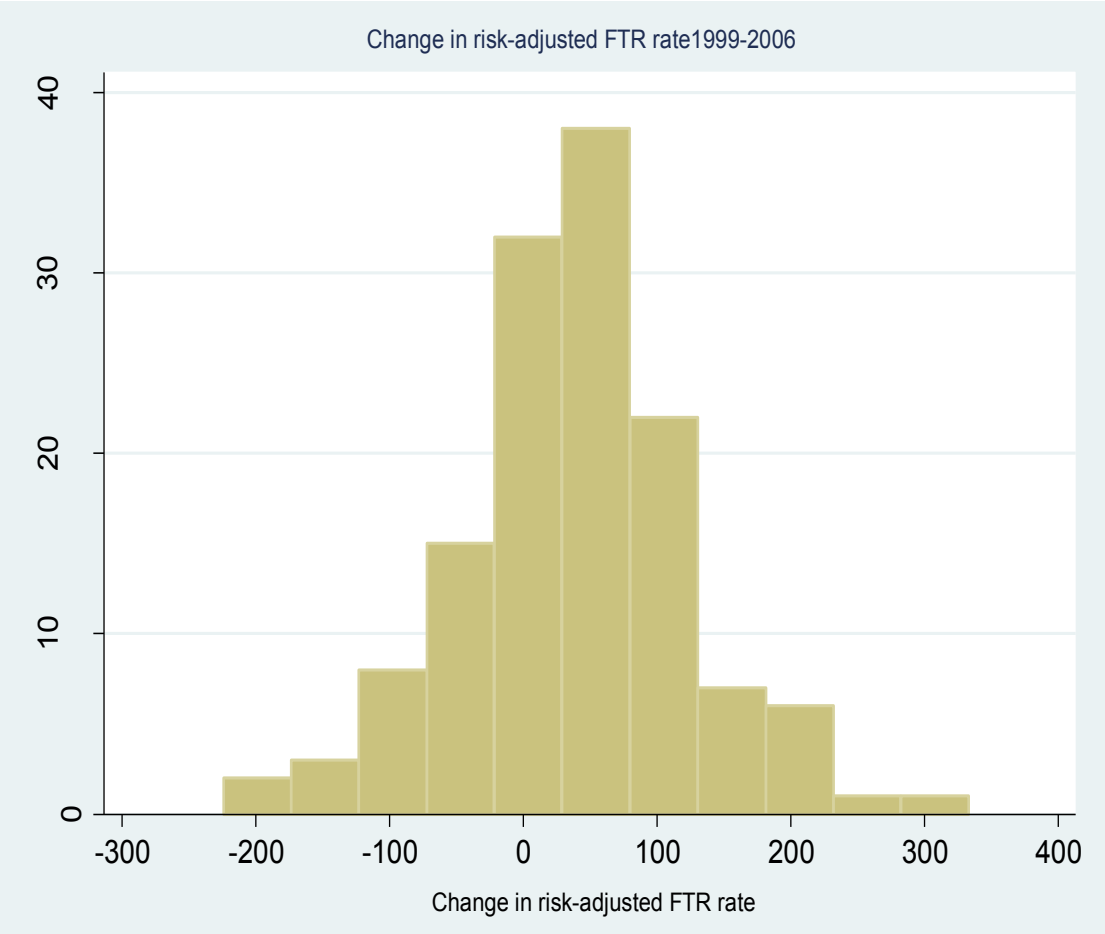


Figure 4-26: Hospital level distribution of the change in risk-adjusted failure-to-rescue rate within study hospitals 1999-2006



Between the years 1999 and 2006, the mean value of the change in risk-adjusted 30-day mortality indicates that hospitals on average worsened in regards to adjusted death rate. This number varied considerably from hospital to hospital with ranges from an adjusted change in death rate of -91 to an adjusted change in death rate of 119. The risk-adjusted mean for 30-day mortality shifted from -0.45 to 3.46 in 2006. Figure 4-27 displays the hospital-level distribution of risk-adjusted 30-day mortality rates within hospitals for each study year. Figure 4-28 displays the hospital-level change in risk-adjusted 30-day mortality over the study period. The range of change was expansive. The mean for the change in risk-adjusted death was 3.91.

Figure 4-27: Hospital level distribution of risk-adjusted 30-day mortality rate within study hospitals in 1999 and 2006

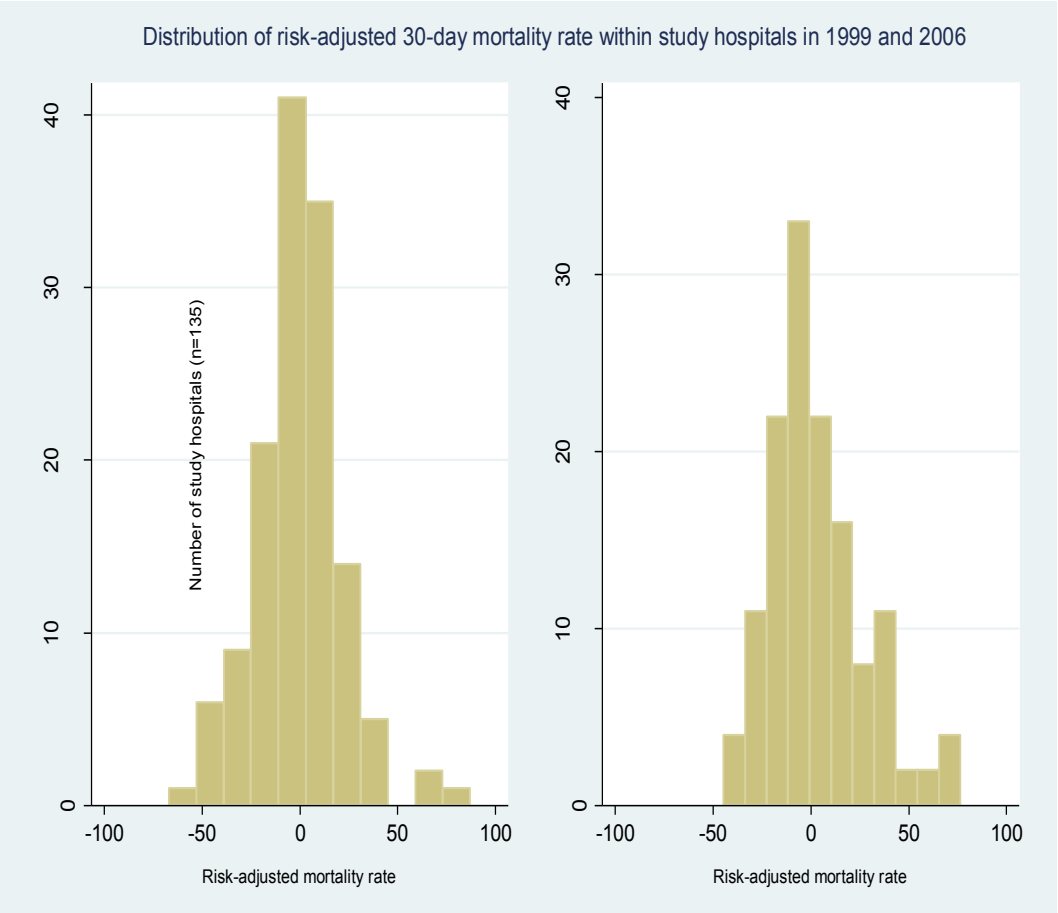
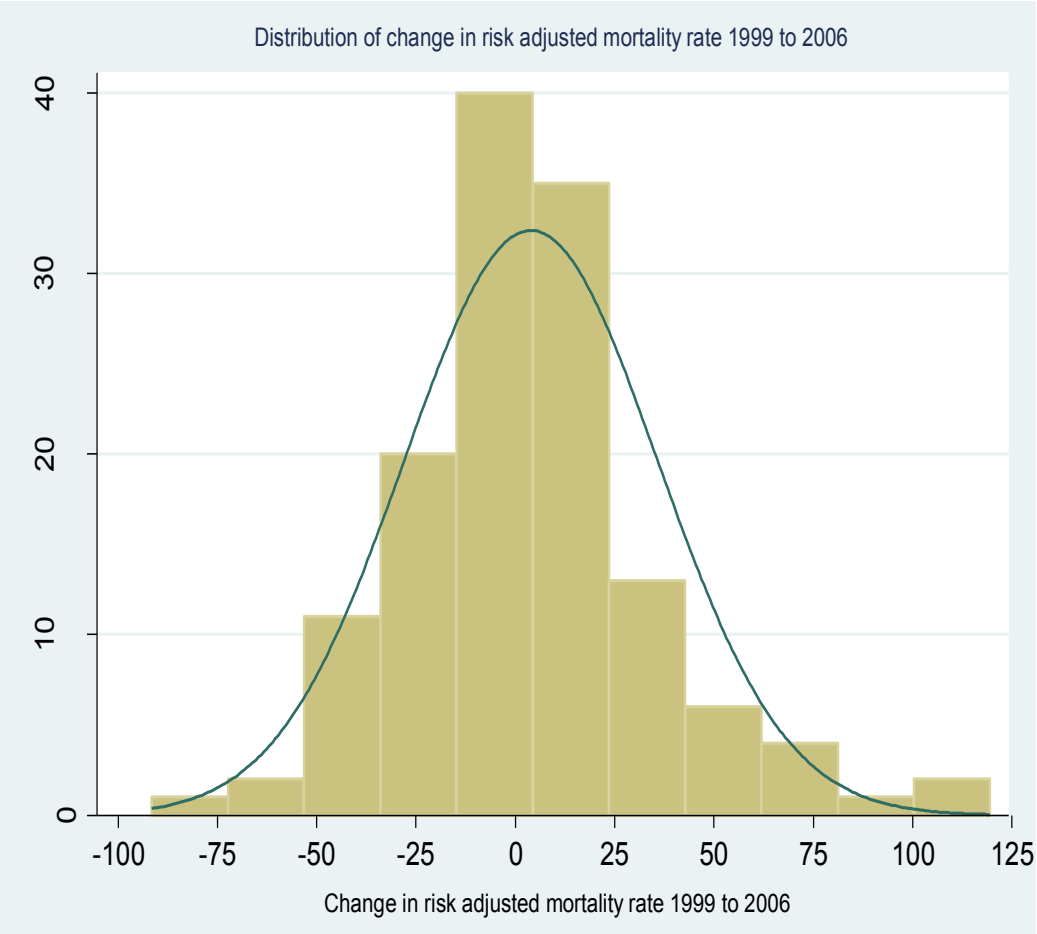


Figure 4-28: Hospital level distribution of the change in risk-adjusted 30-day mortality rate within study hospitals 1999-2006



A Pearson product-moment correlation coefficient was computed to assess the relationship and potential for multicollinearity between the changes in the independent study variables and changes in patient outcomes. Spearman correlations were computed to account for non-parametric data. Results between analyses were consistent; therefore, the Pearson correlation coefficients only were reported. Table 4-19 displays the correlation matrix of the changes in independent variables and in patient outcomes.

Results indicate that changes in risk-adjusted 30-day mortality were negatively correlated (coefficient=-.17, $p<.05$) with changes in level of nurse education. Subsequently, changes in risk-adjusted failure-to-rescue and risk-adjusted 30-day mortality were positively correlated (coefficient=.20, $p<.05$) with changes in level of nurse staffing. As to be expected, changes in the two patient outcome variables were positively correlated with one another (coefficient=.86, $p<.001$). Change in level of nurse staffing was significantly correlated with change in the nurse practice environment (coefficient=-.19, $p<.05$). Interpretation is such that as the level of nurse staffing worsens, rating of the nurse practice environment declines. This constitutes a relationship that has been evidenced in other research, and warrants further investigation.

Results are interpreted as such that increases in the level of nursing education within a hospital and decreases in the patient-to-nurse ratio, were positively correlated with reductions in risk-adjusted 30-day mortality. Improved staffing was significantly correlated with improved failure-to-rescue rates.

Table 4-19: *Pearson Correlations between the Changes in the Organization of Nursing and Changes in Risk Adjusted Mortality and FTR in Study Hospitals n=135*

Variables	1	2	3	4	5
1.Change in Level of RN staffing	---				
2.Change in Level of BSN Education	-.09	---			
3. Change in Rating of Work Environment	-.19*	-.05	---		
4. Risk Adjusted Change in FTR	.20*	-.05	-.08	--	
5. Risk Adjusted Change in Mortality	.19*	-.17*	-.11	.86***	--

***p<.001, **p<.01, *p<.05*

Table 4-20 displays the results of regression models that were used to estimate the effect of changes in nursing-specific organizational features on changes in the patient outcome of failure-to-rescue. Unadjusted regression models were completed to assess the bivariate relationship between changes in each of the three nursing-specific organizational features and the patient outcome. The independent variables of change in level of nursing education, level of nurse staffing, and rating of the nurse practice environment were treated as continuous variables, with results shown in Table 4-20 . The first column displays regression coefficients adjusted for patient characteristics. The second column displays regression coefficients when adjusting for both patient and hospital characteristics. The last column displays the regression coefficients for changes in independent variables jointly adjusted for patient and hospital characteristics. The fully adjusted multiple regression model produced R2=.056, F (6, 128) =1.26, and indicated that improvement in the level of nurse staffing (decrease in the nurse to patient ratio) was significantly associated with a decrease in failure-to-rescue. For the subset of patients with complications, regression results indicate that the addition of one patient to the average nurses' assignment was associated with an average increase of 13.47 deaths for every 1,000 patients ($p<.05$). Predictor variables including level of nurse education and rating of the practice environment were not significantly associated with failure-to-rescue in any of the three models regression models.

Table 4-20: Multivariate Regression Coefficients Estimating Effects of the Changes in Nursing-Specific Organizational Variables on Failure-to-Rescue at the Hospital Level, n=135

	^			^^			^^^		
	(B)	(SE)	p	B	SE	p	B	SE	p
Education*	-3.69	6.99	0.599	-2.26	7.17	0.753	-1.03	7.12	0.884
Staffing	14.64	6.21	0.020	14.29	6.23	0.024	13.47	6.42	0.038
Practice Environment	-32.80	32.77	0.319	-32.72	32.96	0.323	-20.34	33.38	0.543

*Education variables were multiplied by 10 to interpret the effect of a 10% change in the hospital proportion of bachelors prepared nurses
^Adjusted for patient characteristics (age, sex, admission status, cancer variables, comorbidities, primary cancer diagnosis), Estimated separately, Adjusted
^^Adjusted for hospital structural characteristics (teaching status, technology status, and bedsize), Estimated separately, Adjusted
^^^ Estimated Jointly, Adjusted

Table 4-21 displays the results of regression models that were used to estimate the effect of changes in nursing-specific organizational features on changes in the patient outcome of 30-day mortality. Unadjusted regression models were completed to assess the bivariate relationship between changes in each of the three nursing-specific organizational features and the patient outcome. The independent variables of change in level of nursing education, level of nurse staffing, and rating of the nurse practice environment were treated as continuous variables, with results shown in Table 4-21. The first column displays regression coefficients adjusted for patient characteristics. The second column displays regression coefficients when adjusting for both patient and hospital characteristics. The last column displays the regression coefficients for changes in independent variables jointly adjusted for patient and hospital characteristics. The fully adjusted multiple regression model produced R2=.077, F (6, 128) =1.78, and indicated that improvement in the level of nurse staffing (decrease in the nurse to patient ratio) was significantly associated with a decrease in 30-day mortality. Regression results indicate that the addition of one patient to the average nurses' assignment was associated with an average increase of 4.34 deaths for every 1,000 patients ($p<.05$). A ten-point increase in a hospital's percentage of nurses with a baccalaureate degree in nursing was associated with an average reduction of 5.07 deaths for every 1,000 patients ($p<.05$) when adjusting for patient characteristics. This predictor variable but did not remain statistically significant in fully adjusted regression models. Change in rating of the practice environment was not significantly associated with 30-day mortality in any of the three models regression models.

Table 4-21: Multivariate Regression Coefficients Estimating Effects of the Changes in Nursing-Specific Organizational Variables on 30-day Mortality at the Hospital Level, n=135

	^			^^			^^^		
	(B)	(SE)	p	B	SE	p	B	SE	p
Education*	-5.07	2.54	0.048	-4.35	2.61	0.098	-4.02	2.58	0.122
Staffing	5.19	2.29	0.025	5.16	2.29	0.026	4.34	2.33	0.039
Practice Environ-ment	-15.74	12.03	0.193	-16.97	12.09	0.163	-13.54	12.12	0.266

*Education variables were multiplied by 10 to interpret the effect of a 10% change in the hospital proportion of bachelors prepared nurses
^Adjusted for patient characteristics (age, sex, admission status, cancer variables, comorbidities, primary cancer diagnosis), Estimated separately, Adjusted
^^Adjusted for hospital structural characteristics (teaching status, technology status, and bedsize), Estimated separately, Adjusted
^^^Estimated Jointly, Adjusted

Summary of Specific Aim 2

Specific Aim 2:

To document how rates of failure-to-rescue and 30-day mortality for selected surgical oncology patients changed in a panel of hospitals between 1999 and 2006, and to analyze whether these changes were associated with the effects of changes in nurse educational composition, changes in level of nurse staffing, and changes in nurse practice environment ratings.

To address Specific Aim 2, the relationships among the changes in the three nursing-specific organizational variables and changes in patient outcomes of failure-to-rescue and thirty-day mortality were assessed. Linear regression models were used to estimate the effects of the changes in nursing-specific organizational variables on changes in failure-to-rescue and 30-day mortality. Bivariate analyses were performed in order to assess the relationship between changes in each of the nursing-specific organizational characteristics on changes in patient outcomes. Bivariate analyses did not include the use of unadjusted variables, as both outcome measures of failure-to-rescue and 30-day mortality were risk-adjusted prior to analysis.

Fully adjusted regression models jointly estimated the effects of changes in nursing-specific organizational characteristics while adjusting for both patient and hospital characteristics (teaching status, technology status, bed size). Changes in both independent nursing variables and patient outcomes were treated as continuous variables in all regression models.

Summary of Specific Aim 2 Results:

- Four-hundred thirty-one (2.9%) patients died within 30 days of hospital admission in 1999, while 352 (2.4%) of patients died within 30 days of hospital admission in

2006. Observed rates of failure-to-rescue declined from 1999 to 2006, decreasing from a rate of 7.5% to 6.0% in 2006.

- The risk-adjusted mean for failure-to-rescue shifted from -61.67 in 1999 to -24.24 in 2006. The risk-adjusted mean for 30-day mortality shifted from -0.45 to 3.46 in 2006.
- The mean value for the change in risk-adjusted failure-to-rescue is 37.43, while the mean value for the change in risk-adjusted 30-day mortality is 3.91.
- Changes in the proportion of bachelor's prepared nurses within a hospital did not have a statistically significant effect on failure-to-rescue.
- A ten-point increase in a hospital's percentage of nurses with a baccalaureate degree in nursing was associated with an average reduction of 5.07 deaths for every 1,000 patients ($p<.05$) when adjusting for patient characteristics. This predictor variable but did not remain statistically significant in fully adjusted regression models.
- Improved patient to nurse staffing ratios (fewer patients to each registered nurse) was a significant predictor of lower rates of death within 30 days of hospital admission, as well as of lower rates of failure-to-rescue.
- The addition of every one patient to the average nurses' assignment was associated with an average increase of 4.34 deaths for every 1,000 patients ($p<.05$).For the subset of patients with complications, the addition of every one patient to the average nurses' assignment was associated with an average increase of 13.47 deaths for every 1,000 patients ($p<.05$).

- Significant reductions in mortality or failure-to-rescue rates were not associated with changes in nurse-reported rating of the practice environment.

CHAPTER 5: DISCUSSION

Introduction

The purpose of this study was to determine the association between changes in nursing-specific organizational variables and changes in outcomes of a population of surgical oncology patients between the years 1999 and 2006. This study's findings report for the first time that improved patient-to-nurse staffing ratios (fewer patients to each registered nurse) was a significant predictor of lower rates of death within 30 days of hospital admission, as well as of lower rates of failure-to-rescue in a surgical oncologic patient population. This chapter begins with a discussion of the main findings from this study according to patient outcome. A discussion on the limitations of the study is presented. Lastly, recommendations for future research and policy implications in this area are suggested.

Discussion of Principal Findings

Organization of changes in nursing-specific organizational variables and changes in failure-to-rescue and mortality

Changes in hospital characteristics, nursing-specific organizational characteristics, and patient characteristics between the years 1999 and 2006 were described in this study. In an effort to contextualize the effects of changes in nursing-specific organizational characteristics on changes in patient outcomes, changes within hospital structural characteristics were described. As compared to 1999, more hospitals in 2006 had the capability to perform high technology procedures, had a greater number of beds, and were affiliated with a medical school. Although the primary objective of this study was not to specifically examine the relationship between changes in hospital characteristics

and changes in nursing-specific organizational characteristics, it was shown that the two are likely correlated. Hospital characteristics improved over the study period, as did observed means for changes in nursing-specific organizational characteristics. As described, the mean change in all nursing-specific organizational characteristics trended in the proposed direction (increased level of nurse education and rating of practice environment; decreased patient-to-nurse staffing ratio between study years), as did observed values of hospital characteristics. Improvement in hospital characteristics could potentially be viewed as a proxy for improvement in nursing workforce characteristics, or vice versa. It is hypothesized that as hospitals improve, improvement in all levels, both structural and at the workforce level, would be seen concurrently. This claim cannot be substantiated without further research. Research as to the effect of changes in hospital structural characteristics on changes in nursing-specific organizational characteristics is warranted. Changes in all three nursing-specific organizational features grew increasingly more variable over the seven-year study period. Changes in both directions (positive and negative) for all three nursing-specific organizational characteristics were quite sizable for some hospitals. This could be the result of investment by hospital administration into only one of the three nursing-specific organizational characteristics at a time, or it could be the result of factors not able to be directly measured in a study of this kind.

Significant reductions in failure-to-rescue and mortality rates were associated with improvement in nurse staffing. Study findings indicate that the addition of one patient to the nurse's average workload resulted in an average increase of 4.34 deaths for every 1,000 patients. For the subset of patients with complications, it was found that the addition of one patient to the nurse's average workload resulted in an average increase of

13.47 deaths for every 1,000 patients. Study findings clarify the relationship between level of nurse staffing and quality of care. Evidence of an association between higher levels of nurse staffing and lower rates of failure-to-rescue and 30-day mortality is consistent with studies performed in the acute care setting with a similar sample of hospitals and nurses (Aiken, et al, 2002). Findings of this study by Aiken and colleagues included evidence that for each additional patient over four in a nurse's workload, the risk of death for general surgical patients increased by 7% (Aiken, et al, 2002).

The detection of staffing effects is consistent with other longitudinal studies that have found significant relationships between staffing and patient mortality over time (Harless & Mark, 2010; Mark, Harless, McCue, & Xu, 2004; Sochalski, Konetzka, Zhu, & Volpp, 2008). The effect of staffing was shown to be larger for the outcome of failure-to-rescue as compared to 30-day mortality. Failure-to-rescue, or lack of prevention of a clinically important deterioration including death from a complication of an underlying illness or complication of medical care provides a measure of the degree to which providers respond to adverse occurrences developed during a patient's hospital course. This measure is thought to reflect the quality of monitoring and surveillance by providers, and the effectiveness of interventions taken once complications are recognized. The larger effect of staffing for the failure-to-rescue outcome, in part, is hypothesized to occur due to the nature of the outcome itself, indicative of the fact that failure-to-rescue and the prevention of complications is more amendable to increased staffing versus an outcome such as mortality.

A significant association between the proportion of baccalaureate-prepared nurses and 30-day mortality was found when adjusting for patient characteristics, but lost

statistical significance when accounting for both patient and hospital characteristics. When accounting solely for patient characteristics, with every 10% increase in the proportion of nurses with a baccalaureate degree, hospitals had an average reduction of 5.07 deaths for every 1,000 surgical oncology patients. No significant association between the proportion of baccalaureate-prepared nurses and failure-to-rescue rates was shown. Increasing the proportion of baccalaureate prepared nurses showed a significant effect in improving outcomes when adjusting for patient characteristics. Results from this study add to existing evidence supporting the association between higher-educated registered nurses and improved patient outcomes. The finding of a significant mortality advantage with the increase of baccalaureate-prepared nurses within a hospital when controlling for patient characteristics adds evidence to support initiatives at the local, state, and federal level to shift the minimum education level of nurses to a baccalaureate-degree. The Institute of Medicine's report on *The Future of Nursing* calls for an increase in the number of baccalaureate-prepared nurses in the workforce to 80% by the year 2020 (Institute of Medicine, 2010; Robert Wood Johnson Foundation, 2010). The findings of this study support the Institute of Medicine's expert committee charge that to respond "to the demands of an evolving health care system and meet the changing needs of patients, nurses must achieve higher levels of education" (Institute of Medicine, 2010). Increase in the production and number of baccalaureate-prepared nurses has been proposed through a number of policy initiatives, including increased local and federal funding mandated to policy change, support of the "BSN in 10" legislative campaign proposed by states such as New York, which would require that all nurses earn a baccalaureate degree within ten years of entering the workforce in order to continue as licensed professionals, and

support of the ability of community colleges to grant baccalaureate degrees (Zimmerman, Miner, & Zittel, 2010). Further exploration of the impact of employing education-focused initiatives alone or in conjunction with the improvement of nurse staffing ratios, warrants further attention.

Findings from this study have implications regarding patient safety and quality of care within the hospital. The significant effects of registered nurses on both failure-to-rescue rates and mortality suggest that the improvement of patient-to-nurse ratios may extend beyond those patients considered high-risk for mortality. The prevention of adverse outcomes to hospitalized patients not considered high-risk for poor outcomes but who are still susceptible to adverse events is difficult to measure but would appear to be a benefit of improving patient-to-nurse ratios within an institution. Investment in registered nurses, both in terms of staffing levels and in level of education, suggests that preventable mortality for surgical oncology patients will be reduced.

Interpretation of results from this research must be conducted within the context of the healthcare environment. The provision of healthcare is done in an ever-changing environment, reflective of innovation and progress in the field of medicine. Transformation of the healthcare system is due, in part, to regulatory pressure, economic constraint, and emerging technologies, all of which are occurring in the context of passage of the Patient Protection and Affordable Care Act (PPACA). Among other provisions in the law, the PPACA contains regulations to penalize hospitals for high Medicare readmission rates. The transformation of healthcare is occurring due to goals that include keeping patients out of the hospital, thereby reducing increased medical costs. This has led to the development of outpatient procedures, clinics, and ambulatory

services among all healthcare institutions. The development of ambulatory clinics and facilities reflect a shifting care delivery model focused on delivery of complex patient care in an outpatient market.

As healthcare systems attempt to control the increasing cost of the provision of medical care, innovations in technology have allowed for an increasing number of procedures to take place in ambulatory centers. Health care delivery, including health systems, insurers, and patients, continues to move towards a delivery model involving ambulatory care. The shift in care to the outpatient setting has increased the need for professional nursing services, as nurses provide not only complex procedural care, but support to patients in decision making, patient education, and coordination of services. As the delivery of healthcare evolves by moving to different setting, providers must remain vigilant in educating themselves to allow for adjustment of their practices. The evolution of the delivery system to an ambulatory patient-centered model will offer providers, especially registered nurses, opportunities to provide care coordination, management, and leadership. Establishment of accountable care organizations (ACOs) and patient-centered medical homes will require an increased demand for registered nurses and advanced practice nurses to deliver primary care, manage chronic conditions, and instruct patients on preventive measures. With more than 30 million people joining the ranks of the insured, provider services will be in demand.

Findings from this study cannot be fully interpreted without the provision of context. The study focused on the effects of changes in level of nurse education, staffing, and rating of practice environment on outcomes of inpatient oncology patients hospitalized for a primary surgical procedure. As the delivery of healthcare evolves, it

can be surmised that a number of surgical procedures performed as primary treatment for an oncology patient will be performed in an ambulatory setting. This was a reason for the exclusion of those patients with a breast cancer diagnosis from the study, as a number of surgical procedures for the purpose of primary intervention for breast cancer are already completed in an ambulatory setting and often require no inpatient stay from a patient. Conducting a study focusing on this patient population alone would provide important findings regarding the effects of changes in nursing-specific organizational characteristics on outcomes for breast cancer patients. Study findings reflect care provided in the inpatient setting, and should be interpreted as such. As surgical procedures are performed in an ambulatory setting, the change in environment and the effect that this has on patient outcomes will need to be studied. It should be noted, however, that specific complex procedures, such as and esophagectomy, which currently has a median inpatient stay of 13 days for a patient, will likely never be conducted in an outpatient setting. With current technology it is not safe, nor feasible, for all care to transfer outside of an inpatient setting. The study of complex procedures that require inpatient hospitalization remains relevant and necessary in the field of oncology.

We did not find significant associations between changes in nurse-reported rating of the practice environment and changes in either patient outcome. The inability to detect an effect of the practice environment was not consistent with previous work by Aiken and colleagues that reported that patients had significantly lower risks of death and failure-to-rescue in hospitals with better care environments (Aiken, et al, 2008). A follow up study to the 2008 work by Aiken included study of the conditions under which the impact of hospital nurse staffing, nurse education, and work environment were associated with

patient outcomes. Study results showed that the effect of 10% more BSN nurses decreased the odds of both failure-to-rescue and 30-day mortality in all hospitals regardless of their work environment, by approximately 4% (Aiken, et al, 2011). The effect of decreasing nurse workload however, was shown to be contingent upon the work environment. This study does not substantiate this claim, as it did not test the dependency of effects of nursing-specific organizational characteristics on type of practice environment in either study year. This study controlled for the changes in practice environment. Future research that examines whether improvements in nurse staffing or education are more effective given better nurse practice environments in 1999 could provide additional insight into relationships amongst nursing-specific organizational characteristics within a hospital. Further examination into the effect of changes of the nurse practice environment on patient outcomes as well as on other nursing-specific organizational characteristics is warranted. This study showed a correlation between changes in rating of the practice environment and changes in level of nurse staffing. Examination of the association between changes in these variables and their effects on one another should be completed, as it could provide additional evidence and insight into the contextual relationship between changes amongst these variables.

This study builds primarily on the work of Kutney-Lee and colleagues (2013), who used Pennsylvania nurse survey and patient discharge data from 1999 and 2006 to enhance the understanding of the relationship between nurse education and patient outcomes. A retrospective, two-stage panel analysis of a sample of surgical patients admitted for general, vascular, and orthopedic surgery in hospitals within the state of Pennsylvania was completed in an effort to examine the effect of changes in the

percentage of nurses with baccalaureate degrees within a hospital on changes in rates of surgical patient mortality and failure-to-rescue (Kutney-Lee et al., 2013). The surgical patient population examined in this study constituted a much larger sample of patients, with 223,000 surgical patients in 1999 and 244,000 patients in 2006. The average age of the patient population was approximately 60 years old and female, compared to an average age of 67 and a primarily male surgical oncologic patient population.

Authors found that a ten-point increase in the percentage of baccalaureate-prepared nurses within a hospital was associated with an average reduction of 2.12 deaths for every 1,000 patients, with an average reduction of 7.47 deaths per 1,000 patients for those patients with complications, or failure-to-rescue. Study authors accounted for simultaneous changes in nurse-reported staffing levels, skill mix, and years of experience as a registered nurse. No significant reductions in mortality or failure-to-rescue rates were associated with changes in nurse-reported staffing levels, skill mix, or years of experience. Kutney-Lee and colleagues (2013) found that improvement in level of nurse education within a hospital is associated with decreased mortality amongst a surgical patient population. Results indicating that improvement in level of nurse staffing had significant effects on patient outcomes in a surgical oncologic patient population differ from results of the previous study, which showed no significant association between level of nurse staffing and patient outcomes. When bivariate regression models were run without the addition of control hospital characteristics including bed size, teaching status, and technology status, change in education was shown to have a statistically significance effect on the patient outcome of 30-day mortality. It can be surmised that the change in proportion of baccalaureate-prepared nurses within a hospital could be correlated with

hospital characteristics. This in turn might lead one to believe that the inclusion of hospital characteristics "controls away" the effect of change in baccalaureate-prepared nurses, especially if most increases in this proportion occurred within hospitals that exhibited high technology status, major teaching status, and large bed size. The omission of hospital characteristics as control variables in the regression model for 30-day mortality might be warranted. Further research investigating whether those hospitals that increased the percentage of baccalaureate-prepared nurses were the same hospitals categorized as having a large bed size, major teaching status and major technology status, is warranted. If the hospitals that showed increased percentages of baccalaureate-prepared nurses correlate with those characteristics of large bed size, major teaching and technology status, perhaps the two are crowding the significance of the other out.

Important to the field of health services research is the building of evidence upon previously completed studies. Additional evidence examining the effects of changes in nursing-specific organizational characteristics within hospitals using longitudinal data is warranted. Although findings between studies highlighted the significance of different nursing-specific organizational characteristics on patient outcomes, the finding of significance in and of itself on both patient populations is notable.

Limitations

Despite the findings of this study, there are limitations that must be discussed. The use of panel data to assess the associations between changes in nursing-specific organizational features and changes in patient outcomes over a seven-year period represents a methodological step beyond cross-sectional analysis. The use of additional time points would have allowed for stronger support for a causality argument as more

rigorous analysis would have been able to be completed. Data sources were collected for purposes other than to provide answers to the research questions asked in this study. The use of large administrative databases for secondary analysis did allow for examination of the effect of changes in the organization of nursing within hospitals on trends in patient outcomes in a manner that has not been done to date in the field of oncology health services research. This study remains the largest and most comprehensive examination of changes in nursing organization on outcomes of surgical oncology patients admitted for primary surgical intervention from the state of Pennsylvania in years 1999 and 2006 to date.

Generalizability of findings is limited by the analysis of a select population of surgical oncology patients admitted to hospitals in one state. Although the patient sample in this study was limited to a select population of patients admitted for a primary surgical intervention related to his or her solid tumor oncology diagnosis, it is thought that improvement in patient-to-nurse ratios would affect outcomes for other patient populations, including medical patients. The solid tumor diagnoses included in this study were selected based on criteria previously defined. Selection was meant to represent a homogenous group of solid tumors in which a surgical procedure is commonly used as a primary intervention. The exclusion of patients with a diagnosis of breast cancer represents a limitation in that breast cancer accounts for approximately 23% of all cancer diagnoses worldwide. For women in the United States, breast cancer death rates are higher than those for any other cancer expect for lung. Exclusion of this primary diagnosis was done due in part due to the fact that a percentage of primary interventions for this diagnosis are performed in an ambulatory setting and require no inpatient

hospitalization. Generalizability of findings and continuity based on previous research performed by Friese (2005) were also factors influencing the decision to omit this diagnosis. Acknowledgement that the diagnosis of breast cancer could have been included in this study, and treated differently at the level of analysis if necessary is made. Future research including this diagnostic group is necessary and warranted.

An additional limitation of this study includes the inability to measure the effect of variables that are likely to offer explanations for improved rates of mortality and failure-to-rescue over the seven-year period from 1999 to 2006. Rates of improved patient outcomes post-surgical intervention have been attributed to a number of items, including improved technology, increase in patient safety initiatives, and the innovation of improved surgical techniques. Such items were unable to be measured directly in this study. Difference models indicate an effect of both improved nurse staffing and an increase in the proportion of baccalaureate-prepared nurses within a hospital as having significant effects on patient outcomes. Certain assumptions must be addressed, including the assumption that we correctly specified the model, omitting no variables that were significantly associated with changes in either nursing-specific organizational variables or patient outcomes. Another assumption that must be addressed when reviewing study results includes the assumption that coefficients associated with changes in outcomes due to nursing-specific variables were linear in nature and interpretation.

The use of PHC4 data combined with Pennsylvania Cancer Registry data allowed for the use of cancer-specific variables for the purpose of risk-adjustment. The use of combined administrative datasets with clinical parameters reduces the impact of patient differences when comparing hospitals. When reporting on both failure-to-rescue and

mortality outcomes, a hospital's ranking is dependent upon the accuracy of the risk adjustment and the risk adjustment methods are dependent upon the data having enough information to accurately reflect the patient population. Evidence that strategic enhancement of existing hospital administrative data with select clinical data (such as cancer registry variables) improves the validity of risk adjustment by predicting hospitalized patients' risks of adverse outcomes exists (Rudolph & Love, 2007). As described, risk adjustment was performed using 45 unique variables including but not limited to Elixhauser comorbidities, patient age, diagnosis, surgical procedure, and cancer stage at presentation. The variable list is not exhaustive, as pertinent clinical information was not able to be obtained from patient medical records. Inclusion of cancer variables did increase model specificity, with the model's C-statistic increasing from .85 in both study year models to .88 with the addition of cancer-specific variables. Lack of clinical variables and medical information is acknowledged as a limitation. A prospective study aiming to evaluate the effect of changes of nursing-specific organizational characteristics on outcomes of surgical oncology patients would be designed for collection of clinically relevant data from patient records including laboratory values, treatment regimen, and concurrent patient responses to interventions in 'real time'.

Limitations to the use of the discharge databases used include the inability to determine the exact unit location where a patient's pre- or post-surgical care occurred, which has been suggested to effect outcomes in critically ill patients (Randolph, 1999). PHC4 discharge claims do not identify if the patient was transferred between hospital units (i.e. an intensive care unit) during the length of his or her hospital stay. An inherent limitation with the use of discharge abstract data includes lack of space to list all co-

morbidities and patient conditions. The possibility that "upcoding" for higher reimbursement rates occurred cannot be excluded, representing bias and an inherent limitation with the use of administrative data.

This study was not able to link patients to the individual nurses who provided their care, nor was it able to link patients to the unit on which they received care. The study provided analysis at the hospital-level of selected oncology patients treated with a primary surgical intervention within a unit(s) of a given hospital, with reports from staff inpatient nurses. All inpatient staff nurse reports were aggregated to the hospital level although a patient may have been cared for in a unit other than one from which a nurse respondent worked. This constituted a reasonable approach as preliminary analysis demonstrated the reliability of measures when data was aggregated (all intraclass correlations >0.60). Analysis at the hospital-level remained consistent with the nursing-specific organizational measures, meant to quantify characteristics at both the unit and the hospital level.

Implications

Introduction

Progress has been made on the "war on cancer", primarily due to the advancement of science in regards to treatment regimens and improved surgical technique. Overall mortality rates attributed to cancer declined from 1999 to 2006, but the incidence rate of cancer cases during this time period surged. As the population continues to age, the need for oncologic healthcare services will increase. The inevitable expansion of the healthcare needs of the United States' population will affect all aspects of the healthcare system, including the largest group of care providers, registered nurses. The Patient Protection

and Affordable Care Act (PPACA), enacted as public law in 2012, is arguably the most significant piece of legislation affecting healthcare since the 1960s. The law provides health insurance coverage to previously uninsured citizens through a combination of public and private sector expansions. Through the extension of insurance coverage to an estimated 32 million United States' citizens, the demand for nursing services will markedly increase in all areas of patient care, from acute inpatient care to hospice and long-term chronic care. If the law's objective of increased healthcare access to citizens is to be realized, workforce issues, particularly those surrounding the nursing workforce, must be addressed. The shortage of health professionals is addressed in the PPACA with provisions including the expansion of education and training opportunities for nurses. The role of the registered nurse is highlighted within this legislation in a number of programs directed towards chronic care management, primary care prevention, nurse-managed health clinics, and accountable care organizations (ACOs). The PPACA recognizes the need for nurses at every level of care, and has established legislation that provides opportunities for advancement of the profession. The need for improved nurse staffing at every level of care has never been more necessary than with the enactment of this piece of legislation. If healthcare access is to expand, and patient safety is to be maintained, adequate levels of nurse staffing must be achieved. Although the PPACA provides context for expansion and advancement of the registered nurse through such means as increased funding for education and nurse-led initiatives, it remains the responsibility of individual hospital administrations to ensure that appropriate nurse staffing levels are achieved in order to maintain patient safety and improve patient outcomes. Comprehensive analysis of how changes in nursing-specific organizational

characteristics affect patient outcomes provides information that is needed in order to optimize outcomes. The implementation of quality improvement interventions by hospital administrators and staff cannot be effective without a baseline understanding of the effects of nursing on patients within the healthcare system.

Care of the patient with cancer has evolved from a primary focus on the eradication of the disease to a focus on holistic treatment of the patient, involving a multidisciplinary team approach meant to achieve high quality care. Survival rates and quality of life outcomes for cancer patients have improved due to advances in screening, prevention, and systemic treatment. As advanced as care of the cancer patient has become, substantial evidence that shows variation in quality of care provided across institutions exists. A call for increased quality care for the cancer patient has been addressed in seminal reports authored by expert committee members of the Institute of Medicine. The 1999 report entitled "*Ensuring Quality Cancer Care*" and the more recent 2013 report "*Delivering High-Quality Cancer Care: Charting a New Course for a System in Crisis*" include key recommendations to assure that all citizens receive high-quality cancer care.

The IOM's *"Delivering High-Quality Cancer Care: Charting a New Course for a System in Crisis"* calls for an increase in the number of healthcare providers trained to provide expert care to an oncology patient population. The report concluded that the cancer care delivery system is in crisis due to a growing demand for cancer care, increased complexity of treatment, a shrinking workforce, and rising cost of care. One of many recommendations written into the report is one that advises the increase in the number of health care providers who are trained to treat people with this complex disease

process. The number of adults aged 65 and older, the group most susceptible to cancer, is expected to double by 2030, contributing to a 45% increase in the number of people developing cancer. The committee noted that high-quality cancer care is delivered by a diverse multi-disciplinary team of health care professionals. Recommendations include the elimination of reimbursement and scope-of-practice barriers to team-based care by federal and state regulatory bodies. The committee states that academic institutions and professional societies should develop inter-professional education programs to train the workforce in team-based cancer care. Finally, the committee states that it is critical that cancer care delivery organizations require members of cancer care teams to have the necessary skills to deliver high-quality cancer care. Findings from this study support recommendations provided in the seminal reports on the state of oncology care. Studies of this extent are those that will answer the call set forth by national organizations such as the Institute of Medicine to provide evidence to shape future clinical practice guidelines. The Commission on Cancer (CoC), a consortium of professional organizations dedicated to improving survival and quality of life for cancer patients through standard-setting, prevention, research, education, and the monitoring of comprehensive quality care, is a part of the professional organization of the American College of Surgeons. The CoC released new standards of care in 2012, to be implemented by accredited organizations by the year 2015. These new standards contain three new patient-centered standards meant to enhance the cancer care experience for all patients, and include patient navigation implementation, screening patients for psychosocial distress and offering resources related to this, and implementation of treatment summaries and survivorship care plans for initial treatments.

Further understanding of the effects of nursing on patients within the healthcare system supports standardized guidelines and recommendations put forth by influential organizations such as the IOM. A plethora of organizations track and evaluate the performance of healthcare providers and institutions by comparing actual clinical practice to recommended practice. The best available evidence and existing clinical practice guidelines serve to establish recommended practice. A substantial barrier to practice and the development of standard performance measures has been lack of evidence and no relevant clinical practice guidelines to support recommended practice. Findings from this study will contribute evidence showing that changes in the effects of nursing-specific organizational characteristics, specifically staffing, affect the outcomes of surgical oncology patients.

California Nurse-Staffing Mandated Legislation

According to a 2002 report by the workforce commission of the American Hospital Association, the nursing shortage "reflects fundamental changes in population demographics, career expectations, work attitudes, and worker dissatisfaction" (American Hospital Association, 2002). Predictions estimate that hospital nursing vacancies will reach 800,000, or 29% , by the year 2020 (Health Resources and Services Administration, 2004), while the number of nurses is expected to increase by only 6% by the same year, with demand for nursing care expected to increase by 40% (Agency for Healthcare Research and Quality, 2004). Concerns regarding hospital understaffing related to the hospital nursing shortage have been expressed by media outlets and healthcare providers alike. The Institute of Medicine issued a report in 1996 stating the importance of determining appropriate nurse-patient ratios and nursing skill mix in

ensuring patient safety and maintaining a standard quality of care (Institute of Medicine, 2005).

Initiatives implemented since the Institute of Medicine's report release include California state legislation passed in 1999 and made effective in 2003, mandating patient-to-nurse ratios for all hospitals within the state. Various stakeholder groups advocated for varying minimum ratios, with a ratio of 1 nurse to every 5 patients being implemented on medical and surgical units after full legislative action (Aiken, et al, 2002). California's implementation of a mandated patient-to-nurse ratio constituted a natural experiment, an empirical observational study in which individuals, or groups of individuals, are exposed to experimental and control conditions determined by factors not in the control of the researcher. California's implementation of mandated nurse staffing ratios has been studied in detail by health services researchers in an effort to ascertain whether legislated mandates would result in improved staffing levels and patient outcomes. Forms of nurse staffing legislation exist in other states, but the ability to analyze nurse staffing prior to, during, and after, a legislated mandate, makes the study of California unique. Research focusing on the pre-implementation period prior to establishment of the California mandate suggests a link between changes in nurse staffing and changes in patient outcomes. Increases in nurse staffing in California was associated with reductions in mortality and in failure-to-rescue rates in a population of general surgical patients and cardiac patients (Rothschild, Bates, Franz, Soukup, & Kaushal, 2009; Sochalski, Konetzka, Zhu, & Volpp, 2008).

Examination of this legislative action indicated that the mandate did improve staffing within all California hospitals, including safety-net hospitals, without

compromising skill mix (McHugh, et al, 2012). California hospitals on average followed the trend of hospitals nationally by increasing their nursing skill mix, using more highly skilled registered nurses in an effort to meet the state-legislated staffing mandate (McHugh, Kelly, Sloane, & Aiken, 2011). McHugh and colleagues (2011) measured registered nurse staffing as hours per adjusted patient day, and found that, on average, staffing in California hospitals was higher than in matched hospitals in other states in any given year. A downward trend in staffing between 1997-2001 (pre-legislation implementation) in California and in nation-wide matched hospitals was noted. Nurse staffing began to improve in both California hospitals and in hospitals in other states after 2002, but appears steeper in California than elsewhere. A significant increase, or improvement, in staffing was noted for California hospitals in the implementation period (2003-2007) (McHugh et al., 2011). Research has shown that the increased staffing in California hospitals following the mandate was associated with better patient outcomes, as compared to outcomes for patients treated in hospitals in states without similar mandated legislation (Aiken, Sloane, Cimiotti, Clarke, Flynn, & Seago, 2010). Specifically relevant to this study are results indicating that both failure-to-rescue and mortality rates in general surgical patients in hospitals in New Jersey and Pennsylvania would be greatly reduced if those hospitals were to increase their nurse staffing levels to those of the levels mandated by California in the legislation (Aiken et al., 2010). Aiken and colleagues (2010) reported that California hospital nurses cared for one less patient on average than nurses in both New Jersey and Pennsylvania, and two fewer patients on units that were identified as medical and surgical units. Lower ratios were associated with significantly lower mortality, and when nurses' workloads were on par with California

mandated ratios, nurse outcomes including burnout and job dissatisfaction were lower, and nurses reported better quality of care (Aiken et al., 2010).

Continued research on the impact of California's staffing mandate must be completed in order to provide recommendations for states considering similar legislation. Current recommendations include investigating a 'paired' intervention, involving implementation of a nurse staffing mandate in conjunction with initiatives to increase the available pool of registered nurses in the workforce (McHugh, et al, 2012). Development and pilot implementation of policy designs targeting hospitals most in need of increased staffing while calling for better-resourced hospitals to develop innovative approaches to staffing issues, including the development of staffing models, and combined approaches that include mandates with compliance and financial incentives are needed. On the federal level, passage of the Nurse Reinvestment Act in 2002 established measures meant to improve the recruitment and retention of nurses through such initiatives as establishment of a National Nurse Service Corps and loan-forgiveness programs (Agency for Healthcare Research and Quality, 2004). Policy initiatives cannot be discussed without providing context in which those provisions will be implemented. The issue of cost must be addressed in a discussion involving changes in policy surrounding the healthcare workforce. Research regarding implementation of California's nurse-staffing mandate indicates that in order to comply with the legislation, the expected registered nurse spending per hospital was estimated to be between $700,000 and $800,000 (Rothschild et al., 2011). Issues specific to the state of California could have enhanced the cost of this staffing initiative, making it more costly than implementation in other states. Policy makers and hospital administrators must account for the cost effectiveness

of a staffing mandate prior to implementation. There is evidence to support the costs of implementation of increased staffing, as it is offset by costs attributed to poor patient outcomes, adverse events, and low rates of nurse retention (Rothschild et al., 2011) Studies of this nature have been used by authors of the PPACA and federal legislation in order to support implementation of programs that enhance opportunities for increased education, training and staffing initiatives for registered nurses.

Lowering the patient-to-nurse ratio is one option that hospitals may employ in order to lower the rate of failure-to-rescue and mortality of adult oncology patients admitted for a primary surgical intervention for disease management. This study suggests that improving staffing alone, although a costly intervention, would provide a significant effect in improving patient outcomes. Increased nurse staffing is associated with lower hospital-related mortality and adverse patient events, generating net savings from a societal standpoint in regard to avoided patient events (Shamliyan, Kane, Mueller, Duval, & Wilt, 2009). Policy decisions surrounding nurse staffing should include cost-utility analysis, with future research needed to examine the impact of in-hospital adverse events and failure-to-rescue on patient quality of life, mortality, length of stay, and discharge status. Examination of the newly implemented Medicare reimbursement reduction policy that serves to reduce payment to institutions when risk-adjusted patients have a length of stay at least one day less than the geometric mean length of stay for the provided DRG will add to the existing literature base surrounding hospital incentives and cost (MEDPAC, 2009).

A number of accredited organizations, including the American Hospital Association, Joint Commission on the Accreditation of Healthcare Organizations, and the

Institute of Medicine have expressed concerns regarding the current status of the nation's nursing workforce through the issuing of statements, reports, and expert committee recommendation white papers. Hospital nurse staffing is a matter of concern not only due to effects on patient safety and quality of care, but due to concern regarding nursing shortages.

Considerations for Future Research

The purpose of this study was to determine how change in nursing-specific organizational characteristics was associated with changes in outcomes of surgical oncology patients admitted for primary surgical intervention. Changes in variables including nurse staffing and level of nurse education were significantly associated with patient outcomes of failure-to-rescue and 30-day mortality. Analysis assessing for the effect of changes of nursing-specific organizational variables on changes in patient outcomes in a joint manner, controlling for both patient and hospital characteristics, was completed. Joint assessment of nursing-specific variables reflects the underlying theory that patient care is provided in a dynamic healthcare system. Relationships previously shown in other research between staffing and failure-to-rescue, staffing and mortality, and education and mortality, were identified in this research. This research did not support relationships identified in previously published research, notably between the practice environment and mortality. This could be due in part to the joint estimation of all nursing-specific organizational variables on patient outcomes, creating a 'crowding-out' effect.

Relationships between changes in individual subscales of the nurse practice environment and changes in patient outcomes could not be fully assessed in this study.

No significant effect of changes in the composite score of the PES-NWI were associated with changes in patient outcomes, but further analysis of the effects of individual subscales is warranted. No research identifying how the five subscales of the PES-NWI have changed over a period of time has been published. Although the purpose of this study was not to provide a detailed examination of the individual practice environment subscales, future research identifying how these subscales changed and the potential rationale behind the change is necessary. Evidence from this study revealed that the staffing and resource adequacy subscale had the lowest mean score (2.19) in 1999, but significantly increased (2.41) in 2006. The staffing and resource adequacy subscale was the subscale with the largest increase in mean value between study years, with a mean change value reported at 0.21. The subscales with the largest change between study years were the staffing and resource adequacy scale and the nursing participation in hospital affairs subscale. Identification of why and how these scales increased to such an expansive level between years would provide for supplemental research. Further examination of changes in subscales between study years including the role of hospital administration, the potential shift in management priorities within institutions, financial incentives, and changes in the context of overall healthcare system-wide innovations is warranted. Changes in the practice environment subscales must be examined within the context of changes, both direct and indirect, that occurred simultaneously over the seven-year study period.

Future research should work to present effects of changes and trends in organizational characteristics in a manner that reflects the complexity of the healthcare system, accounting for the interaction of multiple organizational features on outcomes. A

more detailed exploration of the effect of changes in the proportion of baccalaureate prepared nurses, nurse staffing, and rating of the practice environment conditional upon one another is warranted. Improved hospital nurse staffing, nurse education, and practice environments have each been shown to have an association with patient outcomes including decreased hospital mortality. Little is known about under what conditions each type of investment works best to improve patient outcomes. Aiken and colleagues (2011) explored the effect of nurse education and nurse staffing conditional on practice environment in a cross-sectional study of general surgical patients in four large states. Findings showed an effect of increased proportion of baccalaureate-prepared nurses across all hospitals, regardless of the type of practice environment. The effect of lowering patient-to-nurse ratios, however, was not consistent across all hospitals, and showed no effect in institutions with poor practice environments (Aiken, et al, 2011). This study did not substantiate these claims as we controlled for nurse practice environment change, and not for a baseline nurse practice environment. Further exploration into the effects of interactions between nursing-specific organizational characteristics would provide increased knowledge regarding how the organization of nurses and nursing-specific characteristics within an institution may affect patient outcomes.

Research cited above was based on a conceptual framework developed by Aiken and colleagues that hypothesized that the specialization of nurses affected outcomes by improving nurse autonomy, strengthening multi-disciplinary relationships amongst providers, and by granting increased control of institution-wide resources to nurses (Shang, Friese, Wu, & Aiken, 2012; Aiken Clarke, & Sloane, 2000). Aiken and colleagues reported that changes in nurse practice environments required evolution of the

inter-professional culture and development of increased autonomy and care management decisions to be given to those providers closest to patients, or nurses (Aiken et al., 2011). As evidenced in previous research conducted within Magnet® hospitals, a number of institutions seeking to improve practice environments have found effective strategies for change within the Magnet® Recognition Program guidelines published by the AACN.

The use of panel data represents a step ahead in the field of oncology in terms of the methodology used to explore relationships between nursing-specific organizational features and patient outcomes. Continued use of longitudinal-type datasets is needed to improve upon existing analyses. The use of multiple time points in future research would allow for stronger support for causality rather than association. Generalizability of findings from this study are limited due to the analysis of surgical oncology patients admitted to acute care hospitals in one state for a primary surgical intervention. The study of additional patient populations, specifically medical oncology patients, would add to the existing literature base on effects of the organization of nursing within institutions on patient outcomes.

This study explored the addition of cancer-registry variables to information contained within administrative datasets for the purpose of risk-adjustment. More detailed exploration of the addition of clinical data to existing risk-adjustment formulas is warranted in order to ascertain which variables aid in identifying and classifying surgical oncology patients according to severity. Standard risk adjustment techniques for an oncology patient do not exist. Further work in developing a standard approach to the risk-adjustment of an oncology patient using both clinical and administrative data is warranted.

Summary

Improvement in patient-to-nurse staffing ratios was associated with a reduction in failure-to-rescue rates and a reduction in 30-day mortality in oncology patients admitted for primary surgical intervention disease management. This study provides evidence that hospitals with better resourced and staffed inpatient units offer improved outcomes for surgical oncology patients. The adult surgical oncology patient population constitutes a vulnerable group who routinely present to an institution with increased co-morbidities who are considered at high risk for the development of complications and mortality. This study suggests that the organization of nursing-specific characteristics within an institution contributes to the variation in outcomes for this patient population.

In summary, this study contributes to literature supporting the hypothesis that improved nurse staffing significantly improves patient outcomes. The data support a similar hypothesis that an increased proportion of bachelor's prepared nurses within a hospital improves patient outcomes, although with less statistical conviction. Continued research is needed in order to identify factors influencing staffing levels and level of education attainment of nurses within a hospital.

Given the findings from this study, it is recommended that development of hospital outcome measures that are sensitive to the level of nurse staffing within an institution be explored. Hospital personnel, including administrators, nurse managers, and executive officers have a responsibility to ensure that adequate staffing ratios are met within an institution in order to provide superior patient care. Investments in nursing-specific organizational features including increasing the proportion of baccalaureate-

prepared nurses and lowering patient-to-nurse ratios within hospitals will contribute to improvement in patient outcomes.

APPENDICES

APPENDIX A: SURGICAL PROCEDURES OF THE PATIENT SAMPLE (ICD-O-2; ICD-O-3 CODES)

Cancer Site: HEAD AND NECK
ICD-03 CODES INCLUDE THE FOLLOWING:
LIP ICD-O-3: C00.0-C00.9
BASE OF TONGUE: C01.9
UNSPECIFIED PARTS OF THE TONGUE: C02.0-C02.9
GUM: C03.0, C03.1, C03.9
FLOOR OF MOUTH: C04.0, C04.1, C04.8, C04.9
PALATE: C05.0, C05.1, C05.2, C05.8, C05.9
UNSPECIFIED PARTS OF THE MOUTH: C06.0, C06.1, C06.2, C06.8, C06.9
PAROTID GLAND: C07.9
UNSPECIFIED MAJOR SALIVARY GLAND: C08.0, C08.1, C08.8, C08.9
TONSIL: C09.0, C09.1, C09.8, C09.9
OROPHARYNX: C10.0, C10.1, C10.2, C10.3, C10.4, C10.8, C10.9
NASOPHARYNX: C11.0, C11.1, C11.2, C11.3, C11.8, C11.9
PYRIFORM SINUS: C12.9
HYPOPHARYNX: C13.0, C13.1, C13.2, C13.8, C13.9
ILL-DEFINED SITES LIP, ORAL CAVITY, PHARYNX: C14.0, C14.2, C14.8
NASAL CAVITY AND MIDDLE EAR: C30.0, C30.1,
ACCESSORY SINUSES: C31.0, C31.1, C31.2, C31.3, C31.8, C31.9
LARYNX: C32.0, C32.1, C32.2, C32.3, C32.8, C32.9
THYROID GLAND: C73.9

ICD-9 Procedure Codes:
22.62 Excision of lesion of maxillary sinus with other approach (not Caldwell-Luc)
24.0 Incision of gum or alveolar bone
24.11 Biopsy of gum
24.12 Biopsy of alveolus
24.19 Other diagnostic procedures on teeth, gums, and alveoli
24.2 Gingivoplasty
24.31 Excision of lesion or tissue of gum
24.39 Other operations on gum
24.4 Excision of dental lesion of jaw
24.5 Alveoloplasty
24.99 Other dental operations
25.01 Closed (needle) biopsy of tongue
25.02 Open biopsy of tongue
25.09 Other diagnostic procedures on tongue
25.1 Excision or destruction of lesion or tissue of tongue
25.2 Partial glossectomy
25.3 Complete glossectomy

25.4 Radical glossectomy
25.59 Other repair and plastic operations on tongue (includes fascial sling of tongue, fusion of tongue (to lip), graft of mucosa or skin to tongue)
25.91 Lingual frenotomy
25.92 Lingual frenectomy
25.93 Lysis of adhesions of tongue
25.94 Other glossotomy
25.99 Other operations on tongue
26.0 Incision of salivary gland or duct
26.11 Closed (needle) biopsy of salivary gland or duct
26.12 Open biopsy of salivary gland or duct
26.19 Other diagnostic procedures on salivary glands and ducts
26.29 Other excision of salivary gland lesion (excludes marsupialization of salivary gland cyst)
26.30 Sialoadenectomy, not otherwise specified
26.31 Partial sialoadenectomy
26.32 Complete sialoadenectomy
26.49 Other repair and plastic operations on salivary gland or duct (includes fistulization of salivary gland, plastic repair of salivary gland or duct NOS, transplantation of salivary duct opening)
26.91 Probing of salivary duct
26.99 Other operations on salivary gland or duct
27.21 Biopsy of bony palate
27.23 Biopsy of lip
27.24 Biopsy of mouth, unspecified structure
27.32 Wide excision or destruction of lesion or tissue of bony palate
27.41 Labial frenectomy
27.49 Other excision of mouth
27.91 Labial frenotomy
27.92 Incision of mouth, unspecified structure
27.22 Biopsy of uvula and soft palate
27.29 Other diagnostic procedures on oral cavity
27.31 Local excision or destruction of lesion or tissue of bony palate
27.42 Wide excision of lesion of lip
27.43 Other excision of lesion or tissue of lip
27.71 Incision of uvula
27.72 Excision of uvula
27.79 Other operations on uvula
27.99 Other operations on oral cavity
28.11 Biopsy of tonsils/adenoids
28.19 Other diagnostic procedures on tonsils and adenoids
28.2 Tonsillectomy without adenoidectomy
28.3 Tonsillectomy with adenoidectomy
28.5 Excision of lingual tonsil
28.6 Adenoidectomy without tonsillectomy
29.11 Phayngoscopy

29.12 Pharyngeal biopsy
29.19 Other diagnostic procedures on pharynx
29.31 Cricopharyngeal myotomy
29.32 Pharyngeal diverticulectomy
29.33 Pharyngectomy (partial)
29.39 Other excision or destruction of lesion or tissue of pharynx
30.09 Other excision or destruction of lesion or tissue of larynx (excludes biopsy of larynx, laryngeal fistulectomy, laryngotracheal fitulectomy)
30.1 Hemilayngectomy
30.21 Epiglottidectomy
30.22 Vocal cordectomy
30.29 Other partial laryngectomy
30.3 Complete laryngectomy
30.4 Radical laryngectomy
31.43 Closed (endoscopic) biopsy of larynx
31.44 Closed (endoscopic) biopsy of trachea
31.45 Open biopsy of larynx or trachea
31.48 Other diagnostic procedures on larynx
31.49 Other diagnostic procedures on trachea
31.5 Local excision or destruction of lesion or tissue of trachea
40.41 Radical neck dissection, unilateral
40.42 Radical neck dissection, bilateral
76.31 Partial mandibulectomy
76.39 Partial ostectomy of other facial bone
76.41 Total mandibulectomy with synchronous reconstruction
76.42 Other total mandibulectomy
76.43 Other reconstruction of mandible
76.44 Total ostectomy of other facial bone with synchronous reconstruction
76.45 Other total ostectomy of other facial bone
76.46 Other reconstruction of other facial bone

Cancer Site: ESOPHAGUS
ICD-03 CODES INCLUDE THE FOLLOWING:
ESOPHAGUS: C15.0, C15.1, C15.2, C15.3, C15.4, C15.5, C15.8, C15.9
ICD-9 Procedure Codes:
30.1 Hemilaryngectomy
30.21 Epiglottidectomy
30.29 Other partial laryngectomy
30.3 Complete laryngectomy
30.4 Radical laryngectomy
42.11 Cervical esophagostomy
42.40 Esophagectomy, not otherwise specified
42.41 Partial esophagectomy
42.42 Total esophagectomy
42.51 Intrathoracic esophagoesophagostomy
42.52 Intrathoracic esophagogastrostomy

42.53 Intrathoracic esophageal anastomosis with interposition of small bowel
42.54 Other intrathoracic esophagoenterostomy
42.55 Other intrathoracic esophageal anastomosis with interposition of colon
42.56 Other intrathoracic esophagocolostomy
42.58 Intrathoracic esophageal anastomosis with other interposition
42.59 Other intrathoracic anastomosis of esophagus
42.61 Antesternal esophagoesophagostomy
42.62 Antesternal esophagoesophagogastrostomy
42.63 Antesternal esophageal anastomosis with interposition of small bowel
42.64 Other antesternal esophagoenterostomy
42.65 Antesternal esophageal anastomosis with interposition of colon
42.66 Other antesternal esophagocolostomy
42.68 Other antesternal esophageal anastomosis with interposition
42.69 Other atesternal anastomosis of esophagus
42.81 Insertion of permanent tube into esophagus
43.91 Total gastrectomy with intestinal interposition
43.99 Other total gastrectomy

Cancer Site: COLON-RECTUM
ICD-03 CODES INCLUDE THE FOLLOWING:
COLORECTAL CODES: C18.0-C18.9
RECTOSIGMOID JUNCTION: C19.9
RECTUM: C20.9
ANUS AND ANAL CANAL: C21.0, C21.1, C21.2, C21.8
ICD-9 Procedure Codes:
45.26 Open biopsy of large intestine
45.27 Intestinal biopsy, site unspecified
45.28 Other diagnostic procedures on large intestine
45.29 Other diagnostic procedures on intestine, site unspecified
45.3 Endoscopic excision-duodenum
45.62 Partial resection of small intestine
45.72 Cecectomy
45.73 Right hemicolectomy
45.74 Resection of transverse colon
45.75 Left hemicolectomy
45.76 Sigmoidectomy
45.79 Partial excision of large intestine
45.8 Total intra-abdominal colectomy
45.93 Other small-to-large intestinal anastomosis
45.95 Anastomosis to anus
46.01 Exteriorization of small intestine
46.02 Resection of exteriorized segment of small intestine
46.03 Exteriorization of large intestine
46.1 Colostomy, not otherwise specified
46.11 Temporary colostomy
46.13 Permanent colostomy

46.14 Delayed opening of colostomy
46.21 Temporary ileostomy
46.22 Continent ileostomy
46.23 Other permanent ileostomy
46.24 Delayed opening of ileostomy
48.5 Abdominoperineal resection of rectum
48.61 Transsacral rectosigmoidectomy
48.62 Anterior resection of rectum with synchronous colostomy
48.63 Other anterior resection of rectum
48.64 Posterior resection of rectum
48.65 Duhamel resection of rectum
48.69 Other rectal resection
49.22 Biopsy of perianal tissue
49.23 Biopsy of anus
49.29 Other diagnostic procedures on anus and perianal tissue
49.6 Excision of anus
51.69 Excision of other bile duct
54.11 Exploratory laparotomy
54.19 Other laparotomy

Cancer Site: PANCREAS
ICD-03 CODES INCLUDE THE FOLLOWING:
PANCREAS: C25.0, C25.1, C25.2, C25.3, C25.4, C25.7, C25.8, C25.9
ICD-9 Procedure Codes:
52.52 Distal pancreatectomy
52.59 Other partial pancreatectomy
52.51 Proximal pancreatectomy
52.53 Radical subtotal pancreatectomy
52.6 Total pancreatectomy
52.7 Radical pancreaticoduodenectomy
52.96 Anastomosis of pancreas

Cancer Site: LUNG
ICD-03 CODES INCLUDE THE FOLLOWING:
LUNG CODES: C34.0, C34.1, C34.2, C34.3, C34.8, C34.9, C33.9
ICD-9 Procedure Codes:
32.1 Excision of bronchus (excluding local excision or destruction of lesion or tissue of bronchus)
32.22 Lung volume reduction surgery
32.29 Local excision or destruction or lesion or tissue of lung (excluding endoscopic excision)
32.3 Segmental resection of lung
32.4 Lobectomy of lung
32.5 Complete pneumonectomy
32.6 Radical dissection of thoracic structures
32.9 Other excision of lung

33.25 Open biopsy of bronchus
33.28 Open biopsy of lung
33.29 Other diagnostic procedures of lung/bronchus (excluding open/closed biopsy or bronchoscopy)
34.02 Exploratory thoracotomy
34.23 Biopsy of chest wall
34.24 Pleural biopsy
34.27 Biopsy of diaphragm
34.28 Other diagnostic procedures on wall, pleura, diaphragm
34.09 Other incision of pleura—pleural window for drainage, open chest drainage
34.21 Transpleural thoracoscopy
34.22 Mediastinoscopy
34.26 Open mediastinal biopsy
34.29 Other diagnostic procedures on mediastinum

Cancer Site: OVARY
ICD-03 CODES INCLUDE THE FOLLOWING:
OVARY: C569
ICD-9 Procedure Codes:
54.11 Exploratory (abdominal) laparotomy
54.19 Other (abdominal) laparotomy (i.e. drainage of intraperitoneal abcess or hematoma)
54.3 Excision or destruction of lesion or tissue of abdominal wall or umbilicus
54.4 Excision or destruction of peritoneal tissue
65.29 Local excision or destruction (not by laparoscopy) of ovary (excluding wedge resection)
65.31 Laparoscopic unilateral oophorectomy
65.39 Other unilateral oophorectomy
65.41 Laparoscopic unilateral salpingo-oophorectomy
65.49 Other unilateral salpingo-oophorecomty
65.51 Removal of both ovaries at same operative episode
65.52 Removal of remaining ovary (not by laparoscopy)
65.53 Laparoscopic removal of both ovaries at same operative episode
65.54 Laparoscopic removal of remaining ovary
65.61 Removal of both ovaries and tubes at same operative episode (not by laparoscopy)
65.62 Removal of remaining ovary and tube (not by laparoscopy)
65.63 Laparoscopic removal of both ovaries and tubes at same operative episode
65.64 Laparoscopic removal of remaining ovary and tube
66.11 Biopsy of fallopian tube
66.21 Bilateral endoscopic ligation and crushing of fallopian tubes
66.22 Bilateral endoscopic ligation and division of fallopian tubes
66.29 Other bilateral endoscopic destruction or occlusion of fallopian tubes
66.31 Other (not endoscopic) bilateral ligation and crushing of fallopian tubes
66.32 Other (not endoscopic) bilateral ligation and division of fallopian tubes
66.39 Other (not endoscopic) bilateral destruction or occlusion of fallopian tubes
66.4 Total unilateral salpingectomy

66.51 Removal of both fallopian tubes at same operative episode
66.52 Removal of remaining fallopian tube
66.61 Excision or destruction of lesion of fallopian tube
66.63 Bilateral partial salpingectomy
66.69 Other partial salpingectomy
68.14 Open biopsy of uterine ligaments
68.29 Excision or destruction of lesion of uterus (excluding endometrial ablation or division of endometrial synechiae)
68.3 Subtotal abdominal hysterectomy
68.4 Total abdominal hysterectomy

Cancer Site: PROSTATE
ICD-03 CODES INCLUDE THE FOLLOWING:
PROSTATE: C619
ICD-9 Procedure Codes:
55.51 Nephroureterectomy
57.0 Transurethral clearance of bladder
57.32 Other cystoscopy (i.e. Transurethral cystoscopy)
57.49 Other transurethral excision or destruction of lesion or tissue of bladder (i.e. Endoscopic resection of bladder lesion)
57.71 Radical cystectomy
57.79 Other total cystectomy
57.91 Sphincterotomy of bladder
58.5 Release of urethral stricture
60.12 Open biopsy of prostate
60.15 Biopsy of periprostatic tissue
60.18 Other diagnostic procedure on prostate and periprostatic tissue
60.21 Transurethral (ultrasound) guided laser induced prostatectomy
60.29 Other transurethral prostatectomy
60.3 Suprapubic prostatectomy
60.4 Retropubic prostatectomy
60.5 Radical prostatectomy
60.61 Local excision of lesion of prostate
60.62 Perineal prostatectomy
60.69 Other prostatectomy

Cancer Site: ENDOMETRIUM
ICD-03 CODES INCLUDE THE FOLLOWING:
ENDOMETRIUM: C54.1
ICD-9 Procedure Codes:
54.11 Exploratory laparotomy
65.61 Removal of both ovaries and tubes at same operative episode (not by laparoscopy)
65.62 Removal of remaining ovary and tube (not by laparoscopy)
65.63 Laparoscopic removal of both ovaries and tubes at same operative episode
65.64 Laparoscopic removal of remaining ovary and tube
68.4 Total abdominal hysterectomy

68.6 Radical abdominal hysterectomy
68.9 Other and unspecified hysterectomy
68.8 Pelvic evisceration

APPENDIX B: OUTCOME DISTRIBUTION BY CLINICAL CLASSIFICATION GROUP

Patient Outcomes Distribution by Clinical Classification Group (ICD-O3) (1999)

Clinical Classification Groups (ICD-O3)	*No. (%)*	*Complications (%)*	*Failure to Rescue (%)*	*30-day mortality (%)*
HEAD AND NECK	1,097 (7.4)	378 (34.46)	19 (4.96)	19 (1.73)
ESOPHAGUS	217 (1.46)	128 (58.99)	11 (8.59)	11 (5.07)
COLON-RECTUM	6,525 (43.78)	2,916 (44.69)	253 (8.61)	253 (3.88)
PANCREAS	157 (1.05)	79 (50.32)	10 (12.50)	10 (6.37)
LUNG	2,335 (15.67)	1,157 (49.55)	107 (9.19)	107 (4.58)
OVARY	793 (5.32)	298 (37.58)	17 (5.69)	17 (2.14)
PROSTATE	3,636 (24.4)	676 (18.6)	11 (1.63)	11 (0.3)
ENDOMETRIUM	65 (0.44)	16 (24.62)	0 (0)	0 (0)

Patient Outcomes Distribution by Clinical Classification Group (ICD-O3) (2006)

Clinical Classification Groups (ICD-O3)	*No. (%)*	*Complications (%)*	*Failure to Rescue (%)*	*30-day mortality (%)*
HEAD AND NECK	1, 141 (7.90)	353 (30.94)	12 (3.38)	12 (1.05)
ESOPHAGUS	231 (1.60)	132 (57.14)	12 (9.09)	12 (5.19)
COLON-RECTUM	6, 071 (42.01)	3, 019 (49.73)	180 (5.95)	180 (2.96)
PANCREAS	276 (1.91)	143 (51.81)	12 (8.28)	12 (4.35)
LUNG	2, 677 (18.52)	1, 422 (53.12)	119 (8.34)	119 (4.45)
OVARY	588 (4.07)	229 (38.95)	9 (3.93)	9 (1.53)
PROSTATE	3, 312 (22.92)	512 (15.46)	7 (1.36)	7 (0.21)
ENDOMETRIUM	64 (0.44)	22 (34.38)	0 (0)	0 (0)

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