THE RELATIONSHIP BETWEEN NURSE STAFFING, NURSING TIME, AND ADVERSE EVENTS IN AN ACUTE CARE HOSPITAL

by

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of the requirements for the degree of
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CERTIFICATE OF APPROVAL

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Dedication

I want to dedicate my dissertation to my husband, Jerry Cheung and my family, whose love, encouragement, and commitment, gave me the support I needed to complete this research.

Acknowledgements

I would not have been able to complete this endeavor without the help, guidance, and encourage of many people, whom I would like to thank here. First, I want to acknowledge my committee members. My Committee Chair, Dr. Linda Moody, has generously and unselfishly given me many opportunities to advance to a higher level and I thank her profusely. She has inspired me to model myself according to her high standards and impressive academic achievements. My career as a nurse researcher will greatly benefit from her gracious gifts. I would like to recognize Dr. Jason Beckstead for his unwavering belief in me that kept me going when I was certain I could not. Dr. Cecile Lengacher, for her kindness and understanding. Dr. Mary Lou VanCott, for her advice to keep the faith, and Dr. Victoria Rich who opened many doors for me. Second, I would like to thank Ed Cockram for his help in the technical aspects of downloading the data, and particularly for his willingness to take time to go with me to get the data. Third, I want to thank the nursing staff who put up with my weekly excursions into their space and answered my questions without complaining. I would especially like to thank Olive Williams, Terri Warmack, and Doris Thornburg for keeping the records up to date and ensuring their accuracy; Mary Whillock, Cathy Conover, Susie Webster, Bev Fulmer, Edie Luzzi, and Deb Martoccio for helping me get the assistance I needed. Finally, I want to thank the Hill-Rom Company for believing in my study and funding this project.

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An Abstract

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Studies have shown that nurse-staffing patterns affect patient safety, but it is not known how staffing patterns affect time spent in direct and indirect care. This study explores the relationships between nurse staffing, registered nurse (RN) time spent in direct and indirect care, and the occurrence of adverse events on 5 inpatient units in an acute care hospital. Time spent in direct and indirect care was determined by examining patterns of electronically recorded data that captured, via locator badges, continuous intervals of time. Electronic data were captured using the Hill-Rom COMposer® nurse locator system. The average amount of time RNs spend in direct care per shift is 54% and 42% in indirect care. The multivariate model that includes the proportion of RN hours, unit acuity, and unit secretary hours best explains the variance in the percent of RN time spent in direct care ($R^2 = .188$, $p = .000$). Results from regression procedures predict that RNs spend 31.5% more time in direct care as the proportion of RN hours increase and 2.7% more time in direct care as hours of unit secretary increase. The largest effect size in the model is for the percentage of RN hours ($\eta^2 = .127$). The effect size for unit secretary is $\eta^2 = .014$. No significant relationships were found between adverse events, ratios of nurse staffing, or percent of RN time spent in direct or indirect care. The study findings indicate that RN time is driven by the proportion of RN hours in the skill mix, and highlights the important contribution the unit secretary makes in allowing RNs to spend more time in direct care. The findings from this study emphasize the importance of using staffing variables that distinguish between the unique contributions of the RN and LPN proportion in the skill mix. This study, the first to use electronic technology to measure RN time spent in direct and indirect care, demonstrates that this method of data

collection provides data that permit researchers to examine key variables related to nurse staffing and patient outcomes in acute and long term care settings.

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CHAPTER 1

Introduction

Beginning in the early 1980's, acute care hospitals implemented restructuring techniques designed to contain costs and maintain or improve efficiency and productivity while still maintaining quality (Aiken, Clarke, & Sloane, 2000). Because the nursing workforce comprises the largest labor component in acute care hospitals (Aiken, Sochalski, & Anderson, 1996; Kovner, Jones, & Gergen, 2000), restructuring efforts have had a large impact on the distribution and utilization of the nursing workforce (Buerhaus & Staiger, 1999; Buerhaus & Needleman, 2000). During the period of hospital restructuring, hospital length of stay steadily decreased while patient acuity increased and the intensity of resources consumed by hospital patients continued to grow (Aiken et al., 2000). Although the percentage of registered nurses (RNs) employed in acute care hospitals continues to rise, employment of licensed practical nurses (LPNs) and nursing assistants (NAs) has decreased (Aiken et al., 1996, 2000; Buerhaus & Staiger, 1996, 1999; Buerhaus & Needleman, 2000; Kovner et al.). These changes in the supply and distribution of the nursing workforce have resulted in a limited support staff available to registered nurses. Despite the growth in the percentage of RNs employed by acute care hospitals, it has not kept pace with the larger increases in patient acuity and consumption of resources, thereby outstripping any potential gains obtained by the rise in employment of RNs (Aiken et al., 1996, 2000). As a result, RNs are working with less support staff

and caring for patients that are more acutely ill and require a higher intensity of nursing services.

Hospital restructuring incorporates a number of strategies, one of which is labor reduction. As the labor component of other departments is downsized, nursing often assumes functions that were formally carried out by downsized departments (Prescott, Phillips, Ryan, & Thompson, 1991). However, departmental downsizing is effective only if adequate resources are made available to staff members assuming the additional functions (Sovie, 1995). Process re-design, a type of internal restructuring, may include changes in work assignments, alterations in staffing and skill mix, and reductions in management positions (Aiken et al., 2000). The documented changes in the distribution and supply of nursing personnel combined with the known effects of downsizing of other departments is concerning because of the potential negative effects on increasing work intensity and workload, the ability to complete tasks, the availability of resources, quality of care, and utilization of nursing personnel. While there are many reports that the quality of patient care has suffered as a result of restructuring efforts (American Nurses Association, 2001), scientific evidence that would either support or refute these claims is lacking (Aiken et al., 2000; Buerhaus & Needleman, 2000; Wunderlich, Sloan, & Davis, 1996).

Research findings demonstrate an association between nurse staffing patterns and patient outcomes in acute care hospitals (Aiken, Smith, & Lake, 1994; American Nurses Association, 2000; Blegen, Goode, & Reed, 1998, Blegen & Vaughn, 1998, Kovner & Gergen, 1998; Sochalski, 2001). In fact, these study findings consistently demonstrate that patient outcomes improve and the incidence of adverse events decrease as the

proportion of registered to nonregistered nurses (skill mix) increases. Past studies provide evidence that there is a positive association between total number of nursing personnel and patient outcomes, although not as consistently as the findings for skill mix (American Nurses Association, 2000; Blegen & Vaughn, 1998; Blegen et al.). Though study findings support a relationship between staffing patterns and patient outcomes, they do not explain the mechanisms through which staffing patterns impact patient outcomes. This study will attempt to clarify the mechanism through which nurse staffing affects patient outcomes by proposing that the mechanism is the pattern of the percentage of time RNs spend in direct and indirect care.

Researchers are just beginning to examine the link between nurse staffing patterns and patient outcomes. One area of study explores how nurse staffing patterns affects the amount of time nurses spend on patient care activities. Previous research findings demonstrate that nurses spend on average one third of their time with patients (Hendrickson, Doddato, & Kovner, 1990; Prescott et al., 1991), and that the amount of time devoted to direct patient care is strongly related to nurse-to-patient ratio and patient acuity (Hendrickson et al.). That is, as the number of patients assigned to an RN decreased, the amount of time RNs spent in direct care increased. Moreover, nurses reprioritize or omit tasks when they are faced with time constraints or competing tasks (Hendrickson & Doddato, 1989; Hendrickson et al.; Williams & Murphy, 1979), and higher nurse-to-patient ratios negatively affect the ability to complete tasks (Sochalski, 2001). In addition, findings from studies suggest that RNs reallocate direct care tasks to a lower priority or even omit some tasks while they are faced with time constraints. The implication from these findings is that as RNs and nursing personnel are faced with

shorter lengths of patient stays, sicker patients that consume more resources, and higher intensity workloads, they may not be spending as much time as they could on direct patient care activities. However, what has not been studied is whether nurse staffing influences patient outcomes by virtue of the effect on the amount of time nurses devote to patient care activities.

With the publication of the Institute of Medicine's (IOM) 1999 report *To Err Is Human,* the healthcare community has begun to take a hard look at the occurrence and sources of medical error and adverse events in acute care hospitals (Kohn, Corrigan, & Donaldson, 1999). The IOM reported that as many as 98,000 annual deaths are related to medical error and adverse events. Furthermore, it is estimated that 38% of errors are attributable to nurses (Leape et al., 1995). One source of error is the result of system failure, specifically the organization of health care delivery and the provision and delivery of health care resources. Given that nursing personnel constitute 25% of the total workforce in acute care hospitals and are the primary labor component that delivers and provides healthcare (Kovner et al., 2000), these estimates of medical error have important implications for nursing and its relationship to patient safety. As system-level factors, the organization of nursing personnel, delivery of care, and nurse staffing may be a contributing factor to the occurrence of medical error and adverse events.

A more recent IOM report makes a call for action to improve the American health care delivery system (Institute of Medicine, 2001). Discussed within the report are recommendations to appropriately prepare the workforce for the changes in health care delivery as well as efforts to retool practicing clinicians and develop clinical leadership. The report recommends exploring certification as a measure of quality as well as

exploring the relationship between the education of healthcare providers and quality of care. It is clear from the IOM report that an educated workforce is necessary to adapt to and work within a changing health care delivery system. However, the relationship between educational level of healthcare providers and quality has not been established.

Statement of the Problem

Re-engineering efforts by acute care hospitals have changed the distribution, structure, and utilization of the nursing workforce (Buerhaus & Needleman, 2000). Furthermore, research findings over the last 20 years show that as RNs assume more tasks and functions previously assumed by other disciplines, patient care activities are either reprioritized or omitted, leaving less nursing time allocated toward direct care activities (Hendrickson & Doddato, 1989; Sochalski, 2001; Williams & Murphy, 1979). Although it has been established that nurse staffing patterns are related to patient safety (American Nurses Association, 2000; Blegen et al., 1998; Kovner & Gergen, 1998), it is not known whether or how staffing patterns affect the amount of time RNs spend in direct and indirect care activities, and in turn, whether there is an association between where RNs spend their time and patient safety factors. In addition, the recent focus on quality in healthcare highlights the role that educational level and specialty training of the health care workforce may play in delivering quality healthcare (Institute of Medicine, 2001). Therefore, it is important to study how the distribution, structure, and utilization of the nursing workforce influences the amount and distribution of RN time spent on patient care activities and whether the amount of RN time spent in direct and indirect patient care explains the link between staffing patterns and patient outcomes. In addition, it is

important to explore whether educational level and specialty training of RNs are related to the amount of time spent on direct and indirect care and quality.

Purpose of the Study

The primary purpose of this study is to explore the effect of nurse staffing on the amount of RN time spent in direct and indirect care, and whether RN time spent in direct and indirect care influences the occurrence of adverse events. Further, this study will explore whether educational level of RNs, experience, and certification by specialty training is related to the amount of nursing time spent in direct and indirect patient care and adverse events.

Specific Aims

The specific aims of the study are as follows:

1. To examine the relationship between nurse staffing and the amount of time RNs spend in direct and indirect care on five inpatient units in an acute care hospital.
2. To examine whether nurse staffing and the amount of time RNs spend in direct and indirect care is related to adverse events on five inpatient units in an acute care hospital.
3. To determine whether educational level, length of nursing experience, and specialty certification status of nurses affects RN time spent in direct and indirect patient care and adverse events on five inpatient units in an acute care hospital.

Definition of Terms

The following terms are defined below and will be used consistently throughout the study. The study definitions are derived in part from their use in previous research and are accepted definitions in health services research.

Nurse Staffing

Nurse staffing includes the following three elements:

1. Total number of nursing personnel, defined as the total number of nursing personnel on an inpatient unit for each shift, including the number of registered nurses (RNs), Licensed Practical Nurses (LPNs), Aides (CNAs, NA), and Unit Secretaries (US) (American Nurses Association, 2000; Blegen et al., 1998; Kovner et al., 2000).
2. Nurse-to-patient ratio, defined as the number of patients assigned to a licensed nurse during a shift and is expressed as the ratio of licensed nursing personnel to the number of patients (American Nurses Association, 1995; Sochalski, 2001).
3. Two measures of skill mix were used. One measurement reflects the percent of licensed to nonlicensed personnel and is defined as the ratio of RNs and LPNs to unlicensed nursing staff (American Nurses Association, 1996). A similar measurement reflects the RN percent of licensed staff, defined as the ratio of RNs to LPNs (American Nurses Association, 2000).

Nursing Time

Nursing time is defined as the amount of electronically recorded time in minutes and seconds RNs spend in direct and indirect care on an inpatient unit during each shift. Direct and indirect care is defined as follows.

1. Direct care is defined as RN time electronically recorded in a patient room, in the hallway outside a patient room, in the medication room or at the narcotic medication cart.
2. Indirect care is defined as RN time electronically recorded in areas not related directly to care, such as the nurses' station, at the reception desk, or in the break room.

Adverse Events

As defined in the IOM report (Kohn et al., 1999), an adverse event is an injury not due to the underlying condition of the patient (p.3). It is conceptually defined as an unexpected injury or potential for injury that occurs during the care of the patient, is caused by care processes, rather than the underlying disease, and may adversely affect the costs of care and the health of the patient.

Staff Preparation

Staff preparation includes educational level, length of nursing experience, and certification status of all levels of nursing personnel on an inpatient unit.

1. Educational level is defined as the highest level of education in nursing attained by an RN on each inpatient unit, and is expressed as the distribution of educational preparation among RN staff (American Nurses Association, 1995).
2. Length of experience is defined as the length of time in years a nurse staff member has been employed in the nursing profession. If an RN originally entered the nursing profession as an LPN or aide, the total number of years will be added together and counted as total length of experience. If an LPN originally entered the nursing profession as an aide, the total number of years will be added together and counted as total length of experience. For nonlicensed staff, total length of experience will count as the total number of years employed as an unlicensed assistant. Length of experience is expressed as the distribution of educational preparation among the individual levels of staff (American Nurses Association, 1995).
3. Specialty certification status is defined as a formal, specialized training course that awards the participant with certification to document distinctive levels of practice after licensure (Cary, 2000). Examples include, but are not limited to, certification in oncology, medical-surgical, or orthopedic nursing; advanced cardiac life support, basic life support.

Significance of This Study

Given that there is an established relationship between nurse staffing and patient safety (American Nurses Association, 2000; Blegen et al, 1998; Kovner & Gergen, 1998), it is important to study how these variables are linked, and to examine the

mechanisms by which nurse staffing and patient safety are linked. This is particularly important when considering changes in the composition of the nursing workforce and the subsequent impact on the delivery of nursing care in acute care hospitals. Furthermore, it is imperative to establish how the composition of the nursing workforce influences patient safety. Although study findings consistently demonstrate a relationship between nurse staffing patterns and patient safety, these findings provide limited insight into how staffing patterns influence patient safety. This study proposes that staffing patterns impact the occurrence of error and adverse events by influencing the amount of time RNs spend in direct and indirect patient care activities. In turn, this study will examine whether errors and adverse events are lower when RNs spend more time on direct patient care activities. The findings from this study will provide insight into how hospital restructuring and reengineering efforts have affected one aspect of nursing care delivery: the distribution of RN time spent in direct and indirect patient care. With the current focus on systems and their effect on patient safety, these findings will add to the scientific literature that seeks to identify ways to enhance patient safety and reduce the incidence of error and adverse events. In this age of downsizing and restructuring, it is important to identify the impact of administrative decisions on the patients that hospitals and nurses serve. Another contribution of this study will be to test a new application of the Hill-Rom technology to study the affect of nurse staffing on distribution of RN time. The technology may demonstrate usefulness in other research studies where nurse staffing and patient safety issues are of concern, such as long-term care.

Chapter Summary

To summarize the discussion in Chapter One, the nursing workforce in acute care hospitals has undergone changes in supply, distribution, and utilization as a part of overall restructuring efforts hospitals have implemented to maintain cost efficiency and work productivity (Aiken et al., 2000). While there is scientific evidence that nurse staffing affects quality, patient safety, and patient outcomes (American Nurses Association, 2000; Blegen et al., 1998; Kovner & Gergen, 1998), the effects of re-engineering on quality, patient safety, and patient outcomes have not been tested, and therefore, are unknown (Buerhaus & Needleman, 2000; Wunderlich et al., 1996). Findings that structure, in the form of nurse staffing patterns, is associated with changes in outcomes can only be fully appreciated by understanding that structure causes changes in outcomes by virtue of its impact on the process of nursing. Thus, while study findings that link nurse staffing with outcomes are important, studies of the impact nurse staffing has on the process of nursing are vitally important in order to further elucidate the link between structure, process, and outcome.

CHAPTER 2

Review of the Literature

Chapter Overview

This chapter begins with a review of study findings that have examined trends in the supply, distribution, and utilization of the nursing workforce in acute care hospitals over the last 20 years. Since this time period coincides with the implementation of hospital restructuring, these findings shed light on the effects restructuring, and particularly re-engineering have had on the nursing workforce. Studies that have examined the impact of nurse staffing on patient outcomes in acute care hospitals are reviewed next. This will lead into a discussion of possible effects re-engineering has had on the types of activities in which nursing personnel engage, namely, the amount and distribution of nursing time spent on direct and indirect care, as well as the prioritization and completion of nursing tasks. Characteristics of nurses that may be relevant factors associated with quality of care are discussed within the context of studies that have examined these traits as they relate to delivery of nursing care and quality. The chapter ends with a discussion of the conceptual model used to guide this study and the hypotheses.

Criteria and Method for Selection of Research Literature

Methods of selection of studies included computerized searches of relevant databases, i.e., Medline 1966 through October 2001; Premedline; and the Cumulative

Index of Nursing and Allied Health Literature 1982 through December 2001. Computerized searches for well-known authors, who have a history of publishing in the areas of the nursing workforce, nurse staffing and patient outcomes, task performance, and nursing characteristics were conducted as well. In addition, ancestry searches of references cited in relevant journal articles identified pre-1966 studies. The following keywords were used as search terms: Nursing Workforce, Time Management, Task Performance, RN Mix, RNs, Nursing Staff/hospital and Quality of Nursing Care, Nursing Care and Patient Outcomes, Certification, and Professional Development.

Computerized searches were limited to research, acute care, and studies conducted in the United States. While many international research studies were located, the current study's focus is on nursing workforce issues within the context of a national health care system that is not subsidized totally by the government. Thus, while findings from international studies shed light on these very same issues from a global perspective, international health care environments, because of funding and other policy perspectives, may not parallel that of the United States, and thus are difficult to compare and interpret. The combined hand and electronic search for studies using the subject headings described previously yielded 243 studies. Of these, 83 were relevant and selected for review.

The Impact of Restructuring on the Nursing Workforce in Acute Care Hospitals

In the 1980's, hospitals began to notice the financial effects of governmental strategies, such as the Prospective Payment System (PPS) and Diagnosis Related Groups (DRG), designed to contain and control costs (Buerhaus & Needleman, 2000; Sochalski, Aiken, & Fagin, 1997). Hospital administrators responded by reducing excess capacity,

merging with other organizations, and decreasing hospital length of stay (LOS), as well as re-engineering the processes used to deliver patient care (Buerhaus & Needleman).

A key strategy that hospitals use to curtail costs is to reduce the cost of labor (Sovie, 1995) and reorganize the workforce (Sochalski et al., 1997). Over the last five years, several researchers have examined the effects of restructuring on the supply and distribution of the nursing workforce in hospitals. Findings demonstrate that although employment levels of RNs have risen, LPN employment has decreased, along with employment of aides (Aiken et al., 1996; Aiken et al., 2000; Buerhaus & Staiger, 1996, 1999; Kovner et al., 2000). The decreased numbers of support staff, LPNs and aides, weaken whatever effects may have been gained by increases in RN employment (Aiken et al., 1996, 2000). This, combined with the increasing acuity level of hospitalized patients is of concern as it relates to the overall effects of re-engineering on the nursing workforce and the ability to deliver quality care that is safe and effective.

The Current State of the Nursing Workforce in Hospitals

Aiken et al. (1996) examined hospital employment data in response to increasing concerns expressed by nurses, the media, and Congress that hospitals were reducing nurse staffing levels to the point that patient care and outcomes were adversely affected. Using the American Hospital Association's (AHA) Annual Survey data tapes 1981-1993, the researchers grouped employees by category: nursing, technicians, nonnurse administration, nonprofessional, and other professional. Though the category nursing contained total nursing personnel, the category did not differentiate between the levels of RN, LPN, and aides. Employment data specific to RN employment were drawn from the

AHA Hospital Statistics reports, also contained within the Annual Survey, and are reported as full-time equivalent (FTE) employees. Data were also drawn from the National Sample Survey of Registered Nurses, conducted every four years by the Bureau of Health Professions in the Division of Nursing. An acuity measure for each hospital contained within the AHA database was computed as the case-mix index, which was adjusted by the number of FTEs per hospital. This measure reflected the consumption of resources per patient for each hospital.

Aiken et al. (1996) found that nursing personnel, as a percentage of hospital employees, declined from 45% in 1981 to 37% in 1993. Moreover, while total hospital employment grew by 11.3% between 1981 and 1993, employment of nursing personnel actually decreased by 7.3% during the same period. However, data specific to RN employment demonstrated that the number of FTE RNs grew by 27.6%, calculated to represent an almost 30% increase in the RN-to-patient ratio. These findings then indicate that the 7.3% decrease in employment of nursing personnel primarily reflects losses of LPNs and aides, rather than registered nurses. Although a growth of 27.6% appears to be a significant increase in the numbers of RNs employed in acute care hospitals, when adjusted for case-mix, the percent change was 0.3, indicating almost no change in the RN-to-patient ratio in spite of the rising acuity of patients. This finding indicates that for the time period 1981-1993, when adjusted for case-mix, RN–to-patient ratio has essentially remained unchanged and is at the 1981 level. Therefore, RN employment has not kept pace with increasing patient acuity, RNs are working with less assistive staff, and care for patients that consume more resources. In combination with the decreasing numbers of support staff, these findings validate concerns that RNs are working harder

and with less staff. A more recent study by Aiken et al. (2000) finds similar results for the time period 1987-1997, where Medicare case-mix has more than tripled and the percent of RN positions has remained unchanged and even dropping off in 1996.

Other researchers have come to similar conclusions, finding that the employment trend for RNs is stable or increasing, while employment for LPNs and aides is decreasing (Buerhaus & Staiger, 1996, 1999; Kovner et al., 2000). One of the drawbacks to the studies by Aiken et al. (1996, 2000) is that the measurement of nursing personnel combined all levels of nursing into one variable. Later studies extended the work of Aiken and colleagues by differentiating between levels of nursing personnel, i.e., RN, LPN, and aides (Buerhaus & Staiger, 1996, 1999; Kovner et al., 2000).

Data from the Current Population Survey (CPS) Outgoing Rotation Group Annual Merge Files were examined for the years 1984-1994 (Buerhaus & Staiger, 1996) and 1983-1997 (Buerhaus & Staiger, 1999). These data contain information specific to the level of nursing; however, the CPS files do not distinguish between clinical and administrative positions (Buerhaus & Staiger, 1996), thereby combining RNs involved in both patient and nonpatient care. Findings from both studies demonstrated that hospital employment for RNs grew substantially. However between 1994-1997, the percent growth was minimal and seemed to be stabilizing (Buerhaus & Staiger, 1999). This finding validates that of Aiken et al. (2000), where in 1996, the percentage of RNs in acute care decreased. Between 1983-1997, Buerhaus and Staiger (1999) found a sharp decline in hospital employment for LPNs and aides. By 1994, only 40% of LPNs and 22% of aides were employed in hospitals, compared with 65% and 42% in 1984 respectively (Buerhaus & Staiger, 1996). However, the latest statistics for 1994-1997

show that the percentage of aides is increasing and is up 4.5 percent (Buerhaus & Staiger, 1999). Figure 1 displays the findings by Buerhaus and Staiger (1996; 1999); Figure 2 displays findings from Kovner et al. (2000).

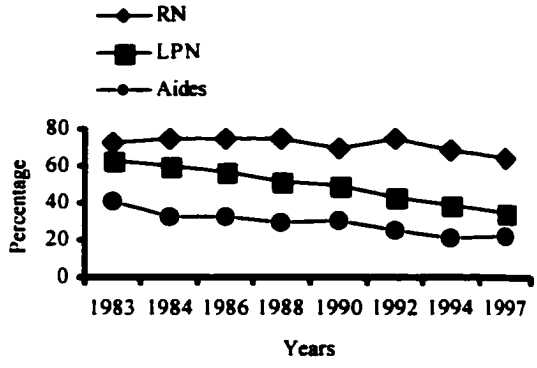


Figure 1. Change in nursing personnel as a percentage of all employed nursing personnel in hospitals, 1996 – 1997. Adapted from Buerhaus and Staiger, 1996, 1999.

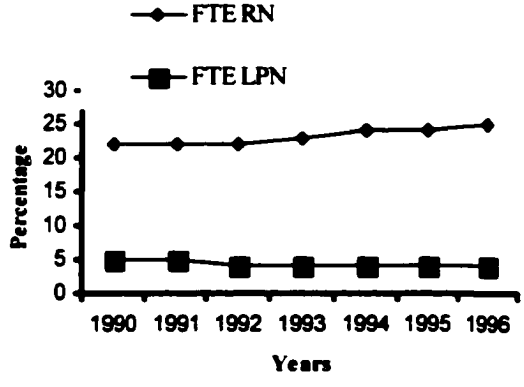


Figure 2. Change in nursing personnel as a percentage of total personnel in hospitals, 1990 – 1996. Adapted from Kovner, Jones, and Gergen, 2000.

In a recent examination of changes in the nursing workforce, Kovner et al. (2000) created a new variable, adjusted patient day, to reflect differences in productivity, staffing needs, and workload between inpatient and outpatient settings. Their findings validate those of Aiken et al. (1996, 2000) and Buerhaus and Staiger (1999), that as total hospital FTE employment increased 14%, RN FTEs increased 15%, while LPN FTEs decreased 14 percent. As concluded by Aiken et al. (2000), the finding that employment of LPNs has decreased suggests that the increase in RN staffing was offset by an almost exact decrease in LPN staffing. Even after adjusting these data for productivity, the findings are similar; RN hours per adjusted patient day increased and LPN hours per adjusted patient day decreased. Unfortunately, because after 1993 the AHA database no longer contains information specific to aides, the researchers were unable to identify trends in this important component of nurse staffing. However, if the trend identified by Buerhaus and Staiger (1999) in hospital employment of nursing assistants has continued, numbers of aides are increasing. Even so, as Kovner et al. point out, increased utilization of aides combined with the significant decline in the employment of LPNs may actually result in an increased workload for registered nurses because of the added responsibilities of supervising and delegating unlicensed staff.

Summary of the Impact of Restructuring on the Nursing Workforce

To summarize the previous section, studies have examined changes in the supply, distribution, and utilization of the nursing workforce over the preceding 20 years (Aiken, et al., 1996; Buerhaus & Staiger, 1996, 1999; Kovner et al., 2000). These findings demonstrate that although the percentage of RNs employed in acute care has risen, the

percentage of LPNs and aides has decreased exponentially. Thus, the advantages gained by the rise in RN employment may be weakened by the corresponding decline in the employment of LPNs and aides. In addition, research findings demonstrate that patient acuity has greatly increased over the last 20 years, indicating that hospitalized patients are more acutely ill, consume more resources, and require a higher intensity of nursing care Aiken et al., 1996, 2000). When the percentage of RNs is adjusted by case-mix, the documented increase in employment of RNs is minimal, indicating that the number of RNs has not kept pace with the increasing acuity of patients in acute care (Aiken et al., 2000). Thus, nursing workload and intensity of care requirements are higher than they were 20 years ago. Although it is documented that the supply, distribution, and utilization of nursing personnel have changed during the time of restructuring, what impact this has on quality and patient outcomes is still unknown.

Studies of Nurse Staffing and Patient Outcomes

The study of nurse staffing patterns and its association with outcomes has been examined over the last 40 years. Early studies examined nurse-staffing patterns as it related to satisfaction of nurses and patients (Abdellah & Levine, 1958; Aydelotte & Tener, 1960; New & Nite, 1960). Study designs were aimed toward discovering how best to optimize satisfaction of nursing personnel, as well as maximizing patient contact (Abdellah & Levine, 1958; Aydelotte & Tener, 1960; New & Nite, 1960; New, Nite, & Callahan, 1959). Early nursing shortages and the quest to improve recruitment and retention efforts were the driving force behind empirical efforts to improve upon nurse satisfaction. Researchers soon discovered that increasing the percentage of RNs did not

correspondingly increase nurse or patient satisfaction, and furthermore, nurses did not increase the amount of time devoted to patient activities (Abdellah & Levine, 1958; Aydelotte & Tener, 1960; New & Nite, 1960; New et al., 1959). Although these study findings did not offer solutions to the nursing shortage, researchers recognized that aspects related to the delivery of nursing care could affect perceptions of quality of care, from the standpoint of both nurses and patients. This realization changed how outcomes were defined, shifting the focus from the effect on nurses to the effect on patients. In addition, researchers theorized that nurse satisfaction was related to how effectively nurses could get their work done. Rather than examining the impact of staffing on satisfaction, studies now examined the impact on quality, fulfillment of tasks, and the order of task completion (Abdellah & Levine, 1958; Safford & Schlotfeldt, 1960; Williams & Murphy, 1979). Findings from these studies suggested that staffing patterns influenced the completion and ordering of tasks related to patient care.

Governmental controls and cost containment strategies were introduced and implemented in the 1980's, bringing about a shift in the types of outcomes that were studied. Studies now focused on the effects of cost containment strategies, such as the PPS and DRG system of reimbursement (Flood & Diers, 1988). In addition, hospitals were now conceptualized as providers of healthcare, and their characteristics were studied as they related to outcomes, both patient and hospital. As one of the many hospital characteristics, nurse staffing has been shown to have an inverse relationship with mortality (Aiken et al., 1994; Hartz et al., 1989; Pronovost et al., 1999; Shortell et al., 1994; Silber, Rosenbaum, & Ross, 1995a).

The release of the 1996 IOM report on the adequacy of nurse staffing in hospitals and nursing homes prompted a resurgence of research examining the role of nursing in quality of care and patient outcomes (Wunderlich et al., 1996). Research studied the relationships between nurse staffing and outcomes that were established as valid indicators of quality (Johantgen, Elixhauser, Ball, Goldfarb, & Harris, 1998) and believed to be nurse-sensitive (American Nurses Association, 1995). Study findings demonstrated a lower incidence of patient complications and adverse events in staffing patterns containing a higher percentage of RNs (Aiken, Sloane, Lake, Sochalski, & Weber, 1999; Aiken et al., 1994; American Nurses Association, 2000; Blegen, Goode, & Reed, 1998; Kovner & Gergen, 1998; Lichtig et al., 1999), although some findings contradicted this pattern (Silber et al., 1995b).

With the current focus on patient safety and medical error, the scientific community is examining how systems and processes of care impact patient safety (Kohn et al., 1999), signaling yet another shift in the study of outcomes and its relationship to nurse staffing. Rather than linking nurse staffing with specific outcomes or predicting outcomes from staffing patterns, researchers are beginning to design studies that examine which aspects of nursing care do staffing patterns affect, and in turn, how that is related to patient safety. Table 1 provides a historical overview of the shifts in outcomes studied as they related to historical developments in the evolution of health care.

Table 1

Evolution of Outcome Variables and Their Corresponding Historical Timeframes

Historical timeframe and study focus	Major study and first author	Staffing variable	Outcome variable
Nursing shortages			
1950 - 1959	Abdellah, 1958	Average daily hours of total nursing care	Perception of inadequacy of
Nurse satisfaction		Average daily hours of professional nursing	nursing service (dissatisfaction)
Inadequacy of services		care	
	New, 1959	Total number of nursing personnel	Satisfaction
		Proportion of professional to	
		nonprofessional nurses	
1960 – 1979			
Patient welfare	Aydelotte, 1960	Number of professional nursing staff	Patient welfare
Quality of care	Safford, 1960	Nurse-to-patient ratio	Quality of nursing care

Continued on next page

Table 1 (Continued)

Historical timeframe and study focus	Major study and first author	Staffing variable	Outcome variable
	Williams, 1979	Perceived staffing adequacy and inadequacy	Prioritization of categories of nursing care
Health care system restructuring			
1980 – 1999			
Hospital length of stay	Flood, 1988	Adequately and inadequately staffed units	Length of stay Patient complications
Nurse-sensitive indicators	American Nurses Association, 1997	Total nursing hours per adjusted patient day Percent RN hours per adjusted patient day	Length of stay Patient complications

Continued on next page

Table 1 (Continued)

Historical timeframe and study focus	Major study and first author	Staffing variable	Outcome variable
Patient outcomes	Blegen, 1998[a]	Total hours of care per patient day	Patient complications
Adverse events		Proportion of hours of care provided by RNs	Adverse events
	Blegen, 1998[b]	Total hours of care per patient day	Adverse events
		Proportion of hours of care provided by RNs	
	Kovner, 1998	Fulltime RNs per adjusted patient day	Postoperative complications
	American Nurses	Total licensed hours per adjusted day	Length of stay
	Association, 2000	Percent RN hours per adjusted day	Patient complications
2000-Present			
Medical error and patient safety	Sochalski, 2001	Nurse-to-patient ratio	Quality of nursing care
			Adverse events

[a]Blegen, Goode, and Reed, 1998; [b]Blegen and Vaughn, 1998.

The Development of Patient Outcomes

Quality of care is a nebulous and subjective concept, making it difficult to define and almost impossible to measure (Silber et al., 1995a). Because the outcome is the endpoint of care, patient outcomes have become proxies for measuring quality (Hammermeister, Shroyer, Gulshan, & Grover, 1995). As discussed in the preceding section, the definition and types of patient outcomes that have been studied in relation to nurse staffing have changed and evolved over the years. Moreover, recent technological developments have advanced the measurement of outcomes as larger, aggregated, and computerized databases have become available, thereby allowing access to information not previously accessible.

Two organizations have developed outcome indicators that serve as guidelines for the study of quality of care. In their *Nursing Care Report Card for Acute Care*, the American Nurses Association (ANA) first defined nursing quality indicators that were judged to be nurse-sensitive (American Nurses Association, 1995). The indicators are categorized to reflect outcome, process of care, or structure of care and are displayed in Table 2. The Agency for Healthcare Research and Quality (AHRQ) developed quality indicators (QI) using hospital discharge data (Johantgen et al., 1998). These indicators, displayed in Table 3, were designed to produce information on adverse outcomes of inpatient care that are preventable. The ANA and AHRQ indicators are the most commonly used indicators of quality in research.

Table 2

American Nurses Association Nurse-Sensitive Outcome Indicators

Mortality rate
Length of stay
Medication errors
Patient injury rate
Patient and family satisfaction
Patient adherence to discharge plan
Patient complications
Decubitus ulcer rates
Nosocomial infection, including surgical wound infection
Nosocomial urinary tract infection
Nosocomial pneumonia

Table 3

Agency for Health Care Research and Quality Outcome Indicators

In hospital mortality following common elective procedures:
Hysterectomy
Laminectomy/spinal fusion
Cholecystectomy
Transurethral resection of prostate
Hip replacement
Knee replacement

Continued on next page

Table 3 (Continued)

Coded complications:
Obstetrical
Wound
Adverse effects and iatrogenic complications
Complications among surgical patients:
Pulmonary compromise after major surgery
Acute myocardial infarction after major surgery
Gastrointestinal hemorrhage or ulceration after major surgery
Venous thrombosis or pulmonary embolism after major surgery/invasive vascular procedure
Mechanical complications due to device implant, or graft, excluding organ transplant
Urinary tract infection after major surgery
Pneumonia after major surgery/invasive vascular procedure

Studies Examining the Effects of Nurse Staffing on Patient Outcomes

Mortality Rates

Although the measure is not without controversy (American Nurses Association, 1995), hospital mortality rates have been widely studied both as indicators of hospital quality and as they relate to nurse staffing. However, most groups caution against direct inferences about quality from mortality rates (Johantgen et al., 1998). As Buerhaus and Needleman (2000) discuss, mortality as well as complications, is associated with nurse

staffing and patient characteristics. Therefore, mortality alone should not be considered the sole or most important indicator of quality. Nevertheless, mortality rates have been shown to be associated with nurse staffing.

In studies describing the relationships between multiple hospital characteristics and mortality, nurse staffing as a hospital characteristic, has been shown to have a significant and negative association with mortality (Hartz et al., 1989; Pronovost et al., 1999; Silber et al., 1995a). However, in their study of patients undergoing coronary artery bypass graft procedures, Silber et al., (1995b) found that the relationship with nurse-to-bed ratio was predictive of expected or better than expected death rates. These results were not significant.

Studies that have specifically examined nurse staffing as it relates to mortality have found conflicting results. Blegen, Goode, and Reed (1998) examined death rates in 42 inpatient units, including general, specialty, and intensive care units. Nurse staffing was measured as the proportion of hours of care delivered by RNs and total hours of nursing care. The multiple regression models for both measures of staffing showed no relationship with mortality. However, by statistically estimating the slope for proportion of hours of care delivered by RNs greater than 87.5, the relationship with mortality became positive and significant. Although this finding intuitively does not make sense, that is, more RNs should produce lower mortality rates, it may be a reflection of a particular staffing pattern. Units that have a very high percentage of RNs may also have less numbers of support staff, such as aides and unit secretaries. On these units RNs may be performing more nonnursing tasks that typically would have been carried out by the aide or unit secretary, removing the RN farther away from patient care activities such as

monitoring and surveilling patient status, as well as recognizing when interventions are warranted. Subtle signs that a patient is dangerously deteriorating may not be noticed until it is too late to intervene. A second explanation for this counterintuitive finding is that acuity and death were highly correlated ($r = .593, p < .05$), as were RN proportion and acuity ($r = .559, p < .05$). In other words, units with high acuity were staffed with a higher percentage of RNs and also had higher death rates, a reasonable expectation in a unit with high acuity patients.

In their ongoing program of research, Aiken and colleagues (1994, 1999, 2000) have studied RN staffing as it relates to mortality rates. Aiken et al. (1994) matched 39 magnet hospitals with 195 control non-magnet hospitals to examine differences in 1988 mortality rates among hospitalized Medicare beneficiaries. Magnet hospitals are known for their good nursing care and were chosen as the experimental group because of their higher ratings by nurses on measures of status, control, and autonomy. Data on Medicare mortality were gathered from the Health Care Financing Administration (HCFA) Medicare hospital mortality rate file, data on hospital characteristics were gathered from the AHA annual survey of hospitals. The nurse staffing variables were RNs per average daily census, which is a measure of the RN-to-patient ratio, and RNs per total nursing personnel, a measure of the proportion of RNs to all nursing personnel. Both nurse-staffing measurements were higher in the magnet hospitals and Medicare mortality rates, adjusted for predicted mortality, were lower in the magnet hospitals. Although in this study, magnet hospitals employed both more RNs per patient and as a percentage of all nursing personnel, the researchers attributed the differences in Medicare mortality, not to the differences in RN staffing, but to higher status, autonomy, and control over practice.

Aiken et al. concluded that although nurse staffing is better in magnet hospitals, it is by virtue of the organization and the organizational climate of magnet hospitals that produce lower Medicare mortality rates.

The findings of higher nurse-to-patient ratios, as well as organizational differences in magnet hospitals have been replicated in other studies. Aiken et al. (1999), in their study of 1995 thirty-day mortality rates in the inpatient AIDS population, found that the odds of dying were significantly lower in units staffed with a higher nurse-to-patient ratio. These differences were found for both dedicated AIDS units and scattered-bed units in magnet hospitals, as compared to scattered-bed units in non-magnet hospitals with and without dedicated AIDS units. In this study, nurse control over practice was not a significant predictor of the odds of dying. Aiken et al. (2000) found similar results using 1997 Medicare death rates for the same group of inpatient units in their 1999 study. Here, the researchers found a strong negative relationship between RNs per average daily census and mortality. Table 4 provides the statistical findings from these studies.

Table 4

The Effect of Nurse Staffing on Mortality

Authors	Definition of nurse staffing	Statistic	*p* value
Silber, Rosenbaum, and Ross (1995a)	RN-to- bed ratio	r = - .38	.03
Silber, Rosenbaum, Schwartz, Ross, and Williams (1995b)	RN-to- bed ratio	OR – 1.04 CI – .92-1.19	ns
Blegen, Goode, and Reed (1998)	All hours direct patient care	B = .361	ns
	RN hours direct patient care	B = - .284	ns
	% RN hours > 87.5	B = .316	< .05
Pronovost et al. (1999)	RN-to-patient ratio	OR – 1.9 CI – 1.2-3.0	< .05
Aiken, Sloane, Lake, Sochalski, and Weber (1999)	RN-to-patient ratio	OR – 0.43 CI - .24-.78	< .01
Aiken, Clarke, and Sloane (2000)	Ratio of FTE RN positions to average daily census	r = - .49	.02

Note. OR = odds ratio; CI = confidence interval; ns = not significant; FTE = fulltime equivalent.

Hospital Length of Stay

Implementation of the PPS and the DRG method of reimbursement have focused attention on hospital length of stay (Marchette & Holloman, 1986). The amount of time patients spend in a hospital is a recognized measure of quality. Longer lengths of stay are

associated with higher utilization of resources (American Nurses Association, 1995), and the incidence of complications (Silber et al., 1999). Table 5 summarizes findings from research that studied the effect of nursing staffing on hospital length of stay.

Table 5

The Effect of Nurse Staffing on Length of Stay

Authors	Definition of nurse staffing	Statistic	*p*
Flood and Diers	Inadequately staffed inpatient units		
(1988)	Gastrointestinal hemorrhage	t = 1.86	< .05
	Respiratory infection	t = - 0.26	ns
	Cerebrovascular disorders	t = 1.604	.10
Lichtig, Knauf, and	Total nursing hours/adjusted day[a]	ß = - 4.40 to -6.5	< .05
Milholland (1999)	% RN hours/adjusted patient day[a]	ß = - .07 to - .19	< .05
American Nurses	Licensed hours/adjusted patient day	ß = - 1.4	< .05
Association (2000)	% RN hours/adjusted patient day	NR	

Note. ns = not significant; NR = no relationship.

[a]all four data sets.

Comparing inpatient units that were adequately and inadequately staffed over a three-month period, Flood and Diers (1988) found a statistically significant shorter LOS for one of six DRG categories. Adequacy of staffing was determined by examining the match between staffing data for each unit compared to the required level of staffing. On the inadequately staffed unit, the average LOS was 9.49 days compared to 8.56 days on

the adequately staffed unit. No test of significance was performed for this difference. When the researchers examined LOS by DRG, they found a significant difference for GI hemorrhage, with a mean LOS on the inadequately staffed unit of 9.17 days, as compared to a mean LOS of 5.37 days on the adequately staffed unit. Although the inadequately staffed unit had a higher number of complications, inadequate staffing was the explanation for the longer length of stay. Tests of significance were not done for the difference in complication rates between the two units. The researchers reasoned that a minimally staffed unit would be less likely to deliver safe care and meet patients' needs, thereby increasing the potential for development of complications.

There are a number of problems with the design and methodology of this study. As the researchers point out, the definition of adequate versus inadequate staffing was not standardized or quantified. In addition, nurse staffing is defined as total number of nursing personnel, the assumption being that the mix of personnel remained the same throughout the timeframe of the study. The findings would have had more meaning if the particular changes in day-to-day mix of nursing personnel were included in the design, particularly as it related to the rate of complications. Finally, it is likely that LOS and complications are related concepts; therefore, multicollinearity becomes a problem in explaining the contribution of nurse staffing versus complications to length of stay. These findings would have provided a more meaningful explanation of the relationships between the variables had the researchers performed higher-level statistical analyses. Doing so would have allowed the researchers to determine the unique contribution of nurse staffing and complications to length of stay. Although there are some issues with

this study's design and methodology, it is one of the first studies to relate nurse staffing to length of stay and complications.

The ANA considers LOS to be an indicator that is sensitive to nursing care and continues to study LOS as it relates to nurse staffing (American Nurses Association, 1995, 2000, Lichtig et al., 1999). One of the first studies to use large public databases as the sampling frame, Lichtig et al. examined the Annual Hospital Disclosure Report from California, 1992-1994 and the Institutional Cost Reports from New York for the same time period. The total sample consisted of 478 hospitals in 1992 and 426 in 1994. This study defined nurse staffing as: (a) the percentage of RN hours to total nursing hours (skill mix) and (b) the total nursing hours per Nursing Intensity Weight (NIW) -adjusted patient day (staffing level). The NIW allows for differences in patients' acuity of need for nursing care and is a measure of nursing intensity. Both staffing measures were associated with LOS, that is, more nursing hours per NIW and a higher percentage of RN hours were significant predictors of a shorter length of stay ($p < .05$). The ANA expanded this study using 1996 data from nine states (American Nurses Association, 2000). In this sample, only licensed hours per NIW-adjusted day showed a significant inverse relationship with LOS, no relationship was established for the percent of RN hours to total nursing hours.

Complications

Although mortality rates may serve as gross indicators of quality, it is difficult to detect statistical differences in mortality rates given the low rates of occurrence. Complication rates, as another indicator of quality, are more common and it would be

reasonable to expect more complications in hospitals with worse quality of care (Silber et. al., 1995b). In addition, development and prevention of complications are more directly associated with nursing care, and therefore, more nurse-sensitive (American Nurses Association, 2000). In the patient safety literature, complications are defined as adverse events (Kohn et al., 1999), some of which may be the result of error. Adverse events as they relate to nurse staffing are reviewed next.

Decubitus ulcer. Also referred to as pressure ulcers, the occurrence of decubitus ulcer partially reflects the availability and quality of nursing care, given that skin assessment and implementing interventions to prevent pressure ulcer formation is a basic nursing function (American Nurses Association, 1995). Since the ANA established decubitus ulcer formation as a nurse-sensitive indicator, several studies have found that a higher percentage of RNs is predictive of a lower incidence of pressure ulcers (American Nurses Association, 2000; Blegen et al., 1998; Lichtig et al., 1999). Table 6 summarizes research findings for the effect of nurse staffing on decubitus ulcer formation.

Using the same data sets described in the previous section, Lichtig et al. (1999) found that the percent of RN hours was a strong predictor of lower rates of decubitus ulcer across all four data sets (New York, 1992, 1994 and California, 1992, 1994). In fact, each additional percentage point of RNs was associated with a reduction in the rate of decubitus ulcer. Furthermore, in the New York 1992 and California 1994 data sets, the total nursing hours per NIW was associated with lower rates of decubiti. For both staffing measures, the ANA (2000) study found significant relationships between skill mix and total number of licensed hours.

Table 6

The Effect of Nurse Staffing on Decubitus Ulcer

Authors	Definition of nurse staffing	Statistic	*p*
Lichtig, Knauf, and	Total nursing hours/adjusted day[a]	ß = - 17.89	< .05
Milholland (1999)	% RN hours/adjusted day[b]	ß = - .79 to -1.7	< .05
American Nurses	Licensed hours/adjusted day	ß = - 2.65	< .05
Association (2000)	% RN hours/adjusted day	ß = - .47	< .05
Blegen, Goode, and	All hours direct patient care/day	ß = .413	ns
Reed (1998)	RN hours direct patient care/day	ß = - .485	< .05
	% RN hours > 87.5	ß = .379	ns

Note. ns = not significant. All nurse staffing hours are per adjusted patient day.

[a]New York 1992 dataset.

[b]New York 1992, 1994; California 1992, 1994.

In their study of 42 acute care inpatient units, Blegen et al. (1998) found that the rate of decubitus ulcer was lower in units with a higher proportion of RNs, but found no relationship with all hours of care. Again, as with their finding for death rate, the direction and strength of the relationship for skill mix reversed when the proportion of RNs was estimated to be greater than 87.5 percent. The researchers' discussion pertaining to staffing patterns that include high percentages of RNs is relevant here as well. Attending to nonnursing activities may have resulted in less patient contact and less time spent on direct patient care activities, thereby affecting the basic nursing functions that include initial and ongoing skin assessment.

Infection rates. Preventing the spread of infection, identifying patients at risk for postoperative infection and implementing interventions are basic nursing functions. Basic hygiene is a fundamental nursing practice and is considered the most effective guard against infection (American Nurses Association, 1995). Aseptic and sterile technique is vital when nurses perform invasive procedures. Therefore, the incidence of infection can be expected to reflect safe practice and high quality nursing care. Several studies have examined the relationship between nurse staffing and infection rate, with inconsistent findings. Table 7 summarizes research findings as discussed in the next section.

Table 7

The Effect of Nurse Staffing on Infection Rates

Authors	Definition of nurse staffing	Statistic	*p*
UTI			
Lichtig, Knauf, and	Total nursing hours PAPD	NR	
Milholland (1999)	% RN hours PAPD	ß - .65	<.05
American Nurses	Licensed hours PAPD	NR	
Association (2000)	% RN hours PAPD	ß = - .61	<.05
Kovner and Gergen	FTE RNs PAPD	ß = - 637.	<.05
(1998)			
Postoperative infection			
Lichtig, Knauf, and	Total nursing hours PAPD	NR	
Milholland (1999)	% RN hours PAPD	ß = - .47 to -.53	<.05

Continued on next page

Table 7 (Continued)

Authors	Definition of nurse staffing	Statistic	*p*
American Nurses	Licensed hours PAPD	ß = - .89	< .05
Association (2000)	% RN hours PAPD	ß = - .38	< .05
Nosocomial infection			
Archibald, Manning,	Ratio of monthly nursing hours	r = - .77	.003
Bell, Banerjee, and	to patient day		
Jarvis (1997)			
Respiratory and UTI			
Blegen, Goode, and Reed	All hours direct patient care	ß = .458	ns
(1998)	PPD		
	RN hours direct patient care	ß = -.242	ns
	PPD		

Note. UTI = Urinary tract infection; NR = no relationship; FTE = Fulltime equivalent; PAPD = per adjusted patient day; PPD = per patient day.

Infection rates have been defined as nosocomial or postoperative. The most common sites of infection studied are: urinary tract (American Nurses Association, 2000; Archibald et al., 1997; Blegen et al., 1998; Kovner & Gergen, 1998; Lichtig et al., 1999), wound (American Nurses Association, 2000; Archibald et al., 1997; Lichtig et al., 1999), and respiratory (American Nurses Association, 2000; Archibald et al., 1997; Blegen et al., 1998; Lichtig et al., 1999). Pneumonia is often studied apart from respiratory infections (American Nurses Association, 2000; Kovner & Gergen, 1998; Lichtig et al.,

1999). In general, the most consistent findings have been those that relate a higher percentage of RNs to a lower incidence of infection, as compared to findings for total number of personnel, where findings are mixed or not statistically significant.

Urinary tract infections (UTI) have been the most studied, most likely because of the role sterile technique plays in preventing infection in this procedure most commonly carried out by licensed nurses. As an ANA established nurse-sensitive indicator, the incidence of UTI has been an outcome studied in relation to nurse staffing in both ANA studies (American Nurses Association, 2000, Lichtig et al., 1999). Both studies found no relationship between nursing hours per NIW, while the percentage of RNs was associated with a lower rate of UTI across all samples, except the New York 1992 sample. In fact, each additional percentage of RNs was associated with a 0.65% lower UTI rate (Lichtig et al.). Kovner and Gergen (1998) had similar results in their study of 506 hospitals using 1993 data from the AHA Annual Survey of Hospitals matched with discharge data from the Nationwide Inpatient Sample (NIS). For postoperative UTI, they found a lower incidence was predicted by a higher number of FTE RNAPD. Furthermore, an increase of 0.5 RN hours per adjusted patient day was associated with a decrease of 4.5% in the rate of urinary tract infection.

Several studies have combined multiple infection sites into a single category of infections (American Nurses Association, 2000; Archibald et al., 1997; Blegen et al., 1998; Lichtig et al., 1999). Defining post operative infection as any secondary diagnosis of infection in surgical patients, Lichtig et al. found no relationship with total nursing hours per NIW across the four data sets, while only the 1992 and 1994 California data sets had significant and negative relationships with the percentage of RN hours. The

ANA (2000) study found more consistent results, with both a higher percentage of RN hours and total nursing hours per day predicting lower rates of infection. Archibald et al. examined rates of nosocomial infections in a pediatric cardiac intensive care unit. Nosocomial infections were defined by the Center for Disease Control criteria and gathered by review of patient records, microbiology and infection control records. The nurse staffing variable was defined as the total number of hours per patient day worked by intensive care RNs each month. The study was conducted over 12 months. They found a significant inverse relationship between nurse staffing and the incidence of nosocomial infections.

While these studies found that nurse staffing variables were strong predictors of infection rates, Blegen et al. (1998) found no relationships between both nurse staffing variables and infection rates. Given that acuity was significantly correlated with infections ($r = .551, p < .05$), this finding is surprising. Reducing the infection variable by combining urinary and respiratory into one variable may have diluted any effect nurse staffing may have had on these two infection sites. Even so, in the studies reviewed above, the effect of staffing on infection rates was apparent.

Pneumonia. Three studies have examined the impact of nurse staffing on the incidence of pneumonia (American Nurses Association, 2000; Kovner & Gergen, 1998; Lichtig et al., 1999). Table 8 provides a summary of these studies. Results from the ANA and Lichtig et al. studies were similar, that is, significant relationships were found for the percent of RN hours, while no relationship was found for the total number of nursing hours. Specifically, the ANA study found that a higher percentage of RN hours predicted

lower rates of pneumonia, while Lichtig et al. found a lower rate of pneumonia in the 1992 and 1994 California data sets. Kovner and Gergen studied pneumonia coded as occurring after a major surgical procedure. In this study, they found that FTE RNAPD strongly predicted lower rates of pneumonia, and that a 4.2% decrease in pneumonia was associated with a 0.5 increase in FTE RNAPD. Findings that have consistently demonstrated a significant relationship between a higher percentage of RNs in the staffing mix and pneumonia rates validate the important contribution of RNs to patient outcomes. Given that postoperative respiratory exercises, such as coughing and deep breathing and use of incentive spirometry are nursing interventions implemented by RNs to prevent pneumonia, these findings are not surprising.

Table 8

The Effect of Nurse Staffing on Pneumonia

Authors	Definition of nurse staffing	Statistic	*p*
Lichtig, Knauf, &	Total nursing hours PAPD	ns	
Milholland (1999)	% RN hours PAPD[a]	ß = - .39 – ˙.56	< .05
American Nurses	Licensed hours PAPD	ns	
Association (2000)	% RN hours PAPD	ß = - .29	< .05
Kovner and	FTE RNs PAPD	ß = - 159.41	< .05
Gergen (1998)			

Note. ns = not significant; FTE = Fulltime equivalent; PAPD = per adjusted patient day.

[a]Represents data for the California 1992, 1994 datasets.

Adverse Events

Medication errors. According to Leape et al. (1991), adverse drug events are the most common type of iatrogenic injury in hospitals. It is estimated that 38% of medication errors are nursing related (Leape et al., 1995). From their ongoing research, Mark, Salyer, and Wan (2000) report preliminary findings where skill mix was associated with higher rates of medication errors (.23, *p* value not reported). As displayed in Table 9, Blegen et al. (1998), in their study of 42 inpatient units found a significant and inverse relationship between RN proportion of nursing hours and rate of medication errors, but no relationship for total hours of nursing care. Blegen and Vaughn (1998) studied rate of medication errors in 24 inpatient units over a period of 36 months. Although they too found that RN proportion predicted a lower rate of medication error, total hours of nursing care were related to a higher rate of medication errors. Given that RNs are directly responsible for medication administration, it is likely that total hours of nursing care, would have no effect on rates of medication error.

Table 9

The Effect of Nurse Staffing on Medication Errors

Authors	Definition of nurse staffing	Statistic	*p* value
Blegen, Goode, and	All hours direct patient care per patient day	ß = - .202	ns
Reed (1998)	RN hours direct patient care per patient day	ß = - .525	< .05
	% RN hours > 87.5	ß = .556	< .05
Blegen and Vaughn	All hours direct patient care per patient day	ß = .497	< .05
(1998)	RN hours direct patient care per patient day	ß = - .576	< .05
	% RN hours > 87.5	ß = .483	< .05

Note. ns = not significant.

Patient falls. Extensive scientific literature documents that patient falls are related to nurse staffing, however, the bulk of these findings are in the geriatric and long-term care literature (Rubenstein, 2000). Studies that examine the incidence of falls in acute care as it relates to nurse staffing are lacking. Two recent studies have examined falls in acute care as they related to nurse staffing (Blegen et al., 1998; Blegen & Vaughn, 1998). Both studies found no relationship with total hours of nursing care, while only study findings by Blegen and Vaughn found that a higher percentage of RNs in the staff mix predicted a lower rate of falls. Preliminary findings from Mark et al. demonstrated that a higher percentage of RNs was associated with a higher incidence of falls (.21, *p* value not reported). Like medication errors, documentation of the occurrence of falls is gathered by incidence reports. It is known that the actual rate of medication errors and falls are grossly underreported (Kohn et al., 1999). Relationships have been more easily established in long-term care environments, and are likely because falls in the elderly result in injury requiring hospitalization (Rubenstein, 2000) and federal guidelines mandate reporting of these events. Therefore, these data are more readily available and may explain the lack of findings relating nurse staffing to medication errors and patient falls in acute care, where so far, reporting is not federally mandated.

Other Quality Indicators

The outcomes reviewed thus far are those that were developed as part of the ANA project (American Nurses Association, 1995) to identify outcome indicators that are sensitive to nursing. To date, the ANA developed outcomes have been most studied as they relate to nurse staffing. Other than post surgical mortality rate, the quality indictors

developed by the AHRQ have been least studied as they relate to nurse staffing. Kovner and Gergen (1998), in addition to examining selected ANA nurse-sensitive indicators, also examined the relationship of nurse staffing to DVT or PE after major surgery or after invasive vascular procedure, pulmonary compromise after major surgery, acute myocardial infarction (MI) after major surgery, GI hemorrhage after major surgery, and mechanical complications secondary to device, implant, or graft, excluding organ transplant. In their study of 506 hospitals, they found that a lower occurrence of some adverse events was predicted by the staffing variable. Specific findings include those for DVT ($\beta = -33.22, p < .01$) and pulmonary compromise ($\beta = -59.69, p < .05$). No relationships were found for the remaining outcomes. They were also able to estimate that by adding 0.5 RN hours per patient day, the incidence of DVT decreased by 2.6%, as well as a 1.8% decrease in pulmonary compromise. These study findings are important and add to the scientific literature by identifying specific patient conditions of which the outcome may be sensitive to nurse staffing and nursing care.

Summary of Findings for Studies of Nurse Staffing and Outcomes

In summary, inverse relationships have been found between nurse staffing patterns and patient outcomes. The strongest relationship is for skill mix, the percentage of RNs in the mix of nursing personnel. The most consistent findings have been for those studies that have examined these relationships using samples drawn from large, federal databases (Aiken et al., 1994, 2000; American Nurses Association, 2000; Kovner & Gergen, 1998, Lichtig et al., 1999). These studies have found that a higher percentage of RNs in the skill mix was a strong predictor of lower mortality (Aiken et al.), shorter LOS (American

Nurses Association; Lichtig et al.), and lower rates of patient complications (American Nurses Association; Kovner & Gergen, 1998; Lichtig et al.). Findings from studies with smaller samples using local databases were more mixed, particularly for the relationships between skill mix, medication errors, patient falls, and death rates (Blegen et al, 1998; Blegen & Vaughn, 1998).

All studies, regardless of the sample source or size, have found mixed and conflicting results when examining the relationships between total number of nursing personnel and patient outcomes. These studies have found either strong positive relationships with pneumonia (Lichtig et al., 1999) and medication errors (Blegen & Vaughn, 1998), or no relationship with pneumonia (American Nurses Association, 2000) or infections (American Nurses Association; Blegen et al; Blegen & Vaughn; Lichtig et. al.). It is not known why total number of nursing personnel is not as consistently linked to patient outcomes as is skill mix. Because studies have not differentiated RNs, LPNs, and aides in the count of total staff, the variable may not be sensitive enough to reflect the unique contribution of each level of nursing personnel to the dependent variable in the equation.

In addition, though Aiken and colleagues (1994, 2000) have consistently found in magnet hospitals lower mortality rates, as well as higher proportions of RNs and higher nurse-to-patient ratios, they maintain that it is the organizational climate in magnet hospitals that explains the differences in mortality and not so much the higher skill mix or nurse-to-patient ratios. However, other studies that may or may not have included magnet hospitals in their sample have similar findings in respect to mortality rates, apart from considering the contribution of the organizational climate.

Although a higher proportion of RNs in the skill mix is generally associated with improved patient outcomes, as demonstrated by Blegen et al. (1998) and Blegen and Vaughn (1998), there may be a point where the strength and direction of these relationships is reversed. These studies found that when the percentage of RNs was greater than 87.5, significant relationships were no longer significant or were predictive of higher rates of complications. As discussed earlier, this finding may actually reflect staffing patterns where a high percentage of RNs is combined with lower numbers of support staff, thereby leaving RNs responsible for nonnursing tasks normally assigned to aides and unit secretaries. Nevertheless, this is only an educated guess and has not been tested by scientific study.

Finally, although it is known that the percentage of RNs in the skill mix, and to a lesser extent, total numbers of nursing personnel, is related to patient outcomes, these studies do not answer the question of how different configurations of staffing patterns affect patient outcomes. In other words, is the process or the delivery of nursing care affected to the extent that patient outcomes are better or worse, and in what way is the delivery of nursing care affected? This next step in the study of nurse staffing and the impact on patient outcomes is crucial. Unless it is understood how staffing patterns affect patient outcomes, responsible management and administrative decisions will not maximize nursing personnel in order to optimize patient outcomes.

Effect of Nurse Staffing on Delivery of Patient Care

Patient and Nurse Satisfaction

The early research on nurse staffing patterns examined the effect of increasing the number of RNs on patient and nurse satisfaction, the aim being that by improving upon satisfaction, retention and recruitment of nurses would increase. Abdellah and Levine (1958) hypothesized that nurse dissatisfaction centered on feelings of inadequacy of nursing services rather than not having enough RNs in the nursing staff. Their premise was that the proliferation of patient services, coupled with the increasing complexity of those services translated into more responsibility for the nurse, leading to feelings that the delivery of nursing services was inadequate. Because nurses were feeling that they were not delivering care as effectively as they could, satisfaction with nursing care diminished. And because nurses were dissatisfied, this negativity was transferred to their patients, who also became dissatisfied with nursing services. Like Abdellah and Levine, New and Nite (1960) believed the issue was one of utilization of nursing personnel and that some staffing patterns were more conducive to maximizing the use of nursing staff. Registered nurses would better utilize their time and allocate more of their time to direct patient care activities when the staff mix contained higher numbers of registered nurses. As a result of more nursing time spent on direct patient care, nurse and patient satisfaction would increase. Although findings from both studies were mixed and inconclusive, researchers found that nurses utilize their time differently as the staffing patterns change and that some areas of nursing care delivery are more affected than others.

New and Nite (1960) hypothesized that the introduction of more staff nurses would result in more nursing time spent with patients and an increase in nurse and patient

satisfaction. This study examined a variety of different staffing ratios, ranging from a low to high proportion of professional nurses to nonprofessional staff. A low proportion was defined as a staffing ratio with 25% of RNs in the mix; medium proportion was a ratio with 50% of RNs, and a high proportion was defined as a ratio of 75% of RNs in the skill mix. Nonparticipant observers recorded the amount of time all members of the nursing staff on four medical and surgical units spent on various activities. Results showed that as the number of RNs in the staff mix increased, the average amount of time RNs spent with patients did not increase, remaining at an average of 35 percent. However, the amount of nursing time per patient did increase. For example, an average of 22% of nursing time was devoted to each patient when the staffing pattern contained a 25% mix of RNs. When the RN percentage increased to 75%, RNs devoted on average 70% of their time to each patient. Although RNs did not increase the average amount of time spent on patient care, as the number of RNs increased, they did increase the amount of time devoted to each patient, suggesting that the RNs utilized their time differently depending on the number of RNs, and that when the percentage of RNs is higher, RNs may allocate more time to some patients. The addition of more RNs to the skill mix did not increase nurse satisfaction, in fact, nurses reported higher levels of dissatisfaction. The effect on patient satisfaction was minimal. Patients reported high levels of satisfaction regardless of the percentage of RNs in the skill mix.

Abdellah and Levine (1958) believed that hospitals perceived a shortage of nursing personnel because nurses were assuming more responsibilities and the responsibilities were becoming more complex and complicated, resulting in higher workloads and more patients that required a higher intensity of services. Nurses were then unable to deliver

adequate nursing services and the higher the inadequacy of services, the greater the patient dissatisfaction with nursing care. These researchers studied the effect of differences in the average daily hours of professional and nonprofessional nursing care on patients' perceived inadequacy of nursing services. Inadequacy of services, which served as a proxy for dissatisfaction, was measured with a 50-item instrument containing patient needs or unpleasant events that could conceivably occur during a hospital stay and were not fulfilled by the nursing staff. The unfulfilled needs and unpleasant events were grouped into three clusters: unfulfilled dietary needs, incidents that disturbed patients' rest, and need for therapy not met satisfactorily. Respondents were asked to indicate those needs that had been unfulfilled or unpleasant events they had experienced. For each of the 57 hospitals in the sample, one study day was assigned to each, during which all patients able to were asked to complete the instrument, generating a total of 8,660 usable patient responses. The researchers found that the strongest relationship was between the hours of professional nursing care and patient scores on unfulfilled needs ($p < .01$). In other words, as hours of professional care decreased, patients were more likely to notice when aspects of nursing care were omitted or unfulfilled and their dissatisfaction increased. No relationship was established for total hours of nursing care and unfulfilled needs.

The most interesting finding from this study is that specific nursing services were more affected than others when hours of nursing care decreased. Patients' need for therapy was most strongly related to professional hours of care ($p < .01$), unfulfilled rest needs were also strongly related to professional hours of care ($p < .05$). No relationship was established between patients' unfulfilled dietary needs and hours of care. Because

therapy needs, and to a lesser extent, rest needs are the direct responsibility of professional nurses, it is important to note that these categories of care are most likely to be noticed as being inadequate when hours of professional care are less. Furthermore, the fact that the areas where RNs have the most dominant role are the very same categories that were most adversely affected points to the potential impact on patients. These findings suggest that as nursing care hours delivered by RNs decrease, the adequacy of nursing services that are directly related to patient care suffers.

This study is important because the findings provide insight into which aspects of nursing care are affected by differences in the available hours of professional nursing care. Furthermore, this study begins to delineate which aspects of nursing care fall into the realm of nursing and nonnursing responsibilities and which aspects of nursing care are most likely to be omitted or unfulfilled when less hours of professional nursing care are available. By identifying how differences in staffing patterns affect patient care, specifically which aspects of patient care are affected; researchers are better able to describe how staffing patterns affect the quality of patient care.

Components of Nursing Care and Quality

The above reviewed study findings have been inconclusive in terms of the effect of nurse staffing on patient and nurse satisfaction. Even so, Abdellah and Levine (1958) demonstrated that available hours of professional nursing care made a difference in the types of services nurses were able or unable to deliver. Researchers no longer were directing their efforts at determining how nurse staffing could increase satisfaction. Now that scientific evidence established that staffing patterns influenced the delivery of

nursing care and were associated with meeting patient needs, the research focus shifted to the effect of staffing patterns on quality of nursing care.

Safford and Schlotfeldt (1960) tested their hypothesis that quality of nursing care decreased when the nurse-to-patient ratio increased. In this study, quality of nursing care was defined as the performance of nursing action identified as components of good nursing care, as defined by nurses, physicians, hospital administrators, and patients in the study hospital. These components of nursing action were grouped into five categories: physical care, emotional care, nurse-physician relationships, teaching and preparation for home care, and administration. Scored items were assigned a value ranging from 5 (nursing action always observed) to 1 (nursing action never observed). Questionnaires were distributed to personnel, including nurses and physicians, and patients at the time of discharge. Over a three-week period the nurse-to-patient ratio was increased, with 13 patients the first week, increasing to 16 patients the second week, and ending with 19 patients the third week. Staffing remained constant during the three-week period.

As expected, mean scores of quality of nursing care decreased as the nurse-to-patient ratio increased. On a 5-point scale, the average score from all respondents for the 13-patient assignment was 4.36, decreasing to 4.25 for the 16 patient assignment, and falling to 4.14 for the 19-patient assignment. Quality of physical care was the category most markedly affected as the nurse-to-patient ratio increased, with a mean score of 4.44 for the 13-patient assignment, 4.34 for the 16-patient assignment, and 4.07 for the 19-patient assignment. Categories consistently rated as high in quality despite the increasing nurse-to-patient ratios were administration and nurse-physician relationships. Nursing

actions that were most consistently reported as omitted were spiritual needs, preparation for home care, and helping the patient to understand their illness.

The study by Safford and Schlotfeldt (1960) makes two important points. By demonstrating that quality of care suffered as the nursing workload increased, like Abdellah and Levine (1958), they were able to determine which components of nursing care suffered more than others. Specifically, quality of physical care was most markedly reduced as the ratio increased, followed by spiritual care, teaching, and preparation for home care. The second point illustrated by this study is that while overall quality of care scores decreased as the nurse-to-patient ratio increased, categories of care that could be considered as indirect care were least affected, while those categories that involve direct patient contact, such as physical care, were most affected. This finding supports that of Abdellah and Levine, that is, nursing services considered as direct patient care responsibilities were most affected, and reflects the dominant contribution nursing care contributed to meeting patient needs. This suggests that as the nursing workload increases, the ability of the RN to meet patient needs diminishes.

Ordering of Tasks

Williams and Murphy (1979) examined nurse staffing from the perspective of its affect on ordering of tasks and perceived quality of care. Their findings indicate which nursing activities directly related to patient care were re-prioritized as staffing became less than adequate. This study examined the relationship between charge nurses' subjective evaluations of staffing adequacy and prioritization of activities carried out by nurses in six medical-surgical units. Charge nurses completed questionnaires at the end of

each shift designed to measure their evaluation of staffing adequacy as well as the emphasis placed by staff nurses on levels of direct care. Ten categories of direct care were scored according to whether the charge nurse judged that at least 90% of patients received that aspect of care during that shift. Possible scores ranged from 1 (poor) to 5 (good). Similar to findings by Safford and Schlotfeldt (1960), areas most affected when staffing was judged as inadequate were patient and family communication, patient observation, timely implementation of physician orders, mobility, and basic hygiene. Areas least affected and remained top priorities were taking vital signs and administering medications, including intravenous medications. The area most affected was patient observation, falling from a priority of 2 to 8, with a mean score of 4.0 when staffing was judged as adequate and falling to a mean score of 2.8 when staffing was judged to be inadequate ($t = 6.82$, $p < .0005$).

These findings suggest that as the staffing situation deteriorated, some nursing activities assumed a higher priority over others, with patient observation being the category most likely to assume a lower priority. At the same time, the adequacy of nurse staffing influenced the type and categories of care delivered by nurses, and direct patient care activities were more negatively affected than indirect activities. The finding that RNs re-prioritized patient care activities may explain why some components of care were more adversely affected than others when less hours of RN care were available. That patient care activities related to physical care, therapy, and patient observation were most adversely affected is cause for concern because of the potential consequences for patient safety.

The Allocation of Nursing Time to Direct and Indirect Care

Norrish and Rundall (2001) discuss the impact of hospital restructuring on the work of nursing, stating that nurses report they are less able to spend time on providing care and comfort measures and are spending more time on indirect care activities (p.59). Hendrickson and Doddato's 1989 survey of hospital nurses found that when pressed for time, nurses were more likely to perform nonnursing activities rather than allocating time to patient education and collaborative activities. Re-allocation of nursing time has implications for surveillance and monitoring activities in which nurses typically engage because the information gained from surveillance and monitoring serves as the basis for implementing interventions (Fagin, 2001).

How much time nurses spend on providing direct care is important, particularly as it relates to previous findings that a strong relationship exists between prioritization and completion of direct care activities and nurse staffing. The amount of time nurses spend on direct and indirect care activities has been studied. Work time studies have shown that RNs spend about one-third of their time on direct care activities, half their time on indirect care, and 10% on personal time (Hendrickson et al., 1990; Prescott et al., 1991). In view of the current re-engineering efforts of the nursing workforce combined with the documented changes in the supply and utilization of nursing personnel, it is concerning that RNs spend more of their time on indirect care than on direct care activities.

Hendrickson et al. (1990) studied the allocation of time to various activities by RNs according to shifts, services, and days of the week. Using work-sampling techniques, observations were taken every 15 minutes by trained observers on six specialty units: orthopedics, medical, surgical, neurology, obstetrics and gynecology, and pediatrics.

Direct care was defined as time spent with patients. Their finding that RNs spend 30% of their time on direct care and 45% on indirect care is similar to findings of other studies. The major variation in allocation of time was not in the percentage of time devoted to all patients, but the time in minutes spent with each patient. This variation was related to the nurse-to-patient ratio, that is, RNs spent more time with patients on units that had the lowest ratios. When the nurse-to-patient ratio was 1:4, RNs spent an average of 35 to 39 minutes with each patient, compared to an average of 15 to 17 minutes per patient when the ratio was one RN to nine patients.

Although this study did not examine the impact of allocation of nursing time on patient outcomes, there are some relevant implications in terms of the amount of time devoted to direct patient care. In the context of other findings that RNs devote less time to patient observation and attending to physical care needs as staffing ratios increase, the finding by Hendrickson et al. (1990) supports the hypothesis that patient outcomes are adversely affected by virtue of the impact staffing patterns have on the allocation of nursing time to direct and indirect care activities. These findings support those of New and Nite (1960) in that nurses allocate a larger proportion of time per patient when more RNs are available. Furthermore, in situations where nurses are faced with tasks competing for their time, nursing tasks directly related to patient care, such as provision of physical care and patient observation assume a lower priority, and less time is devoted to direct patient care. This then has a negative effect on the ability of the RN to adequately monitor patients, detect early subtle signs of complications, and implement timely interventions.

Combining Quality of Care, Tasks Undone, and the Occurrence of Adverse Events

The most recent focus in the literature concerns how nurse staffing impacts the work of nursing, and how that in turn, affects patient outcomes. Norrish and Rundall (2001) make the case that when the aims of restructuring changed, from one centered on patient care to one focused on improving efficiency, the negative effects on nursing workload became more apparent. It has been argued that hospital restructuring has had a negative impact on the work of registered nurses, and it is through this moderated effect that staffing impacts quality and patient outcomes. As Abdellah and Levine (1958) theorized, completion of tasks served as a measure of adequacy of nursing services.

More recently, Sochalski (2001) measured nursing workload as the number of patients assigned to each nurse. This study examined factors that were associated with quality of care as reported by nurses surveyed in Pennsylvania hospitals. Quality of care was assessed using self-report measures asking respondents to rate the quality of nursing care in their unit over the past year, as well as during their last shift. In particular, participants were asked to indicate which tasks were left undone during their last shift because they lacked the time to complete them. Other survey items measured patient workload, emotional exhaustion, job satisfaction, and the occurrence of adverse events. Survey questionnaires were mailed to a 50% random sample, drawn from the State Board of Nursing in Pennsylvania. The response rate was 52%, out of which 13,200 questionnaires met the inclusion criteria.

One out of every five surveyed nurses reported the quality of care in their unit during their last shift as being fair or poor, and as the number of tasks left undone

increased, ratings for quality of care decreased. For example, nurses rating quality as excellent reported on average that 0.54 tasks were left undone, compared to those nurses who rated quality as poor reported 5.14 tasks left undone. Most importantly, as the number of tasks left undone increased, the rates of medication errors, nosocomial infection, and patient falls with injury increased. Medical-surgical nurses reported the lowest quality of care scores ($p < .01$) and also reported the highest numbers of tasks left undone ($p < .001$). Workload, measured as the number of patients assigned to the nurse during their last shift demonstrated a negative relationship with ratings of quality ($r = -.24$, $p < .001$). That is, higher workloads were associated with lower quality ratings. Although this study found a significant, but weak correlation between workload and quality of care, the stronger relationship was between tasks left undone and quality of care ($r = -.59$, $p < .001$). This would indicate that a task left undone moderates the relationship between workload and quality of care and that higher workloads alone do not produce ratings of poor quality, but as a result of higher workload, tasks left undone strongly influences quality.

To summarize, the findings from this study demonstrate that staffing, by virtue of its effect on task completion had an impact on ratings of quality of care, patient complications, and adverse events. Therefore, tasks undone moderated the effect of staffing on patient outcomes. As in the study by Abdellah and Levine (1958), omitted or unfulfilled nursing tasks served as a marker for effectiveness of nursing care. The study by Safford and Schlotfeldt (1960) would suggest that some nursing care activities are more unfulfilled than others. Findings by Williams and Murphy (1979) demonstrated that nurses reprioritize nursing care activities when staffing was inadequate, while the study

by Sochalski (2001) demonstrated that not only are unfulfilled tasks strongly related to quality of care, the result is an increase in patient complications and adverse events. Findings from these studies generate new questions, such as: How does nurse staffing affect the work of nursing? Does staffing impact the work of nursing by its affect on where RNs spend their time? And does the amount of time devoted to direct patient care activities influence the occurrence of adverse events?

Preparation of the Nursing Workforce and the Impact on Quality

To achieve the aims set forth in the 2001 IOM report, the importance of appropriately preparing the workforce cannot be underestimated, where clinical training and education are seen as particularly important (Institute of Medicine, 2001). New or enhanced skills that are especially relevant to the nursing workforce include those that center around: (a) synthesizing and combining the evidence base, (b) use of decision support systems to aid in clinical decision-making, (c) understanding and implementing basic safety design principles, (d) design and measurement of processes and quality of care in order to develop and implement best practices and measure their effectiveness, (e) understanding how to find new knowledge, and (f) understanding determinants of health, the link between medical care and healthy populations, and professional responsibilities (p. 222). Although much of the need for enhanced skills is discussed as they relate to changes in curriculum, there are significant implications for nursing as they relate to ongoing advanced clinical education and specialty training, as in certification, and advancement of lifelong learning. And although it is clear from this report that education

and training are fundamental to the attainment of quality, there is a paucity of research that examines this connection.

Educational Level and Experience

Given that patients in acute care settings are those that are most acutely ill and physiologically unstable, their care requirements are complex. Safe care requires knowledge that is both technologically and physiologically sound. Adequate monitoring requires keen observation skills, as well as the knowledge base to detect subtle changes in status. Implementation of accurate and timely interventions demands critical thinking skills, as well as the ability to make high-level decisions. It would seem reasonable to expect that educational level and experience would contribute to the acquisition of these skills and that this would contribute to improved outcomes for patients.

Several studies have examined how education and experience influence nursing practice by focusing on differences in skill complexity, decision-making, and leadership abilities (Johnson, 1988; Rose, 1988; Young, Lehrer, & White, 1991). In their review, Kovner and Schore (1998) examine research findings that would clarify the relationship between practice and education and experience. They concluded that the research generally supports an association between education and complexity of RN practice; however, they could find no evidence of systematic relationships between practice and experience. Furthermore, no studies had examined the link between educational level, experience, and quality.

A more recent study has shed some light on the effect of nurse experience and education on quality of care. In their secondary analysis, Blegen, Vaughn, and Goode

(2001) defined education as the proportion of RNs with a baccalaureate in nursing, experience was defined as the proportion of RNs with more than five years experience or as the average years of experience. Quality was defined as medication errors per 10,000 doses and as patient falls per 1,000 patient days. The data were analyzed from two prior studies, 39 inpatient units from Study I (Blegen & Vaughn, 1998), and 42 inpatient units from Study II (Blegen et al., 1998), for a total of 81 inpatient units. Findings were more consistent for the effect of experience, where more experience was predictive of lower rates of medication errors and lower rates of patient falls. Only one significant relationship was established for the effect of education, where higher education was predictive of higher rates of medication errors.

These findings suggest that as RNs gain more experience, they are less likely to commit medication errors. In addition, with the exception of Study I findings, it seems that baccalaureate nurses deliver care similar in quality to units with fewer baccalaureate nurses. The positive relationship found for education and medication errors may reflect situations where more medication errors are reported as one attains a higher level of education, rather than higher rates of committed errors.

Certification

Although more than 67 organizations offer certification for RNs (Cary, 2000), currently, there is no systematic method to assure continued competency beyond initial licensing (Institute of Medicine, 2001). Furthermore, with the rapidly expanding knowledge base, there are no mechanisms to ensure practitioners remain up to date (Institute of Medicine, 2001). Although the IOM committee did not offer

recommendations, initial and periodic re-certification was one of the approaches discussed.

Certification is a method to differentiate distinctive levels of practice after licensure, and signifies ongoing attainment of quality and achievement (Cary, 2000). However, as with the relationship between quality and education, data supporting a relationship between certification and quality are lacking. The process of certification has been examined to the exclusion of outcomes; most research has focused on the characteristics of certified nurses (Cary, 2000).

In her ongoing program of research, Cary (2000), among other aims, is investigating the association between certification and practice outcomes. In a survey of more than 19,000 certified nurses, practice outcomes were reported as being enhanced as a result of their certification. These six practice outcomes are: (a) satisfaction as a professional nurse, (b) personal growth, (c) skill competence, (d) credibility, (e) accountability, and (f) confidence in practice. Additional behavioral enhancements reported were more confidence in decision-making, increased ability to detect and initiate early interventions for complications, more control over practice, and fewer adverse incidents in patient care. Although the link between these qualities and patient outcomes has not yet been empirically tested, these are the same qualities advocated by the IOM (2001) and necessary for safe and effective care in the changing environment of acute care.

In summary, education and certification are assets advocated to enhance patient safety and are needed not only to successfully participate in the rapidly changing hospital environment but also to understand and apply technological advancements. As part of

the vision for the education and training of health professional for the 21st century (Institute of Medicine, 2001), study designs need to establish the relationship between education and training of healthcare providers and quality of care.

Conceptual Model

This study proposed to examine how nurse staffing affects the amount of time nurses devote to categories of care, and whether the allocation of nursing time influences the occurrence of adverse events. The constructs of nurse staffing patterns and nurse characteristics, time spent in categories of care, and adverse events are conceptualized according to the Donabedian model of structure, process, and outcome (Donabedian, 1969; 1988). Donabedian defines structure as the attributes of the setting in which the care occurs. It includes equipment, human resources, and financing. Process defines the delivery of care itself, and outcome is the end result of the effects of care. The underlying assumption of the model is that when certain conditions are met, good care will follow, thereby increasing the likelihood of good outcome.

This model was chosen to represent the empirical basis for the study because of its comprehensive approach to delivery of care. To date, studies that have examined the impact of nurse staffing on patient outcomes have done so from a structure – outcome approach. As Donabedian (1988) asserts, it is necessary to establish that good structure facilitates good process, which in turn, promotes good outcome. These relationships must be defined before any particular construct can be used to assess quality. While study findings thus far have established that a relationship exists between nurse staffing and

patient outcomes, the processes through which structure and outcome are related has not been established. A diagram of the conceptual model is provided in Figure 3.

Structure

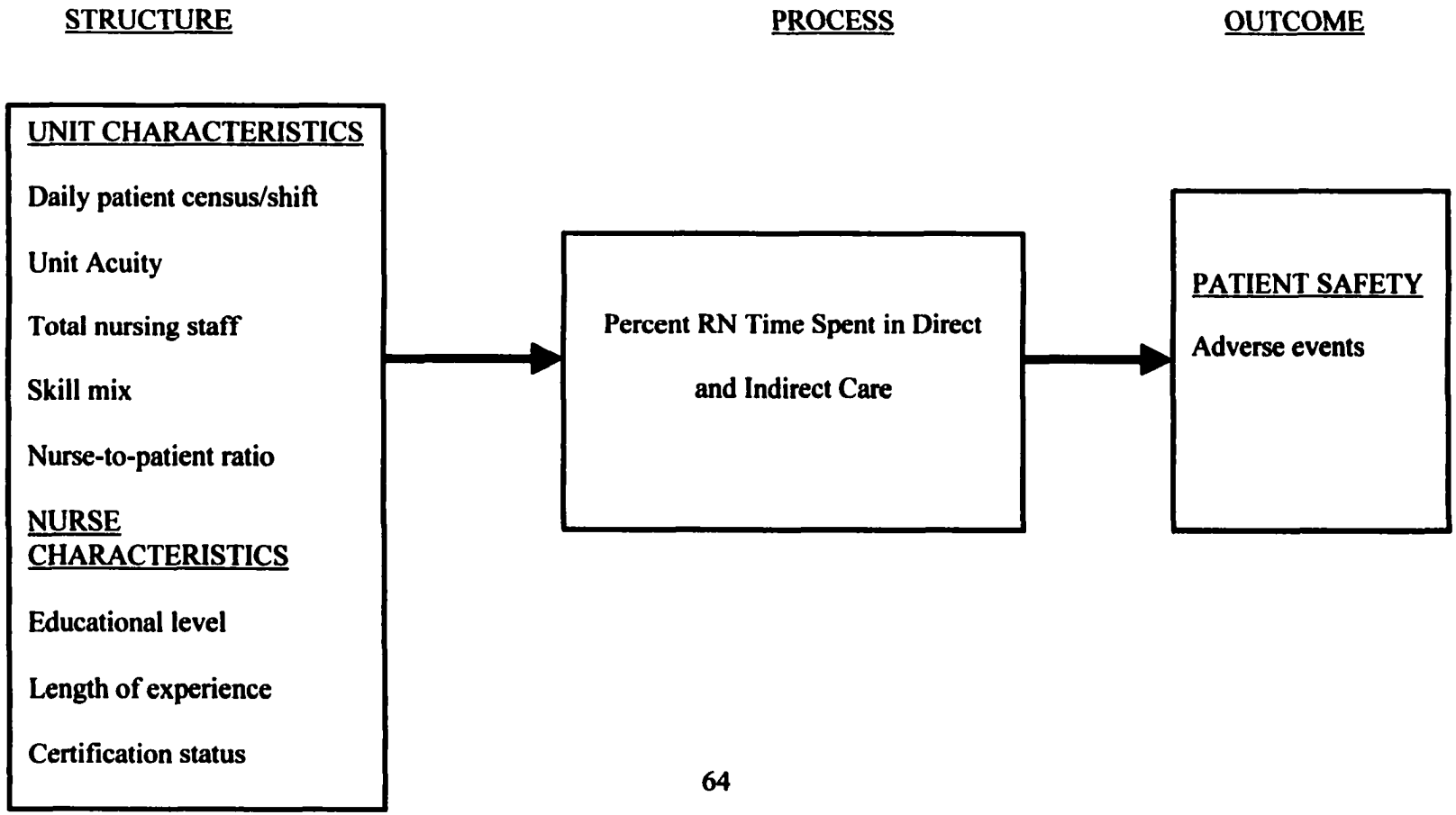
This study defines structure as unit characteristics, nurse staffing patterns, and staff preparation. Although findings from previous research demonstrate that provider characteristics are associated with nurse staffing patterns and patient safety (Aiken et al., 1994; Kovner & Gergen, 1998), these relationships are not under investigation in this study for several reasons. The unit of analysis for this study is at the individual and unit level, not at the level of the hospital. Furthermore, this is a one-site study, which does not allow for a hospital-to-hospital comparison. Therefore, including hospital characteristics as predictors of allocation of nursing time or patient safety factors would be pointless because there is no means for comparison.

Unit Characteristics

Daily patient census per shift and the acuity level of the unit are variables that characterize workload and determine patient assignments (Norrish & Rundall, 2001). Because the number of patients and the acuity level of the unit determine nurse staffing, unit characteristics are expected to influence the staffing pattern on a specific unit. In addition, findings from research demonstrate that both patient census and acuity influence the amount of time RNs devote to direct and indirect patient care activities (Hendrickson et. al., 1990; Norrish & Rundall, 2001). Hence, there is a unidirectional relationship between unit characteristics, nurse staffing pattern, and allocation of nursing time.

Figure 3.

Donabedian Model of Quality of Care.



Nurse Staffing

Based on previous research, studies have examined nurse staffing within the context of the total number of nursing personnel on a unit, the proportion of RNs to nonRN staff (skill mix), and the number of patients assigned to an RN or LPN. As discussed in the review of literature section, these findings indicated that the number and skill mix of nursing staff, as well as the patient assignment influence the amount of time nurses allocate to patient care activities. However, no studies have examined the affect of the unit secretary on where RNs spend their time or on the occurrence of adverse events. In addition, daily patient census and unit acuity determine whether extra staff members are needed. Extra staff attained by floating nursing personnel or by using temporary staff is a strategy employed by hospitals as a temporary method to meet unpredicted unit needs. Although studies conducted within the last five years have not included temporary staff as a measure of nurse staffing patterns, it is reasonable to assume that temporary staff members are not as vested as are permanent staff, thereby affecting the quality of care. In addition, they may be unfamiliar with the architectural layout of the unit, the unit policies and procedures, the permanent nursing staff, the medical staff, and the patient population residing on the unit to which they have been temporarily assigned. The inexperience with the unit, the staff, and the workings of the unit may compromise the quality of care as well. Therefore, the model hypothesized a unidirectional relationship between nurse staffing and allocation of nursing time, and reflects previous research findings that allocation of nursing time to direct and indirect care activities is influenced by the permanency of staff members.

Staff Preparation

As indicated in the 2001 IOM report on quality in healthcare, educational level and certification for ongoing training are factors related to quality. Although no studies have examined the relationship between educational level and patient safety factors, surveys of practicing RNs demonstrate that those RNs who have gained certification in a specialty feel more confident in their ability to provide quality patient care and respond to unanticipated patient needs (Cary, 2000). This may translate into higher quality of care as demonstrated by devoting more time to direct patient care activities, which may influence patient safety factors. Therefore, a unidirectional relationship exists between staff preparation and allocation of nursing time to patient care activities.

Process

Allocation of RN Time

As the process concept in this model, it was hypothesized that structure influences the amount of time RNs allocate to direct and indirect patient care activities, and it is through this process piece that explains the impact of unit characteristics, nurse staffing patterns, and staff preparation on patient safety factors. This relationship has not been previously tested, and therefore, is an important relationship that needs to be clarified in order to advance the knowledge related to how structure affects outcomes.

Outcome

Outcomes were defined as adverse events that have been empirically tested and found to be associated with nurse staffing patterns.

Adverse Events

The recent 2001 IOM report defines patient safety in terms of medical error and adverse events. As discussed in the review of literature, medical error and adverse events are related to nurse staffing patterns, however, the mechanism through which this relationship exists is unknown and has not been tested. Recent study findings suggest that patient safety is negatively affected when staffing patterns are such that RNs are unable to complete tasks related to direct care activities, presumably because they do not have enough time (Sochalski, 2001). This model hypothesizes that less time spent on direct patient care activities is analogous to less time spent on tasks related to patient care.

Assumptions of This Study

The assumptions underlying this study related to the operational definitions for direct and indirect care. The first assumption of this study was that time electronically recorded in a patient room, in the hallway, in the medication room, or at the narcotic medication cart captured RN time spent in direct care. This assumption was supported by the following observations and anecdotal information. Direct observation of the nursing staff revealed no instances where RNs noted to be in a patient room, the medication room, or at the narcotic medication cart were engaged in any activity other than patient care. Time spent in the hallway outside of a patient room was included as a direct care activity primarily because of the structural and functional design of the hospital setting in this study. Patient charts were kept in cabinets hung on the wall outside of each patient room and a large portion of nursing documentation took place in the hallway. In addition, an informal survey of nursing personnel in this sample setting revealed that nursing

personnel said that 99% of time spent in the hallway was devoted to documentation, communicating with other members of the healthcare team and family members, or spent on other activities directly related to patient care. Only 1% reported that time spent in the hallway was devoted to social or other indirect care activities. Therefore, because nursing care activities carried out in these locations could not be measured, RN time recorded in any of the above locations was assumed to be direct care.

The second assumption underlying this study was that time electronically recorded in the break room, at the nursing station, or in any room not designated as a patient room captured RN time spent in indirect care. This assumption is supported by the following observations. Some percentage of RN time spent in locations coded as indirect care was direct care related, such as documentation and communicating with physicians and other members of the health care team. However, a good part of RN time was not related to direct care, such as socializing and personal phone calls. Using the data collection method employed in this study, a consistent, valid, and reliable method to differentiate between time spent in direct and indirect care could not be established. As a conservative measure, all RN time spent in the above areas were coded as indirect. Therefore, because RN activities carried out in these locations would not be measured, RN time recorded in the nursing station, break room, or any room other than a patient room was assumed to be indirect care.

The third assumption underlying this study was that RNs were wearing the locator devices that captured and electronically recorded intervals of time and that the recordings represented the actual location. This assumption is supported by the following observations and information. Hospital policy stipulated that all nursing personnel wear

the locator devices while on duty. When initially assigned a locator badge, the employee signed an agreement stating they would comply with the policy. In addition, nursing management monitored adherence to the policy. If the employee had forgotten to bring their locator device with them, a temporary device was assigned to them for that shift. Furthermore, one of the unit secretary's responsibilities was to ensure that all nursing staff were electronically noted in the COMposer® system, and if not, a temporary device was issued and recorded in a log. However, nursing staff were noted to be wearing the locator devices approximately 95% of the time during direct observation. In addition, comparing assignment records of temporary locator devices with staffing schedules revealed that during the entire study period approximately 10% of nursing personnel could not be accounted for in the electronic database. Because data were downloaded every 35 days, failure to adhere to hospital policy or oversight on the part of the unit secretary could not be completely confirmed because of the retrospective nature of the method for data collection. Therefore, because 100% compliance with hospital policy could not be determined, it was assumed that all RNs appearing on the staffing schedule also were captured in the electronic database.

In addition, it was assumed that RN time recorded in a specific location represented the RN rather than the locator device. For instance, if an RN left their jacket and the locator device at the nursing station while tending to a patient in their room, the RN time recorded would be at the nursing station despite that the RN was in a patient room. Because the data did not capture activities that the RN was engaged in, there was no way to determine the frequency of this occurrence. Therefore, it was assumed that RN time recorded in a specific location accurately reflected the location of the registered nurse.

The fourth assumption underlying this study was that the locator badge accurately reflected the location of the registered nurse when wearing the locator device. There were no prior studies using this method of data collection on which to base an estimation. Furthermore, the company that developed the COMposer® system had not established instrument validity and reliability (D. Willbanks, personal communication, June, 2001). Direct observation determined that the location of an RN was accurately reflected when viewed on the terminal, however, a delay of approximately 23 seconds was noted when the RN moved from one location to another. Because there are no reported measures of instrument validity, it was assumed that RNs wearing the locator devices were valid reflections of RN time recorded in that location.

Study Hypotheses

The following study hypotheses were tested.

1. A higher skill mix will result in more RN time spent in direct care and less RN time spent in indirect care.
2. Higher numbers of total nursing personnel will result in a higher percentage of RN time spent in direct care.
3. The percentage of RN time spent in direct care will decrease when the nurse-to-patient ratio is higher.
4. A higher percent of RN time spent in direct care will result in a lower occurrence of adverse events.
5. A higher proportion of licensed staff to nonlicensed staff will result in a lower occurrence of adverse events.

6. Higher numbers of total staff will result in a higher occurrence of adverse events.
7. Longer length of experience in nursing, higher educational level, and certification will be associated with lower occurrence of adverse events.
8. Longer length of experience in nursing, higher educational level, and certification will be associated more time spent in direct care.

Chapter Summary

Cost containment strategies implemented by acute care hospitals, such as restructuring and in particular, re-engineering, have influenced the supply, distribution, and utilization of the nursing workforce (Aiken et al., 2000; Buerhaus & Staiger, 1996, 1999; Kovner et al., 2000). Although the employment of RNs has increased, the concomitant deployment of LPNs and NAs has affected the distribution, as well as the utilization of nursing personnel (Aiken et al., 2000). Less available support staff coupled with the increasing acuity of hospitalized patients has weakened the gains that otherwise would have accrued from the increasing numbers of registered nurses. As a result, RNs are providing nursing care in environments characterized by patients that are more acutely ill, require a higher intensity of services, and consume more resources, while at the same time, working with less support staff. This accumulation of events has caused concern among healthcare providers, consumers, and policy makers that changes in the composition of the nursing workforce have adversely affected quality and patient outcomes.

Research examining workforce composition and the effects on quality has focused primarily on nurse staffing and the relationship with patient outcomes (Aiken et al., 1994;

Blegen et al., 1998; Kovner & Gergen, 1998). The most consistent findings have shown that skill mix, or the proportion of RNs in the staffing mix, is associated with lower rates of complications and patient falls (Blegen & Vaughn, 1998; Blegen et al., 1998). The findings for the total numbers of nursing staff are mixed and inconclusive. Although it has been established that a relationship exists between skill mix and outcomes, the research is just beginning to identify the process of how nurse staffing can impact outcomes.

Early study findings indicated that a higher proportion of RNs and a lower nurse-to-patient ratio improved ratings of quality for specific components of care and increased the likelihood that patient needs would be met (Abdellah & Levine, 1958; Aydelotte & Tener, 1960). But why some components or patient needs were more affected was unknown. In later studies, it was found that RNs re-allocated their time and re-prioritized tasks when they were pressed for time (Hendrickson et al., 1990; Williams and Murphy, 1979). Moreover, the amount of time devoted to direct patient care activities was related to the nurse-to-patient ratio, possibly explaining the effects of nurse staffing on the process of care delivery by virtue of the impact of staffing on the allocation of nursing time to direct and indirect care activities (Sochalski, 2001). One drawback to these studies is that they did not examine the mix of support personnel in the overall staffing pattern, possibly missing the effect on RN time allocated to indirect care activities. However, what the implications are for patient outcomes as it relates to allocation of nursing time has not been studied and is unknown.

The recent focus on factors affecting patient safety and the occurrence of medical error in acute care has drawn attention to the link between preparation of the workforce

and quality, namely, education, training, and continued competency (Cary, 2000; Institute of Medicine, 2001). With the rapidly changing knowledge base and increases in technology, it is vital that healthcare providers possess high level decision-making and critical thinking abilities. Furthermore, with the increased patient acuity of hospitalized patients, RNs must be prepared to function at these levels, and must also be prepared to pursue lifelong learning. Even so, there is no empirical basis that would support continued education and training as a means to improve upon quality and patient safety.

Nursing is one of the primary delivery systems of care in hospitals. If nurse staffing affects the delivery of care, the potential to decrease incidence of medical error and adverse events is great. Research is needed that will begin to identify how nurse-staffing patterns impact delivery of care. Doing so will provide much needed insight into how hospitals can modify, redesign, or re-engineer the nursing workforce in order to maximize patient safety and minimize error.

Based on this review of findings from past research in the area, the following conclusions can be drawn:

1. Although re-engineering has changed the composition of the nursing workforce, findings are lacking that establish the impact of re-engineering on patient outcomes.
2. Research has established that RNs re-allocate their time and re-prioritize tasks and that this is associated with nurse staffing, however, these findings have not established the affect on patient outcomes.
3. Research methodologies for measuring the allocation of nursing time have not used computer technology to gather data; rather they have relied on data gathered by direct observation.

4. Studies have established an association between nurse staffing and patient outcomes. However, whether nurse staffing influences the delivery of care, thereby affecting outcomes, is only beginning to be studied.
5. Scientific findings are lacking that support the current emphasis on the link between education and training of RNs and the effect on patient outcomes.
6. Few studies have examined the complete linkage of nurse staffing, its effect on the allocation of nursing time to direct and indirect care, and the association with patient outcomes. Therefore, studies designed to further clarify these linkages are warranted.

CHAPTER 3

Research Design and Analysis

Chapter Overview

This study was an analysis of nurse staffing, RN time, and adverse events using data from three organizational databases in a community hospital. These data were contained within the Hill-Rom COMposer® System, the Automated Nursing Staff Office System (ANSOS™), and the Excalibur™ software program. The Hill-Rom COMposer® System served as the electronic measure of the amount of time RNs spend in direct and indirect care. The ANSOS™ database was the source for data related to nurse staffing patterns. The third database, Excalibur™, was a software program designed to track medical error and adverse occurrences. Whether the amounts of RN time spent in direct and indirect care influence the occurrence of medical error and adverse events was determined using multivariate procedures.

Sample and Setting

Sample Size

The sample consisted of all nursing personnel on five medical-surgical units, including RNs, LPNs, aides, and unit secretaries who were working during the time period during which data were collected. In addition, the sample included all permanent

(such as those hired to work on that specific unit) and temporary nursing personnel (such as those working on a unit other than their home unit), as well as those who were employed in the hospital's float pool employed or through outside employment agencies.

Sample Setting

A 400-bed, not-for-profit community hospital served as the setting for data collection. Five inpatient units that utilized the Hill-Rom COMposer® System provided the data. The five-inpatient units were: 18-bed medical-surgical, 26-bed oncology, 27-bed pulmonary, 19-bed neuro-orthopedic, and a 48-bed cardiac step-down unit.

Table 10 describes the patient population of each unit by listing the top five Diagnosis Related Groups and average length of hospital stay for the study time period.

Table 10

Description of Patient Population by DRG and Average LOS by Unit

Top five diagnosis related groups	N	Length of stay
Unit 1		
Major joint procedure	88	4.36
Back and neck procedure	35	2.37
Hip and femur procedure > age 17	27	5.67
Cervical spinal fusion with CC	17	1.71
Lower extremity/humerus procedure	16	2.44

(table continues)

Table 10 (continued)

Top five diagnosis related groups	N	Length of stay
Unit 2		
Major small and large bowel procedure	31	6.77
Laparoscopic cholecystectomy without common bile duct exploration, without CC	20	1.70
Laparoscopic cholecystectomy without CDE, with CC	16	3.00
Esophagitis, gastroenteritis > age 17	14	6.93
Appendectomy without complicated diagnosis	11	2.36
Unit 3		
Simple pneumonia	89	4.22
Septicemia > age 17	16	5.75
Gastrointestinal hemorrhage > age 69 with CC	12	5.75
Esophagitis, gastroenteritis > age 17	11	3.73
Chronic obstructive pulmonary disease	10	6.10
Unit 4		
Simple pneumonia/pleurisy > age 17	26	5.04
Septicemia > age 17	19	6.74
Esophagitis, gastroenteritis	17	3.82
Chronic obstructive pulmonary disease	14	5.64
Respiratory infections > age 17	13	2.69

(table continues)

Table 10 (Continued)

Top five diagnosis related groups	N	Length of stay
Heart failure and shock	85	4.18
Circulatory disorders excluding acute myocardial infarction	54	2.70
Chest pain	54	1.69
PTCA with acute myocardial infarction	27	2.11
PTCA with stent, without acute myocardial infarction	24	2.67

Note. CC = comorbid condition; CDE = common bile duct exploration.

Exclusion Criteria

The database was limited to the electronic records for nursing personnel assigned to work on a particular day during a particular shift. For example, electronic recordings representing house wide nursing supervisors or the wound care specialist were excluded from the analyses.

Study Measures

Nurse Staffing

Data for total number of nursing personnel, skill mix, and nurse-to-patient ratio were collected from the Automated Nurse Staffing Office System. ANSOS is a staff scheduling system used primarily for unit scheduling. The database contains three components: Controller, Scheduler, and Staffer. Controller is generated daily in hard copy format as the daily staffing sheet and placed in a notebook kept at each nursing station. This component includes employee information, including the unit to which they

are hired to work (home unit), the unit on which they are working during a particular shift, their position (RN, LPN, aide, unit secretary, clinical nurse specialist), employee name and number, and the hours worked during that shift. In addition, employees floating to a unit other than their home units are noted as such. Also noted on the daily staffing sheet is the unit patient census by shift, the total number of nursing personnel by level, and the targeted number of nursing personnel by level. This allowed accurate calculation of measures of skill mix and nurse-to-patient ratio.

Nursing Time

The computerized recording of minute-to-minute locations of all nursing staff were electronically captured in the Hill-Rom COMposer® System. This system electronically recorded the location of nursing personnel on a nursing unit and continually recorded in minutes the amount of time spent in each location. The data were captured via badges worn by the nursing staff. Locations were noted in the database by room number, so that one could differentiate between a patient room, the utility room, the medication room, or the break room. Also, location included time spent in the hallway outside of a room, as noted by the room number, and time spent at the nursing station. Time spent in the restroom or off the unit was not electronically recorded or noted. The electronic record for these data were in continual 35-day batches, so that on day 36, day 1 dropped off. This data file, known as the Staff Activity report, contained the following variables: unit, date, staff ID number, staff level, and time spent in each location. The staff ID was the identifier for each employee.

Direct and Indirect Care

Direct patient care was time recorded in a patient room, in the hallway, in the medication room, or at the narcotic medication cart. Indirect patient care was time recorded in the break room, at the nursing station, or in any room not designated as a patient room.

Adverse Events

Adverse events were tracked by incident reports, quality referrals, and medical record coding and were electronically stored in the Excalibur ™ system. Excalibur™ is a software system developed by Safety-Centered Solutions to provide hospitals with patient safety-related solutions using measurement tools targeted toward reducing the incidence and cost of medical error (Safety-Centered Solutions, Inc., 2000). Clinical Decision Support personnel, who abstract and enter all incident reports and quality referrals, maintain the Excalibur™ system. Incident reports and quality referrals were generated by self-report from staff members or management personnel. Clinical Decision Support tracks 85 types of events in Excalibur™, however some were not germane to this study and were not tracked. For this study, adverse events included patient falls, medication errors, decubitus ulcer, intravenous catheter infiltrations or extravasations, skin tears, patients fed by mouth who had medical orders not to be orally fed, primary bloodstream infections, specimen collection errors, and errors associated with obtaining consent.

Staff Preparation

Information related to highest level of education for RNs, number of years of nursing experience for RNs and LPNs, and certification in a nursing specialty for RNs and LPNs was obtained from employee files in human resources. These variables were added to the daily staffing report and entered into the spreadsheet, linked by the employee badge number.

Unit Acuity

The targeted number of nursing staff was based on the average annual census for a unit. The daily staffing sheet noted both the actual number of all levels of nursing personnel scheduled to work and the targeted number of nursing personnel based on annual patient census. Because each unit had its own unique patient care needs, the targeted number of nursing personnel changes by shift and day according to those needs. This facility computed unit acuity by calculating the difference between targeted and actual staffing, so that the calculation was as follows:

$$\text{Unit acuity} = \frac{\text{Actual staffing} - \text{Target staffing}}{\text{Targeted staffing}}$$

However, because the maximum number of patients per unit differed, dividing unit census by targeted staffing provided a more standardized measure that equalized the effect of a higher acuity patient population on a unit. Therefore, this study calculated unit acuity as follows:

$$\frac{\text{Unit census}}{\text{Targeted staffing}}$$

Institutional Review Board

The study proposal was reviewed and approved by the community hospital IRB in which the data were to be collected, as well as the University of South Florida institutional review board (Appendix A). Because this was a secondary analysis, the requirement for individual consent was waived. However, the researcher conducted educational sessions for staff members on each of the five units during their staff meetings. The educational session described the study aims and research questions, the methods, and procedures. This information also was displayed on a written announcement that was placed on each unit where it would be accessible to all staff members. The announcement also contained the name and home phone number of the researcher and encouraged staff members to call with questions or comments. The researcher received no inquiries.

Procedures

The study procedure involved creating and merging files of the various databases used in this study. The following steps were followed in the procedure.

1. Data contained within the Hill-Rom COMposer® System for the five units were downloaded into a Staff Activity File. These data covered three periods of 35 continuous days each, for a total of 105 continuous days.
2. For each of the five units, the ANSOS daily staffing sheets for the identical time periods of data collected from the Hill-Rom COMposer® System were obtained from the Administrative Nurse Staffing Coordinator. These also served as a validity check against the data downloaded from the COMposer® system.
3. From Human Resources, information pertaining only to the highest level of education and number and type of certification for all nursing staff listed on the daily staffing sheets were entered as data next to that employee's name.
4. For all employees listed on the daily staffing sheets for each of the five units, their badge numbers were substituted for their names, so that the only identifier for an employee was by a badge number.
5. For each of the five units, a spreadsheet was created, labeled as the Personnel File, and all above information was entered onto the spreadsheet. Additional data points entered were the unit census per shift and the computed standardized unit acuity measure. Once all data points relevant to the study were entered into the spreadsheet from the daily staffing sheets,

the staffing sheets were shredded and destroyed, leaving no way to identify a staff member by name. For each unit, the Personnel File contained data related to the employee, including the employee badge number, employee position title, employee level, hours worked per shift, highest level of education, number and type of certifications, and number of years worked since first nursing degree. In addition, the Personnel file contained data related to the unit, such as unit census per shift and unit acuity.

6. The Staff Activity File and the Personnel File were merged, using the employee badge number as the common identifier between the two files.
7. Entering all reported adverse events contained within Excalibur™ created a third file, Adverse Events File.

Checks for Reliability and Validity of the Database

During a pilot study conducted to test the validity and reliability of the database for statistical analysis, a significant amount of missing categorical data for Staff Title in the Composer® database was noted. This variable categorizes staff according to their level, i.e., registered nurse, licensed practical nurse, certified nursing assistant, nurse technician, patient care assistant, telemetry technician, or unit secretary. Descriptive statistics revealed that 11% of staff titles were missing during a 35-day pilot study for units 1, 2, 3, and 4. The majority of missing data were for temporary nursing staff, that is, staff working on a nursing unit but were based on another unit. Missing staff titles for nursing personnel that were working on their home unit was not a problem because once the staff

title is entered for a staff member, the system retains the staff title until it is intentionally changed. These missing data presented a limitation in the assignment of time allocation to a specific level of staff. To minimize this problem, all staff members responsible for inputting staff titles into the Composer® system attended an in-service where the procedure for inputting temporary nursing personnel was reviewed. In addition, each unit's roster of temporary badge assignments was reviewed weekly in an effort to monitor and encourage compliance with accurate record keeping. The staff title of each temporary staff member assigned a badge, the unit, and the shift the employee worked was recorded in a log. Once the 105 days of data are downloaded, the file will be reviewed for missing data for staff title and if noted on the monitoring log, the accurate data will be inserted.

Protection of Confidentiality and Anonymity

As discussed in the procedure section under Step five, the only piece of information that would identify an employee was the daily staffing sheet. Once the employee badge number was substituted for the employee name, the employee identifier then became the badge number. Once this step was accomplished, all daily staffing sheets were shredded and destroyed, leaving no way to identify an employee by name.

Data Analysis

The unit of analysis was at the level of the individual registered nurse. The data were considered as filling a 3-way factorial block (shift x unit x day). The covariates

(total number of staff, staff skill mix, educational level, length of nursing experience, certification, events) were assessed in each of the cells of the factorial design and were the focus in the subsequent analysis. The covariates were adjusted for unit acuity. Step one in the data analysis was to describe the independent and dependent variables using descriptive statistics. For step two, the 3 (shift) x 5 (unit) x 105 (date) factorial design provided the framework in which to test the main effects of shift, day, and unit by performing multivariate analysis of covariance (MANCOVA). While adjusting for unit acuity, the effects of skill mix, total number of nursing personnel, events, and nursing characteristics on the amount of RN time spent in direct and indirect care was tested using multivariate regression procedures.

Using MANCOVA in a nontraditional way allowed isolation of sources of variation, including interaction terms and staff mix, which in a strictly technical sense, are a covariates. The focus of the analysis was on the variation in outcomes that is uniquely associated with staff mix as differentiated from the main effects and interaction effects of unit, shift, and date. Data were analyzed using SPSS.

Chapter Summary

Chapter 3 reviewed the methods, procedures for data collection, and operational definitions used in this study. Three administrative databases were merged to examine the effect of nurse staffing on RN time spent in direct and indirect care, and the occurrence of adverse events on five inpatient units in an acute care hospital. A three-way factorial block served as the research design to test the study hypotheses.

CHAPTER 4

Results

Introduction

Chapter 4 begins with a discussion of the screening methods employed to prepare the data for analysis. A description of the sample's unit and nurse staffing characteristics, amount of RN time spent in direct and indirect care, and adverse events is given, followed by the statistical analyses used to test each hypothesis.

Data Preparation

Accuracy of Input

Prior to data analysis, data were screened for accuracy of input, missing data, and outliers using univariate and bivariate descriptive statistics and examining graphical representations of distributions. All continuous variables were examined for unexpected ranges, plausible means and standard deviations. Any unexpected values were checked against the master file and the accurate values inserted if necessary. Categorical variables were examined and corrected for inaccurate coding as described in Chapter 3.

Missing Data

The sample contained unit-level data for 70 continuous days for the five units.

Frequency statistics revealed that 4.6% of the data for staff title were missing. The majority of the missing data were from incomplete records of badge numbers assigned to temporary personnel. Missing staff titles were inserted if known from the weekly log, thereby decreasing the percentage of missing data to 1.6 percent.

Outliers

Screening procedures using multivariate and bivariate frequencies and distribution histograms were used to identify outliers. Unit-level data contained no outliers. At the level of the individual, outliers were identified for the variable staff title, where two categories were removed from all analyses because they were not among the population intended to be sampled. One was the orthopedic technician, who has no direct patient care responsibilities. The second was for the pulse oximeter, that nursing staff tagged with a locator badge to facilitate speedy location if needed in an emergency. Therefore, any values related to the orthopedic technician or the pulse oximeter were removed from all computations and analyses. In addition, the data file contained time values recorded in locations that were not physical rooms. These were sensors geographically placed on the units to intermittently collect cumulative data. These data were removed from analyses as well.

Descriptive statistics for the amount of time RNs spent in individual locations revealed a distribution with extreme values ranging from zero to 4,320 minutes (four days). These prolonged recordings of time spent in one location were referred to as an "abandoned badge". Strategies were devised to determine a record of time that would represent a realistic interval of time spent in one location. The first strategy involved

computing mean length of stay by excluding length of stay values that fell outside four standard deviations. Although this was considered a conservative estimate, the frequency distribution still produced extreme length of stay values, with a maximum time of 19 hours in one location. The decision was then made to limit time observations per location per shift to eight hours. While many nursing staff worked twelve-hour shifts, these data were grouped by day and eight hour shifts. Thus, a nurse who worked 12 hours would appear for eight hours on shift one and four hours on the subsequent shift. Therefore, the maximum amount of time an RN could spend in any one location would be eight hours per shift. Limiting the amount of time spent in any location to not greater than eight hours was considered to be the most conservative calculation, as well as one that would select out time intervals representing an abandoned badge from the analyses.

Level of Analysis

The time data were summed for each RN working a given shift, unit, and day. This resulted in 5,797 unique observations. For each observation, the total time was divided into direct, indirect, and time in non patient care. The data then were grouped in a 70 (day) by 3 (shift) by 5 (unit) factorial design with 1,050 cells of data. To examine for systematic differences in the effects of day, shift, and unit on the allocation of RN time to direct and indirect care categories, analysis of variance using ANOVA was conducted. The effects were minimal, with η^2 of .014, .001, .014 for day, shift, and unit respectively. Given the minimal effects of day, shift, and unit, time data were averaged for RNs in each cell of the factorial design, e.g., day, shift, unit combinations, producing 1,050

observations that could then be matched to unit and shift characteristics, such as census and skill mix.

Profile of Study Sample

Unit and Nurse Staffing Characteristics

The sample is described according to unit and nurse staffing characteristics. One hundred and ninety-one RNs were studied. Unit characteristics include unit acuity, skill mix, nurse-to-patient ratio, and census. Nurse staffing characteristics include descriptions of staff by level and hours per shift, and total numbers of nursing staff. Calculations were done to transform the total number of hours worked per shift per person into a number that would provide a method for comparison with findings from other studies. The total numbers of hours per shift per person were divided by eight, so that numbers of staff reported represent hours worked as a function of an eight-hour shift. For instance, four RNs per shift represent 32 RN hours.

Skill mix was measured as the proportion of licensed (RN, LPN) to nonlicensed, and the proportion of RN to LPN. Unit acuity is a measure that reflects the optimal nurse-to-patient ratio for a particular unit and is expressed in terms of the targeted number of RNs and LPNs based on a unit's average annual census. Ratio is a measure of the actual nurse-to-patient ratio and is expressed in terms of the actual numbers of RNs and LPNs per shift.

As displayed in Table 11, there was little difference between the targeted (acuity) and actual (ratio) numbers of RN and LPN staffing. Skill mix varied from 36% to 100 percent, with a mean of 65% when calculated as the proportion of licensed to nonlicensed

staff. The mean was 81% when calculated as the proportion of RNs to LPNs. The average number of patients on any unit was approximately twenty-five.

Table 11

Mean, Range, and Standard Deviations for Unit Acuity and Census

	Mean	Minimum	Maximum	SD
Unit acuity	4.34	2.95	6.94	0.57
Ratio	4.4	2.50	7.58	0.65
Skill mix[a]	65.26	36.0	100.0	.08
Skill mix[b]	81.00	26.0	100.0	15.75
Unit census	24.60	11.00	44.00	7.63

Note. Acuity = census / targeted RN + targeted LPN; ratio = census / RN + LPN.

[a]Skill mix computed as licensed staff / nonlicensed staff*100 .

[b]Skill mix computed as RN / LPN*100.

Table 12 shows the percentage and total hours of staff level per shift, with RNs comprising about half and LPNs about eight percent. Assistive staff and secretaries made up about 46 percent of total staffing per shift. The average number of RNs per shift was close to five, numbers of LPNs was less than one, assistive staff contributed an average of three staff members, and there were about 0.75 unit secretaries per shift.

Table 12

Percentage of Nursing Hours Per Shift

	RN	LPN	Assistant	Secretary	Total[a]
Mean	4.78	0.90	3.14	0.73	9.55
Minimum	1.00	0.00	0.00	0.00	3.78
Maximum	12.00	3.30	8.4	3.50	20.30
SD	2.31	.745	1.47	0.60	3.3
N	191	37	167	36	441
Percentage of total staff	45.5	8.4	37.8	8.16	99.86

Note. Assistive personnel include certified nursing assistants, nurse technicians, patient care technicians, telemetry technicians, and sitters.

[a]Does not total 100% due to rounding.

Percent of Nursing Time Spent in Direct and Indirect Care

The percentage of time RNs spent in direct and indirect care was examined from different perspectives, from the level of the individual RN and from the unit level. Table 13 displays the mean percentage of RN time spent in direct and indirect care at the level of the individual. Table 14 displays the mean percentage of RN time at the unit level. The analysis chosen for this study was at the level of the individual RN. While it is recognized that the characteristics and resources of the unit in which they are working may place limits on RN time, the unique characteristics of care that each individual RN brings to the situation are more stable and should not be discounted.

Table 13

Average Percentage of RN Time Per Shift Spent in Direct and Indirect Care at the Level of the Individual

	N	Mean	Minimum	Maximum	SD
Direct care	191	54.35	9.96	100.00	20.64
Indirect care	191	42.46	0.00	90.04	20.93

Table 14

Average Percentage of RN Time Per Shift Spent in Direct and Indirect Care at the Unit Level

	N	Mean	Minimum	Maximum	SD
Direct care	1018	44.14	0.00	100.00	14.13
Indirect care	1018	52.96	0.00	100.00	14.84

Adverse Events

The maximum amount of adverse events that occurred on any day was eight, the range varied from zero to eight. Measures of central tendency showed an average adverse event per day of 0.35, standard deviation was 0.89, and the mode was zero.

Statistical Analyses

The General Linear Model was used to test each study hypothesis. Multivariate and univariate tests were reported. Regression analyses were presented in tabular form. Analyses were performed using regression and frequencies for evaluation of assumptions.

Whether the sample met the assumptions underlying multiple regression was addressed first. Residual scatterplots between obtained and predicted values on percentage of time spent in direct and indirect care categories demonstrated outliers, indicating a violation of the assumption of normality. Mahalanobis distances were assessed using a critical $\chi^2(7) = 24.322, \alpha = .001$. Based on this criterion, ten outliers were removed from all analyses. This produced a final sample of 1,009 cells. The normal probability plot demonstrated a straight-line relationship between expected and actual values of residuals. Scatterplots of residuals against predicted dependent values demonstrated that the assumptions of homoscedasticity, normality, and linearity had been met. The correlation matrix was assessed for multicollinearity and singularity. As displayed in Table 15, correlations of greater than .70 were found between census, RN, and total staff; RN and RN to LPN; RN and total staff; AT and total staff, LPN and RN to LPN. The high correlations with census demonstrated multicollinearity, while the correlations between RN, LPN, and AT demonstrated singularity because RN, LPN, and AT are included in the computation of total staff and RN to LPN. Given that the skill mix variables were of primary interest in this study, the variables RN, LPN, and AT were not used in analyses with the variable skill mix. To adjust for the influence of unit acuity, all regressions included acuity. For adverse events, a frequency histogram did not demonstrate a normal distribution. Because the expected occurrence of adverse events is zero, a normal distribution is not expected, thus the data are truncated at zero and are not distributed normally (Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2001). In the current study, 77% of the 1,009

Table 15

Correlation Matrix

	Census	Acuity	RN	LPN	AT	US	Ratio	L to NL	RN to LPN	Total staff	Direct	Indirect	AE
Census	_												
Acuity	.200	_											
RN	.897	.011^{ns}	_										
LPN	-.492	.064	-.694	_									
AT	.650	-.226	.684	-.414	_								
US	.176	-.300	.323	-.136	.179	_							
Ratio	.042^{ns}	.364	-.260	-.058^{ns}	-.193	-.438	_						
L to NL	.011^{ns}	.369	-.006^{ns}	.112	-.675	.099	-.050^{ns}	_					
RN to LPN	.595	-.012^{ns}	.783	-.949	.456	.216	-.054^{ns}	-.042^{ns}	_				
Total staff	.840	-.133	.909	-.470	.865	.458	-.361	-.262	.578	_			
Direct	.423	-.136	.481	-.348	.423	.221	-.143	-.150	.382	.487	_		
Indirect	-.432	.209	-.499	.365	-.471	-.198	.164	.203	-.381	-.514	- .952	_	
AE	.063^{ns}	.043	.059^{ns}	-.062	-.009^{ns}	.011^{ns}	.017^{ns}	.023^{ns}	.060^{ns}	.033^{ns}	.037^{ns}	-.041^{ns}	_

Note. ^{ns} = nonsignificant correlation; All correlations significant unless noted. RN = Registered Nurse, LPN = Licensed Practical Nurse, AT = Assistive Technician, US = Unit Secretary, Ratio = Nurse-to-Patient Ratio, L to NL = licensed to nonlicensed, RN to LPN = proportion of RNs to LPNs, AE = Adverse Events.

cells had a zero value and as expected, the frequency distribution was positively skewed. In order to improve linearity and reduce the extreme skewness and kurtosis for this variable, adverse events was logarithmically transformed, reducing the degree of kurtosis to 5.633 and the measure of skewness to 2.353. All statistical analyses that included adverse events were reported with the transformed variable included in the variable set.

Hypotheses, Statistical Procedures, and Results

Hypothesis 1

Hypothesis 1 stated that a higher skill mix will result in more time spent in direct care and less time spent in indirect care. The hypothesis was tested with two different calculations for skill mix. The first analysis, displayed in Table 16 calculated skill mix as the proportion of licensed staff (RNs and LPNs) to nonlicensed staff (assistive staff). The second analysis, displayed in Table 17 calculated skill mix as the proportion of RN to LPN hours.

For the model testing skill mix as the proportion of licensed to nonlicensed staff, the multivariate test was significant ($\Lambda = .975, p = .000$). Results from the multivariate regression procedure demonstrated that the proportion of licensed to nonlicensed staff was a significant predictor of RN time spent in direct and indirect care per shift. That is, as the proportion of licensed to nonlicensed staff increased by 1%, the percent of RN time spent in direct care decreased 20%, while the percent of RN time in indirect care increased 26 percent. However, the relationship was not in the hypothesized direction.

The values for Eta squared demonstrated that the proportion of licensed to nonlicensed hours contributed 1.2% to the variance in direct care and 1.9% to the

variance in indirect care. Using Cohen's convention for effect sizes (Cohen, 1969), the effect size was small. Although the overall power for the model was .99, the variance explained by the model was only 6 percent.

Table 16

Multivariate Regression Analysis for the Proportion of Licensed to Nonlicensed Staff and Acuity Predicting the Percentage of RN Time Spent in Direct and Indirect Care (N=1,007)

Dependent variable	Parameter	*B*	*SE B*	η^2	ω^2
Direct care	Intercept	66.880*	4.121	.208	.999*
	Acuity	-2.270*	0.813	.008	
	Licensed to nonlicensed	-19.959*	5.758	.012	
Indirect care	Intercept	18.640*	4.270	.019	1.000*
	Acuity	3.972*	.843	.022	
	Licensed to nonlicensed	26.467*	5.967	.019	

Note. Adjusted $R^2 = .060$.

*$p = .000$.

Hypothesis 1 was tested using the second calculation of skill mix, measured as the proportion of RN hours to LPN hours. Table 17 displays the results of the multivariate regression. Multivariate tests were significant for the proportion of RN to LPN hours ($\Lambda = .848$, $p = .000$). Defining skill mix as the proportion of RN to LPN hours demonstrated a significant relationship with the percent of RN time spent in direct and indirect care per

shift, where as the proportion of RN to LPN hours increased by 1%, RNs spent 31.5% more time in direct care and 34% less time in indirect care.

Table 17

Multivariate Regression Analysis for the Proportion of RN to LPN Hours, Unit Secretary, and Acuity Predicting the Percentage of RN Time Spent in Direct and Indirect Care (N=1,007)

Dependent variable	Parameter	*B*	*SE B*	η^2	ω^2
Direct care	Intercept	26.801*	3.843	.046	1.000*
	RN to LPN hours	31.529*	2.606	.127	
	Acuity	-2.373*	.733	.010	
	Unit secretary	2.657*	.715	.014	
Indirect care	Intercept	61.308*	4.009	.189	1.000*
	RN to LPN hours	-35.098*	2.719	.135	
	Acuity	4.752*	.764	.037	
	Unit secretary	-1.557*	.746	.004	

Note. Adjusted $R^2 = .188$.

*$p < .05$.

The values for Eta squared demonstrated that the proportion of RN to LPN hours contributed 12.7% to the variance in direct care and 13.5% in indirect care, a moderate to large effect size (Cohen, 1969). The overall power for the model was .99, while the

variance explained by the model was 18.8 percent. Adding unit secretary to the model demonstrated significant relationships with RN time spent in direct and indirect care as well. The addition of a unit secretary predicted that RNs spend 2.6% more time in direct care and 1.5% less time in indirect care.

These findings support the first study hypothesis, which stated a higher skill mix will result in more RN time spent in direct care and less RN time spent in indirect care. However, given that the model for RN to LPN hours explained a larger portion of the variance in the model and the effect size was large compared to the small effect size for licensed to nonlicensed hours, defining skill mix as the percent of RN hours to LPN hours is a better and stronger predictor of the percent of RN time spent in direct care.

Hypothesis 2

Hypothesis 2 stated that higher numbers of total number of nursing personnel would result in a higher percentage of RN time spent in direct care. Table 18 displays the results of the multivariate regression. The multivariate test was significant for total staff (Λ = .749, p = .000). Results from the regression procedure demonstrated that as total staff increased by 1%, RNs spent 2% more time per shift in direct care and 2.2% less time per shift in indirect care. Values for Eta squared indicated that total staff explained 23% of the variance in direct care and 25% of the variance in indirect care, both large effect sizes (Cohen, 1969). The overall power for the model was above .99, while the model explained 28.3% of the variance in percent of RN time spent in direct and indirect care. The research findings support the second study hypothesis, which stated that higher

numbers of total nursing personnel will result in a higher percentage of RN time spent in direct care.

Table 18

Multivariate Regression Analysis for Total Staff Hours and Acuity Predicting the Percentage of RN Time Spent in Direct and Indirect Care (N=1,007)

Dependent variable	Parameter	*B*	*SE B*	η^2	ω^2
Direct care	Intercept	32.356*	3.292	.088	1.000*
	Acuity	-1.767*	0.674	.007	
	Total staff	2.021*	.117	.229	
Indirect care	Intercept	58.309*	3.372	.229	1.000*
	Acuity	3.668*	.690	.027	
	Total staff	-2.205*	.120	.251	

Note. Adjusted $R^2 = .283$.

*$p < .05$.

While findings for the relationship between total staff and percent RN time spent in direct and indirect care were significant, it is difficult to interpret the findings. This study defined total staff as the sum of all levels of staff, which led to the question of what was the effect of each level of staff. Therefore, a multivariate analysis was conducted to determine the relationships between RN time and individual levels of staff. The results of this analysis are presented in Table 19.

Table 19

Multivariate Regression Analysis for Hours of Staff by Level Predicting the Percentage of RN Time Spent in Direct and Indirect Care (N=1,007)

Dependent variable	Parameter	*B*	*SE B*	η^2	ω^2
Direct care	Intercept	29.908*	1.661	.244	1.000*
	RN	1.665*	.301	.030	
	LPN	-1.207	.720	.003	
	AT	1.818*	.358	.025	
	Unit secretary	2.056*	.675	.009	
Indirect care	Intercept	68.625*	1.715	.615	1.000*
	RN	-1.601*	.311	.026	
	LPN	1.483*	.743	.004	
	AT	-2.563*	.370	.046	
	Unit secretary	-1.488*	.697	.005	

Note. Adjusted $R^2 = .283$. AT = assistive technicians, does not include unit secretary.

*$p < .05$.

With the exception of LPN, multivariate tests were significant (RN, $\Lambda = .036$; AT, $\Lambda = .970$; AT, $\Lambda = .940$; secretary, $\Lambda = .987$; LPN, $\Lambda = .996$). All variables, except LPN, demonstrated significant relationships with percent RN time spent in direct and indirect care. Examining the values for Eta squared presents a clearer picture of the effect of each level of staff on RN time. For direct care, hours of RN have the largest effect, followed by assistive staff, and secretary. The largest effect on indirect care is the assistive staff,

followed by RN, and secretary. However, using Cohen's (1969) convention for effect sizes, all effects were quite small.

Hypothesis 3

Hypothesis 3 stated that the percentage of RN time spent in direct care will decrease when the nurse-to-patient ratio is higher. The multivariate test was significant for nurse-to-patient ratio ($\Lambda = .990, p = .006$). As displayed in Table 20, the model explained 5.1% of the variance in percent of RN time spent in direct and indirect care. Results from the multivariate regression indicated that as the ratio of patients to nurse increased by 1%, RNs spent 2.3% less time per shift in direct care and 2.3% more time per shift in indirect care.

Values for Eta squared demonstrated that the effect size for nurse-to-patient ratio was small (Cohen, 1969), where 1% contributed to the variance in direct care and 0.9% in indirect care. The power for the overall model was .99. Although the effect size for nurse-to-patient ratio was small, the relationships established for the percent of RN time spent in direct and indirect care were significant. Therefore, these findings support the third hypothesis, which stated that the percentage of RN time spent in direct care will decrease when the nurse-to-patient ratio is higher.

Table 20

Multivariate Regression Analysis for Nurse-to-Patient Ratio and Acuity Predicting the Percentage of RN Time Spent in Direct and Indirect Care (N= 1,007)

Dependent variable	Parameter	*B*	*SE B*	η^2	ω^2
Direct care	Intercept	64.347*	3.797	.222	.999*
	Nurse-to-patient ratio	-2.293*	0.712	.010	
	Acuity	-2.360*	.812	.008	
Indirect care	Intercept	23.962*	3.951	.035	1.000*
	Nurse-to-patient ratio	2.287*	.7410	.009	
	Acuity	4.404*	.845	.026	

Note. Adjusted $R^2 = .051$.

*$p < .05$.

Hypothesis 4

Hypothesis 4 stated that a higher percent of RN time spent in direct care would result in a lower occurrence of adverse events. As noted in the correlation matrix of Table 15, percent of RN time spent in direct care did not demonstrate a significant relationship with adverse events. This was confirmed through univariate analysis of variance using the General Linear Model procedure. The model was not significant ($p = .569$), and therefore, hypothesis four was not supported.

Hypothesis 5

Hypothesis 5 stated that a higher proportion of licensed staff to nonlicensed staff will result in a lower occurrence of adverse events. As noted in Table 15, the bivariate correlations between adverse events and licensed to nonlicensed staff were not significant. This was confirmed by univariate analysis of variance using the General Linear Model. The model was not significant ($p = .377$). Therefore, the fifth study hypothesis was not supported by the research findings.

Hypothesis 6

Hypothesis 6 stated that higher numbers of total staff will result in a higher occurrence of adverse events. Again, as noted in Table 15, the bivariate correlation between adverse events and total staff was not significant, and this was confirmed with univariate analysis of variance ($p = .989$). Therefore, the research findings do not support the sixth hypothesis.

Hypotheses 7 and 8

Data related to characteristics of the nursing staff were inaccessible using methods described in the Methods and Procedures section of Chapter 3. As an alternative strategy, short questionnaires asking nursing staff to report their highest level of education, year of graduation from basic training, and certification status were distributed on Unit 5. In addition, the rationale for the questionnaires was presented at their staff meeting. The response rate was less than 10 percent. Given the poor response rate and the low level of

representation of the returned questionnaires, hypotheses seven and eight could not be tested.

Chapter Summary

Chapter 4 discussed screening procedures used to verify data accuracy and procedures undertaken to prepare the data for analysis. Unit and nurse staffing characteristics were presented, followed by the results of statistical analyses conducted to test each study hypothesis.

CHAPTER 5

Discussion

This chapter will begin with a discussion of the descriptive findings as they relate to each of the variables under study and then proceed to findings as they relate to aims one and two, and the study hypotheses. The chapter will conclude with a discussion of the contribution of these findings to nursing and nursing science, implications for nursing and health policy, and recommendations for future research.

The aims of this study were threefold: (a) to examine the relationship between nurse staffing and the amount of time RNs spend in direct and indirect care, (b) to examine whether nurse staffing and the amount of time RNs spend in direct and indirect care is related to adverse events, and (c) to determine whether educational level, length of nursing experience, and specialty certification status of nursing staff are related to the amount of time RNs spend in direct and indirect patient care and adverse events.

Findings from this study suggest that nurse-staffing patterns have a significant effect on the amount of time RNs spend in direct and indirect care. However, different components of nurse staffing have differing effects on the amount of RN time spent in direct and indirect care. This study found no significant relationships between the percent of RN time spent in direct or indirect care and the occurrence of adverse events. The third aim of this study could not be addressed because hospital policy prohibited the release of

person-specific information, even for research purposes. Therefore, data related to nurse characteristics were not available for study.

Nurse Staffing Characteristics

The characteristics of nurse staffing in the five units comprising this sample were examined for their comparability to those reported in other studies. The staffing characteristics in this study appeared to be similar to other studies. The differences and similarities of this sample as it compared to others is presented in the following discussion.

Skill Mix

Two measures of skill mix were used in this study. This study found an average skill mix of 81% when calculating the proportion of RNs to LPNs, and 65% when skill mix was calculated as the proportion of RNs, LPNs to nonlicensed staff. How this compares to findings from other studies depends on the calculation of skill mix. Lichtig et al. (1999) reported an average skill mix of 65.4% when computed to reflect the RN percentage of all staff, while Blegen et al. (1998) reported an average 72% skill mix. However, Lichtig et al. computed skill mix as the proportion of RNs to total nursing staff, while Blegen et al. used the proportion of RN hours per patient day to all nursing hours per patient day. Kovner and Gergen (1998) reported a 67.8% skill mix, but they compared FTE RNs to total FTE hospital nursing employees. The American Nurses Association (2000) reported an average skill mix of 83% when calculated to reflect the RN percent of licensed (RN, LPN). The current study found an average skill mix of 81%

when computed as the proportion of RN to LPN. Given that the computation methods are the same, the average skill mix found in this study is comparable to that found in the American Nurses Association (2000) study. No studies reported skill mix computed as the proportion of licensed to nonlicensed, therefore, there are no means for comparison for the 65% average skill mix found in this study.

Total Staff

In this study, the average number of RN hours was 4.78, LPN hours were 0.9, licensed hours (RN, LPN) were 5.68, and total staff hours were 9.5. This compares to an average of 6.23 RN hours and 1.46 LPN hours (Kovner et al., 2000), 5.76 licensed hours (American Nurses Association, 2000), and 10.75 total staff hours (Blegen & Vaughn, 1998). In their multisite study across eleven states, Needleman et al. (2001) cited sample mean hours of 7.8 RNs, 1.2 LPNs, 2.4 aides, and 11.4 total staff. Florida was not one of the states included in their study. With the exception of the study by Needleman et al., this study found a similar skill mix and staff hours compared to that reported in other studies.

Nurse-to-Patient Ratio

This study found an average nurse-to-patient ratio of 4.4 per shift, meaning that on average, a licensed nurse was assigned four to five patients. Hendrickson et al. (1990) reported a range of four to ten with a mean of 5.78 patients per RN, depending on the unit and shift. Sochalski (2001) found that medical-surgical nurses reported patient assignments ranging from six to eight, also varying depending on the shift. The ratio of

patients to nurses found in this study is lower than that reported by Hendrickson et al. and Sochalski. However, neither study included LPNs in the calculation. In this study, had the calculation omitted LPNs, the ratio of patients to nurse would have been higher. Few studies reported this measure of staffing. Thus, how the findings of this study compare are difficult to interpret in the context of where RNs spend their time.

The California legislature recently passed AB 394 *The Safe Staffing Bill*, mandating hospital-staffing ratios (California Nurses Association, accessed March 14, 2002 at www.calnurse.org/cna/12202). Although the bill is still in the public comment period and has not been finalized, it provides a more current means for comparison of nurse-to-patient ratio. The proposed minimum staffing ratios in California are categorized by specialty area. For example, the medical-surgical non-intensive care setting should be staffed so that the ratio of nurse to patient is no more than 1:6 (after an 18 month phase-in, the ratio should be 1:5). The ratio for specialty/oncology is 1:5, while for telemetry/step-down the ratio is one to four. It would seem that the mean ratio of 4.4 found in this study is in line with that recommended by the California legislature. However, the legislative language contained in the bill is vague as it relates to what level of staff is defined as nurse. By defining nurse as RN or LPN, the mandated staffing ratios are higher than those found in this study. Defining nurse as RN only, the mandated ratios are lower than those of this study. The inconsistency in defining what level of staff constitutes a nurse limits any effort to compare differences in staffing across facilities.

It should be noted that methods to obtain and calculate nurse staffing statistics in the current study differ from the studies cited here. All staffing measures were obtained at the level of the hospital. In addition, staff hours were either computed as FTE hours per

adjusted patient day (Kovner & Gergen, 1998), hours per patient day (Blegen et al., 1998), or hours per patient day weighted by nursing intensity (American Nurses Association, 2000). This study had available the actual hours worked by staff per shift per unit, and thus, comparisons may not be commensurate. In addition, the most current statistics from studies cited here are from 1997 (Needleman et al., 2001). While those statistics are from five years ago, it is difficult to find national data on the nursing workforce. The General Accounting Office notes that these data are limited and not adequate to allow comparisons across states, specialties, or provider types (General Accounting Office, 2001). Therefore, a limitation of this study is that the descriptive findings may not be comparable to state or national statistics, limiting the application of these findings to other acute care facilities.

RN Time Spent in Direct and Indirect Care

The current study found that the average percent of RN time spent in direct care was 54%, while the average time spent in indirect care was 42 percent. The remaining 4% was spent in non-patient care. Based on work sampling studies, RNs spend one third of their time in direct care, one half in indirect care, and 14% in personal time (Prescott et al., 1991). Hendrickson et al. (1990) found similar results. Registered nurses spent on average 31% time in direct patient care, 45% in indirect patient care, 10% in non-clinical activities, and 13% in miscellaneous activities. That the findings from this study differ from other findings are attributed to differences in the operational definitions of direct and indirect care, as well as the methods used to collect the data.

Important to the reported percentages of time spent in categories of care is the categorization of direct, indirect, and non-care. The Division of Nursing in 1978, recommended methods for studying nurse staffing (Prescott et al, 1991), where four categorizations of care were established: (a) direct care, (b) indirect care, (c) unit related care, and (d) personal. Direct care was defined as any activity performed in the presence of the patient or family, while activities performed away from the patient but on the patient's behalf were classified as indirect. On the other hand, Sherrod, Rauch, and Twist (1981) defined direct care as care given in the presence of patients or nursing activities carried out with or without the patient. As Prescott et al. pointed out, activities categorized as direct care and personal activities are generally consistent, however there are inconsistencies in categorizing care as indirect. In work sampling studies of nurses, Feyerherm (1966) defined cleaning and restocking as direct care, whereas Misener, Frelin, and Twist (1987) defined transporting patients as indirect care. Hendrickson et al. (1990) categorized direct care as time spent with the patient; indirect care, such as medication preparation and documentation, was subcategorized into clinical and non-clinical; miscellaneous was classified as non-clinical.

This study defined direct care as time spent in a patient room, in the hallway directly outside of a patient room, or in the medication room. Therefore, in the present study, any RN time devoted to medication preparation, documentation, or discussing patient care with other disciplines that took place in the hallway was counted as direct time. This categorization of percent time in direct care is straightforward as well as being the definition used by Hendrickson et al. (1990). The current study differs from Hendrickson et al. in the classification of indirect care. In the current study site, RNs

surveyed stated that 99% of time spent in the hallway was devoted to documentation or discussing the plan of care with disciplines such as case management, physicians, physical therapists, or respiratory therapy. Therefore, time spent in the hallway was classified as direct care. Hendrickson, as well as other studies cited here, classified these activities as indirect care. Given that these activities such as documentation and discussing the plan of care constitute a large part of RN time, inclusion or exclusion of these activities could account for the difference between the 31% direct care found by Hendrickson et al. and the 54% found in this study. In addition, had Hendrickson et al. categorized as direct care the 11% time spent on charting, 10% preparing therapies, 8% interacting with other professionals, and 3% spent checking physician orders, the reported 31% time spent in direct care would have been over 60 percent. Therefore, in this study the average RN time spent in direct care is actually quite similar to that reported by Hendrickson et al.

For indirect care, this study found a mean RN time of 42 percent. While this is more in line with findings from other studies (Feyerherm 1966; Hendrickson et al., 1990; Misener et al., 1987), there are again, differences in the definition of indirect care. Because this study method did not use direct observation, it was impossible to discern which activities conducted outside of a patient room or hallway were direct versus indirect care. While recognizing that much of RN time spent in areas other than these just mentioned was actually direct care, the decision to code them as indirect care was considered the most conservative, and most importantly, one that would not overestimate time spent in direct care. However, the trade off is that this definitely may have underestimated time spent in direct care.

Aim One

Hypothesis 1

Aim one of this study was to examine the influence of nurse staffing on the amount of time RNs spend in direct and indirect care. The research hypothesis stated that a higher skill mix would result in more RN time spent in direct care and less time spent in indirect care. Findings from this study suggest that when skill mix was defined as the proportion of licensed to nonlicensed staff (RN + LPN/RN + LPN + assistive staff), a significant positive relationship was established between skill mix and the percent of RN time in indirect care, while a significant inverse relationship was established with direct care. These findings do not demonstrate the hypothesized relationships. That is, as the proportion of licensed to nonlicensed staff increases, one would expect that RNs would spend more time in direct care. However, an increase in the licensed staff proportion of the calculation may not reflect an increase in the RN proportion. Rather, it may reflect an increase in the LPN proportion. For example, two RNs and four LPNs is the same proportion of licensed staff as is four RNs and 2 licensed practical nurses. This was supported by Needleman et al. (2001), where they found that LPN hours were higher in hospitals when the share of RN hours were lower. In a situation with a higher proportion of LPNs to RNs, the supervisory role RNs assume with added support staff may be consuming RN time that could have been directed toward direct care. Instead, the RN is spending more time in indirect care, such as supervising and delegating. This may be an explanation for the findings of this study where a higher proportion of licensed to nonlicensed staff did not predict that RNs would spend more time in direct care.

The difference in methods used to calculate skill mix may explain why in this study, a higher ratio of licensed to nonlicensed staff did not predict a lower percentage of RN time spent in direct care. The supervisory role RNs assume when working with LPNs and unlicensed staff may reflect the increased percent of RN time spent in indirect care as either the proportion of licensed to nonlicensed staff increases or the proportion of RNs to LPNs decreases. Because skill mix calculated as the proportion of licensed to nonlicensed staff does not provide a means to differentiate between the RN portion and the LPN portion, the regression results must be interpreted with caution. The positive relationship with RN time spent in indirect care and the inverse relationship established with direct care may be confounded by a measure of skill mix that lacks sensitivity to the proportion of RN to nonRN staff. Although the power for the model was .99, the effect size for licensed to nonlicensed staff was small. Moreover, the model explained 6% of the variance, leaving 94% of the variance unexplained. Although the model was statistically significant, it was not clinically significant.

Hypothesis 1 was tested using a second measure of skill mix. Calculating skill mix as the ratio of RNs to LPNs (RN/RN + LPN) presents a clearer picture of the unique contribution of RNs to the skill mix, as well as the distribution of RN time. Partialing out the effect of the percentage of RNs, skill mix becomes a significant predictor of more time spent in direct care when the percentage of RNs is higher, and more time spent in indirect care when the RN percentage is lower. This model explained a larger portion of the variance ($R^2 = .188$) and the more detailed distinction between RNs and LPNs had a larger effect. This suggests that the percentage of RNs is more important than total numbers of staff. Furthermore, the additive effect of adding a unit secretary frees up 2.4%

more RN time to spend in direct care, while decreasing the amount of RN time spent in indirect care by 1.6 percent. Therefore, this model is a stronger predictor of the amount of RN time spent in direct and indirect care.

The additive effect of a unit secretary on RN time spent in direct or indirect care has not been studied. Results from work sampling studies demonstrate that 10% of RN time is nonclinical (Hendrickson et al., 1990) and a substantial amount of time on unit management activities (Prescott et al., 1991). Nonclinical personnel could perform many of the nonclinical and unit management functions. In their review, Prescott et al. proposed that better secretarial support would improve the delivery of nursing care in hospitals. This recommendation is echoed by Hendrickson et al. who posited that adding adequate support staff may be the most important step hospitals can take to ease the pressures on an overworked nursing staff, possibly adding up to 10% more time for essential nursing task completion. Applying these results to Sochalski's (2001) finding that RNs reported increasing amounts of tasks undone, the addition of a unit secretary may free up enough RN time to facilitate completion of tasks.

The effect found in this study of adding a unit secretary may explain the puzzling finding by Blegen et al. (1998) that the incidence of adverse events increased when the RN percentage reached 85 percent. In this case, a high percentage of RNs may signal a unit staffed with low numbers of supportive personnel and one where RNs perform nonclinical tasks ordinarily performed by unlicensed staff. Spending more time in indirect care leaves less time that could be spent on patient observation and assessment, thereby creating an environment more conducive to adverse events. Given the mean percentage of RN time found in this study, the addition of one unit secretary per shift

would increase the average RN time spent in direct care to 57%, while the average time spent in indirect care would decrease to 41 percent.

The findings discussed here as they relate to skill mix measured as the proportion of RNs to LPNs, support the first hypothesis. The difficulties in interpretation of results when skill mix is measured as a ratio of licensed to nonlicensed staff have been discussed. Because of the insensitivity of calculating skill mix as a ratio of licensed to nonlicensed staff, the small percentage of variance explained by the model, and the small effect size, a recommendation would be to calculate skill mix so that the contribution of the RN percentage mix is accurately represented and results can be interpreted accordingly.

Hypothesis 2

Hypothesis 2 stated that higher numbers of total nursing staff would result in a higher percentage of RN time spent in direct care. Examining the effect of total numbers of nursing staff on the amount of RN time spent in direct and indirect care demonstrated significant relationships. Higher numbers of total staff predicted more RN time spent in direct care and less time spent in indirect care. While this model explained 28% of the variance in RN time spent in direct and indirect care and the effect size was large, the findings are difficult to interpret. Total staff could be any combination of numbers of individual levels of staff. The calculation of this variable has met the same fate as that of calculating skill mix as licensed to nonlicensed staff. The measurement does not allow one to differentiate the unique contribution of a level of staff, thereby limiting the scope of decision-making related to establishing staffing levels.

Information that is more useful is gained by examining the unique effects of the distinct levels of staff on RN time, where this study found that the RN and assistive staff demonstrated the largest effect on where RNs spend their time. Because assistive personnel engage primarily in indirect care and include telemetry technicians and sitters, these findings demonstrate the contribution they make toward relieving the RN of indirect care tasks. In addition, the finding that the RN had the largest effect on time spent in direct care lends support to other findings in this study where the RN seemed to be the driving force behind the distribution of RN time.

It would not be a recommendation to aspects of staffing ratios from the perspective of total staff in future studies. Findings from studies that include total staff as an independent variable must be interpreted with this caveat in mind. Based on the findings from this study, the hypothesis was supported. However, as stipulated in the previous discussion, this result must be interpreted within the context of staffing patterns. A better indicator of the contributions of staff members is to test the specific level of staff.

Hypothesis 3

Hypotheses 3 stated that the percentage of RN time spent in direct care would decrease when the nurse-to-patient ratio is higher. Nurse-to-patient ratio, the final staffing component tested in this study, was found to be a significant predictor of RN time spent in direct and indirect care. In this study, as the number of patients per licensed staff (RN, LPN) increased, the amount of RN time spent in direct care decreased, while time spent in indirect care increased. These findings replicate those of Hendrickson et al. (1990), where more time was spent with patients in areas that had more favorable ratios. A

difference between the Hendrickson et al. study and this study is in the operational definition of nurse-to-patient ratio. For this study, both RNs and LPNs were included in the calculation The ratio used in the Hendrickson et al. study only included RNs; LPNs were included as clinical support staff. Therefore, as with skill mix and total staff, the combination of staffing levels in the calculation becomes an issue. The ratio of nurse to patients tells us nothing about which portion relates to RNs or LPNs in the term nurse-to-patient. For example, four RNs and two LPNs would give us the same six nurses as two RNs and four LPNs.

In spite of the differences in the measures used to define nurse-to-patient ratio, the findings in this study that as the number of patients assigned decreased, the percent RN time in direct care increased are likely explained by the correlation between nurse-to-patient ratio and unit secretary. Inspection of the correlation matrix in Table 15 reveals a significant inverse relationship between ratio and unit secretary, indicating that there were less hours of unit secretary when the number of patients assigned increased. To test this relationship, a post hoc analysis was conducted, using a multivariate regression model testing the effect of nurse-to-patient ratio, unit secretary, and acuity on the percent RN time spent in direct and indirect care. The multivariate test, adjusted for acuity, was significant for unit secretary ($\Lambda = .956, p = .000$). However, the multivariate test was not significant for nurse to-patient ratio ($\Lambda = .996, p = .169$), nor was it a significant predictor of the percent of RN time spent in direct (B = -.805, $p = .288$), and indirect care (B = 1.178, $p = .137$). Unit secretary, however, was a significant predictor of RN time spent in direct care (B = 4.272, $p = .000, \eta^2 = .027$), and indirect care (B =-3.182, $p = .000, \eta^2 = .014$). However, this model explained a small portion of the variance in direct and

indirect care (R^2 = .063) and the size of the effects were small. Therefore, the deciding factor may not be the number of patients assigned to a nurse, it may be the presence of a unit secretary that makes a difference in the amount of RN time spent in direct and indirect care. This finding adds further support to the important contribution of the unit secretary and the impact on where RNs spend their time, however, the effect size was small, and therefore, may not be clinically significant. Based on the findings from this study, hypothesis 3 was supported.

Aim Two

Hypothesis 4

The second aim of this study was to investigate the effects of staffing on the occurrence of adverse events. Hypothesis 4 stated that a higher percentage of RN time spent in direct care would result in a lower occurrence of adverse events. In this study, there were no significant relationships established between components of nurse staffing and adverse events. This is in contrast to other studies that have found significant inverse relationships between skill mix and complications (American Nurses Association, 2000; Archibald et al., 1997; Blegen et al., 1998; Kovner & Gergen, 1998; Lichtig et al., 1999), and medication errors (Blegen et al., 1998). However, Blegen et al., found no relationship with patient falls. The argument given earlier that differences in findings may be explained by differences in the calculation of skill mix, total staff, and nurse-to-patient ratio does not apply here. The correlation matrix in Table 15 does not demonstrate a significant relationship between nurse staffing ratios and adverse events. This was

confirmed by univariate testing, where all models tested were not significant. For these reasons, hypothesis 4 was not supported.

Hypothesis 5

Hypothesis 5 stated that a higher proportion of professional to nonprofessional staff would result in a lower occurrence of adverse events. The univariate test confirmed that the model was not significant. For the reasons given under the discussion pertaining to hypothesis 4, the relationships proposed in hypothesis 5 were not supported by the findings from this study.

Hypothesis 6

Hypothesis 6 stated that higher numbers of total nursing staff would result in a higher occurrence of adverse events. The univariate test was not significant, and therefore, the findings from this study did not support the proposed relationships.

Validity and Reliability Issues

An important point that distinguishes this study from other cited studies is the method used to collect time data. Studies cited here used work sampling techniques, where nonparticipant observers recorded RN time spent in various activities. The time data in this study were collected electronically, thus the methodological issues associated with participant observation were avoided. Much of the bias associated with the observer and observed does not apply here to the same extent as with work sampling techniques.

However, there are issues related to the validity of these data that must be acknowledged. While RN staff in this study did not have data collectors observing and recording their every move, they were very aware that the locator badges they wore were recording the amount of time they spent in unit locations. Time spent on breaks may not be captured in the data file because the locator badge may have been strategically placed elsewhere. It is possible that an RN left their locator badge on their jacket draped over the back of a chair while the RN was moving from patient to patient. The recorded data for this RN would have shown time spent wherever the jacket was, the fact that the RN was moving from patient to patient would not have been captured. Furthermore, given that time in one location was considered valid up to an interval of eight hours, it would seem unlikely that an RN would spend the entire shift in one location. Time data from this study only tell us where an RN was, not the specific activities in which they were engaged.

Study Limitations

The first limitation to this study is that while the data contained within this database provided a record of time spent by RNs in each location, there was no information as to what specific nursing activities were being conducted in each location. Whether time spent in a specific location was measured as direct or indirect care was left to the judgment of the researcher. Time recorded in specific locations was categorized as either direct or indirect based on the researcher's experience and observations of nurses' activities.

A second limitation to this study is that electronic data were captured only if nursing personnel were wearing locator devices. Hospital policy dictated that all nursing personnel wear the locator device and nursing management monitors adherence. However, there were some shifts where there was no recording of a badge assignment to temporary personnel. The possibility that this would occur was tracked weekly by comparing records of badge assignments against unit staffing schedules. Based on these data, it is estimated that approximately 10% of nursing personnel who were scheduled as working were not captured in the electronic recordings.

A third limitation concerns accurate input of staff titles. Correct categorization of nursing staff by staffing level was dependent upon accurate input by staff members responsible for entering those data. Although measures were taken to ensure accuracy, 1.2% of staff titles were missing from the database. The majority of these missing data were determined to represent RNs on the night and weekend shifts and temporary staff. Although the percentage of missing data is small, the apparent nonrandom pattern of missing data limits interpretation of these findings.

The fourth limitation to this study relates to the sample setting. While the findings of this study found significant effects of nursing staff on the amount of RN time spent in direct and indirect care, the findings can only apply to this community hospital on five nursing units. Replication of this study method in other acute care hospitals will validate the representativeness of these findings.

Findings as They Relate to the Donabedian Model of Quality of Care

This study defined structure as unit and nurse characteristics, process as the percent of RN time spent in direct and indirect care, and outcome as the occurrence of adverse events. The findings of this study suggest that the construct of process links structure and outcome through the distribution of RN time to direct and indirect care and established that there are significant relationships between components of nurse staffing, specifically the RN, assistive staff, unit secretary, and the distribution of RN time. Further, these findings demonstrated that it was the RN that made the difference in determining whether nurses spent their time in direct or indirect care. This study was not able to explore nurse characteristics as they relate to process. Findings from other studies that nurse staffing is related to the occurrence of adverse events were not borne out in this study. Despite the fact that the findings of this study did not entirely support the proposed relationships of structure, process, and outcome, the findings do suggest that categories of care in which RNs engage in is a process component that should be considered in future studies. Furthermore, the model studied explained only 19% of the variance, leaving 81% unexplained. As suggested by Aiken and colleagues (1994, 1996, 1999, 2000), the relationships established between nurse staffing and adverse events are largely explained by organizational culture more so than the staffing ratios. While the current study did not measure characteristics of organizational culture, it may explain a portion of the 81% unexplained variance. Future studies would benefit from adding this important measure to the study design.

Contribution of Findings to Nursing and Nursing Science

The primary aim of this study was to explore how staffing ratios influence the amount of RN time spent in direct and indirect care. The model that best explained this relationship included the proportion of RN to LPN hours, unit secretary hours, and unit acuity. Findings from this study indicate that the proportion of RN to LPN hours has a significant and positive effect on RN time spent in direct care. Conversely, there is a significant and inverse effect on RN time spent in indirect care. Few studies have examined this relationship and none have used the methods used in this study to explore this relationship.

One advantage for the current study is that data were available that enabled differentiation between levels of staff, specifically, aides and unit secretaries. This has been a limitation cited in other studies (Kovner et al., 2000; Needleman et al., 2001), where they were not able to assess the contribution to the staffing mix of these important staffing components. Furthermore, no studies were able to test the additive effect of a unit secretary on the outcomes tested in this study, that is, RN time spent in direct and indirect care, and adverse events. Findings from this study demonstrate that an important component of nurse staffing is the unit secretary as it relates to the percent of RN time spent in direct and indirect care. Although the relationship established for unit secretary was significant, the clinical significance was small and merits further study.

Findings from this study shed light on the utility of measuring outcomes with staffing measures such as licensed, nonlicensed, and total staff. Studies that explore the impact of nurse staffing on outcomes are primarily testing the contribution of the RN proportion. Researchers must be certain that their measures accurately reflect the RN

portion of the staff mix and avoid misinterpreting high levels of skill mix to mean high levels of registered nurses. As discussed earlier, interpretation of findings as they relate to staffing ratios must consider the computations used to define staffing in order to ensure that the interpretations are valid.

A secondary aim was to explore the affect of where RNs spend their time on the occurrence of adverse events. While this study did not find significant relationships between RN time and adverse events, the findings that RN and unit secretary hours best predict the percent of RN time spent in direct and indirect care shed light on the linkages that have been found between structure and outcome. We know through empirical findings that nurse staffing can impact patient outcomes. The question is, how does nurse staffing impact outcomes? Put another way, what is the mechanism through which better staffing predicts better outcomes? The findings here provide evidence that as RNs work on units staffed with lower numbers of RNs and unit secretaries, they are spending more time in indirect care and less time in direct care. Thus, time that could have been spent on patient observation and assessment is directed elsewhere. This has been demonstrated in other studies where RNs reprioritized and omitted tasks when faced with time constraints or competing tasks (Hendrickson & Doddato, 1989; Sochalski, 2001; Williams & Murphy, 1979). This redirection of RN time may compromise care delivery by removing the RN from their direct patient care functions, and may explain the relationships between nurse staffing and patient outcomes.

Finally, this study examined the utility of using this type of database for research purposes, specifically the measurement of the distribution of RN time recorded from electronic devices. As a flat file, the database did not lend itself to the creation of

relational databases. A significant amount of time was spent on data management. Dates were numerically formatted in seconds, requiring calculations into a date format. To check for accuracy of date calculations, badge numbers in the time database were compared to scheduled staff on the daily staffing sheet. The badge numbers matched with the scheduled staff, thereby verifying accurate calculations of the date field. The data file required restructuring to allow matching with the daily staffing file. In order to improve the usability of this database, new variables would have to be incorporated into the file, while the date field would require reformatting into the correct month, day, and year. Incorporating these recommendations into the database design will facilitate its use for the purposes of research.

This is the only known study that used this technological method to investigate where RNs spend their time and how staffing ratios influence the percent time spent in direct and indirect care. The methods used here describe a use of technology to access data not previously possible, as well as demonstrate an original application of the technology. Using this technology as a measurement tool for time data did prove to be a reliable measure of time spent in unit locations. Researchers using this method to collect time data need to keep in mind the caveat that the data recorded are those generated by the location of the locator badge, and not necessarily the staff member. Strategies have to be developed in order to effectively deal with measures of extreme intervals of time, while still preserving the integrity and validity of the data as much as possible. For this study, once these strategies were developed and tested, there was confidence that the data were accurate and as valid as possible. This study has identified problematic areas that

future researchers can address beforehand, thereby improving the utility of such databases.

The methods used here may prove to be useful in other applications, such as in long-term care where staffing, utilization of human resources, and the occurrence of adverse events have long been a concern. In addition, the data generated from this tracking technology can help guide nurse executives in decisions about allocation of human resources, as well as optimizing staffing ratios and maximizing resources. These findings demonstrate that the staffing issue in hospitals is not simply one of numbers of nursing staff. When nurse executives are faced with the decision as to which nurse staffing component would best optimize resources, the solution is to increase the percentage of RNs in the nursing staff.

Implications for Nursing and Health Policy

Much of the nursing workforce literature contends that although numbers of RNs employed in hospitals are increasing, the numbers of support staff are decreasing, thereby diluting the effect of adding more registered nurses. Much concern has been expressed in the aftermath of the IOM (Kohn et al., 1999) report that estimated the high number of adverse events in acute care hospitals. As the principal labor component in hospitals, the occurrence of adverse events has significant implications for nursing. The public and private concerns related to nurse staffing in hospitals has prompted several states to establish minimum staffing ratios, California being the first state to establish such ratios. A criticism of minimum staffing ratios is that they are shortsighted and the established minimum may become the maximum (Buerhaus, 1997). An area of concern in California

is that the staffing term, nurse, is not clearly defined. The findings from this study demonstrate that where and how RNs distribute their time is driven by the percent of RN hours in the staff mix. Registered nurses appear to be spending more time on direct care when RN hours are higher in proportion to LPN hours. Furthermore, this finding is reversed when the percentage of licensed hours increases, because it may reflect the indirect time RNs spend in supervising LPNs and unlicensed staff, or the proportion of LPNs is higher compared to RN hours. This finding should be kept in mind when establishing minimum staffing ratios, as well as defining the level of staff that constitutes a nurse.

In addition, a strong predictor of RN time spent in direct care was the unit secretary. Adequate support personnel are critical to the efficiency and productivity of a nursing unit. Negotiations related to staffing should include support personnel in the discussions, while nurse executives should not overlook the important contribution a unit secretary makes to relieve RNs of clerical tasks.

Implications for Future Research

Recommendations revolve around the limitations encountered during this study. First, because this is the first study known to use this technology as a method for data collection, replication using these methods in other sites would validate that these data are accurate reflections of where RNs spent their time. Second, calculation of staffing ratios should be computed so that the specific components of nursing staff are reflected in the calculation. However, total numbers of nurse staffing did not prove to be useful in this study, and therefore, future researchers should carefully consider the usefulness of

this variable. Third, in future studies, detailed plans regarding preparation of the data and data file should be developed prior to data collection. This study has identified areas where programmers could be a valuable asset to a research team. Fourth, replication of this study, but incorporating better measurement of adverse events could shed light on the relationship of this outcome to the processes examined. Fifth, a crucial aim of this study was to explore the relationship between nurse characteristics, distribution of RN time, and adverse events. These data were not made available for this study. Because of the recent concerns related to privacy, confidentiality, and security, the difficulties encountered in this study may become more common. Researchers should try to develop alternate plans for collecting data of these types. There is a delicate balance when trying to protect confidentiality on the one hand and preservation of an environment that is conducive to research on the other hand. Researchers are bound by the standards established to protect confidentiality and anonymity. Developing a trusting relationship between health care executives and researchers would not only advance science, but also would aid health care executives in basing their decisions on empirical evidence and promoting evidence-based practice.

Chapter Summary

Chapter 5 discussed the findings of this study as they related to the aims of the study, each research hypothesis, and the study model. How the study findings contributed to nursing science and health policy were discussed. The chapter concluded with a discussion of implications for future research.

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APPENDIX A

University Community Hospital

October 26, 2001 **REVISED**

Robin Cheung, R.N., MSN

Dear Ms. Cheung:

The Institutional Review Board (I.R.B.) conducted a continuing review of your research protocol, **A Study of How Nurses Spend Their Time and the Relationship to Nurse Staffing Patterns dated 10/07/01"** at their October 25, 2001 meeting and approved it for continuation subject to the following conditions:

1. You are required to conduct a Twelve month review of the research and report that review in writing to the Institutional Review Board.
2. You are required to report any changes in research activity promptly to the Institutional Review Board.
3. Changes in approved research may not be initiated without I.R.B. review and approval, except where necessary to eliminate apparent immediate hazards to the subjects.
4. You are required to promptly report to the I.R.B. any unanticipated problems involving risks to subjects or others.
5. **You are required to post flyers about the research study at all relevant nursing stations.**
6. This IRB approval is valid through October 24, 2002.

Please refer to the document entitled "University Community Hospital, Institutional Review Board" if you require further clarifications of these requirements. You may also refer to Part 56, Chapter 1, Title 21 of the Code of Federal Regulations (or 21 CFR Pt. 50, 21 CFR Pt. 56, and 45 CFR Pt. 46 for DHHS studies).

James P. Orlowski, M.D.
Chair, Institutional Review Board

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About The Author

Robyn Cheung completed her ADN at the Lexington Technical Institute in Lexington, Kentucky. She worked as a staff nurse at the University of Kentucky Hospital while pursuing her BSN and MSN at the University of Kentucky. She graduated with honors from her master's program, where she completed the critical care clinical nurse specialist track, and worked as a case manager for the Emergency and Trauma Surgery service after receiving her master's degree. Upon completion of the acute care nurse practitioner program at the University of South Florida, she entered the doctoral program, also at the University of South Florida.

Ms. Cheung's research interests center on nursing workforce issues, patient outcomes, health policy, and methods in health services research. She is the author of several papers published in peer-reviewed journals, as well as several book chapters.