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Monthly Variation of Unfinished Nursing Care at the US Army Burn Center

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Monthly Variation of Unfinished Nursing Care at the US Army Burn Center

by

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Dedication

This work is dedicated to the members of the nursing staff at the US Army Burn Center, who work tirelessly to improve the lives of those afflicted by dermal and soft-tissue conditions. Their unique dedication to patient-centered care is admirable. Their willingness to participate in this research was evidence of their willingness to put others above themselves for the greater good. I am proud to have served with them and I am proud to call many of them my friends.

This work is also dedicated to my grandfather, “Dude,” and grandmother, Carol. They are the foundation on which my very existence was built. They were my parents and my first cheerleaders. I cannot imagine where I would be without their love, support, and guidance growing up. We lost “Dude” during the data analysis phase of this work and I was heart broken. I know he would be proud and I am elated to be able to share the final product with Carol.

Finally, this work is dedicated to my wife, Kelly, and my children (Tyler, Dylan, Haley, and Holly). They are my life and my newest cheerleaders. Their dedication to my service in the Army Nurse Corps is second only to their dedication to me as a father. It is with their support that I have enjoyed success throughout my career. I hope that my service to the nation and to the profession of nursing are thanks enough for their support and love throughout my life.

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Monthly Variation of Unfinished Nursing Care at the US Army Burn Center

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Unfinished nursing care (UNC) is a problem of time scarcity and has been classified as an error of underuse. More than half of hospital nurses (52-98%) report leaving at least one element of care unfinished due to time scarcity. Relationships between UNC, nursing staff supply, and working conditions were identified in previous cross sectional studies at civilian hospitals; no studies occurred in the burn care or military environments. The purpose of this study was to identify the prevalence and patterns of UNC in relation to variations in nursing staff supply and working conditions at the US Army Burn Center. Registered nurses and licensed vocational nurses working at the 40-bed burn center were asked to complete a 50-item, paper survey once a month for six months. Administrative data related to nursing staff supply and working conditions (e.g., supply/demand ratio, patient turnover, and overtime paid) were collected. Descriptive statistics and multilevel modeling were used in the analysis. The mean response rate for the survey was 44.9% (n = 36-50). Cronbach's alpha was .96-.98. Each month, 85.7%-100% of all nurses reported leaving at least one element of care unfinished. The mean composite score on the Perceived Implicit Rationing of Nursing Care instrument was 1.69-2.27. Elements of care most frequently left unfinished were: documentation of care, emotional support, and reviewing interdisciplinary documentation to inform nursing care. Elements of care least frequently left unfinished were: the provision of enteral/parenteral nutrition, monitoring patient safety, and having important conversations with staff, family, or the patient. Only nursing care hours provided by float staff significantly predicted nurse estimates of UNC, $\beta = .008$, $p < .05$, $R^2 = .021$. These results indicated that the prevalence and patterns of UNC were consistent with findings in previous studies of UNC. This was first study to describe variations in UNC over time and the first to measure UNC in the burn and military environments. Implications for practice, policy, education, and research were discussed.

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Chapter 1: Introduction

In an ideal health care system, hospitalized patients receive high quality, safe care that improves their overall health. Although the definition of health has been debated and may be a matter of perspective (Frank, 2013; Huber, 2011; Shilton, Sparks, McQueen, Lamarre, & Jackson, 2011), high quality care has been well defined. High quality care has been defined as the right care consistently provided to the right person in the right manner at the right time (Institute of Medicine [IOM], 2000). Patients cared for in US civilian hospitals do not consistently receive high quality care (IOM, 2001) and are increasingly at risk of experiencing harm due to errors (Chassin & Loeb, 2011). The Military Health System (MHS) is vulnerable to many of the same quality challenges of civilian health care systems (US Department of Defense [DOD], 2014). Although the combat-oriented health care provided by members of the MHS on the battlefield has been lauded (Butler & Blackbourne, 2012; Kleinke, 2013; Pruitt, 2006; Wood, 2006), the quality of care in the MHS outside the combat environment has been criticized (Granger, Boyer, Weiss, Linton, & Williams, 2010). For example, a 2001 patient safety survey of MHS employees identified 17 items of concern that were related to time scarcity and what is now referred to as unfinished nursing care (UNC) (Connelly & Powers, 2005).

The experience of UNC is inconsistent with MHS goals to provide high quality care in highly reliable organizations. The staff in high reliability organizations have the explicit goal to provide quality, safe patient care in a highly reliable manner and consistently have low error rates over long periods of time (Chassin & Loeb, 2011; King et al., 2008). If the staff cannot efficiently and effectively translate nursing resources into positive changes in patient conditions the organization cannot be considered highly reliable (Chassin & Loeb, 2013); the presence of UNC is an indication of this shortfall. In

2003, the MHS began its journey toward high reliability (King et al., 2008). More than a decade later, a series of articles in the *New York Times* highlighted continued quality and safety concerns at several military hospitals (LaFraniere, 2014, 2015; LaFraniere & Lehren, 2014a, 2014b). Consequently, in 2014, the Secretary of Defense ordered a review of the care provided throughout the MHS. That report, written by a panel of experts from outside the DOD, found that, although MHS hospital quality and safety performance was comparable to that of similar civilian hospitals, MHS facilities did not appear to provide high quality care reliably across the system (DOD, 2014). These findings suggested military hospitals, including the US Army Burn Center (USABC), may experience a prevalence and pattern of UNC similar to civilian hospitals. However, given the unique resourcing, organization, and structure of the MHS, this assertion should be verified.

BACKGROUND AND SIGNIFICANCE

UNC is a well-established problem in civilian hospitals around the world. Data from 36 studies, representing over 111,000 nurses from 23 countries, indicated that more than half of hospital nurses (52-98%) leave at least one element of nursing care unfinished due to time scarcity (Brooks-Carthon, Lasater, Rearden, Holland, & Sloane, 2016; Brooks-Carthon, Lasater, Sloane, & Kutney-Lee, 2015; Cho et al., 2016; Jones, 2015; Jones, Hamilton, & Murry, 2015; Lake, Germack, & Viscardi, 2015; Papastavrou, Charalambous, Vryonides, Eleftheriou, & Merkouris, 2016; Roche et al., 2016; Talsma & McLaughlin, 2015; Tubbs-Cooley, Pickler, Younger, & Mark, 2015). Also referred to as tasks left undone (Aiken et al., 2001), missed care (Kalisch, 2006), and implicitly rationed care (Schubert, Glass, Clarke, Schaffert-Witvliet, & De Geest, 2007), UNC is a problem of time scarcity. Nurses frequently do not have enough time to complete everything that needs to be done for their assigned patients during their shift (Jones et al., 2015; Papastavrou, Andreou, & Efstathiou, 2014a). When time is limited, bedside nurses prioritize the necessary elements of care in order to decide which tasks they will complete (Jones et al., 2015). The necessary elements of care are determined by nursing judgment, provider prescription, and/or professional standards.

UNC represents a special type of underuse, which is the most common problem in health care (Agency for Healthcare Research and Quality [AHRQ], 2015). Shortcomings in the provision of quality care are generally the result of health care overuse, misuse, or underuse. Health care overuse occurs when a patient receives care under circumstances in which its potential for harm exceeds the possible benefit. Health care misuse occurs when the patient does not experience the entire favorable effect of a properly selected health care service. Health care underuse occurs when care that is likely to produce a favorable effect is not provided to a patient (Chassin & Galvin, 1998). It is estimated that at least half of American patients experience an underuse of beneficial health care services (AHRQ, 2015; Schuster, McGlynn, & Brook, 2005). However, prevalence estimates from research conducted in the civilian sector suggested that underuse, as measured by UNC, is even more common. Because more than half of hospital nurses reported leaving at least one element of potentially beneficial nursing care unfinished due to lack of time, most (if not all) hospitalized patients experience an underuse of nursing services.

Research shows that UNC increases a patient's risk of experiencing an adverse event such as falls, pressure ulcers, medication errors, nosocomial infections, or inpatient mortality, $\beta = .29$, $r = .34$ (El-Jardali & Lagace, 2005; Sochalski, 2004). Patients who experience UNC are also at increased risk for readmission within 30 days of discharge, $OR = 1.01$ to 1.12 (Brooks-Carthon et al., 2015). This form of underuse also affects nurses. Consequences of UNC for nurses and hospitals include decreased nurse job satisfaction, $r = -.48$ (Jones, 2014; Kalisch, Tschannen, & Lee, 2011b), decreased nurse occupation satisfaction, *OR* = .60 (Jones, 2014), increased intent to leave, and increased nursing turnover, *r* = .2 to .4 (Tschannen, Kalisch, & Lee, 2010).

A better understanding of the antecedents of UNC is needed. Patient characteristics (such as patient acuity and nursing intensity) were shown to influence the reported prevalence of UNC, β = .02, *r* = .30 (Friese, Kalisch, & Lee, 2013; Nelson & Flynn, 2015). Nursing characteristics (such as licensure and experience) also were shown to influence the reported prevalence of UNC, *F* = 4.79 to 66.73 (Lucero, Lake, & Aiken, 2009; Orique, Patty, & Woods, 2015). And, unit characteristics [such as staffing, non-nursing task requirements, and patient turnover] were shown to influence the reported prevalence of UNC, β = .09 to 2.18, *r* = -.07 to -.13, *OR* = 1.03 (Al-Kandari & Thomas, 2009; Ausserhofer et al., 2014; Cho et al., 2016). Furthermore, broader work environment characteristics (such as adequacy of resources, teamwork, and patient safety climate) were shown to influence the reported prevalence of UNC, β = -.773 to .06 (Castner, Wu, & Dean-Baar, 2014; Hessels, Flynn, Cimiotti, Cadmus, & Gershon, 2015; Rochefort & Clarke, 2010). Many of the relationships between UNC and these characteristics were weak or inconsistent, indicating that more information is needed before sustainable interventions can be developed to reduce the risk of adverse outcomes due to UNC for patients and nurses.

Statement of the Problem

The nursing care system at the USABC is particularly vulnerable to UNC. A portion of the DOD health care mission is dedicated to the care of burn patients; USABC nurses care for approximately 800 patients annually (US Army Institute of Surgical Research [USAISR], 2015b). As the only burn center in the DOD, the 40-bed USABC serves military beneficiaries and Veterans' Administration patients from around the world. The USABC also is the only American Burn Association (ABA)-verified facility in the geographic region (ABA, 2015). Consequently, the USABC provides burn care to civilian burn and trauma patients as the regional burn-referral facility for more than 20 counties in south central Texas (Renz et al., 2012; USAISR, 2015a; US Army Medical Department [AMEDD], 2015). The USABC is located at Joint Base San Antonio – Fort Sam Houston, Texas, within San Antonio Military Medical Center (SAMMC), a regional Level 1 trauma center with its own patient care mission (AMEDD, 2015). A burn surgeon, who serves as the burn director, oversees the USABC. A registered nurse (RN) serves as the chief nursing executive of the USABC. Along with members of the medical, behavioral, rehabilitation, and respiratory therapy staff, RNs, licensed vocational nurses (LVNs), and unlicensed assistive personnel (UAPs) provide direct patient care. Although it is physically located within SAMMC, the USABC and its parent command, the USAISR, are subordinate elements of the US Army Medical Research and Materiel Command, located at Fort Detrick, Maryland (USAISR, 2015a). Because it is administratively separated from SAMMC, the USABC has limited surge capacity for responding to increased nursing care demand and/or staff shortages.

The prevalence of UNC in civilian hospitals is consistently highest in the areas of emotional support, care coordination, patient education, and timeliness (Jones et al., 2015; Papastavrou et al., 2014a). These elements of care are essential for successful management of fragile patients with complex needs such as those suffering from burn injuries. Burn care is associated with physical and emotional trauma, long hospitalizations, complex interdisciplinary interventions, and significant post-discharge self-care burden (Price & Milner, 2012; Renz et al., 2012). A significant presence of UNC at the USABC would indicate that the nurses could not reliably meet the needs of their patients.

A desire to describe the prevalence and patterns of UNC at the USABC led to the current study. The science of UNC comes almost exclusively from cross-sectional designs in the settings of acute and critical care nursing units in civilian hospitals (Brooks-Carthon et al., 2016; Cho et al., 2016; Jones et al., 2015; Leineweber et al., 2016; Pacsi, Soderman, & Kertesz, 2016; Papastavrou et al., 2014a; Papastavrou et al., 2016; Roche et al., 2016; Tubbs-Cooley et al., 2015). Consequently, the variability of UNC over time is not known and temporal relationships between UNC and changes in the nurse work environment have not been examined. Additionally, there are no published studies of UNC in any military hospitals or ABA-verified burn centers. Although civilian hospitals and ABA-verified burn centers, such as the USABC, are similar in many ways, the differences in patient care requirements, resourcing, organization, and structure are distinct enough to warrant the study of UNC in these environments. For example, surge capacity is particularly important in military hospitals because military nurses are occasionally removed from patient care duties to attend military training or other military requirements, which are given priority over patient care. Additionally, nurses in burn centers face distinct time management challenges due to care requirements unique to this patient population (e.g., full-assist showers and hours-long dressing changes). These differences in nursing staff supply and working conditions may affect the prevalence of UNC and result in previously unrecognized patterns of UNC that are unique to the MHS and/or burn centers.

PURPOSE

Given the dearth of literature related to UNC in the military and burn environments, and the limited understanding of the temporal relationships between the proposed antecedents and UNC, the purpose of this descriptive, longitudinal study was to examine the variability in the prevalence and patterns of UNC in the USABC over time.

RESEARCH QUESTIONS

The following research questions were examined in the current study:

1. What is the monthly variation in the prevalence and patterns of UNC in the USABC?
2. What is the relationship between nursing staff supply and UNC in the USABC?
3. What are the relationships between working conditions and UNC in the USABC?

CONCEPTUAL FRAMEWORK

Nursing Care Performance Framework

In hospitals, no other professional provides more direct patient care than nurses and few other professionals are positioned to engage the patient through the entire continuum of care (IOM, 2011). As such, nurses and the nursing care system are seen as a major vehicle for quality improvement efforts in hospitals. The nursing care system also has been referred to as nursing services. It is conceptualized as a complex set of interrelated, functional subsystems within each healthcare organization that are aimed at producing a change in patient condition (Dubois, D'Amour, Pomey, Girard, & Brault, 2013). However, the relationships between the nursing care system and patient outcomes have not been adequately described, in part due to a poor conceptualization of the nursing care system (Griffiths, 2009; Thomas-Hawkins, Flynn, & Clarke, 2008; Wong, Cummings, & Ducharme, 2013). In a review of the literature related to nursing care performance, Dubois and colleagues (2013) identified 31 conceptualizations of nursing care systems. This variation in nursing care system conceptualizations introduces gaps in system performance measurement and makes cross-study comparisons challenging. A unifying framework would provide clarity to the relationships within the nursing care system.

The Nursing Care Performance Framework (NCPF) was designed to guide performance evaluation of nursing care systems within healthcare delivery systems (Dubois et al., 2013). The NCPF (see Figure 1) is a synthesis of the 31 conceptual frameworks for nursing care systems. It is based on the structure-process-outcome triad (Donabedian, 2005), Parsons' framework for social analysis (Parsons, 1960), and systems theory (Reid, Compton, Grossman, & Fanjiang, 2005). The NCPF depicts the general mechanisms involved in transforming resources into nursing care to achieve desired outcomes for patients. Additionally, each subsystem must perform reliably in order for the larger system to achieve maximum benefit from each subsystem (Dubois et al., 2013). Therefore, the NCPF can be used to clarify the relationships between the nursing care system and patient outcomes. The NCPF guided the selection of study variables and relationships evaluated in the current study.

Nursing performance is broadly defined in the NCPF as "the capacity demonstrated by the organization or an organizational unit to acquire the needed nursing resources and use them in a sustainable manner to produce nursing services that effectively improve patients' conditions" (Dubois et al., 2013, p. 6). The functional subsystems of the NCPF include a) acquiring, deploying, and maintain resources, b) transforming resources into services, and c) producing changes in patient conditions (Dubois et al., 2013). These subsystems are multidimensional and interdependent with multiple hypothesized cross-functional relationships between structures, processes, and outcomes of care related to nursing services. Within the NCPF framework, the nursing process represents the transformation of resources into nursing care and is portrayed as the mechanism through which nurses influence patient outcomes. The capacity to transform resources through application of the nursing process is determined by the availability, deployment, and management of human and material resources.

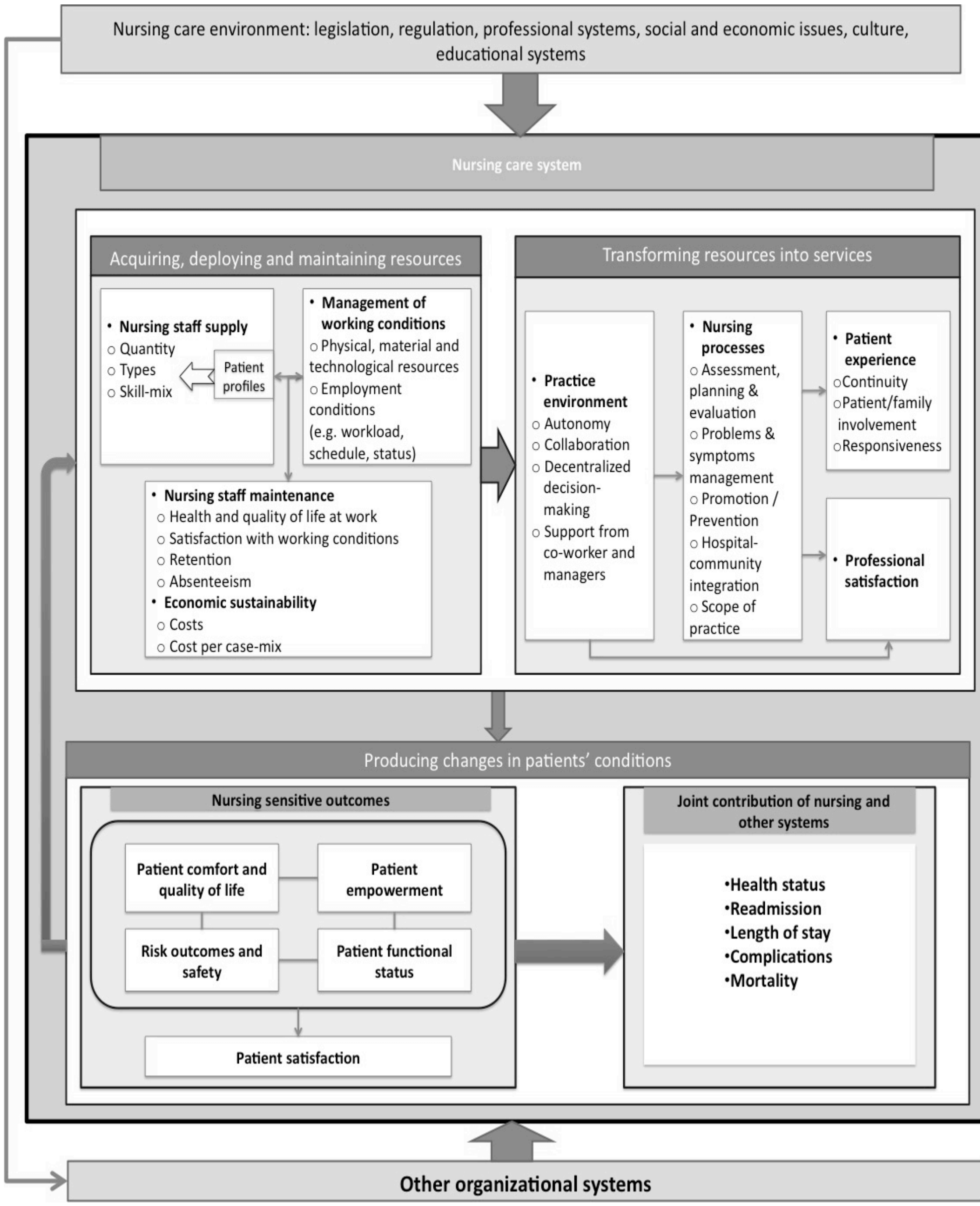

Figure 1. The Nursing Care Performance Framework.

From "Conceptualizing performance of nursing care as a prerequisite for better measurement: A systematic and interpretive review," by C. A. Dubois, D. D'Amour, M. P. Pomey, F. Girard, & L. Brault, 2013, *BMC Nursing, 12*(7), 17. Copyright 2013 by the authors.

Conceptual Framework for Research

The current study focused on selected cross-functional relationships between the subsystems of **acquiring, deploying, and maintaining resources** and **transforming resources into services.** Without these activities, the nursing care system cannot produce changes in patients' conditions. The activities associated with **acquiring, deploying, and maintaining resources** represent nursing care system structures that provide the means to meet the healthcare needs of patients (Dubois et al., 2013). Dubois and colleagues (2013) posited four dimensions in the structure subsystem of the framework (*nursing staff supply*, *management of working conditions*, nursing staff maintenance, and economic sustainability), proposing that all four dimensions influence the processes through which patient care is provided. Structure measures have been considered in the nursing quality literature (Alexander, 2007; Naylor, 2007) and were shown to influence changes in patient conditions (Aiken, Clarke, Sloane, Sochalski, & Silber, 2002; Bae, Kelly, Brewer, & Spencer, 2014; Blegen, Goode, Spetz, Vaughn, & Park, 2011; Breckenridge-Sproat, Johantgen, & Patrician, 2012; Lasater & McHugh, 2016; Needleman et al., 2011). Structure measures also were considered frequently in studies of UNC, particularly those measures related to *nursing staff supply* and the *management of working conditions* (Jones et al., 2015; Papastavrou et al., 2014a). However, in an environment such as the USABC, where the nursing care system structures may shift depending on military missions, the study of UNC may provide new information about how nursing care system structures influence estimates of UNC.

The activities associated with **transforming resources into services** represent the mechanisms through which the nursing care system meets the healthcare needs of the patient. Dubois and colleagues (2013) also posited four dimensions in the process subsystem of the framework (practice environment, *nursing processes*, patient experience, and professional satisfaction), proposing that interactions between all four dimensions influence changes in a patient's condition. The *nursing processes* dimension is central to this subsystem; without nursing processes, nursing care does not occur and changes in patient condition cannot occur in the nursing care system. Therefore, *nursing processes* are a key mechanism in transforming nursing care resources into changes in patients' conditions. However, process measures have been largely underrepresented in the nursing quality literature (Alexander, 2007; Naylor, 2007). The study of UNC represents an opportunity to more fully understand how nursing care system structures influence *nursing processes* and performance of the nursing care system. As a process measure, higher levels of UNC likely indicate that the nursing care system is performing inadequately (VanFosson, Jones, & Yoder, 2016). At the USABC, variations in nursing care system performance may occur due to competing demands on nursing time (such as military and patient care missions). Therefore, the study of UNC may provide important information about how USABC structures influence the *nursing processes* and performance of the USABC nursing care system.

In the conceptual framework that guided the current study (see Figure 2), dimensions of the structure subsystems were *nursing staff supply* and *management of working conditions* and are represented in the solid squares. The solid arrows represent the possible relationships between the variables. Dashed lines connect the variables to dashed squares, which represent categories of empirical indicators (nurse staff type and employment conditions) for each dimension. For ease of understanding, the variables in the current study were operationalized according to these categories, which align with possible empirical indicators according to the relationships outlined in the NCPF.

The independent variables in the current study reflect the subsystem related to **acquiring, deploying, and maintaining resources** and included the empirical indicators

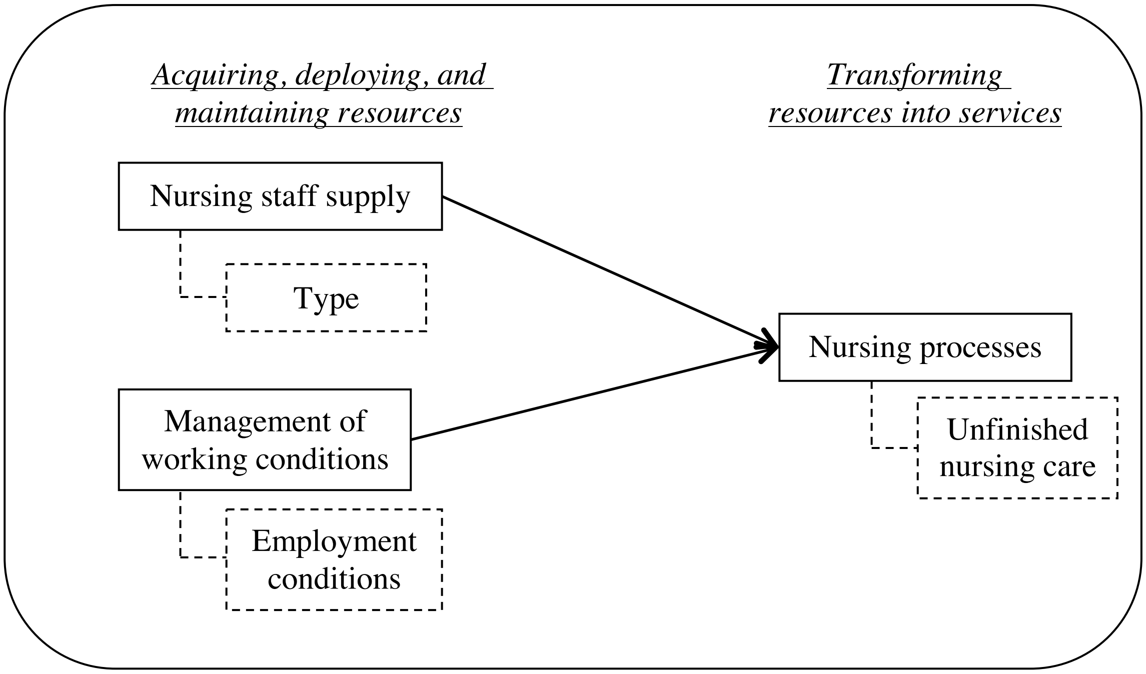

Figure 2. Conceptual framework.

Adapted from "Conceptualizing performance of nursing care as a prerequisite for better measurement: A systematic and interpretive review," by C. A. Dubois, D. D'Amour, M. P. Pomey, F. Girard, & I. Brault, 2013, BMC Nursing, 12(7) p. 17.

of *nursing staff supply* and *management of working conditions*. The empirical indicators used in the current study were generally described and categorized by Dubois et al. (2013) and also were represented in studies of UNC (Jones et al., 2015; Papastavrou et al., 2014). In the current study, *nursing staff supply* was represented by indicators of staff type (nurse licensure, experience in nursing, experience in burn care, employment category, nurse education). The following indicators represented *management of working conditions*: employment conditions [supply/demand ratio (SDR), patient turnover, unit worked, shift worked, overtime paid (OTp), and nursing care hours (NCHs) by float staff]. The dependent variable in the current study reflected the subsystem of **transforming resources into services** and was represented by UNC, an indicator of *nursing processes*. This indicator was not described by Dubois et al. (2013), but has been proposed as an important indicator of nursing process performance (VanFosson et al., 2016).

Definitions

The following definitions were used throughout the current study:

Conceptually, *nursing staff supply* reflects numerous processes needed to provide the right quantity, type, and mix of nursing staff at the bedside at the right time (Dubois et al., 2013). Nursing staff type accounts for the educational preparation, qualifications, and experience of the staff (Dubois et al., 2013).

In the current study, nurse staff type was operationalized as:

- Nurses' licensure, experience in nursing and burn care, and education, all derived from nurse responses on the demographic portion of the nurse survey.

Conceptually, the *management of working conditions* reflects the managerial processes that determine the system resources (physical, material, and technological) and employment conditions (workload, scheduling, employment status, and labor relationships) that influence the stability of the nursing workforce (Dubois et al., 2013).

In the current study, the *management of working conditions* was operationalized using indicators of employment conditions. They were defined as:

- Supply/demand ratio, which resulted from a mathematical calculation of NCHs (available) divided by NCHs (required). Nursing care hours (available) quantified the supply of nurses in terms of the total number of hours actually worked by direct care nurses. These data were derived from administrative records maintained by the nursing administrators of each nursing unit. Nursing care hours (required) quantified the demand for nursing care. These data were derived from the Workload Management System for Nursing-Internet (WMSNi). WMSNi is a standardized, nurse-entered workload-estimating program unique to the MHS (Molter, 1990; Sherrod, 1984; Wolgast, Taylor, Garcia, & Watkins, 2011). The estimates of NCHs (required) were based on a daily review of the patient chart. Over a 24-hour period, at least two nurses reviewed the patient chart and estimated the NCHs (required) in WMSNi. This process previously demonstrated a high level of inter-rater reliability, r = .83 to .95 (Sherrod, 1984). Additionally, inter-rater reliability is assessed quarterly on each nursing unit to ensure that estimates of NCHs (required) remain reliable, $r > .80$ (Army Medical Expense and Performance Reporting System Program Office, 2012).

- Indications of patient turnover were derived from counts of patient census, patient admissions, discharges, and transfers in/out of a nursing unit, and patient death.

- Nurses' employment characteristics, which included indications of employment category, unit worked, and shift worked (derived from nurse responses on the survey), as well as indications of OTp and NCHs provided by float staff (both derived from USABC administrative data).

Conceptually, *nursing processes* are the vehicles through which patient needs are identified and beneficial nursing interventions are planned, implemented, and evaluated. *Nursing processes* reflect a nurse's ability to complete relevant care processes and meet the needs of assigned patients (Dubois et al., 2013).

In the current study, *nursing processes* were operationalized as UNC, derived from the Perceived Implicit Rationing of Nursing Care (PIRNCA) instrument (Jones, 2014). The PIRNCA was the central instrument in the survey completed by the USABC nurses.

Chapter Summary

Patients who receive care in US civilian hospitals are vulnerable to quality of care challenges. Patients cared for in MHS hospitals are vulnerable to the same challenges. The presence of UNC is inconsistent with MHS goals to provide high quality patient care reliably across the system because the presence of UNC in a nursing care system indicates that the system cannot efficiently transform nursing care system structures into high quality nursing care. Due to differences in the patient care requirements and in nursing care system structures, nursing care at the USABC is particularly vulnerable to the potential effects of UNC. Therefore, the purpose of this descriptive, repeated measures study was to examine the variability in the prevalence and patterns of UNC in the USABC over time. In doing so, the current study described the prevalence of UNC on the two USABC nursing units. Furthermore, the current study determined the relationships between *nursing staff supply*, *management of working conditions* and *nursing processes*. The literature review presented in Chapter 2 will provide a more thorough understanding of the phenomenon of UNC and will lay the foundation for the design and methods of the current study.

Chapter 2: Review of the Literature

When looking to improve the quality of care provided in a healthcare system, it is helpful to consider the influence of the processes and structures of the system on the desired outcome (Donabedian, 2005). Measuring system processes is important to healthcare quality because it allows healthcare system leaders to identify latent errors produced by changes in system structures before these errors result in patient harm (Cho, 2001; Reason, 1990). Process-oriented measures have been underrepresented in the nursing care quality literature. Specifically, in their systematic review of nursing care performance conceptualizations, Dubois and colleagues (2013) found that less than one-fifth of the nursing care system performance indicators were process-oriented (Dubois et al., 2013). Therefore, the current study was designed to facilitate a better understanding of the relationship between the processes and structures of the US Army Burn Center (USABC) nursing care system. In the context of the nursing care system, **transforming resources into services** represented the system processes and **acquiring, deploying, and maintaining resources** represented the system structures (Dubois et al., 2013). Therefore, the variables **transforming resources into services** and **acquiring, deploying, and maintaining resources** are described in this chapter. Additionally, the known relationships between indicators of these variables are described and gaps in the literature are identified.

TRANSFORMING RESOURCES INTO SERVICES

The Nursing Care Performance Framework (NCPF) subsystem of **transforming resources into services** represented the dependent variable in the current study. The subsystem includes four subordinate dimensions of the nursing care system: the nurse practice environment, the patient experience, professional satisfaction, and *nursing* *processes* (Dubois et al., 2013). The current study focused on the dimension of *nursing processes*.

Nursing Processes

Nursing processes are the vehicles through which patient needs are identified and beneficial nursing interventions are planned, implemented, and evaluated (Dubois et al., 2013). In the context of the NCPF, *nursing processes* include implementation of the classic five-step nursing process (assessment, diagnosis, planning, implementation, and evaluating) across the entire scope of nursing practice (American Nurses Association, 2016). In addition to the nursing process, *nursing processes* include the technical aspects of care and reflect the degree to which nurses use their entire scope of practice to meet the needs of the patient (Dubois et a., 2013). As such, measurement of *nursing processes* indicates how effectively patients' needs are identified and beneficial nursing care is provided and evaluated.

To date, measurement of *nursing processes* has been limited, in large part because it is difficult to measure the many processes of care undertaken at the bedside. As many as 101 measures can be found in nursing performance measurement programs such as The Joint Commission or the Center for Medicare & Medicaid Services Inpatient Quality Reporting Program (VanFosson et al., 2016); only 15 have been endorsed by the National Quality Forum as nurse-sensitive quality indicators (National Quality Forum, 2004). Additionally, only three of the endorsed measures were considered indicators of *nursing processes*. However, these indicators (which were related to smoking cessation) applied only to a relatively small portion of the patient population and reflected one of a myriad of nursing interventions. As such, these indicators did not adequately reflect the scope of nursing processes for all patients.

In their review of nursing performance measurement, Dubois and colleagues (2013) identified 33 other indicators that target *nursing processes* in the context of patient care quality. For example, a process of nursing care rating system has been proposed (Chang et al., 2002; Pearson et al., 2000). In this system, registered nurses (RNs) conducted structured, retrospective reviews of patient charts. The reviewers assessed each chart for less than adequate care using 16 Likert-type scales about nursing assessment, problem identification, problem management, and overall nursing quality. This system for evaluating nursing care processes was limited by its reliance on nursing documentation, which is often incomplete, and the subjective judgment of the reviewers (Chang et al., 2002). Another study described the use of nurse interviews to identify nurse behaviors that reported, prevented or resolved patient safety issues as measures of *nursing processes (*Stetler, Morsi, & Burns, 2000). Both of these methods of measuring *nursing processes* were labor intensive, requiring nursing leaders and researchers to invest personnel (chart reviewers or interview participants) and time (several days or weeks) to collect and analyze the data. Additionally, due to the time required to collect and analyze the data, any findings from these measures would not be helpful to nursing leaders who want to identify nursing care quality challenges in a timely manner. A review of nurse-sensitive performance measures by Needleman, Kurtzman, and Kizer (2007) indicated that nursing documentation and data systems would be ideal sources for measures of *nursing processes*. These systems would provide a means of querying documentation systems for the occurrence (or, non-occurrence) of a specific element of nursing care. However, this method of measurement is limited because many *nursing processes* may not be captured in nursing documentation, either due to omission or limitations in documentation processes (Needleman et al., 2007).

Because the measurement of *nursing processes* is so challenging, many other nursing care quality indicators found in the literature (such as patient experience, nurse professional experience, and various patient outcomes) have been considered proxy measures of *nursing processes* (Alexander, 2007; Dubois et al., 2013; Naylor, 2007; Needleman et al., 2007). In this way, performance on one of these proxies is presumed to reflect the performance of *nursing processes*. However, in the context of the NCPF, many of these indicators represent phenomena that occur downstream from *nursing processes*. Therefore, these measures were not considered indicators of *nursing processes* in the current study.

Unfinished Nursing Care as a Measure of Nursing Processes

Unfinished nursing care (UNC) has been proposed as an indicator of nursing performance that specifically reflects *nursing processes* (VanFosson et al., 2016) and therefore represented *nursing processes* in the current study. *Nursing processes* reflect a nurse's ability to complete relevant care processes and meet the needs of their assigned patients (Dubois et al., 2013). When UNC occurs, aspects of these processes were delayed or incomplete, indicating that the nursing care system resources were not effectively transformed into services (Ausserhofer et al., 2013; Jones et al., 2015; Kalisch, Landstrom, & Williams, 2009; Schubert et al., 2007). Accordingly, UNC reflects the extent to which nursing care system resources are, or are not, reliably transformed into nursing care.

Conceptualization

The conceptualization of UNC has evolved since the phenomenon was first identified. The phenomenon was originally characterized as nursing care left undone, a byproduct of hospital administration decisions that resulted in nurses spending time completing tasks such as passing meal trays or answering phones (non-nursing tasks) and leaving undone activities that required nurse expertise (Aiken et al., 2001). Other conceptualizations of the phenomenon, such as the implicit rationing of nursing care (Schubert et al., 2007) or missed nursing care (Kalisch, Landstrom, & Hinshaw, 2009), explored the phenomenon in greater detail and indicated that UNC resulted from nurse decision-making in the context of organizational and nurse factors. More recently, Jones et al. (2015) clarified the conceptualization when they described UNC as a problem of time scarcity. During periods of time scarcity, nurses initiate a process of clinical prioritization or implicit rationing to determine which elements of care will be finished and which elements of care, if any, will be left unfinished (Jones, 2016). This prioritization occurs as a result of an imbalance between *nursing staff supply* and *management of working conditions*. Because this decision-making process constitutes a process of allocating a resource (nursing time) in periods of resource scarcity, the mechanism by which UNC occurs is called the implicit rationing of nursing care.

Operationalization

Generally, estimation of UNC has been achieved using various survey-based instruments administered to nurses who provided direct patient care. However, one study in the perioperative environment screened perioperative bundle documentation to identify UNC (Talsma & McLaughlin, 2015). In the remaining UNC literature, there were more than 20 different survey instruments identified. All of the surveys represent one of three research approaches to the phenomenon of UNC: tasks undone, implicit rationing of nursing care, or missed nursing care (Jones et al., 2015). These instruments asked the nurse to think about the care they provided on shifts previously worked and identify the elements of care they were unable to finish during the time period identified on the survey. In the tasks undone approach (Aiken et al., 2001), nurses were asked to consider their last shift worked. The instrument was scored as a summation of nursing tasks left undone ("yes" items scored as one). In the implicit rationing of nursing care approach (Schubert et al., 2007), nurses were asked to consider their last seven working shifts. These instruments used a four- or five-point Likert-type scale to report the frequency with which individual elements of care were left unfinished. In the missed nursing care approach (Kalisch & Williams, 2009), nurses were asked to identify the frequency with which individual elements of care were usually left unfinished (no reference time period was provided). These instruments used a five-point Likert-type scale to report UNC frequency. The scoring of instruments using the implicit rationing of nursing care and missed nursing care approaches was accomplished by numerating the scale responses (less frequent UNC was the lower score) and reporting the mean frequency of UNC for all elements of care and for the individual elements of care.

The instruments used to estimate UNC have been shown to be valid and reliable. The various instruments were constructed after consultation with acute care nursing clinical experts and consideration of previous instruments used to evaluate nursing care (Ausserhofer et al., 2013; Schubert et al., 2007; Jones, 2014; Rochefort & Clarke, 2010). The original instrument in the missed nursing care approach (the MISSCARE Survey) was developed based on the findings of a qualitative study of the phenomenon (Kalisch & Williams, 2009). Construct validity for the Basel Extent of Rationing of Nursing Care (BERNCA) was further supported by negative correlations between estimates of UNC and dimensions of the Nursing Work Index-Revised (NWI-R; Aiken & Patrician, 2000), r = -.26 to -.46, p = .01 (Schubert et al., 2007). Similarly, estimates of UNC established using the Perceived Implicit Rationing of Nursing Care (PIRNCA) instrument were negatively correlated with the subscales of the Essentials of Magnetism II instrument (Schmalenberg & Kramer, 2008), r = -.28 to -.53, $p < .001$ (Jones, 2014). The internal consistency coefficients for the survey instruments ranged from .73 to .97 (Ausserhofer et al., 2013; Jones, 2014; Kalisch, Terzioglu, & Duygulu, 2012; Lucero et al., 2009; Rochefort & Clarke, 2010; Schubert et al., 2007; Zuniga et al., 2016).

The instruments used to estimate UNC have been adapted for use in various situations and target populations. Across the three approaches, the survey instruments contained as few as five and as many as 52 elements of care for research participants to consider (Aiken et al., 2001; Kalisch & Williams, 2009; Rochefort & Clarke, 2010; Schubert et al., 2007; Zhu et al., 2012). Additionally, the MISSCARE Survey was adapted for use in seven different countries (Bragadottir, Kalisch, Smaradottir, & Jonsdottir, 2015; Cho, Kim, Yeon, You, & Lee, 2015; Kalisch, Doumit, Lee, & Zein, 2013; Kalisch, Terzioglu, & Duygulu, 2012; Palese et al., 2016; Papastavrou et al., 2016; Siqueira, Caliri, Kalisch, & Dantas, 2013). And, in one report, the MISSCARE Survey was adapted for patient respondents (Kalisch, Xie, & Dabney, 2014). Also, the BERNCA was adapted for use in nursing homes (Zuniga et al., 2016) and the Neonatal Extent of Work Rationing Instrument (NEWRI) was developed for use in the neonatal intensive care environment (Rochefort & Clarke, 2010).

These instruments also have been used for various members of the acute care nursing team. Reports consistent with the tasks undone approach did not consistently report the members of the nursing team targeted in the study; it appears that only RNs completed surveys in the tasks undone approach. Instruments from the implicit rationing of nursing care and missed nursing care approach were used for populations that included RNs, licensed vocational nurses (LVNs), and nurse managers (Bragadottir, et al., 2015; Bragadottir, Kalisch, & Tryggvadottir, 2016; Gravlin & Bittner, 2010; Jones, 2015; Kalisch & Lee, 2012a). Only the missed nursing care approach included unlicensed assistive personnel (UAPs) in reports of UNC (Kalisch & Lee, 2010; Kalisch, Tschannen & Lee, 2011a).

Previous studies of UNC that were concerned about the possible reasons for UNC generally followed the missed nursing care approach. The primary instrument of the missed nursing care approach, the MISSCARE Survey, was developed with two sections. The first section of the instrument (Part A) was as previously described. The second part of the instrument (Part B) was a four-point Likert-type scale survey that asked participants to identify the frequency with which one of the listed items was a reason elements of care were left unfinished (Kalisch & Williams, 2009). No other instrument contained items used to identify the perceived sources of time scarcity in the nursing care system.

Patterns and Prevalence

Researchers have described the prevalence and patterns of UNC from medical, surgical, critical care, labor and delivery, neonatal, operating room, and nursing home environments (Ausserhofer et al., 2014; Chan, Jones, & Wong, 2013; Kalisch, 2006; Nelson & Flynn, 2015; Schubert et al., 2013; Simpson & Lyndon, 2016; Talsma & McLaughlin, 2015; Tubbs-Cooley et al., 2015). These studies revealed that when *nursing processes* were disrupted (as indicated by the presence of UNC), patient outcomes were significantly influenced (see Table 1).

In the literature about UNC, patient outcomes data were derived from nurses, patients, and administrative records. The use of nurse self-report to identify patient outcomes frequencies exposes the science of UNC to criticism regarding common method/source bias (Jones et al., 2015). Using nurse self-report surveys to estimate patient outcomes assumes that bedside nurses recognize when or how often patient adverse events occur. Additionally, using nurse self-report surveys to estimate UNC occurrence assumes that bedside nurses know what elements of care are required for their patients, recognize when necessary elements of care remain unfinished, and remember to report all elements of care left unfinished. Presumably, the most effective methods of identifying patient outcomes and the occurrence of UNC are by direct observation of

Table 1: *Summary of Patient Outcomes*

Outcome	Effect	References
Subjective Data		
Nurse-Derived		
Overall quality of care	r = -.37 to -.63	a, b, c
Adverse events (composite score)	r = .34; β = .29	c, d
Medication errors	*OR* = 2.5; β = .07	e, f, g
Patient falls	*OR* = 1.7 to 2.4; β = .07	e, f, h
Nosocomial infections	*OR* = 1.3 to 3.0; β = .09	g, h, i, j
Pressure ulcers	*OR* = 1.2 to 3.4	e, g, h
Patient-Derived		
Medication errors	r = 2.19 to 2.84	k
Nosocomial infections	r = 1.93 to 2.81	k
Pressure ulcers	r = 1.80 to 2.05	k
Intravenous line complications	r = 1.68 to 2.83	k
Patient satisfaction	*OR* = .3 to .6; r = -.5 to -2.21	e, g, l
Objective Data		
Administrative Record-Derived		
Patient falls	r = .30	m
Nosocomial infections	*HR* = 1.04; β = .26 to .57	n, o
In-hospital mortality	*OR* = 1.5	p
30-day readmissions	*OR* = 1.03 to 1.16	q, r

Note. All effects were significant at $p \leq .05$. *OR* = odds ratio; *HR* = hazard ratio.
[a]Ball, Murrells, Rafferty, Morrow, & Griffiths, 2014. [b]Jones, 2014. [c]Sochalski, 2004. [d]El-Jardali & Lagace, 2005. [e]Ausserhofer et al., 2013. [f]Lucero, Lake, & Aiken, 2010. [g]Schubert et al., 2007. [h]Schubert, Clarke, Glass, Schaffert-Witvliet, & De Geest, 2009. [i]Lucero et al., 2009. [j]Rochefort & Clarke, 2010. [k]Kalisch, Xie, & Dabney, 2014. [l]Lake et al., 2015. [m]Kalisch, Tschannen, & Lee, 2012. [n]Nelson & Flynn, 2015. [o]Palese et al., 2016. [p]Schubert, Clarke, Aiken, & De Geest, 2012. [q]Brooks-Carthon et al., 2015. [r]Brooks-Carthon et al., 2016.

bedside nurses as they care for their assigned patients or by mining data from nursing documentation systems (VanFosson et al., 2016). These methods would limit the reliance on nurse knowledge of patient outcomes, nurse knowledge of care standards and nurse memory of care left unfinished. Unfortunately, these methods may not capture patient care processes that are not outwardly visible to the observer and/or patient care events that are not documented (Needleman et al., 2007).

Patients who are cognizant also may be able to report outcomes and estimates of UNC. As indicated in Table 1, some patient-reported outcomes are consistent with nurse-reported patient outcomes. However, a study by Kalisch, McLaughlin, and Dabney (2012) indicated that patients could not fully report about the completion of a substantial portion of the necessary elements of care because patients were often unaware of the elements of care for which nurses were responsible, such as discharge planning. Additionally, patients could not identify the occurrence of significant portions of nursing care, such as assessment and surveillance (Kalisch, McLaughlin et al., 2012). Furthermore, limiting patient outcomes and UNC estimates only to cognizant patients eliminates from consideration the outcomes and necessary elements of care owed to patients incapable of reporting such data. Although the ability to know what elements of care are required for their patients and to recognize when necessary elements of care remain unfinished may not be uniform across all nurses, no other stakeholder is better positioned than the nurse to provide estimates of UNC. Additionally, because they are with the patient around the clock, nurses are seen as ideally positioned to report about quality of care concerns (McHugh & Stimpfel, 2012). Therefore, the use of nurse self-report is an appropriate method to estimate UNC. In support of this assertion, the findings derived from administrative records (also found in Table 1) generally support the findings from the nurse-reported patient outcomes.

Nurses and hospitals are not immune to the negative effects of UNC. Nurse reports of UNC were associated with decreased nurse job satisfaction, $r = -.48$, $\beta = -.48$, $p \leq .001$ (Jones, 2014; Kalisch, Tschannen et al., 2011b) and decreased occupational satisfaction, $OR = .57$, $p = .006$ (Kalisch, Tschannen et al., 2011b). Additionally, increased rates of nursing turnover were found in organizations with higher levels of UNC, $r = .23$, $p < .05$ (Tschannen et al., 2010). Higher levels of UNC also were associated with increased reports of nurses who intended to leave their job, $r = .40$, $p < .01$ (Tschannen et al., 2010). Furthermore, nurses reported higher levels of UNC in hospitals with poor nursing employment conditions (Ausserhofer et al., 2014; Ball et al., 2014; Brooks-Carthon et al., 2015; El-Jardali & Lagace, 2005; Hessels et al., 2015; Jones, 2014; Schubert et al., 2008). Outside of the UNC literature, poor nursing employment conditions have been linked to poor quality care (Anzai, Douglas, & Bonner, 2014; Baethge, Muller, & Rigotti, 2016; Berndt, Parsons, & Browne, 2009; Duffield et al., 2011; Gurses, Carayon, & Wall, 2009). Consequently, hospitals with higher levels of UNC and concurrent poor nursing employment conditions may experience cycles of worsening care quality.

Estimates of UNC varied across the literature depending on the instrument used. Studies that used instruments containing fewer elements of nursing care reported a lower prevalence of UNC (Jones et al., 2015). Additionally, instruments that included more specific qualifiers (such as, “ambulate three times per day” versus “ambulate”) in the item inventory reported a higher prevalence of UNC. One study used the MISSCARE Survey and the PIRNCA instruments to obtain concurrent estimates of UNC (Jones, Gemeinhardt, Thompson, & Hamilton, 2016). In this study, estimates of UNC were higher with the MISSCARE Survey, which contained more qualifiers than the PIRNCA (Jones et al., 2016). Additionally, when estimates of UNC were reported as an aggregated mean composite score, these estimates generally equated to rare or occasional occurrences of UNC. However, when estimates of UNC were reported as the mean number of elements of care left unfinished, the instrument containing more items yielded a greater prevalence of UNC (Jones et al., 2016).

Frequency estimates of UNC for individual elements of care were found in the literature. In their state of the science paper, Jones et al. (2015) identified the five elements of care most frequently left unfinished: emotional support; education; care coordination and discharge planning; care planning; and timeliness of care. They also identified the five elements of care least frequently left unfinished: infection control; treatments, tests, and procedures; nutrition; and elimination (Jones et al., 2015). More recent studies of UNC reported similar findings. For example, using the PIRNCA, Jones (2015) found the following elements of care to be most frequently left unfinished: timeliness of care; routine hygiene; important conversations with team members; reviewing documentation of care; patient education; and emotional support. Four other studies, using the MISSCARE Survey, found the following elements of care to be most frequently left unfinished: attending interdisciplinary meetings; patient turning; oral care; ambulation; and discharge planning (Ball et al., 2016; Papastavrou et al., 2016; Roche et al., 2016; Winsett. Rottet, Schmitt, Wathen, & Wilson, 2016)

Numerous studies of UNC have identified the apparent antecedents of time scarcity and UNC in the acute care environment (Al-Kandari & Thomas, 2009; Ausserhofer et al., 2014; Ball et al., 2014; Bragadottir et al., 2016; Cho et al., 2016; Friese et al., 2013; Kalisch et al., 2013; Papastavrou et al., 2014; Schubert et al., 2007; Tschannen et al., 2010). These antecedents generally represent structural dimensions of the nursing care system, such as *nursing staff supply* and *management of working conditions*. These findings will be discussed in the subsequent sections of this chapter.

Gaps

The applicability of the knowledge surrounding the phenomenon of UNC in burn care and military environment has not been established. To date, no studies of UNC have been conducted in either environment. Given the ubiquity of UNC throughout the world, it is logical to assume that UNC exists in these environments. However, it is not acceptable to assume that the prevalence and patterns of UNC established elsewhere are applicable to these unique patient care environments. Burn care requires patient care processes that may result in different prevalence and patterns of UNC. And, the *nursing staff supply* and *management of working conditions* of a military hospital may influence UNC differently than similar factors studied previously in civilian hospitals. Consequently, the current study of the prevalence and patterns of UNC in the USABC was needed.

ACQUIRING, DEPLOYING, AND MAINTAINING RESOURCES

The NCPF subsystem of **acquiring, deploying, and maintaining resources** includes four subordinate dimensions of the nursing care system: *nursing staff supply*, *management of working conditions*, nursing staff maintenance, and economic sustainability (Dubois et al., 2013). Because the research questions focused on the *nursing staff supply* and *management of working conditions* dimensions of this subsystem, they represent the independent variables in the current study.

Reports about the influence of *nursing staff supply* and *management of working conditions* on nurse reports of UNC has been inconsistent. Most studies of UNC were quantitative and cross-sectional in design, delivering a momentary glimpse at the nurses and the environment in which the phenomenon was studied. Four studies considered UNC using a pre-/post-test design (Bragadottir et al., 2015; Kalisch, Terzioglu et al., 2012; Kalisch & Williams, 2009; Kalisch et al., 2014). These studies were aimed at determining the validity and reliability of an instrument and did not consider the changes in nurse reports of UNC as *nursing staff supply* and *management of working conditions* factors changed over time. Two other studies also considered UNC across two time periods. Castner et al. (2014) considered UNC in the context of a hospital merger, measuring UNC and various contextual variables before and after the merger event (approximately two months). Roche et al. (2016) studied UNC as the nursing practice environment changed across two measurement periods, nine years apart. However, these studies do not adequately describe the influence of *nursing staff supply* and *management of working conditions* on UNC as the nursing employment conditions changed because effective longitudinal analysis of change over time requires three or more waves of data (Singer & Willett, 2003). To better understand how the imbalance between *nursing staff supply, management of working conditions,* and nursing care demand influences nursing care, a longitudinal study of three or more data waves was needed.

Nursing Staff Supply

Within the NCPF, *nursing staff supply* consists of the personnel resources necessary to meet the nursing care needs of the patients and represents the numerous processes needed to provide the right quantity and type of nursing staff at the bedside at the right time (Dubois et al., 2013). As a reflection of nursing care system structures, elements of *nursing staff supply* have been widely considered important indicators of nursing care system quality (Alexander, 2007; Naylor, 2007). Dubois et al. (2013) found that 77% of the studies included in their synthesis of the literature included measures of *nursing staff supply*. However, as mentioned previously, *nursing staff supply* at the USABC may differ from civilian nursing care systems because military nurses may be removed from bedside care for military missions that are prioritized over the bedside care mission. For example, military nurses assigned to the burn intensive care unit (BICU) are also assigned to the US Army Burn Flight Team, which is used to retrieve and evacuate burned US military service members from anywhere in the world. These nurses can be removed from bedside care at the USABC on very short notice to participate in an evacuation mission (Renz et al., 2012). Therefore, *nursing staff supply* is an important structural variable when studying nursing care quality in the USABC.

Nurse quantity was described as the number of nursing staff available to provide patient care (Dubois et al., 2013). The term "nurse staffing" generally refers to nurse quantity. Adequate nurse quantity is considered an essential element of quality patient care in the hospital environment. However, the number of nurses available to provide patient care is meaningful only in the context of the demand for patient care. For example, ten nurses may be adequate for patient care in the context of five critically ill patients or but may be inadequate in the context of 20 critically ill patients. Therefore, in the current study, nurse quantity was considered concurrently with indications of nursing care demand as the supply/demand ratio (SDR), an indicator of employment conditions. A more thorough discussion of this topic occurs later in this chapter.

Staff type

Conceptually, nursing staff type is positioned in the NCPF as a factor that influences the quality of nursing care provided within the nursing care system. In their description of the NCPF, Dubois et al. (2013) indicated that nursing staff type could be represented by measures of nurse educational preparation, licensure, and experience. These elements of *nursing staff supply* are described.

Education. ***Conceptualization.*** Nurse education refers to the formal nursing-related academic preparation attained by a nurse. The mean education level of the nursing staff on a nursing unit is considered an essential element of quality patient care in the hospital environment [American Association of Colleges of Nursing, 2014; Dubois et al., 2013; Institute of Medicine (IOM), 2004, 2011].

Operationalization. In the nursing care quality literature, nurse education was frequently measured as a nominal, individual-level variable as the highest level of nursing education achieved. Once collected, the individual nurse education data were frequently aggregated to represent the collective, unit-level education of the entire study population (nursing unit or hospital). For example, nurse education has been reported as the proportion of nurses who reported having bachelor's degree or higher across the study population (Aiken, Clarke, Cheung, Sloane, & Silber, 2003; Aiken et al., 2014; Bae, Mark, & Fried, 2010a; Blegen, Goode, Park, Vaughn, & Spetz, 2013; Friese, Lake, Aiken, Silber, & Sochalski, 2008; McHugh & Lake, 2010; Tourangeau et al., 2007; Yakusheva, Lindrooth, & Weiss, 2014). However, in multi-level studies such as the one conducted by McHugh and Lake (2010), the influence of the individual-level nurse education was considered separately from the influence of the aggregated values used to represent the collective, unit-level education level.

Although the exact means of collecting this data were not reported in every study (Blegen et al., 2013; Estabrooks, Midodzi, Cummings, Ricker, & Giovannetti, 2005; Friese et al., 2008), researchers frequently obtained nurse education data from nurse responses to an inventory of nursing education options on the demographic portion of a survey (Aiken et al., 2003; Aiken et al., 2014; Berkow, Vonderhaar, Stewart, Virkstis, & Terry, 2014; McHugh & Lake, 2010; Tourangeau et al., 2007). Additionally, in at least one case, nurse education data were obtained from hospital administrative records (Yakusheva et al., 2014).

Current knowledge. Numerous studies found a significant relationship between the collective education level of the nursing staff and patient outcomes. For example, in a study by Aiken et al. (2003), a 10% increase in the number of bachelor's-prepared nurses was associated with a 5% decrease in the odds of dying within 30 days of admission and a 5% decrease in the odds of failure to rescue. Additionally, a study by Estabrooks et al. (2005) found that patients cared for on nursing units with a higher proportion of baccalaureate-prepared nurses were at a reduced risk for 30-day patient mortality, *OR* = .81, 95% CI[.68, .96]. More recently, in a study of 21 hospitals, researchers identified that a higher percentage of nurses with a bachelor's degree or higher was significantly associated with lower rates of congestive heart failure-related death, failure to rescue, post-operative deep vein thrombosis or pulmonary embolism, and a shorter length of stay, β = -.004 to -.014, $p < .05$ (Blegen et al., 2013). Additionally, Yakusheva et al. (2014) found that patients who received more than 80% of their care from nurses with at least a bachelor's degree had significantly lower odds of readmission, *OR* = .81, $p = .04$, and a 1.9% shorter length of stay, $p = .03$. These findings also have been supported internationally. For example, a study of 300 hospitals across nine European countries found similar results, noting that a 10% increase in baccalaureate-prepared nurses in a hospital resulted in a 7% reduction in the risk of inpatient death within 30 days of admission (Aiken et al., 2014).

Because of the evident association between nurse education and nursing care quality, nurse education also has been used as a control variable in studies that target other relationships in the nursing care system. For example, in a study by Bae, Mark, and Fried (2010a), the researchers sought to better understand the influence of nurse turnover on workgroup processes and patient outcomes. Nurse education was one of 11 control variables in the analysis of the data and was found to positively influence workgroup cohesion, $\beta = .315$, $p = .05$. Additionally, nurse education was found to negatively influence patient satisfaction, $\beta = -.183$, $p = .05$, and medication administration errors, $\beta = -1.239$, $p = .01$ (Bae et al., 2010a).

Relationship to UNC. Previous studies of UNC found inconsistent relationships between nurse education and nurse reports of UNC. In general, studies of UNC reported nurse education as a nominal variable collected from nurse responses on a survey. Nurses were asked to report their educational background as high school, diploma, associate's degree, bachelor's degree, or graduate degree. In one study, nurse education was reported as a unit-level variable and was found to significantly predict nurse reports of UNC, $\beta = .1951$, $p < .001$ (Ausserhofer et al., 2014). A multi-level study considered the effect of the individual nurse's education and found that nurse education positively influenced nurse reports of UNC, $\beta = .088$, $p < .01$ (Kalisch & Lee, 2012b). Kalisch, Landstrom, and Williams (2009) also considered the influence of nurse education at the individual level and found that associates degree-prepared nurses reported more UNC than nurses with other educational backgrounds, $\chi = 1.913$, $p = .023$. Conversely, four other studies found the relationship between nurse education and nurse reports of UNC to be insignificant (Al-Kandari & Thomas, 2009; Castner et al., 2014; Schubert et al., 2013; Tschannen et al., 2010). In these studies, two considered nurse education at the individual level (Al-Kandari & Thomas, 2009; Castner et al., 2014), one considered nurse education at the unit-level (Tschannen et al., 2010), and one considered nurse education at the individual, unit, and hospital level (Schubert et al., 2013).

Gaps. The relationship between nurse education and nurse reports of UNC has not been definitively established. It appears that nurse education, measured at the individual and unit-level, may influence nurse reports of UNC. However, the influence of nurse education on nurse reports of UNC has been inconsistent (Jones et al., 2015). A repeated measures study of UNC may help clarify the influence of nurse education on nurse reports of UNC.

Licensure. ***Conceptualization.*** Nursing licensure refers to the nursing license (RN, LVN, or none) held by members of the nursing staff. In the NCPF, nurse licensure is considered a component of nursing staff type (Dubois et al., 2013). Nursing licensure is an important factor in the provision of quality nursing care because it reflects the nurse's achievement of a defined minimum level of nursing education and expertise (IOM, 2004).

Operationalization. In the nursing care quality literature, nurse licensure has been considered a structural indicator of the nursing care system at the unit or hospital level of measurement (Blegen et al., 2011; Trinkoff et al., 2011). Nursing licensure also has been considered a characteristic of the individual nurse and was obtained from the nurse response to the demographic portion of a survey (Aiken et al., 2003).

Current knowledge. A search of the literature about nursing care quality supports the assertion that nurse licensure influences nursing care quality. For example, a study by Estabrooks et al. (2005) indicated that higher proportions of RN hours were associated with decreased risk of patient mortality while in the hospital, $OR = .76$ to $.89$, $p < .05$. Licensure also has been significantly associated with the occurrence of several patient outcomes. In a study of nurse staffing in safety-net hospitals, a higher proportion of RNs in medical/surgical nursing units was associated with a decreased occurrence of failure-to-rescue, $b = -.008$, $p < .001$, and nosocomial infections, $b = -.027$, $p < .05$ (Blegen et al., 2011). In the same study, a higher proportion of RNs in critical care nursing units was associated with a decreased occurrence of post-operative sepsis, $b = -.04$, $p < .001$ (Blegen et al., 2011). In a study by Cho, Ketefian, Barkauskas, and Smith (2003), a 100% increase in the proportion of RNs resulted in a 64% decrease in the odds that a patient would develop pneumonia, $p < .05$. An increased proportion of RNs also was associated with decreased falls rates in medical and step-down units, $\beta = -.0059$ to $-.0088$, $p < .05$, and decreased rates of falls with injury in step-down units, $\beta = -.0020, p < .001$ (Dunton, Gajewski, Taunton, & Moore, 2004). The effect of increasing the proportion of RNs on falls was more pronounced in a study of 10,187 hospitalizations in patients aged 60 or older. For every .1 increase in the proportion of RNs, there was a 18.8% decrease in the risk of a fall during hospitalization, $p = .0009$ (Titler, Shever, Kanak, Picone, & Qin, 2011).

Licensure has also been studied in military hospitals. One study considered data available from the Military Nursing Outcomes Database (MilNOD), which included 13 US military hospitals across the world. This study demonstrated that a 10% decrease in the proportion of RNs providing care during a shift on medical/surgical and critical care units resulted in a 13-17% increased risk of medication errors and a 30-36% increased risk of falls with injury (Patrician et al., 2011). Another study of MilNOD data spanned 23 nursing units in four US Army hospitals and demonstrated that a higher proportion of LVNs in the critical care environments predicted higher medication error occurrence, $\beta = 3.807, p < .05$ (Breckenridge-Sproat et al., 2012).

Relationship to UNC. Despite the strength of the previous evidence, the effect of licensure on nurse reports of UNC has been inconsistent. Castner et al. (2014) found that, when measured at the unit level, licensure was inversely predictive of nurse reports of UNC, $\beta = -0.01$, $p < 0.001$. In other words, a greater proportion of RN hours were predictive of lower reports of UNC. Three studies, however, found this relationship to be insignificant (Ball, Murrells et al., 2014; Dabney & Kalisch, 2015; Tschannen et al., 2010).

In five other studies of UNC, licensure was represented as an individual-level, nurse characteristic. These studies measured the variable ordinally, with respondents reporting their work role as an UAP, LVN, or RN. Their findings also were mixed. In one study, UAPs reported significantly more UNC than nurses (LVN or RN), $F = 4.79$, $p = .003$ (Orique et al., 2015). Two studies found that UAPs reported less UNC than RNs, $\beta = -.184$ to $.284$, $p < .01$ (Kalisch & Lee, 2010; Kalisch, Tschannen, Lee, & Friese, 2011). A study by Kalisch, Tschannen, and Lee (2011b) also found that the mean UNC score was higher for RNs ($M = 1.61 \pm .39$) than for UAPs ($M = 1.42 \pm .43$). One study found no significant difference between LVN and RN reports of UNC (Jones, 2014).

Gaps. The influence of licensure on nurse reports of UNC has not been studied in a burn environment. This was of particular interest at the USABC because of the reliance on LVNs to provide burn care. The BICU is staffed almost entirely with RNs, whereas the burn progressive care unit (BPCU) relies more heavily on LVNs for patient care. Therefore, inclusion of an indicator of licensure was warranted in the current study.

Experience. ***Conceptualization.*** Nurse experience refers to the knowledge and skill nurses develop or refine as a result of participation in actual clinical practice. It includes one's overall nursing experience and their experience on a given unit or in specialty area (IOM, 2004). Nursing experience is an important factor in the provision of quality nursing care because nursing experience plays a role in active failures (skills-based lapses) that result in patient adverse events (Cho, 2001).

Operationalization. In the nursing care quality literature, nurse experience was frequently considered a structural (unit or hospital) indicator of the nursing care system. The data were nurse-reported and measured continuously as a count of the number of months or years the individual has worked in nursing (Anzai et al., 2014; Bae et al., 2010a; Blegen, Vaughn, & Goode, 2001; Duffield, Roche, Dimitrelis, Homer, & Buchan, 2015; Han, Connolly, & Canham, 2003; Kendall-Gallagher & Blegen, 2009; Mark, Salyer, & Wan, 2003; McHugh & Lake, 2010). Additionally, at least four studies reported data related to individual experience in a specific hospital, on a specific nursing unit, or in a nursing specialty (Anzai et al., 2014; Bae et al., 2010a; Duffield et al., 2015; Han et al., 2003). Once collected, the individual-level nurse experience data were aggregated to represent the collective experience (the mean amount of experience) of the nurses in that unit or hospital (Anzai et al., 2014; Bae et al., 2010a; Blegen et al., 2001; Duffield et al., 2015; Han et al., 2003; Kendall-Gallagher & Blegen, 2009; Mark et al., 2003; McHugh & Lake, 2010). Four studies further aggregated the experience data into categories for consideration during analysis (Anzai et al., 2014; Blegen et al., 2001; Han et al., 2003; Mark et al., 2003). For example, Blegen et al. (2001) dichotomized nursing experience data as: the proportion of the staff with more than five years of nursing experience and the portion of the staff with less than or equal to five years of nursing experience.

Current knowledge. Researchers have established associations between nursing experience and nursing care quality. Less experienced nurses report lower levels of clinical expertise, $\beta = .11$ to $.63$, $p < .001$ (McHugh & Lake, 2010) and lower nursing care quality, $\beta = -.24$, $p < .05$ (Anzai et al., 2014). Additionally, patient satisfaction with care provided by experienced nurses was significantly different than when care was provided by nurses with less experience, $F = 3.73$ to 4.52, $p < .05$ (Han et al., 2003). Furthermore, nurse experience has been linked to adverse patient events. For example, in one report, increased nursing experience predicted fewer medication administration errors, $\beta = -.345$, $p < .05$, and fewer patient falls, $\beta = -.373$, $p < .05$ (Blegen et al., 2001). Nurse experience also has been shown to significantly influence the occurrence of patient falls, $\beta = .27$, $p < .01$ (Mark et al., 2003). In another report, the relationships were mixed; increased nurse experience predicted higher levels of central catheter infections, $\beta = 1.69$, $p = .05$, and lower levels of urinary tract infections, $\beta = -.86$, $p = .01$ (Kendall-Gallagher & Blegen, 2009).

Because of the association between nurse experience and nursing care quality, nurse experience also has been used as a control variable in studies that target other relationships in the nursing care system. For example, in a study by Purdy, Spence Laschinger, Finegan, Kerr, and Olivera (2010), the researchers sought to better understand the relationship between nurse employment conditions and patient ouctomes. To do so, the researchers controlled for nursing experience as one of three nursing characteristics and found that increased nursing experience was associated with greater feelings of nurse empowerment, $r = .12$ to $.17$, $p < .01$ (Purdy et al., 2010). Additionally, nurse experience was used as a control variable in a study of the influence of nursing unit turnover on workgroup processes and patient outcomes. In this study, nurse experience significantly influenced only workgroup learning, $\beta = .001$, $p = .01$ (Bae et al., 2010a).

Relationship to UNC. The influence of nursing experience on nurse reports of UNC was considered in 13 reports of UNC (Al-Kandari & Thomas, 2009; Ausserhofer et al., 2014; Bragadottir et al., 2016; Castner et al., 2014; Kalisch, 2009; Kalisch et al., 2013; Kalisch & Lee, 2010, 2012a, 2012b; Kalisch, Tschannen et al., 2011a; Lucero et al., 2009; Schubert et al., 2013; Tschannen et al., 2010). Nurse experience was generally measured as the number of years of experience in the nurse's particular patient care role (UAP, LVN, or RN). Five reports considered nursing experience on a specific nursing unit or in a specific hospital (Al-Kandari & Thomas, 2009; Ausserhofer et al., 2014; Bragadottir et al., 2016; Lucero et al., 2009; Schubert et al., 2013). Counter to the trend in the larger body of literature about nursing care quality, nursing experience data were generally considered at the individual level. However, in four reports, nursing experience data were aggregated to a unit- or hospital-level mean (Al-Kandari & Thomas, 2009; Ausserhofer et al., 2014; Schubert et al., 2013; Tschannen et al., 2010). And in four reports, nursing experience was categorized into year groups (such as less than two years, between two and five years, or more than five years) for analysis (Bragadottir et al., 2016; Kalisch, 2009; Kalisch et al., 2013; Kalisch & Lee, 2010).

The influence of nursing experience on nurse reports of UNC has been of varying magnitude and direction. In one study, nurse reports of UNC were shown to be significantly different across the spectrum of nursing experience, $F = 66.73$, $p < .001$ (Lucero et al., 2009). In another study, increased nursing experience significantly predicted lower nurse reports of UNC, $\beta = -.01727$, $p < .0001$ (Ausserhofer et al., 2014). However, a study by Tschannen et al. (2010) also demonstrated that nurses with less than five years of experience reported lower UNC rates, $r = -.20$, $p < .05$. Other studies that considered mean years of experience reported insignificant results (Al-Kandari & Thomas, 2009; Schubert et al., 2013).

Conversely, when nursing experience data were considered as an individual-level measure, greater nursing experience was significantly associated with more frequent reports of UNC. In three studies, increased nursing experience significantly predicted higher nurse reports of UNC, $\beta = .01$ to $.044$, $p < .01$ (Castner et al., 2014; Kalisch & Lee, 2012b; Kalisch, Tschannen et al., 2011a). Two other studies found that more nursing experience predicted more frequent reports of UNC, $\beta = .084$ to $.19$, $p < .05$ (Kalisch & Lee, 2010; Kalisch et al., 2013). Five studies (Bragadottir et al., 2016; Kalisch, 2009; Kalisch & Lee, 2012a; Schubert et al., 2013) found no significant relationship between nursing experience and nurse reports of UNC.

Gaps. The relationship between nurse education and nurse reports of UNC has not been definitively established. Nursing experience may influence nurse reports of UNC. However, previous studies of UNC have demonstrated considerable variability in this relationship. Experience may be a particularly important factor in nurse reports of UNC at the USABC because many of the military LVNs are assigned to the USABC with little clinical experience. Military RNs and civilian nurses (government or contract), on the other hand, are only considered for a position at the USABC after acquiring experience in another clinical environment. Additionally, experienced nurses who are new to burn care may report varying levels of UNC. There are no data in the literature regarding the influence of experience on nurse reports of UNC in the military or burn care settings. Therefore, a study that considered the influence of nursing and burn experience on nurse reports of UNC was needed.

Management of Working Conditions

Within the NCPF, *management of working conditions* reflects the managerial processes that establish system resources (e.g., facilities, technologies, and finances) and employment conditions (e.g., workload, scheduling, and employment status) in support of nursing care (Dubois et al., 2013). As a reflection of nursing care system structures, elements of *management of working conditions* are considered important indicators of nursing care system quality. Dubois and colleagues (2013) found that half of the studies included measures of *management of working conditions*. In the current study, because system resources are the same across the USABC, the influence of these factors is unlikely to vary across individuals and nursing units. Thus, system resources were not considered. Instead, the current study focused on employment conditions, which may vary between the USABC nursing units.

Employment conditions

Employment conditions represent the resourcing decisions of the nursing care system administrators that influence nursing staff stability (Dubois et al., 2013). Employment conditions, also referred to as the nursing work environment, are not the same as the nursing practice environment. The nurse practice environment represents the policies, procedures, and relationships within nursing care systems that facilitate patient care (Schmalenberg & Kramer, 2008). The nursing practice environment is positioned in the NCPF within the process component of the nursing care system (Dubois et al., 2013). Although the nurse practice environment has been shown to significantly influence the quality of patient care delivered in the nursing care system (Aiken, Clarke, Sloane, Lake, & Cheney, 2008; Anzai et al., 2014; Friese et al., 2008; Gabriel, Erickson, Moran, Diefendorff, & Bromley, 2013; Klopper, Coetzee, Pretorius, & Bester, 2012; Leineweber et al., 2016), the nurse practice environment was not addressed in the research questions and therefore not considered in the current study.

In previous studies of nursing care quality, employment conditions have been represented by numerous indicators, to include: nursing workload; patient turnover; unit type; shift worked; overtime paid (OTp); employment category and the use of float nurses. These indicators of employment conditions were included in the current study and are described.

Supply/demand Ratio. ***Conceptualization.*** Supply/demand ratio refers to the unit- or hospital-level balance between nursing care supply and nursing care demand. It represents a confluence of two other concepts related to nursing care quality: nurse quantity and nursing workload. Nurse quantity, hereafter referred to as nursing care supply, was described as the number of nursing staff available to provide patient care (Dubois et al., 2013). Nursing quantity, in conjunction with nurse type and skill mix, is an important indicator of nursing care supply. Nursing workload, hereafter referred to as nursing care demand, is the amount of time, as well as physical and cognitive effort, required to accomplish nursing activities for the patients assigned (Swiger, Vance, & Patrician, 2016). Nursing care demand consists of direct care (patient care activities at the bedside), indirect care (patient care activities away from the bedside), and non-patient care (such as answering telephones) duties that require nurse time, attention, and effort (Alghamdi, 2016). Separately, these indicators provide little understanding of nursing unit context; changes to either indicator are only meaningful when considered within the context of the other indicator. Therefore, in the current study, the balance between nursing care demand and nursing care supply was considered.

The balance between nursing care supply and nursing care demand is an important factor in nursing care quality research. Presumably, when nursing care supply and nursing care demand are balanced, nurses are resourced to provide high quality patient care. A shift in SDR may be predictive of a change in nursing care quality. Such a shift signals the need to investigate the nursing care system and identify changes that may have occurred to cause an imbalance between nursing care supply and nursing care demand. A shift in SDR may also signal a need to closely monitor indicators of nursing care quality to mitigate any negative consequences of shifting SDR.

Operationalization. Information about nursing care supply and nursing care demand have been derived from two sources: nurse self-report surveys (Aiken et al., 2014; Berkow et al., 2014; Kalisch, Friese, Choi, & Rochman, 2011) and government or hospital administrative records (He, Staggs, Bergquist-Beringer, & Dunton, 2016; Kalisch, Tschannen, Lee et al., 2011; Martsolf et al., 2016; Neuraz et al., 2015; Twigg, Duffield, Bremner, Rapley, & Finn, 2011; Twigg et al., 2016; Unruh & Zhang, 2012). Researchers selected a particular source based on the feasibility of obtaining the data needed to answer the research questions. For example, in the multinational study conducted by Aiken et al. (2014), researchers derived the nursing care supply data from the nurse survey in order to avoid the challenges that accompany varying methods of administrative reporting in the different countries.

Nursing care supply has been operationalized based on the nurse's perception of staffing adequacy (Kalisch & Williams, 2009; Mark, 2002; Schmalenberg & Kramer, 2008). This was established using Likert-type four- (Kalisch & Williams, 2009; Mark, 2002) and five-point scales (Schmalenberg & Kramer, 2008). In two questions, Kalisch & Williams (2009) asked nurses to identify if nurse staffing was a reason for UNC (from "not a reason" to "a significant reason"). The questions were part of the larger MISSCARE Survey (Part B) and were shown to have factor loadings of .49 to .55 for the larger labor resources factor, which was internally reliable at .64 to .69 (Kalisch & Williams, 2009). Mark (2002) used a single item to ask nurses to rate their unit staffing, from very much below average to very much above average. And, in six items, Schmalenberg and Kramer asked nurses to rate their agreement that their unit was generally well staffed, from strongly disagree to strongly agree (2008). These items were part of the larger Essentials of Magnetism-II survey and were shown to have factor loadings of .22 to .81 for the perceived adequacy of staffing subscale, which was internally reliable at .88 (Schmalenberg & Kramer, 2008). For these methods, the nurse responses were quantified and aggregated to obtain unit or hospital mean values representing overall nurse perceptions of staffing adequacy.

Nursing care demand has been operationalized using patient volume. Typically, this measure was derived from hospital records and consisted of a count of patients admitted to the unit or hospital (depending on level of measurement needed) at the same time each day (Houser, 2003; Hughes, Bobay, Jolly, & Suby, 2015). However, Beswick, Hill, and Anderson (2010) found that daily patient census underestimated nursing care demand because it did not account for changes in patient census that might occur between measurement periods (patient turnover). It is likely that a more frequent accounting of patient census also underestimated nursing care demand because patient census alone does not account for the non-patient care demands on the nurse (Baernholdt, Cox, & Scully, 2010). Measures that used patient census in conjunction with a count of patient admissions, discharges, and transfers are described in the section of this chapter about patient turnover.

Nursing care demand also has been operationalized using workload management or patient classification systems, which were typically derived from hospital administrative or electronic health records. These systems included mechanisms that account for the volume of nursing tasks in relation to patient care needs (Swiger et al., 2016). For example, the Nursing Activity Score represented nursing workload as a percentage of time spent completing nursing activities (DeBergh et al., 2012). The Project Research in Nursing system was used to represent workload according to intensity- and time-weighted activity scores. Unit aggregation of these scores provided an indication of unit-level nursing workload (Cohen et al., 1999). Like other measures of nursing workload, these methods were limited because they did not capture the process inefficiencies, supply shortages, nursing interruptions, or the cognitive loads experienced by nurses that also influence nursing workload (Swiger et al., 2016).

Researchers also have used subjective measures to operationalize nursing care demand. For example, a German study used the NASA Task Load Index to gauge nurse perceptions of workload (Baethge et al., 2016). Using a 20-point Likert-type scale, nurses responded to seven questions, such as “How fast was the pace at which you had to accomplish your tasks during the last half hour?” Additionally, the Intensity of Labour Scale was used to operationalize nursing workload in a Belgian study (Van Bogaert, Clarke, Willems, & Mondelaers, 2013). On this instrument, nurses were asked to indicate their agreement with six items on a four-point Likert-type scale. In both studies, nurse responses were quantified and summed for analysis.

Some measures found in previous nursing care quality literature were used to represent both nursing care supply and nursing care demand. For example, nursing care supply has been represented as a count of nurse fulltime equivalents (FTEs) working during a defined period of time, such as a shift or a day (Kovner, Jones, Zhan, Gergen, & Basu, 2002; Mark & Harless, 2007; Martsolf et al., 2016; Unruh & Zhang, 2012). Similarly, nursing care supply also has been represented as a count of the nursing care hours (NCHs) available for direct patient care during a defined period of time (Breckenridge-Sproat et al., 2012; He et al., 2016; Kalisch, Friese, et al., 2011; Twigg et al., 2011, 2016). These methods have been used in their pure form (as counts) (Breckenridge-Sproat et al., 2012; Unruh & Zhang, 2012) or were divided by a measure of patient census per day (patient days) (He et al., 2016; Kalisch, Friese, et al., 2011; Kovner et al., 2002; Mark & Harless, 2007; Martsolf et al., 2016; Twigg et al., 2011, 2016; Unruh & Zhang, 2012). When the pure count of nurse quantity was divided by a measure of patient census, it reflected the balance between nursing care supply and the nursing care demand. To account for variations in patient load or unit type, these representations of nursing care supply (FTE or NCH per patient day) also have been adjusted for patient or work environment characteristics, such as patient turnover, case-mix index, or length of stay (Kovner et al., 2002; Mark & Harless, 2007; Twigg et al., 2011, 2016; Unruh & Zhang, 2012).

The balance between nursing care supply and nursing care demand also has been represented as a ratio of nurses-to-patients or patients-to-nurses (Aiken et al., 2014; Berkow et al., 2014; Donaldson & Shapiro, 2010; Neuraz et al., 2015; Numata et al., 2006). When the measure was a ratio of nurses-to-patients, a higher ratio represented better staffing (Berkow et al., 2014). When the measure was of patients-to-nurses, a lower ratio represented better staffing (Aiken et al., 2014; Neuraz et al., 2015).

Current knowledge. The influence of the balance between nursing care supply and demand has been addressed in the literature about nursing care quality. Essentially, when increases in nursing care demand are not accompanied by increases in nursing care supply, nursing care quality suffers. For example, one study found that when nurses perceived increases in nursing care demand, they indicated that they perceived the care they provided to be lower in quality, β = -.07 to -.08, p = .002 (Baethge et al., 2016). Additionally, increased nursing care demand has been associated with increased emotional exhaustion in nurses, β = .50, which negatively influenced the nurse's perception of quality of care, β = -.22, *root mean square error of approximation* = .048 (Van Bogaert et al., 2013). A Belgian study found that unanticipated changes in nursing care demand (such as an unanticipated admission or a cardiac arrest) were associated with increased occurrence of failure to rescue events, β = 1.36, p = .02 (Duffield et al., 2011). One study found that increased nursing care demand was not significantly associated with negative patient outcomes (Houser, 2003). Importantly, in this study, nursing care demand was measured using daily patient census. Although the statistical influence nursing care demand has on nursing care quality may be affected by the chosen method of calculating nursing care demand (Beswick et al., 2010), a review of the literature about nursing care demand leaves little doubt that nursing care demand impacts nursing care quality (Pearson et al., 2006).

Nursing care demand is not constant; it varies from shift-to-shift, from weekday to weekend, and according to unit context. For example, in a study by Beswick and colleagues (2010) that calculated nursing care demand using patient census, nursing care demand was significantly different when measured three times per day compared to when measured once per day (at midnight), $p \leq .001$. Additionally, in a study of nursing care demand in three critical care units (pediatric, surgical, and medical) in one hospital, Debergh and colleagues (2012) found that nursing care demand on day and evening shifts differed significantly from night shift, $p < .001$. Also, nursing care demand on weekday day and evening shifts were significantly higher than on weekends, $p \leq .041$. Demand on weekend nights was not significantly different from weekday nights (Debergh et al., 2012). Finally, when patients were admitted, discharged, or transferred to/from a nursing unit, nursing care demand has been shown to increase significantly, $p = .000$ (Hughes et al., 2015).

In the influential report, *Keeping Patients Safe: Transforming the Work Environments of Nurses*, the IOM (2004) cited numerous cross-sectional studies that identified correlations between measures of nursing care supply and patient adverse events such as nosocomial infections, pressure ulcers, patient falls, and inpatient mortality. Additionally, a systematic review and meta-analysis of 28 studies about nursing care supply by Kane, Shamliyan, Mueller, Duval, and Wilt (2007) found that increasing the nursing care supply by one RN FTE per patient day was associated with a 5.6-16% decrease in the odds of death for hospitalized patients when considered by the type of nursing unit (medical, surgical, or intensive care). One additional RN FTE per patient day also was associated with: a 27.6% decrease in the odds of cardiac arrest across all unit types; a 30.2% decreased in the odds of hospital-acquired pneumonia for patients admitted to an intensive care unit; a 36% decrease in the odds of a nosocomial bloodstream infection for surgical patients; and a 84.5% decrease in the odds of a surgical wound infection for surgical patients (Kane et al., 2007).

More recent studies continue to support nursing care supply as an important factor in patient care quality. For example, increased nursing care supply was significantly predictive of decreased failure-to-rescue rates, $\beta = -.002$ to $-.041$, $p \leq .05$ (Unruh & Zhang, 2012), indicating that more nursing care supply may improve surveillance – a core nursing function (Aiken et al., 2012). Additionally, in a large Australian study, nursing care supply was found to significantly influence rates of up to nine nursing-sensitive patient outcomes, including the occurrence of pressure ulcers, deep vein thrombosis, pneumonia, and mortality, β = .37 to 2.19, $p \leq .05$ (Twigg et al., 2011). Furthermore, a study that considered shift-to-shift variations of nursing care supply in critical care environments, and controlled for patient turnover and severity, found that a patient-to-nurse ratio of greater than 2.5 per shift was associated with a significant increase in the risk of death, $RR = 3.5$, $p < .01$ (Neuraz et al., 2015).

Relationship to UNC. As defined in the current study, unit- or hospital-level SDR has not been previously studied in relation to UNC. A search of the literature about UNC suggested that decreased nursing care supply is associated with increased reports of UNC. Four studies found that increased nursing care supply was associated with fewer reports of UNC when the balance between nursing care supply and nursing care demand was reported as a nurse-to-patient ratio, r = -.07 to -.28, $p \leq .05$ (Al-Kandari & Thomas, 2009; Orique et al., 2015; Schubert et al., 2008; Sochalski, 2004). In another study, higher nurse-to-patient ratios increased the odds of nurse reports of UNC, $OR = 1.03$ (Cho et al., 2016). Additionally, a large, multinational study found that the hospital-level nurse-to-patient ratio was a significant predictor of UNC, $\beta = .09$, $p < .0001$, after accounting for the nesting of nurses within hospitals and countries (Ausserhofer et al., 2014). Two other studies found a similar relationship when nursing care supply was reported as NCHs per patient day, r = -.26 to -.32, $p < .01$ (Kalisch, Tschannen et al., 2012; Tschannen et al., 2010). On the other hand, one study found that two measures of nursing care supply, represented by NCHs per patient day and RN NCHs per patient day, were not significantly related to reports of UNC (Dabney & Kalisch, 2015). However, nursing care supply was significantly related to nurse reports of timeliness of care in the same study, $r = -.09$ to $-.14$, $p \leq .05$ (Dabney & Kalisch, 2015).

Five studies following the missed nursing care approach reported nursing care supply as a reason that nurses reported UNC (Kalisch, Landstrom, & Williams, 2009; Kalisch, Tschannen, Lee et al., 2011; Orique et al., 2015; Siqueira et al., 2013; Tubbs-Cooley et al., 2015). In these studies, 48.6% to 93.1% of nurses reported an inadequate number of nurses and 42.5% to 94% of nurses reported an inadequate number of UAPs. Additionally, in two qualitative studies of UNC, nurses indicated that the quantity of nurses providing patient care influenced their ability to finish all of the necessary elements of care for their assigned patients (Harvey et al., 2016; Winsett, Rottet, Schmitt, Wathen, & Wilson, 2016).

The literature about UNC also generally supports the assertion that increased nursing care demand influences nursing care quality. Aside from NCH per patient day and nurse-to-patient ratios, unit- or hospital-level nursing care demand was represented in three different ways in the literature about UNC: activity volume, nursing intensity, and severity of patient illness. Increased activity volume was associated with decreased completion of nursing care, $r = -.08$ to $-.16$, $p \leq .05$ (Al-Kandari & Thomas, 2009). Additionally, Ausserhofer et al. (2014) found that the volume of non-nursing tasks predicted higher reports of UNC, $\beta = 2.178$, $p < .001$. Increased nursing intensity also was associated with increase reports of UNC. For example, when patients required assistance with activities of daily living or frequent monitoring, nurses were more likely to report UNC, $OR = 1.041$ to 1.05, $p \leq .028$ (Ball et al., 2014). Additionally, when patient assignments were unbalanced or support staff (such as ward clerks) were used inadequately, Blackman and colleagues (2015) noted that nurses reported significantly more UNC, $\beta = .43$. However, when nursing care demand was operationalized as patient acuity or severity (using case-mix index), increased nursing care demand was inversely related to reports of UNC, $r = -.18$, $p < .05$ (Tschannen et al., 2010).

Gaps. The associations between SDR and nurse reports of UNC remain unclear. This is largely because the majority of the studies that considered the balance between nursing care supply and nursing care demand used measures that also have been used to represent other concepts or phenomena (such as nursing workload or nursing quantity). Additionally, the cross-sectional nature of most studies provided little insight into the temporal associations between nursing care demand, nursing care supply, and UNC. Furthermore, the associations between SDR and nurse reports of UNC have not been established in the military or burn environments. Therefore, a longitudinal study of UNC that considers the SDR at the USABC was needed.

Patient turnover. ***Conceptualization.*** Patient turnover is the permanent relocation of a patient in or out of a nursing care unit with a concurrent transfer of responsibility for the nursing plan of care (VanFosson, Yoder, and Jones, 2017). A patient turnover event may include a patient admission, discharge, transfer, or death. It has been proposed that patient turnover influences nursing care quality by increasing nursing workload, which increases the potential for time scarcity and disrupted nursing processes (VanFosson et al., 2017).

Operationalization. More than 20 measures of patient turnover were found in the literature. These measures generally follow one of three approaches: a calculation based on patient census alone; a calculation based on patient length of stay; or, a calculation based on the count of patient turnover events and census. All three approaches treated patient turnover as a discrete variable that was reported at the unit or hospital level. The methods of measuring patient census were discussed in the section about nursing workload and so are not repeated here.

Studies following the length of stay approach reported patient turnover as the mean length of stay (Houser, 2003) or the mathematical inverse of length of stay (1 / length of stay; Duffield et al., 2009; Hughes et al., 2015; Jennings, Sandelowski, & Higgins, 2013). Additionally, one study sought to test a method to adjust nurse staffing calculations for patient turnover (Unruh & Fottler, 2006). To do so, the researchers compared two methods of calculating patient turnover (the mathematical inverse of length of stay and the square root of the mathematical inverse of length of stay) and determined that the second calculation provided a more conservative estimate of actual patient turnover and the related increase in nursing care demand (Unruh & Fottler, 2006). In these studies, the length of stay approach used administrative data already collected in the nursing care systems (length of stay) and so was an attractive method to calculate patient turnover rates. However, there are limitations to this method. For example, a patient may stay in a hospital for a short period of time and experience multiple patient turnover events that would not be captured by calculations consistent with the length of stay approach.

Studies following the approach that used a calculation based on the count of patient turnover events and census reported patient turnover in numerous ways. Four studies referred to patient turnover as the total number of patient turnover events in a given period (shift or day) (Baernholdt et al., 2010; Salyer, 1995; Walker, 1990; Weissman et al., 2007). Patient turnover calculations in these studies resulted in a whole number greater than or equal to zero for each measurement period. Five studies referred to patient turnover as the total number of patient turnover events in a given measurement period (shift or day) divided by the census at the beginning of the measurement period (Baernholdt et al., 2010; Garrett & McDaniel, 2001; Hughes et al., 2015; Needleman et al., 2011; Park, Blegen, Spetz, Chapman, & De Groot, 2012). Patient turnover calculations in these studies resulted in a number that was between zero and one, which represented the proportional change in patient census throughout the measurement period. Two of these studies converted the resulting value to a percent by multiplying the result by 100 (Hughes et al., 2015; Needleman et al., 2011), which represented the percent of change in patient census throughout the measurement period. This approach is the most conceptually sound approach to measure patient turnover because these methods accounted for all patient turnover events as well as the initial patient census in a given measurement period.

Current knowledge. The influence of patient turnover on nurse time was demonstrated in three time and motion studies (Abbey, Chaboyer, & Mitchell, 2012; Cornell et al., 2010; Webster, Davies, Stankiewicz, & Fleming, 2011). A study of critical care nurses found that nearly one-third of all shift activities were related to a patient turnover event (Abbey et al., 2012). Two other studies found that the mean time spent completing a single admission event varied from 5.68 to 30.67 minutes and the mean time spent completing a single discharge event ranged from 24.39 to 90.43 minutes (Cornell et al., 2010; Webster et al., 2011). Based on these findings, patient turnover influences nursing workload and nursing time, which increases the potential that nurses may experience time scarcity.

Through its influence on nursing workload, patient turnover may disrupt nursing processes and influence nursing care quality. As such, patient turnover has been associated with several nurse-sensitive indicators of nursing care quality. Patient turnover was associated with an increased risk of experiencing any adverse event in patients admitted to one major teaching hospital in the US, *relative risk* = 1.008, $p < .001$ (Weissman et al., 2007). In related studies across 37 hospitals in Northern Ireland and England, patient turnover was related to increased rates of nosocomial contraction of methicillin resistant *S. aureus*, $r = .32$ to .854, $p < .05$ (Cunningham, Kernohan, & Rush, 2006a, 2006b; Cunningham, Kernohan, & Sowney, 2005). Furthermore, one study found that patients cared for on units with high patient turnover experienced a 4% per shift increase in the risk of death (Needleman et al., 2011).

Relationship to UNC. Patient turnover was included in two studies of UNC. In one study, patient turnover was calculated as the count of each type of patient turnover event (admissions, discharges, transfers and deaths) reported by nurses on a survey and was divided by the patient census at the beginning of the nurse's shift (Al-Kandari & Thomas, 2009). In this manner, increases in three types of patient turnover events (discharges, transfers, and deaths) positively influenced nurse reports of UNC, r = .07 to .12, p < .05. Admissions had no significant effect on UNC (Al-Kandari & Thomas, 2009). In the other study, patient turnover data were gathered from facility records and was calculated by summating the count of admissions, discharges, and transfers divided by the total number of patient days. This study found no significant relationship between patient turnover and nurse reports of UNC (Orique et al., 2015).

Gaps. Only two studies have considered patient turnover as a potential antecedent of UNC. Neither study considered patient turnover in the military nor burn care environments. As previously discussed, in these environments, the patient care processes, *nursing staff supply* and *management of working conditions* are different than civilian hospitals where UNC has been studied. As such, the influence of patient turnover on nurse reports of UNC also may be different. Additionally, only the Orique study (2015) followed the approach that used a calculation based on the count of patient turnover events and census. Therefore, the inclusion of patient turnover in the current study was warranted.

Unit worked. ***Conceptualization.*** Unit worked refers to the type of nursing unit (e.g., medical-surgical, critical care, labor and delivery, pediatrics) on which the nurse participant worked during the study period.

Operationalization. Unit worked has been measured as a nominal, individual-level variable about the type of nursing unit on which the participant worked during the study period and was collected from nurse responses on the demographic portion of a survey (Bae et al., 2014; Breckenridge-Sproat et al., 2012; Duffield et al., 2015; Ma, Olds, & Dunton, 2015; Trinkoff et al., 2010). Once collected, individual nurse responses were aggregated to the unit- or hospital-level to describe the sample as the proportion of the sample working on a given type of nursing unit (Bae et al., 2014; Breckenridge-Sproat et al., 2012; Duffield et al., 2015; Ma et al., 2015; Trinkoff et al., 2010).

Current knowledge. Unit worked has been used to describe the population sample and to identify participants from the same unit within a sample (Bae et al., 2014; Duffield et al., 2015; Trinkoff et al., 2010). In the ideal nursing care system, there would be no difference in nursing care quality from one nursing unit (or, type of nursing unit) to another. However, there may be contextual differences in nurse employment conditions (patient care goals, clinical tasks, role expectations, and social structures/norms) between the nursing units that are not captured by other measures (Choi & Doyle, 2014; Ma et al., 2015). Therefore, unit worked has been used to reflect differences in nurse employment conditions in studies of nursing care quality that collected data from more than one type of nursing unit (Breckenridge-Sproat et al., 2012; Ma et al., 2015). For example, medical-surgical and step down units in four Army hospitals were predicted to experience a higher rate of medication errors than critical care units, $\beta = 2.148$ and 2.517, $p < .001$, respectively (Breckenridge-Sproat et al., 2012). Additionally, Ma and colleagues (2015) found that 43% of nurses on adult medical units reported excellent quality of care while 73% of nurses on interventional units reported excellent quality of care.

Relationship to UNC. Much of the literature about the relationship between unit worked and nursing care quality came from the literature about UNC. In eight studies of UNC, researchers considered the influence of nursing unit type on nurse reports of UNC; the findings of these studies were mixed. Three studies found no significant relationship between nursing unit worked and nurse reports of UNC (Kalisch, 2009; Kalisch & Lee, 2012b; Kalisch, Tschannen, Lee et al., 2011). Two studies found that nurses who worked on critical care units reported less UNC than other units, $p \leq .01$ (Bradagottir et al., 2016; Castner et al., 2014). Conversely, two studies found that nurses from only two specialty unit types reported more UNC than critical care units: rehabilitation units, $\beta = .17$, $p = .019$ (Kalisch et al., 2013) and renal units (Kalisch, Landstrom, & Williams, 2009). More broadly, Friese and colleagues (2013) found that nurses who worked on oncology units reported less UNC than nurses who worked in non-oncology units, $t = 2.20$, $p < .05$.

Gaps. Although the influence of unit worked on nurse reports of UNC has not been definitively established, there is reason to believe that further study is warranted. In the study by Castner et al. (2014), between-unit differences accounted for 9.5% of the variance related to nurse reports of UNC. Furthermore, the relationship between unit worked and nurse reports of UNC have not been established in the military or burn environments. Therefore, the inclusion of unit worked in the current study was warranted.

Shift worked. ***Conceptualization.*** Shift worked refers to the period of time a nurse was assigned to provide care to patients on a nursing unit. When working at the bedside, nurses typically have been assigned to one of three eight-hour shifts or, increasingly, two 12-hour shifts (Stimpfel & Aiken, 2013). Variation in nursing care supply across shifts occurs because nursing care demand distribution varies between shifts and influences the way nurses are scheduled to work.

Operationalization. Shift worked has been operationalized as a nominal, individual-level variable from nurse responses on the demographic portion of a survey (Ball et al., 2014, 2016; Debergh et al., 2012; Neuraz et al., 2015; Patrician et al., 2011). Once collected, individual nurse responses were typically aggregated to describe the sample and identify whether or not study participants were representative of the 24-hour staffing requirements of the nursing care system. For example, shift worked was reported as a proportion of nurses who reported working on a particular shift (Ball et al., 2014, 2016; Kalisch et al., 2011a, 2013; Kalisch & Lee, 2010; Tschannen et al., 2010).

Current knowledge. Shift worked was used in previous studies of nursing care quality to describe the sample of nurse participants according to their distribution across the 24-hour day. However, working a particular shift (night shift) has been shown to influence nursing care quality. In a study of 255 nurses in three hospitals, Johnson et al. (2014) found that 56% of the nurses who worked night shift were sleep deprived. This sleep deprivation was associated with nurse-reported patient care errors, $F = 7.91$, $p = .0054$ (Johnson et al., 2014). Furthermore, in an experimental study, nurses who worked night shifts were found to have decreased selective attention and this decreased selective attention was predictive of nurse errors, $\beta = .45$, $p < .001$ (Niu et al., 2013). These associations appear to be associated with nurses rotating between day and night shift, which requires the nurse to adjust to a different sleep cycle and may lead to sleepiness, fatigue, and decreased alertness while at work (Dall'Ora, Ball, Recio-Saucedo, & Griffiths, 2016).

Shift length also has been shown to influence nursing care quality. An exploratory study of 12 nurses in one hospital demonstrated that half of the nurses perceived a change in nursing care quality after they changed from eight- to 12-hour shifts (Dwyer, Jamieson, Moxham, Austen, & Smith, 2007). A cross-sectional study of 805 nurses in 13 hospitals found no significant difference in nurse-reported quality of care after changing to 12-hour shifts (Stone et al., 2006). However, other papers reported that longer nursing shifts were associated with decreased nursing care quality. Griffiths and colleagues (2014) indicated that nurses who worked 12 hours or more were more likely to report a patient adverse event, OR = 1.30 to 1.41, 95%CI[1.10, 1.76]. Two reports from overlapping samples found that nurses who worked more than an eight-hour shift were more likely to report decrements in nursing care quality, OR = 1.21 to 2.43, 95%CI[1.11, 2.89] (Stimpfel & Aiken, 2013; Stimpfel, Lake, Barton, Gorman, & Aiken, 2013).

Relationship to UNC. Previous studies of UNC found that nurses who worked on shifts with higher nursing care demand (days and evening shifts) reported more UNC than nurses who worked on shifts with lower nursing care demand (nights). Specifically, among nurses in England, nurses who worked day or evening shifts reported higher levels of UNC, β = .721 to .866, $p < .001$ (Ball et al., 2014). Ball and colleagues (2016) found similar results in a study of nurses in Sweden, β = 1.671 to 1.776, $p < .001$. Additionally, a study of nurses in the Midwestern US found that nurses who worked night shift were predicted to report less UNC than nurses who worked day shift, β = -.052, p = .002 (Kalisch et al., 2011a). A study of nurses in the US and Lebanon also found that working night shift was predictive of decreased nurse reports of UNC, β = -.08, p = .035 (Kalisch et al., 2013). However, shift worked was not significantly associated with nurse reports of UNC in two studies (Kalisch & Lee, 2010; Tschannen et al., 2010). Furthermore, in one study, shift length (12-hour) was not significantly associated with nurse reports of UNC (Tschannen et al., 2010). Of note, all of these studies gathered shift worked data from nursing surveys.

Gaps. The relationship between shift worked and nurse reports of UNC appears to be related to nurse workload differences between the shifts. This relationship has not been studied in the military or burn environments. At the USABC, the nurse quantity on day and night shifts are nearly identical because of the severity of illness of USABC patients. The major difference between shifts is the increased presence of ancillary staff, as well as potential distractors, on the day shift. Therefore, the inclusion of shift worked in the current study was warranted.

Overtime paid. ***Conceptualization.*** Overtime refers to the amount of time a nurse worked over and above the amount of time they are scheduled to work. Overtime is conceptualized as a proxy indicator of stability in nurse employment conditions (Dubois et al., 2013). In unstable employment conditions, nursing care systems cannot meet nursing care demand, resulting in the need for nurses to work overtime.

Operationalization. Typically, overtime was assessed using nurse responses to survey questions (Griffiths et al., 2014; Kunaviktukul et al., 2015; Rogers, Hwang, Scott, Aiken, & Dinges, 2004; Stimpfel & Aiken, 2013; Trinkoff et al., 2011). Overtime has been operationalized as an individual-level count of the number of hours worked beyond the scheduled shift (Kunaviktukul et al., 2015; Rogers et al., 2004; Stimpfel & Aiken, 2013). Overtime also has been operationalized as an individual-level count of the number of hours worked beyond a 40-hour workweek (Kunaviktukul et al., 2015; Rogers et al., 2004; Wu et al., 2013). The individual-level measure was aggregated to the unit- or hospital-level to reflect the mean amount of overtime needed for the entire unit or hospital to meet nursing care demand. In addition to asking for a count of the number of hours worked, Griffiths and colleagues (2014) asked nurses to indicate if they had worked beyond their shift or not.

Current knowledge. Increasingly, working at least 12 consecutive hours is typical (Dall'Ora et al., 2016; Stimpfel & Aiken, 2013). However, the actual length of the shift may be unpredictable due to changes in patient demand or unanticipated staffing changes (Scott, Rogers, Hwang, & Zhang, 2006; Witkoski Stimpfel, Sloane, & Aiken, 2012). These are important considerations for nurse administrators because the risk of error has been shown to increase significantly when nurses work more than 12 hours in a day, $OR = 3.26$, $p = .005$, or work more than 40 hours per week, $OR = 1.92$ to 1.96, $p \leq .0001$ (Rogers et al., 2004). Additionally, working beyond the scheduled shift has been associated with higher odds of reporting poor quality patient care, $OR = 1.32$ to 2.25, $p \leq .05$, and patient safety concerns, $OR = 1.41$ to 2.43, $p \leq .05$ (Griffiths et al., 2014; Stimpfel & Aiken, 2013). Overtime has been linked to increased nurse reports of communication errors, patient identification errors, occurrence of pressure ulcers, and patient complaints, $OR = 1.38$ to 2.33, $p \leq .05$, (Kunaviktukul et al., 2015). Also, adverse patient events were more likely to occur when nurses worked more than 40 hours per week, $OR = 1.08$ to 2.74, $p \leq .009$ (Wu et al., 2013). Finally, work by Trinkoff et al. (2011) found that patients suffering from pneumonia, abdominal aortic aneurysm, or acute myocardial infarction were at significantly higher risk of death when nurses worked long hours, worked more days per week, had fewer than 10 hours away from work, or worked while sick, $OR = 1.24$ to 1.42, $p \leq .05$.

Relationship to UNC. Previously, overtime worked was considered in five studies of UNC and was collected according to nurse responses on a survey. In studies that followed the MISSCARE approach, overtime was operationalized as a nurse-level measure based on nurse reports of the frequency that overtime was worked (Bragadottir et al., 2016; Kalisch et al., 2013; Kalisch & Lee, 2010). These studies reported no significant relationship between nurse-reported overtime and nurse reports of UNC.

The remaining two studies found that overtime worked had some influence on nurse reports of UNC. Cho and colleagues (2016) measured overtime worked as the number of hours worked beyond the nurse's scheduled shift but then dichotomized these values as overtime, yes or no. In this study, nurses who worked more than their scheduled shift had higher odds of reporting UNC, $OR = 1.86$, 95%CI[1.48-2.35] (Cho et al., 2016). Another study also found that working beyond the scheduled shift was associated with an increased risk that tasks would be left unfinished, $OR = 1.29$, $p < .05$ (Griffiths et al., 2014).

Gaps. In the literature about UNC, no study has considered the influence of overtime paid (OTp) on nurse reports of UNC. Overtime paid may underestimate the amount of extra time nurses spend at work because nurses may spend extra time at work without reporting it to their supervisors as overtime due to cost concerns. However, the data collected in the current study about the need to pay nurses to work overtime to meet nursing care demand may be useful in considering future nursing resource decisions at the USABC. Therefore, the inclusion of OTp in the current study was warranted.

Employment category/Float nurses. ***Conceptualization.*** Employment category refers to the status of the employee in the nursing care system (full-time, part-time, or agency). Float nurses are nurses loaned from one nursing unit to another within an organization for a defined period of time (normally a single shift). Temporary nurses are used when the supply of permanent nursing staff cannot meet nursing care demand. This may occur due to periods of increased nursing care demand or decreased nursing care supply (e.g., staff illness or call-ins). When employment conditions warrant the use of temporary nurses to meet nursing care demand, nursing care quality is influenced. In general, temporary nurses are used to provide extra nursing staff during periods of increased nursing care demand. Temporary nurses may come from an agency, hired to work on the unit for short periods of time (an agency nurse), or may be loaned from one nursing unit to another within an organization (a float nurse) (Dziuba-Ellis, 2006). Dubois et al. (2013) indicated that the use of temporary (or, agency) nurses was an indicator of instability in nurse employment conditions. To be consistent with the NCPF, the use of temporary nurses will be considered a reflection of employment conditions.

Operationalization. Employment category has been measured as a nominal, individual-level variable from nurse responses on the demographic portion of a survey (Breckenridge-Sproat et al., 2012; Patrician, Shang, & Lake, 2010). Once collected, individual nurse responses were aggregated to the unit- or hospital-level to describe the sample as the proportion of full-time, part-time, or agency staff members providing direct patient care (Breckenridge-Sproat et al., 2012; Patrician et al., 2010). However, in other studies (Dunton et al., 2004; Pham et al., 2011), employment category was collected from nursing care system administrative records and was reported as the percentage of all NCHs provided by agency staff.

The use of float nurses was measured in four different ways. Data from hospital administrative records have been used to determine the proportion of the total NCHs provided by temporary nurses (Bae, Mark, & Fried, 2010b; Bae, Kelly, Brewer, & Spencer, 2015). Also, data from administrative records were used to determine the number of 12-hour patient care shifts worked by temporary nurses (Roseman & Booker, 1995). Alonso-Echanove and colleagues (2003) represented float nurses categorically; a float nurse either cared for the patient or did not. Finally, the use of float nurses was represented as a proportion of temporary nurses at the hospital level and was gathered from nurse surveys (Estabrooks et al., 2005).

Current knowledge. In previous studies of nursing care quality, the indicators employment category and float nurses have been used to describe the sample of nurse participants (Alonso-Echanove et al., 2003; Bae et al., 2010b, 2015; Breckenridge-Sproat et al., 2012; Dunton et al., 2004; Estabrooks et al., 2005; Patrician et al., 2010; Pham et al., 2011; Roseman & Booker, 1995). Additionally, the use of temporary nurses has been shown to significantly influence nursing care quality. A longitudinal study of nurses in Alaska found that when the use of temporary nurses increases by 10%, the likelihood of medication errors increases by 15% (Roseman & Booker, 1995). Alonso-Echanove and colleagues (2003) also conducted a longitudinal study of eight intensive care units and found that patients who received care from temporary nurses for more than 60% of their hospitalization were at an increased risk of experiencing a central venous catheter-associated blood stream infection, $HR = 2.75$, $p = .0019$. Furthermore, in a study of more than 18,000 patients in 49 hospitals, when the proportion of care provided by temporary nurses increased, so did the risk of 30-day patient mortality, $OR = 1.26$, 95%CI[1.09, 1.47] (Estabrooks et al., 2005). Dunton et al. (2004) found that a higher proportion of agency staff predicted a higher rate of patient falls on medical-surgical units, $\beta = .0095$, $p < .01$. Additionally, in emergency departments across 592 hospitals, medication errors by temporary nurses were more likely to require patient monitoring, $OR = 1.91$, 95%CI[1.21, 3.03], result in temporary harm, $OR = 2.00$, 95%CI[1.11, 3.61], or threaten the patient's life, $OR = 8.63$, 95%CI[1.22, 61.0] (Pham et al., 2011).

The findings related to the use of temporary nurses were not consistent, however. For example, in an attempt to understand how different structural variables influenced nursing care quality in four US Army hospitals, a smaller proportion of Army Reserve nurses who were used in place of active duty Army nurses deployed overseas was found to be significantly predictive of higher medication administration error rates on medical-surgical and critical care units, $\beta = -2.907$ to -4.080, $p < .05$ (Breckenridge-Sproat et al., 2012). Conversely, in the same study, a higher proportion of Army Reserve nurses was found to be significantly predictive of patient falls in step down units, $\beta = 4.921$, $p < .05$ (Breckenridge-Sproat et al., 2012). A study in 12 critical care units from six hospitals found no significant relationship between the use of temporary nurses and rates of central line-associated blood stream infections or ventilator-associated pneumonia (Bae et al., 2015). Additionally, Bae and colleagues (2010b) found that nursing units that used temporary nurses for 5-15% of all nursing care experienced fewer medication errors than nursing units that used no temporary nurses.

Relationship to UNC. In addition to describing the sample of nurse participants according to their employment category or according to the nursing unit use of float nurses (Jones, 2015; Kalisch & Lee, 2010, 2012a; Kalisch et al., 2011a; Papastavrou et al., 2014a; Schubert et al., 2013), previous studies of UNC found an inconsistent relationship between the use of temporary nurses and nurse reports of UNC. In a large study of more than 33,000 nurses in 488 hospitals across 12 European nations, nurse employment status was significantly predictive of nurse reports of UNC, $\beta = .1708$, $p < 0.0001$ (Ausserhofer et al., 2014). However, smaller studies revealed no statistically significant relationship between part-time employment status and nurse reports of UNC (Kalisch et al., 2013; Kalisch & Lee, 2010, 2012a; Kalisch et al., 2011a; Tschannen et al., 2010).

Gaps. The relationship between employment category, float nurses, and nurse reports of UNC has not been established in military or burn environments. Furthermore, at the USABC, agency nurses were not temporary staff members; many agency nurses have worked at the USABC for a year or more. Their presence was less an indication of day-to-day instability and more an indication of annual, fiscal instability related to federal funding of the Military Health System. Instead, the use of float nurses reflected the day-to-day changes in employment conditions that were consistent with the instability discussed by Dubois et al. (2013). Therefore, to be consistent with the literature and the employment of the nursing care system at the USABC, it is important to consider employment conditions using employment category and float nurses.

CHAPTER SUMMARY

Unfinished nursing care is a form of underuse error that occurs in periods of time scarcity and is the result of implicit rationing of nursing care (Jones, 2016; Jones et al., 2015). Factors that create time scarcity (such as an imbalance between the supply of nurses, the conditions under which nurses are employed, and the demand for nursing care on the nursing unit) are presumed to precede the implicit rationing of nursing care. Characteristics of *nursing staff supply* (staff type) and *management of working conditions* (employment conditions) have been associated with an increased prevalence of UNC. An increased prevalence of UNC has been linked to an increase in negative outcomes for the patient (such as patient adverse events, mortality, 30-day readmissions, and patient dissatisfaction), the nurse (such as burnout and job dissatisfaction), and the organization (such as nurse turnover). Hospitals with higher levels of UNC and a concurrent poor nursing employment conditions may experience cycles of worsening care quality.

Unfinished nursing care has been described in a variety of patient care settings and is prevalent in civilian hospitals around the world. The prevalence and patterns of UNC in the military or burn environments have not been described. The current study of UNC in the USABC was warranted because burn care requires *nursing processes* that differ from other patient care environments and the characteristics of *nursing staff supply* and *management of working conditions* of a military hospital may differ from that of civilian hospitals. Additionally, this longitudinal study was justified because studies of UNC to date also have not described UNC as the characteristics of *nursing staff supply* and *management of working conditions* change. In the following chapter, the methods of this repeated measures descriptive study are described.

Chapter 3: Methodology

This chapter describes the research methodology used to identify the prevalence and patterns of unfinished nursing care (UNC) as indicators of *nursing staff supply* and *management of working conditions* changed over time. A description of the research design, sample and selection criteria, instruments and their related psychometric properties, procedures for data collection, processes to ensure the protection of human subjects, and data analysis procedures are presented.

RESEARCH DESIGN

A repeated measures survey design was used to identify differences in the prevalence and patterns of UNC over time and to examine the influence of *nursing staff supply* and *management of working conditions* on variations in individual estimates of UNC. As previously described, earlier cross-sectional studies established associations between UNC and various indicators of *nursing staff supply* and *management of working conditions*. However, cross-sectional studies are insufficient to assess for the presumed sequential relationships among these variables in the highly dynamic hospital environment.

In the case of UNC, it is logical that demands on nursing time change as *nursing staff supply* and the *management of working conditions* change. *Nursing staff supply* is known to vary over time due to staff turnover, as well as shift-by-shift variations in skill mix and types of staff members available to provide care (Aiken et al., 2014; Bae et al., 2010b; Ball et al., 2014; Duffield et al., 2011; Duffield et al., 2015; O'Brien-Pallas et al., 2006). Additionally, nursing employment conditions change over time due to daily variations in patient turnover, the number of hours of care provided by staff members temporarily assigned to the unit (float staff), and the amount of overtime needed to provide care to patients (Duffield, Diers, Aisbett, & Roche, 2009; Garrett & McDaniel, 2001; Jennings et al., 2013; Needleman et al., 2011; Orique et al., 2015; Park et al., 2012; Salyer, 1995; Shindul-Rothschild & Gregas, 2013). Therefore, this repeated measures design was appropriate to detect temporal relationships and to determine whether or not variations in *nursing staff supply* and *management of working conditions* were associated with variations in UNC (Peters & Mengersen, 2008; Powers & Knapp, 2011).

Sample and Selection Criteria

The US Army Burn Center (USABC) is the only burn center in the US Department of Defense and the only American Burn Association-verified burn center in a 26,000-square mile portion of south Texas. Military service members, military beneficiaries, and Veterans' Administration beneficiaries are brought to the USABC from locations around the world. Civilian patients are admitted to the USABC through an agreement with the South Texas Regional Advisory Council for trauma care. Between 2001 and 2011, 27.6% of the patients admitted to the USABC were military service members, 4.7% were military beneficiaries, and 67.6% were civilians (Renz et al., 2012). Patients are typically admitted to the USABC after experiencing thermal, electrical, chemical, friction or inhalation injuries. Many patients are admitted to the USABC with other concomitant injuries (such as amputations or head trauma) from traumatic events (e.g., motor vehicle crash or explosions). Patients also may be admitted to the USABC for treatment of complex dermal syndromes (e.g., necrotizing fasciitis or toxic epidermal necrolysis syndrome) that require specialized multidisciplinary care or extracorporeal membrane oxygenation (ECMO) therapy.

The USABC is comprised of two inpatient nursing units [the burn intensive care unit (BICU; 16 beds) and the burn progressive care unit (BPCU; 24 beds)], two operating rooms, a post-anesthesia care unit, a rehabilitation services department, and an outpatient clinic (Renz et al., 2012). The BICU is staffed primarily with registered nurses (RNs) and licensed vocational nurses (LVNs). The typical patient in the BICU requires a nurse-to-patient ratio of 1:1. However, high acuity patients (such as those requiring ECMO) may require nurse-to-patient ratios of 2:1 or 3:1. The BPCU is staffed with RNs, LVNs, and unlicensed assistive personnel. The typical nurse-to-patient ratio in the BPCU is 1:4. The BPCU also includes a close observation bay, where the nurse-to-patient ratio is 1:2; however, the close observation bay is not used regularly.

The current study was conducted at the USABC under a pre-existing educational partnership agreement between The University of Texas at Austin and the USABC. The current study was added to this agreement as an addendum.

Sample and Selection Criteria

In the current study, all bedside nurses assigned to the USABC (n = 118; the entire population of interest) were asked to participate. Staff nurses at the USABC were assigned to two separate nursing units: the BICU (n = 69 staff members) and BPCU (n = 49 staff members). Participant eligibility criteria included USABC RNs and LVNs who provided at least one entire shift of direct patient care on either USABC nursing unit within the seven-shift time period defined on each survey packet. The inclusion of LVNs was consistent with other studies of UNC that sought to be inclusive of patient care personnel to better reflect how care is provided in the environment being studied (Friese et al., 2013; Gravlin & Bittner, 2010; Jones, 2014; Kalisch, 2009). Temporarily assigned nursing staff members (floated staff) from SAMMC were excluded from the current study because the care they provided over the preceding seven shifts would not have occurred in the USABC. Furthermore, nursing staff members in a student role (e.g., LVN students and critical care nursing students) were excluded because they did not have full responsibility for the care of their assigned patients. Additionally, for the purposes of the current study, participants were asked not to consider the care provided to patients outside of the USABC inpatient setting (e.g., in the clinic, in the operating room, or on a nursing unit elsewhere within SAMMC) during the data collection period.

Power Analysis

A priori power analysis and sample size calculation procedures for multilevel analysis of repeated measures have not been well defined (Hox, 2010; Luke, 2004; Raudenbush & Bryk, 2002; Singer & Willett, 2003). One paper suggested that a sample size of 60 is needed for repeated measured studies that use multilevel modeling for analysis (Huta, 2014). This is consistent with an *a priori* power analysis for repeated measures multivariate analysis of variance using G*Power 3.1, α = .05, f = .25, which also indicated a needed sample size of 60 (Faul, Erdfelder, Lang, & Buchner, 2014).

Because they were employed in a research-intense organization, the USABC nurses were familiar with the research process and most had participated in research studies or evidence-based practice projects previously. For example, 76 bedside nurses participated in a project investigating the effectiveness of an evidence-based precepting program (Robbins et al., 2014). Therefore, it was anticipated that the current study would have sufficient power to detect changes in the prevalence of UNC over time in relation to changes in *nursing staff supply* and the *management of working conditions*.

INSTRUMENTS

A combination of 14 nurse-level and unit-level measures was included in the current study (see Table 2). All study variables were measured on a monthly basis for six months. Measures from both levels were present in the variable categories *nursing staff supply* and *management of working conditions*. *Nursing processes* data were nurse-level only. Because the instrument to assess the prevalence of UNC refers the respondent to the last seven shifts worked, unit-level measures from a 14-day window of time preceding the last day of survey packet administration were collected to provide a reasonable estimate of the work environment during the respondent's most recent shifts. Matching unit-level measures to participant shifts was not possible due to the anonymity of the participants in the current study.

Table 2: *Summary of Measures*

Measure Name	Source	Survey Question	Reliability
Dependent Variable (Nursing Processes)			
Unfinished nursing care	Survey	PIRNCA (20-50)	α = .97[a]
Independent Variables			
Nursing Staff Supply			
Nurse education	Survey	15	
Experience in nursing	Survey	13	
Experience in burn care	Survey	14	
Nurse licensure	Survey	10	
Management of Working Conditions			
Supply/demand ratio	WMSNi		
Patient turnover	WMSNi		
Unit type	Survey	9	
Shift worked	Survey	12	
Overtime paid	Admin data		
Employment category	Survey	11	
Nursing care hours provided by float staff	Admin data		

Note. PIRNCA = Perceived Implicit Rationing of Nursing Care; WMSNi = Workload Management System for Nursing-Internet.
[a](Jones, 2014).

Nursing Processes

Perceived Implicit Rationing of Nursing Care

Nursing processes were operationalized as **UNC** using the Perceived Implicit Rationing of Nursing Care (PIRNCA) instrument (Jones, 2014). The PIRNCA was adapted from the Basel Extent of Rationing of Nursing Care (BERNCA) instrument, developed to assess the implicit rationing of nursing care (or, UNC) in Swiss hospitals (Schubert et al., 2007). Respondents to the PIRNCA were asked to identify how often they were unable to complete 31 different nursing tasks over their last seven working shifts. Each item was scored on a four-point Likert-type scale. Response options included "never," "rarely," "sometimes," and "often," which were scored as 1, 2, 3, and 4, respectively. If a nursing task was not appropriate, the respondent could select the option "not needed," which was scored as a zero (Jones, 2014). The PIRNCA can be scored in four ways: three methods use a count of dichotomized occurrences for a specific cut point (percent of nurses rationing greater than "never"; mean number of elements of care rationed greater than "never"; mean percent of elements of care rationed greater than "never") and one method uses the arithmetic mean score across all inventory items (a mean composite score; Jones et al., 2016). All four methods of scoring were used in the current study.

Evidence for the validity of the PIRNCA was documented previously (Jones, 2014). This evidence supports the construct validity of the PIRNCA and use of the PIRNCA with RNs and LVNs. The PIRNCA was shown to be a reliable instrument for measuring UNC in civilian medical surgical and critical care environments. UNC, as measured by the PIRNCA, was concurrently assessed using quality of care, overall job satisfaction, and work environment constructs (Jones, 2014). The quality of care and overall job satisfaction constructs were assessed using separate 10-point single-item indicators described by Kramer and Schmalenberg (Kramer & Schmalenberg, 2004; Schmalenberg & Kramer, 2008); there was an inverse relationship between UNC and quality of care, $r = -.56$, $p < .001$, and job satisfaction, $r = -.48$, $p < .001$ (Jones, 2014). The work environment construct was assessed using the Essentials of Magnetism II instrument (Schmalenberg & Kramer, 2008). There also was an inverse relationship between UNC and the work environment, $r = -.44$, $p < .001$. Instrument internal consistency was high, Cronbach's $\alpha = .97$, $p = .000$ (Jones, 2014). Previously, the PIRNCA was associated with a low incidence of missing values (0.4-2%) and was shown to provide a more conservative estimate of UNC than other instruments (Jones, 2014; Jones et al., 2016).

The PIRNCA was selected over other instruments previously used in the US to assess levels of UNC due its conceptual alignment with the Nursing Care Performance Framework (NCPF). When developing the NCPF, Dubois and colleagues (2013) considered a study using the BERNCA (Schubert et al., 2008), the instrument on which the PIRNCA was based. Furthermore, the PIRNCA was selected because of the inclusiveness of the instrument. The PIRNCA inventory consists of 31 nursing tasks that might remain unfinished, whereas other instruments, such as the MISSCARE Survey (Part A) or the Tasks Undone instrument, contain 22 and 13 nursing tasks respectively that might remain unfinished (Kalisch & Williams, 2009; Sermeus et al., 2011). The larger PIRNCA inventory is more reflective of the numerous tasks often required of nurses in the USABC work environment (Jones et al., 2016).

Nursing Staff Supply

In the current study, *nursing staff supply* was operationalized using the following four measures: nurse education, experience in nursing, experience in burn care, and nurse licensure.

Nurse education, an ordinal measure, was assessed in item number 15 on the demographic survey, which included five response options (high school equivalency, some college, associate's degree, bachelor's degree, or graduate degree).

Experience in nursing was assessed as years and months of nursing experience and **experience in burn care** was assessed as years and months of burn care experience (items #13 & 14 respectively; ratio level data).

Nurse licensure, an ordinal measure, represented nurse type. It was assessed in item number 10 on the demographic survey, which includes two response options (RN or LVN). The current study considered whether or not RNs and LVNs reported UNC differently, consistent with other studies of UNC (Kalisch & Lee, 2010; Kalisch et al., 2011a; Kalisch, Tschannen, Lee et al., 2011).

Management of Working Conditions

In the current study, *management of working conditions* was operationalized using seven measures: supply/demand ratio (SDR), patient turnover, unit type, shift worked, overtime paid (OTp), employment category, and nursing care hours (NCHs) provided by float staff.

Supply/demand ratio was represented as the arithmetic mean (across 14 days) of NCHs (available) divided by NCHs (required). A ratio equal to 1.0 represented an ideal balance between nursing care supply and nursing care demand. A value greater than 1.0 indicated that nursing care supply exceeded nursing care demand (overstaffed). A value less than 1.0 indicated that nursing care demand surpassed nursing care supply (understaffed).

Nursing care hours (available), a ratio-level measure, represented nursing care supply. It was operationalized as the arithmetic mean of total nursing hours actually worked (providing direct patient care) by RNs, LVNs, and unlicensed assistive personnel (UAPs) across the 14 calendar days before the last day of survey administration. It was derived from the administrative records of the clinical nurse officer in charge (CNOIC; the Army equivalent of a nurse manager). Nursing care hours (available) was a measure used by the USABC to identify the number of nursing staff hours available to care for patients on a given unit during a given 24-hour period. Leaders in the Military Health System (MHS) have used this measure in conjunction with NCHs (required) to identify nurse staffing shortages and overages.

Nursing care hours (required) represented an estimate of nursing care demand. It was calculated as the summated number of hours of care required by all patients in a given unit based on the context of each patient's clinical condition; these data were drawn from the Workload Management System for Nursing-Internet (WMSNi) a standardized, nurse-entered workload-estimating program unique to the MHS (Molter, 1990; Sherrod, 1984; Wolgast et al., 2011). In the WMSNi system, nurses indicated the number of times a nursing task was required for an individual patient during a 24-hour period. As patient needs changed throughout the day, the previously entered information was adjusted. Each nursing task was associated with an evidence-based time value. To obtain the total time required for a given nursing task, the time value associated with the nursing task was multiplied by the number of times the nursing task was required for an individual patient. To determine the total NCHs (required) for an individual patient, the total task time for all nursing tasks required for the patient in a 24-hour period were summated. To determine the total NCHs (required) for the nursing unit in a 24-hour period, the NCHs (required) for all patients assigned to the nursing unit in a 24-hour period were summated (Korowicki, Gow, & Fisher, 2016). As such, NCHs (required) reflects nursing intensity and the volume of patients on the unit in a 24-hour period. This representation of nursing care demand was selected over other operationalizations because it was a more complete estimate of nursing care demand.

Patient turnover was calculated as the 14-day arithmetic mean of the daily patient census (at 0700 hours) plus the total number of admissions, discharges, and transfers in a workday (0700 to 0659 hours), divided by the daily patient census. This calculation was proposed by VanFosson et al. (2016) and resulted in a number that represented the proportional change in patient census on the nursing unit in a 24-hour period. These data were drawn from WMSNi data and verified using administrative records maintained by the CNOIC.

Unit type was a nominal measure that was assessed in item number 9 of the demographic survey. This measure served to differentiate the reported prevalence and patterns of UNC between the two participating units.

Shift worked was a nominal measure that was assessed in item number 12 of the demographic survey. This measure served as a proxy indicator of context because staffing levels and workload distribution vary between shifts.

Overtime paid was operationalized as a unit-level measure that was the arithmetic mean of overtime hours paid (greater than 80 work hours) by all nurses over a 14-day period for each study month. These data were drawn from Human Resources data collected from the CNOIC.

Employment category was a nominal measure and was measured as a nurse's self-reported status on a demographic survey (item number 11) as a military, government civilian, or contract employee.

Nursing care hours provided by float staff was operationalized as the arithmetic mean of the number of hours of nursing care provided by float staff per day. These data were obtained from CNOIC administrative records. It was not calculated as a proportion of total NCHs; the data remained in the same mathematical format as the other NCH data collected.

Data Collection Procedures

Two weeks prior to the initiation of data collection, the principal investigator (PI) visited the research sites to coordinate with nursing leaders on both units. After data collection began, for one week each month, for a period of six months, the nurses at the USABC were asked to complete a paper survey to assess the prevalence of UNC during that month. The PI provided potential participants with a study fact sheet (Supplemental File A) on each survey occasion. The survey packet (Supplemental File B) consisted of three major sections in addition to the fact sheet page. The first section of the survey packet was designed to create a participant-generated identification code (Damrosch, 1986), which facilitated linking the participant's responses from month to month while protecting the participant's identity across all survey submissions. The second section consisted of 10 short-answer questions to elucidate participant demographic characteristics. The final section of the survey packet consisted of the PIRNCA instrument, used to measure UNC prevalence (Jones, 2014).

The survey packet was designed according to the principles described by Dillman, Smyth, and Christian (2009), which include reducing the potential for survey error, encouraging responses to the survey, and developing procedures that build positive social exchange and encourage responses. All bedside nurses were invited to participate in the current study (100% of the population of interest) to minimize the risk of sampling bias. Strategies to increase survey response rates and further minimize the risk of sampling bias included the use of paper surveys and reminder notices. Paper surveys reduce the risk for coverage error because all potential participants have equal access to the survey. Furthermore, previous studies involving nurse surveys found that paper surveys resulted in higher response rates than online surveys (Jones, 2014; Kramer, Schmalenberg, & Keller-Unger, 2009). Measurement error was minimized through the use of a valid and reliable instrument shown to assess the prevalence of UNC with a high degree of reliability.

To ensure a consistent time interval between data collection periods, survey packet distribution occurred during the week of the month that contains the 15th day of the month. Beginning on Sunday of that week, the PI visited each nursing unit at approximately 0700 and 1900 hours to distribute blank survey packets to the nurses on shift. The PI alternated the units visited first in order to interact with off-going nurses as equally as possible. During each visit, the PI conducted a short briefing to describe the specific aim of the study. The briefing was completed in the same manner during each visit because some nurses may have been absent during previous briefings. After the briefing, the PI answered any questions and then handed survey packets to all nurses who willingly accepted them. The nurses were asked to deposit all completed surveys in a locked drop box located at a central location on each unit (e.g., nurse's station or break room). A few blank copies were left at the drop box on each unit for nurses who were not immediately present.

The repeated measures design and the length of the survey may have negatively influenced the number of participants willing to participate, potentially introducing some level of nonresponse error (Dillman et al., 2009). This was addressed through the use of a retention plan. To encourage initial participation and maintain a high level of participation, the current study relied on principles of social exchange theory as described by Dillman et al. (2009). Social exchange theory posits that surveyors need to establish trust among the pool of participants that the benefits of participation outweigh the burden of completing the survey. To establish this trust, surveyors provide information about the survey, demonstrate a positive regard for the potential participants, express appreciation for their willingness to participate, and support the nurses' focus on patient care. Additionally, the survey should be convenient to complete and security of personal information should be maximized (Dillman et al., 2009). In the current study, the nurses were asked to participate after the PI explained that this new information may help USABC nursing leaders understand and communicate how nursing care system structures influence nursing care quality. Additionally, the nurses were asked to complete paper surveys anonymously to maximize convenience and decrease the risks to personal security that they might perceive. Furthermore, the PI was present regularly to encourage participation and answer questions that staff and clinical leaders had. Because participation incentives are heavily restricted in military facilities, techniques often used to improve retention were not an option for the current study (Office of Government Ethics Standards of ethical conduct for employees of the Executive Branch, 1992).

The survey packets were printed on brightly colored paper to differentiate them from the white paper normally used by the staff. A different colored survey packet was used each month to differentiate the completed surveys from each other. To provide a reasonable estimate of the work environment during the seven shifts considered by survey packet respondents, the PI collected 14 days of unit-level administrative data. On the Monday following the week of survey distribution, the PI returned to the nursing units to collect all completed surveys from the locked drop box on each unit. All remaining blank surveys also were collected to prevent errant submission during a subsequent month. At a time convenient for the administrators, the PI worked closely with the CNOIC of both units to collect the 14 days of administrative data. These study data came from data normally collected by the CNOICs and administrators at the USABC as a part of their daily management processes, to include WMSNi. The PI used prepared data collection worksheets (see Supplemental File C) to collect and collate the required unit-level raw data from the CNOICs.

Protection of Human Subjects

The current study was conducted after being considered by three different institutional review boards (IRBs). The IRB at The University of Texas at Austin determined this research to be exempt from IRB review and a waiver of documentation of informed consent was granted (Supplemental File D). The US Army Institute of Surgical Research's Research Regulatory Compliance Division, in coordination with the US Army Medical Research and Materiel Command IRB, agreed with this determination and provided approval to conduct the study at the USABC (Supplemental File E). Because the current study was funded through a grant from the TriService Nursing Research Program, the Human Research Protections Program Office at the Uniformed Services University of the Health Sciences also reviewed the protocol and authorized conduct of the current study (Supplemental File F).

Privacy and Confidentiality of Participants

Two risks to participants were identified. The first risk was the potential that participants may have felt obligated to participate because the PI was formerly a supervisor at the USABC. This was partially mitigated by the fact that the PI had no formal supervisory relationship with any person at the USABC at the time of the study. Additionally, only 50% of the current nursing staff were present when the PI served in the previous supervisory role. During recruitment, the PI informed all potential participants that they were being asked to participate anonymously so the PI and USABC leaders could not identify who participated (or did not participate) in the study. To reinforce this, the PI emphasized that participation was voluntary and that participation in the current study (or not) would not influence an individual's performance evaluations. Finally, to mitigate the coercion that may have occurred due to the PI's military rank, the PI wore civilian clothing during the recruiting and data collection processes and no information about the PI's military rank was present on any study documents. Furthermore, during the research period, the PI was on site for only one hour per data collection day (15 minutes per unit, twice a day) to prevent participants from feeling pressured to participate involuntarily.

The second risk to participants was the potential that survey anonymity would be breached. As previously mentioned, in order to provide additional protection against coercion due to the PI's previous supervisory role, participants were asked to identify themselves on the survey using a participant-generated identification code (Damrosch, 1986). This code limited the possibility that anyone could link any survey to a specific individual. Because a waiver of signed consent was approved by the IRBs, participants were not required to provide any indication of their participation in the current study. Furthermore, no participant placed personally identifying information on a submitted survey. Therefore, there was no means of linking the participants to their responses. Participant consent was implied by completion of the survey packet and depositing the survey packet in the locked drop box. The absence of a signed consent provided an additional layer of protection of participant anonymity.

Furthermore, the PI did not know which staff members decided to complete a survey because the PI did not know which individuals deposited surveys in the lock box. During the week-long data collection period each month, the PI was present on each nursing unit to answer any questions. When all questions were answered, the PI left extra survey packets near the locked drop box and departed the study site. The PI never accepted survey packets directly from a participant. Rather, to help maintain anonymity, if a nurse approached the PI with a completed survey packet, the PI asked the nurse to place the packet in one of the locked drop boxes.

Potential Benefits and Risks

There were no direct benefits to participants in the current study. Participants may have developed intrinsic feelings of pride for participating in research that may improve our understanding of UNC in the USABC and that may influence the nursing care system at the USABC in the future. The potential risks of the current study were minimal. However, the time required to participate in the current study may have been a burden to those who participated. It was estimated to take 15-30 minutes to complete the survey packet. However, participants were given as much time as they needed to complete the packet. Given the potential benefit to society, the Department of Defense, the USABC, and burn centers nationwide, the current study demonstrated a favorable risk-benefit profile.

Confidentiality of the Research Data

Study data integrity and participant anonymity were further protected through access control measures. Only the PI had access to the surveys deposited in the drop box. Additionally, the data were not stored at the USABC, where USABC personnel may have had inadvertent access to the raw data. Instead, all raw data remained under the control of the PI at all times. Once aggregated and entered into statistical software, the data were stored on a password-protected external hard drive. No raw survey data were shared with anyone on the USABC leadership team. The PI shared only aggregated data with the USABC leaders at the end of the study period.

Data Analysis

Statistical analyses were performed using SPSS Statistics for Mac OS, version 23.0 (IBM Software, 2015) and SAS, version 9.4 (SAS, 2015). The statistical significance criterion was set at $p \leq .05$; a medium effect size (0.25) was assumed (Castner et al., 2014; Cohen, 1988). After the data were collected each month, the PI entered the raw data generated from the current study into SPSS. Each survey was inspected to determine if the participant met inclusion or exclusion criteria as well as completeness of the data. Data from participants who did not meet inclusion criteria (or met exclusion criteria) were not coded into the software program. Additionally, the information from the participant-generated identification codes were combined into one alphanumeric string and used as the participant identification number. Administrative data collected by the PI were inspected for completeness before entry into the software program. The raw data were entered per survey response. In a separate file, the administrative data were entered for each of the 14 days that data were collected.

After the data were entered into the SPSS software each month, the PI depicted all the data graphically to assess their distribution and to assess for outliers or nonsensical values in order to clean the data. Descriptive statistics also were analyzed for each indicator; any missing data were identified. The patterns and amount of missing data were identified and described to determine their influence on the outcomes of subsequent data analyses.

In the current study, missing data occurred when previous participants were not working or available during a subsequent data collection period (such as when on leave). Missing data also occurred when a previous participant elected not to participate in one or more subsequent data collection periods (attrition). Multilevel modeling (MLM) was selected as a means to analyze the data in the current study in part because it allows for the retention of all of the individual estimates of UNC, even in the event of missing data due to attrition or unavailability at a particular sampling period; it provides the researcher a way of analyzing the data without rejecting the entire string of observations (Raudenbush & Bryk, 2002). However, in order to analyze the data using MLM, all variable-related nurse data, such as education, experience, or licensure, must have been reported at least once in the series of repeated measures. Therefore, surveys that did not contain all variable-related nurse data were excluded from the analysis. However, if participants completed multiple surveys throughout the study (identified by matching participant-generated identification codes), incomplete surveys were not excluded if the nurse-specific missing data could be gathered from one of the other surveys completed by the participant. Because these items were not used in data analysis, participants could omit responses to questions about gender or race without affecting the inclusion or exclusion of the survey.

Prior to directly considering the research questions, descriptive statistics were used to describe the participants and the study measures for each month and in the aggregate. Additionally, exploratory analyses were conducted to describe the sample and the study variables (Field, 2013).

Research Question 1

What is the monthly variation in the prevalence and patterns of UNC in the USABC?

To answer research question 1, the PI used descriptive statistics to describe the prevalence and patterns of UNC on each month. In keeping with another study that estimated UNC using the PIRNCA (Jones, 2015), the data were analyzed to determine: the mean composite score (or, the mean frequency of UNC); the percent distribution of mean composite scores; the percentage of nurses reporting at least one element of care being left unfinished; the percentage of nurses reporting more than one element of care being left unfinished; the mean number of elements rationed per participant; item-level frequencies; and the elements of care most/least frequently left unfinished.

Research Questions 2 and 3

What is the relationship between nursing staff supply and UNC in the USABC?

What is the relationship between the management of working conditions and UNC in the USABC?

To address Research Questions 2 and 3, the PI used MLM to analyze the longitudinal relationships between UNC and the presumed antecedents that represent *nursing staff supply* and *management of working conditions*. Multilevel modeling was an appropriate choice to analyze the data collected in the current study because the individual responses over time were seen as nested within each individual. Because the measurements of the same participant, repeated over time, were likely to be correlated, these correlations had to be accounted for statistically (Hox, 2010; Huta, 2014; Luke, 2004; Raudenbush & Bryk, 2002). Additionally, it was logical to recognize that the nurse decision to leave care unfinished because of perceived time scarcity must be considered within the context of that decision. Multilevel modeling allowed the researcher to statistically account for structural and contextual variables, at unit and individual levels, that might have influenced nurse decision making (Hox, 2010). Multilevel modeling also was considered for data analysis because the study of nurses and nursing units are inherently hierarchical. However, in order to model at the unit level (a three-level model), Hox (2010) suggests a minimum of 30 units would be required to achieve adequate power. Therefore, a two-level model was considered for the current study (repeated measures of the nurse).

The PI completed MLM using SAS. To do so, the PI arranged the data in SPSS by individual and month. The SPSS file of cleaned data was imported into SAS for analysis of the multilevel model. Multilevel modeling assumptions of linearity, normality, and homoscedasticity were tested *post hoc* according to methods described by Singer and Willett (2003). The PI completed analysis of the longitudinal data according to the multilevel modeling processes described by Singer and Willet (2003) and Schonfeld and Rindskopf (2007). Modeling occurred iteratively at two levels: within individuals (month) and between individuals. Initially, the analysis considered the unconditional, or intercept-only, model to estimate the intraclass correlation, which provided an estimate of the proportion of total variance accounted for by the proposed statistical model (Hox, 2010; Luke, 2004; Raudenbush & Bryk, 2002). The unconditional model for the current study is represented in the equation

$$\mathrm{UNC}_{\mathrm{ijk}} = \beta_{00} + u_{0\mathrm{j}} + r_{\mathrm{ij}}$$

where β_{00} represents the overall mean composite score across the entire sample and across all months. The terms $u_{0\mathrm{j}}$ and r_{ij} represent between-person and within-person variance, respectively.

The MLM entailed building a series of modeling equations to assist in the interpretation of the variability of UNC over time. All time variant measures were modeled at the first (month) level. Time invariable characteristics of the participant were modeled at the second (individual) level. The entire model was represented in the multilevel combined equation

$$\begin{aligned}\mathrm{UNC}_{\mathrm{ij}} = {} & \beta_{00} + \beta_{10}(\mathrm{SDR})_{\mathrm{ij}} + \beta_{20}(\mathrm{OTp})_{\mathrm{ij}} + \beta_{30}(\mathrm{Patient\ Turnover})_{\mathrm{ij}} + \beta_{40}(\mathrm{Float})_{\mathrm{ij}} \\ & + \beta_{01}(\mathrm{Lic})_{\mathrm{j}} + \beta_{02}(\mathrm{Unit})_{\mathrm{j}} + \beta_{03}(\mathrm{Shift})_{\mathrm{j}} + \beta_{04}(\mathrm{EmpCat})_{\mathrm{j}} + \beta_{05}(\mathrm{Edu})_{\mathrm{j}} \\ & + \beta_{06}(\mathrm{ExpNur})_{\mathrm{j}} + \beta_{07}(\mathrm{ExpBurn})_{\mathrm{j}} + u_{0\mathrm{j}} + r_{\mathrm{ij}}\end{aligned}$$

where $\mathrm{UNC}_{\mathrm{ij}}$ represented the predicted mean composite score reported on *i*-th month by *j*-th nurse after accounting for the predictor variables represented *nursing staff supply* and the *management of working conditions*.

The modeling process was used to verify the proposed equation and partition the variance identified in the unconditional model. Subsequent steps of the modeling process included: iteratively adding the predictive variables to the unconditional model to establish estimates of their fixed effects on UNC; testing for random effects of each variable on UNC; and testing for interactions between each predictor variable and those variables that vary randomly. This process built the model of best fit used in the final analysis of the data collected in the current study.

The statistical parameters were estimated using restricted estimation of maximum likelihood due to the relatively small sample size and the desire to obtain the least biased results (Littell et al., 2006). Additionally, while testing for random effects, three different covariance structures were evaluated: unrestricted, compound symmetry, and heterogeneous compound symmetry (Hox, 2010; Singer & Willett, 2003; Littell et al., 2006). The PI identified the model of best fit by testing for a significant change in the Bayesian information criterion (BIC; Littell et al., 2006; Singer & Willett, 2003). Using this process, variables and random effects were dropped from the proposed equation if they were not included in the model of best fit. The equation derived from the variables remaining in the model of best fit was used to answer Research Questions 2 and 3.

CHAPTER SUMMARY

This chapter detailed the methodology used in this repeated measures study to determine the prevalence and patterns of UNC at the USABC as indicators of *nursing staff supply* and *management of working conditions* changed over time. The setting, inclusion and exclusion criteria for sample selection were presented. Procedures for data collection, as well as methods for protecting the identity and confidentiality of the participants and the data were described. The survey packet and the psychometric properties of the instruments were described. Finally, the data analysis plan used to answer the research questions was described.

Chapter 4: Findings

Study findings based on descriptive and inferential analysis of data collected from self-report surveys of participating nurses and administrative records of the US Army Burn Center (USABC) are presented in this chapter. Procedures for descriptive analyses were completed using SPSS, version 23.0 (IBM Software, 2015). Procedures related to multilevel modeling were completed using SAS, version 9.4 (SAS, 2015). The findings are presented in the following sequence: preparation of the data file, description of the sample, description of the predictor variables, Research Questions 1-3, and *post hoc* analysis.

Data Cleaning and Preparation for Analysis

Data collection procedures were implemented as described in Chapter 3. Data collected from two sources (nurse self-report surveys and administrative data) were hand-entered into an electronic data file for analysis. The data file was examined for accuracy, subject eligibility, and missing values. Data were accepted as accurate if values fell within the range of possible values appropriate for each variable. Values outside this range were compared to the original data source (e.g., the paper survey or the administrative reports) and data entry errors were corrected as indicated. Similarly, values for demographic variables that were inconsistent with eligibility criteria were compared to the original source documents for validation. Accurate values inconsistent with eligibility criteria resulted in exclusion of the entire survey from further analysis. This resulted in the exclusion of four surveys.

Thresholds for missing survey data were established *a priori* and varied by study variable. The threshold for missing data on demographic variables designated as predictor variables in the planned model analysis was set at zero. In repeated measures studies, multilevel modeling is useful for dealing with panel dropout and missing values for the time-variant measures at Level-1. However, missing values among the time-invariant measures above Level-1 require exclusion of the entire case (Hox, 2010). Therefore, surveys with any missing data related to education, licensure, experience, employment category, shift worked, and unit worked were excluded from further analysis. This resulted in the exclusion of two surveys. The threshold for missing data on the Perceived Implicit Rationing of Nursing Care (PIRNCA) instrument used to estimate the primary outcome variable, unfinished nursing care (UNC), was set at 10%. Therefore, surveys with missing data on greater than or equal to four of the 31 items on the PIRNCA were excluded from further analysis. Two surveys were excluded due to missing PIRNCA data (5 and 18 items missing, respectively).

In total, eight surveys were excluded from the final sample. Survey distribution and response rates across all six months are summarized in Table 3. A total of 599 surveys were distributed to 118 nurses over the data collection period with a return of 269 useable surveys (overall response rate = 44.9%). Monthly response rates ranged from 37.9% to 51.0%. A total of 95 unique identification codes were identified, indicating that 80.5% of the 118 eligible nurses participated in the study during at least one of the six months. Sixty-five nurses (55.1% of all nurses) participated during more than one month and 55 nurses (46.6% of all nurses) participated during three or more months.

Across the retained surveys, the incidences of missing data were low, 0% to 5.2%. At the item level, the incidence of missing data ranged from 0% to 3%. The distribution of missing values was as follows: ethnicity (n = 8; 3%); PIRNCA item #46 (review documentation; n = 2; .7%); PIRNCA item #47 (initiation/review plan of care; n = 6; 2.2%); PIRNCA item #48 (document assessment and monitoring; n = 2; .7%); and, PIRNCA item #49 (documentation of care; n = 3; 1.1%). No methods for imputation of data were applied.

Table 3. *Survey Completion Data*

	Month					
	Jul	Aug	Sep	Oct	Nov	Dec
Nurses scheduled						
USABC	108	98	102	109	110	110
BPCU						
RNs	21	21	23	25	23	23
LVNs	18	18	17	16	18	18
BICU						
RNs	62	55	57	63	63	63
LVNs	7	4	5	5	6	6
Surveys						
Distributed	108	98	99	104	95	95
Returned	49	51	49	45	37	46
Excluded	2	1	2	0	1	2
Retained	47	50	47	45	36	44
Response rate (%)	43.5	51.0	47.5	43.3	37.9	46.3
Unique participants						
USABC	47	22	15	5	3	3
BPCU	18	7	9	0	3	3
BICU	29	15	6	5	0	0

Note. The count of unique participants represents the number of nurses participating for the first time. The response rate is the percent of returned surveys after subtracting the number of surveys excluded. BICU = burn intensive care unit; BPCU = burn progressive care unit; LVN = licensed vocational nurse; RN = registered nurse; USABC = US Army Burn Center.

The threshold for missing data on the administrative data reports also was set at zero. Missing values were identified for the following items on seven days in the burn intensive care unit (BICU): census, admissions, discharges, transfers, nursing care hours (NCHs) provided by float staff, NCHs (available), and NCHs (required). These items were necessary for the computation of daily values for key predictor variables [supply/demand ratio (SDR) and patient turnover]. Consequently, the data from these seven days were excluded from further analysis. These seven days occurred during two separate months (August and September). As a result, the mean values computed for the month of August were based on 10 days and mean values computed for the month of September were based on 11 days rather than 14 days as planned.

DESCRIPTION OF TIME INVARIANT PREDICTOR VARIABLES

The demographic characteristics of the nurse sample reflect time invariant predictor variables in the current study. In cases where a nurse participated during more than one month of data collection, demographic values were recorded on the survey associated with the first month of participation were carried forward to subsequent months. Characteristics for the 95 unique participants are summarized in Table 4. Across the USABC, most participants were female, 66% (n = 63), and registered nurses (RNs), 81% (n = 77). The majority of the participants identified their race as Caucasian, 51% (n = 48). A large portion of the participants reported working in the BICU, 58% (n = 55), consistent with the distribution of all nurses at the USABC. Also consistent with the distribution of nurses at the USABC, most participants were civilian employees of the US federal government, 56% (n = 53), and military nurses participated in the current study least frequently, 14% (n = 13). More than half of all participants reported working on the day shift, 59% (n = 56). No nurses reported working swing shift. As such, the swing shift was not considered in further analysis in the current study. Additionally, most participants reported having achieved at least a bachelor's degree, 55% (n = 52).

One military licensed vocational nurse (LVN) reported that high school was their highest level of formal education. This level of education was re-coded to "Advanced

Table 4. *Time Invariant Characteristics of the Nurse Sample*

	BPCU		BICU		Total	
	n	%	n	%	n	%
N	40	42	55	58	95	100
Gender						
Male	13	33	19	35	32	34
Female	27	67	36	65	63	66
Race						
Caucasian	16	40	32	58	48	51
African American	4	10	7	13	11	11
Hispanic	17	42	10	18	27	28
Other	3	8	2	4	5	6
Missing response	0	0	4	7	4	4
Education						
AIT only	1	3	0	0	1	1
Some college	13	32	2	4	15	16
Associate's degree	13	32	14	25	27	28
Bachelor's degree	10	25	37	67	47	49
Master's degree	3	8	2	4	5	6
Licensure						
LVNs	15	37	3	6	18	19
RNs	25	63	52	94	77	81
Employment category						
Military	2	5	11	20	13	14
Government civilian	24	35	29	53	53	56
Contracted civilian	14	60	15	27	29	30
Shift worked						
Days	23	58	33	60	56	59
Nights	17	42	22	40	39	41
Nursing experience						
≤ 3 years	2	5	2	4	4	4
> 3 to ≤ 10 years	12	30	21	38	33	35
> 10 years	26	65	32	58	58	61
Burn experience						
≤ 3 years	9	22	23	42	32	34
> 3 to ≤ 10 years	19	48	20	36	39	41
> 10 years	12	30	12	22	24	25

Note. AIT = advanced individual training; BPCU = burn progressive care unit; BICU = burn intensive care unit; LVN = licensed vocational nurse; RN = registered nurse.

Individual Training (AIT) only" because a participant could not be a LVN without undergoing some sort of professional training beyond high school. However, the LVN training received in the military is not directly affiliated with a college or university. To obtain college credit, AIT graduates must apply to a college in order to receive credit for their training. Therefore, it was likely that the designation of "AIT only" more accurately reflected the true highest level of education achieved by the military LVNs.

In the current study, participants were asked to report their nursing and burn experience in years and months. An individual's professional experience has been shown to be an important factor in nursing competence and the quality of care delivered by the nurse (Anzai, Douglas, & Bonner, 2014; Blegen, Vaughn, & Goode, 2001; McHugh & Lake, 2010). For greater precision, experience values were converted to months for analysis. However, for ease of understanding, experience is reported in years in Table 4. The categories of experience used in Table 4 (less than or equal to three years, between three and ten years, and greater than ten years) were arbitrary thresholds meant to represent low, moderate, and high levels of experience, respectively. The mean years of nursing experience was nearly equal in the two units, burn progressive care unit (BPCU) = 14.67, *Mdn* = 12.25, *SD* = 8.4 and BICU = 14.63, *Mdn* = 12.0, *SD* = 9.2. However, nurses in the BPCU reported more mean burn experience (7.69 years, *Mdn* = 8.0, *SD* = 5.3) than the BICU (5.78 years, *Mdn* = 4.3, *SD* = 4.7).

DESCRIPTION OF TIME VARIANT PREDICTOR VARIABLES

Data collected from the Workload Management System for Nursing-Internet (WMSNi) were transformed into time variant predictor variables using formulas described in Chapter 3. Due to missing values during months August and September, mean values were based on the number of days with complete data rather than the planned 14 days. The time variant predictor variables generated from the WMSNi data

Table 5. *Time Variant Characteristics of Burn Progressive Care Unit*

	Month					
	Jul	Aug	Sep	Oct	Nov	Dec
Days of data	14	14	14	14	14	14
Supply/demand ratio	1.07	1.08	1.39	1.10	.77	.74
NCH (available)	208.50	228.71	187.29	220.14	248.57	200.96
NCH (required)	197.29	216.93	136.07	203.57	325.57	282.14
Patient turnover	1.30	1.43	1.38	1.42	1.31	1.36
Census	11.93	11.50	7.21	11.86	15.86	13.43
Admissions	1.07	1.29	1.14	1.64	1.36	1.50
Discharges	1.79	1.79	1.21	2.29	2.14	2.29
Transfers (in/out)	.71	1.36	.50	1.07	1.5	.79
NCH provided by float staff	7.07	19.43	1.71	7.43	24.57	22.00
Overtime paid (hours)	4.29	2.29	0	1.43	2.43	.29

Note. Except for days of data, all values represent the mean of the data collection period each month. NCH = nursing care hours.

Table 6. *Time Variant Characteristics of Burn Intensive Care Unit*

	Month					
	Jul	Aug	Sep	Oct	Nov	Dec
Days of data	14	10	11	14	14	14
Supply/demand ratio	.81	1.06	1.31	.85	.86	1.20
NCH (available)	309.14	317.60	264.83	295.23	331.79	287.32
NCH (required)	399.93	297.23	199.79	346.71	399.21	252.50
Patient turnover	1.21	1.24	1.27	1.29	1.22	1.29
Census	8.50	6.90	3.42	7.77	9.79	6.29
Admissions	.86	.50	.42	1.08	.64	.64
Discharges	.21	0	.08	0	.14	.21
Transfers (in/out)	.64	1.80	.50	1.08	1.29	1.00
NCH provided by float staff	4.57	0	.50	2.77	5.14	0
Overtime paid (hours)	2.39	1.80	.43	2.34	1.57	0

Note. Except for days of data, all values represent the mean of the data collection period each month. NCH = nursing care hours.

included SDR and patient turnover. The time variant predictor variables generated from unit administrative records included NCHs provided by float staff and overtime paid (OTp). The monthly mean values for these variables are presented in Tables 5 and 6 for the BPCU and BICU, respectively.

Supply/Demand Ratio

The SDR was a reflection of the balance between the number of nurses available and the number of nurses needed for a given timeframe. Thus, a SDR of 1.0 reflected an ideal balance between nursing care supply and nursing care demand. A SDR value greater than 1.0 reflected a higher number of nurses available relative to the number of nurses actually needed for a given timeframe. This reflected a state of imbalance characterized as overstaffed. A SDR value less than 1.0 reflected a lower number of nurses available relative to the number of nurses needed for a given timeframe. This reflected a state of imbalance characterized as understaffed.

The SDRs reported across the six months reflected both types of staffing imbalances within the BPCU and the BICU. The SDR for the BPCU ranged from .74 to 1.39. The BPCU was the most understaffed during November (SDR = .77) and December (SDR = .74). These values occurred during the months with the highest mean census, 15.86 and 13.43, respectively. The BPCU was the most overstaffed during September (SDR = 1.39). This value occurred during the month with the lowest mean census, 7.21. The SDRs for the BICU ranged from .81 to 1.31. The BICU was the most understaffed during July (SDR = .81), October (SDR = .85), and November (SDR = .86). These values occurred during the months with the highest mean census, 8.50, 7.77, and 9.79, respectively. The BICU was the most overstaffed nursing September (SDR = 1.31) and December (SDR = 1.20). These values occurred during the months with the lowest mean census, 3.42 and 6.29 respectively.

Patient Turnover

Patient turnover was a reflection of a proportional increase in nursing care demand related to the permanent movement of patients in or out of a nursing unit during a given timeframe. A patient turnover value of 1.0 reflected no patient movement in or out of the nursing unit for a given timeframe and therefore no change in nursing care demand. A patient turnover value greater than 1.0 reflected permanent movement of patients in or out of the nursing unit for a given timeframe, which resulted in a proportional increase in nursing care demand. Mean patient turnover in both units was moderate during the current study (see Tables 5 and 6, page 94). Patient turnover for the BPCU ranged from 1.30 to 1.43. The BPCU experienced the most patient movement during August (patient turnover = 1.43) and October (patient turnover = 1.42). Patient turnover for the BICU ranged from 1.21 to 1.42. The BICU experienced the most patient movement during October and December (patient turnover = 1.29 during both months).

Nursing Care Hours Provided by Float Staff

Nursing care hours provided by float staff was a reflection of the need to temporarily increase the number of nurses available (or, surge) to provide patient care due to an imbalance between nursing care supply and nursing care demand. These values reflected the number of hours of nursing care temporarily provided by nurses not assigned to the USABC in order to meet the demand for nursing care. Tables 5 and 6 on page 94 depict these data. The BPCU required more NCHs from float staff than the BICU. The mean NCHs provided by float staff in the BPCU ranged from 1.71 to 24.57. The largest mean value of NCH provided by float staff occurred during November (NCH by float staff = 24.57) and December (NCH by float staff = 22.0). These values occurred during the months with the highest mean census, 15.86 and 13.43 respectively. Despite the use of float staff to meet the nursing care demand during these months, the BPCU remained understaffed. The lowest mean value of NCH provided by float staff occurred during September (NCH by float staff = 1.71), the month with the lowest mean census (7.21) and the highest SDR (1.39). The mean NCHs provided by float staff in the BICU ranged from 0 to 5.14. The largest mean value of NCH provided by float staff occurred during July (NCH by float staff = 4.57) and November (NCH by float staff = 5.14). These values occurred during the months with the highest mean census, 8.50 and 9.79 respectively. Despite the use of float staff to meet the nursing care demand during these months, the BICU remained understaffed. There was no NCH provided by float staff during August and December. September had the lowest mean census (3.42) and float staff provided .5 hours of nursing care.

Overtime Paid

Overtime paid also was a reflection of the need to surge due to a low SDR (understaffing). These values reflect the number of hours over and above their normally scheduled hours provided by nurses assigned to the USABC in order to meet the demand for nursing care. Tables 5 and 6 on page 94 depict these data. The BPCU required more hours of OTp than the BICU. The mean number of hours of OTp in the BPCU ranged from 0 to 4.29. The highest mean hours of OTp occurred during July. This coincided with a mean of 7.07 NCHs provided by float staff and a mean SDR of 1.07. The lowest mean hours of OTp occurred during September, a month with the lowest mean census and the highest SDR (1.39). The second lowest mean hours of OTp (.29) occurred during December, coinciding with a high use of NCHs by float staff (NCH by float staff = 22.00) and understaffing in the BPCU (SDR = .74). The mean number of hours of OTp in the BICU ranged from 0 to 2.39. The highest mean hours of OTp occurred during July (2.39), which coincided with a mean census of 8.5, 4.57 NCHs provided by float staff, and understaffing in the BICU (SDR = .81). The lowest mean hours of OTp occurred during September (OTp = .43) and December (OTp = 0), which coincided with the lowest mean census (3.42 and 6.29, respectively) and the best staffing (SDR = 1.31 and 1.20, respectively).

Prevalence and Patterns of UNC

The prevalence and patterns of UNC were examined using nurse self-report data from the PIRNCA instrument. However, the PIRNCA was first examined for acceptability, utility, and reliability in the current study sample. Acceptability was assessed based on the percentage of item-level missing data. Consistent with previous reports (Jones, 2014, 2015), there was a low percentage of item-level missing data on the PIRNCA (0% to 2.2%) in the current study. These findings suggest high acceptability of the PIRNCA among nurses at the USABC. Utility of the PIRNCA in the military and burn care environments was assessed through analysis of item-level response options, particularly the frequency and pattern of response option "not needed." Frequencies and percentages of this response option were computed at the survey- and item-level. The results for the BPCU and BICU are depicted in Tables 7 (page 99) and 8 (pages 100 and 101), respectively.

At the survey level, participants in the BPCU selected "not needed" response option infrequently (.7% to 2.8% of monthly item responses). Participants in the BICU also selected "not needed" response option infrequently (3.4% to 6.9% of monthly item responses). This low frequency reflects the mean proportion of items on the PIRNCA that was not needed for patients in the USABC per each month. At the item level, some elements of care were marked as "not needed" more frequently than others. In the BPCU, the items with the highest frequency of "not needed" responses included administering enteral/parenteral nutrition (10.8% of surveys) and having important conversations with external team members (12.5% of surveys). In the BICU, the items with the highest

Table 7. *Frequency of Elements of Care Marked as 'Not Needed' in the Burn Progressive Care Unit (n = 120 surveys)*

Element of Care	Month						Surveys (n)	% of surveys
	Jul	Aug	Sep	Oct	Nov	Dec		
Routine hygiene		1			1		2	1.7
Ambulation					1		1	.8
Mobilization/position change		1			1	1	3	2.5
Eating/drinking	1	1	1		1	1	5	4.2
Physical comfort						1	1	.8
Medication administration						2	2	1.7
Enteral/parenteral nutrition	1	1	1	3	3	4	13	10.8
Wound care						1	1	.8
Change intravenous catheter						1	1	.8
Safe patient handling		1			1	1	3	2.5
Follow-up					1		1	.8
Important conversations (internal)				1			1	.8
Important conversations (external)	2	3	2	3	2	3	15	12.5
Important conversations (patient/family)			1	2	1		4	3.3
Plan of care initiation/revision						1	1	.8
Total	4	8	5	9	12	16		
Surveys (n)	18	21	21	23	14	23		
% of all elements	.7	1.2	.8	1.3	2.8	2.2		

Note. Values in far right column reflect proportion of surveys with the item marked as "not needed." Values in bottom row reflect proportion of total items marked as "not needed." Elements of care never marked as "not needed" were not included in this table. Blank spaces indicate that the element of care was always needed for care during that month.

Table 8. *Frequency of Elements of Care Marked as 'Not Needed' in the Burn Intensive Care Unit (n = 149 surveys)*

Element of Care	Month						Surveys	% of
	Jul	Aug	Sep	Oct	Nov	Dec	(n)	surveys
Routine hygiene	1						1	.7
Routine skin care	1			1			2	1.3
Change linen	2						2	1.3
Ambulation	9	7	5	4	7	5	37	24.8
Mobilization/position change	1	1					2	1.3
Elimination	2	2	4	2	1	2	13	8.7
Eating/drinking	4	3	4	4	2	1	18	12.1
Physical comfort	1			1			2	1.3
Medication administration	1						1	.7
Enteral/parenteral nutrition	1		1				2	1.3
Wound care	1	1	1			1	4	2.7
Change intravenous catheter	1	1	2				4	2.7
Safe patient handling			1				1	.7
Infection control adherence			1				1	.7
Teaching			1	1			2	1.3
Patient preparation	2		1	1			4	2.7
Emotional support	1		1				2	1.3
Monitoring behavior	1	2	1		1		5	3.4
Monitoring safety	1			1			2	1.3
Follow-up			1				1	.7
Patient/family kept waiting	2	2	5				9	6.0
Important conversations (internal)	2						2	1.3
Important conversations (external)	11	8	6	8	5	7	45	30.2

(continued)

Table 8. *Frequency of Elements of Care Marked as 'Not Needed' in the Burn Intensive Care Unit* (continued)

Elements of Care	Month Jul	Aug	Sep	Oct	Nov	Dec	Surveys (n)	% of surveys
Important conversations (patient/family)	9	9	1	4	6	8	37	24.8
Review documentation	1						1	.7
Plan of care initiation/revision	2						2	1.3
Document assessment & monitoring	1						1	.7
Document care	1						1	.7
Plan of care evaluation	1						1	.7
Total	62	37	36	27	23	25		
Surveys (n)	29	29	26	22	22	21		
% of all elements	6.9	4.1	4.5	4.0	3.4	3.8		

Note. Values in far right column reflect proportion of surveys with the item marked as "not needed." Values in bottom row reflect proportion of total items marked as "not needed." Elements of care never marked as "not needed" were not included in this table. Blank spaces indicate that the element of care was always needed for care during that month.

frequency of "not needed" responses included ambulation (24.8% of surveys), having important conversations with the patient or family (24.8% of surveys), and having important conversations with external team members (30.2% of surveys). Of note, in the BPCU, more nurses rated elements of care as not needed toward the end of the study period. Conversely, in the BICU, more nurses rated elements of care as not needed toward the beginning of the study period. Reliability of the PIRNCA was assessed using Cronbach's alpha; results indicated high reliability (.96 to .98) across all months. These findings demonstrated that the PIRNCA was an acceptable, useful, and reliable instrument for estimating UNC in the current study sample.

Prior to conducting any statistical analysis, certain assumptions must be met in order to properly interpret the findings from the analysis. In other analyses, these assumptions are generally met before analysis begins. However, in multilevel modeling, these assumptions can be demonstrated after the final models are built because the assumptions require knowledge about the values of the residuals identified during the modeling process (Singer & Willet, 2003). Therefore, the testing of statistical assumptions is described after the modeling process is described.

Research Question 1

Research Question 1 was "what is the monthly variation in the prevalence and patterns of UNC in the USABC?" To answer this question, four scoring procedures were applied to generate prevalence estimates for UNC at the USABC, consistent with recommendations by the author of the PIRNCA (Jones et al., 2016). These procedures included one composite score (the mean scale score) and three scores based on dichotomized responses (percentage of nurses rationing one or more elements of care; mean number of elements of care rationed per nurse; mean percentage of elements of care rationed per nurse). For each participant, the composite score was calculated as the arithmetic mean of responses to the 4-point Likert-type scale across the 31 items in the PIRNCA. The mean of composite scores for each unit at each month was calculated. In addition, the distribution of composite scores for each unit was examined. To obtain the three dichotomized instrument scores, each of the 31 items was recorded to reduce the responses from the 4-point scale to a 2-point scale. The cut point used to dichotomize the response was 2.0 (equal to "rarely"). The recoded responses were scored as follows: 0 = no (never or not needed) and 1 = yes (rarely, sometimes, or often).

The survey-level prevalence estimates of UNC at the USABC are depicted in Table 9. The mean composite score reflects the average frequency with which the 31 items in the

PIRNCA were left unfinished. In the BPCU, mean composite scores ranged from 1.76 to 2.27, which reflected mean frequencies of "less than rarely" to "more than rarely," respectively. Across the entire study period, 49.8% of individual mean composite scores fell in the range of 0 to 1.97 (less than "rarely"); 45.7% of individual mean composite scores fell in the range of 2.0 to 3.0 ("rarely" to "sometimes"); and 4.5% of individual mean composite scores fell in the range of 3.03 to 3.94 (less than "often"). In the BICU, mean composite scores ranged from 1.69 to 1.93, which reflected mean frequencies of "less than rarely." In the BPCU, the lowest mean composite score (1.76) occurred during

Table 9. *Prevalence Estimates of Unfinished Nursing Care*

	Month					
	Jul	Aug	Sep	Oct	Nov	Dec
Mean Composite Scores						
Burn Progressive Care Unit	2.27	2.14	1.76	2.00	2.07	2.01
Burn Intensive Care Unit	1.88	1.85	1.69	1.93	1.87	1.71
% Nurses Leaving One or More Elements of Care Unfinished						
Burn Progressive Care Unit	100	100	85.7	91.3	92.9	95.7
Burn Intensive Care Unit	100	100	92.3	95.5	95.5	95.2
Number of Elements of Care Left Unfinished per Nurse						
Burn Progressive Care Unit	24.1	22.3	16.2	20.0	20.7	20.6
Burn Intensive Care Unit	18.2	18.9	16.4	21.5	18.1	16.8
% of Elements of Care Left Unfinished per Nurse						
Burn Progressive Care Unit	77.7	71.9	52.3	64.5	66.8	66.5
Burn Intensive Care Unit	58.7	61.0	52.9	69.4	58.4	54.2

Note. All values represent the unit mean for the month.

September, when the mean census was the lowest (7.21) and the unit was most overstaffed (SDR = 1.39; see Table 5 on page 94). The highest mean composite scores occurred during July (2.27) and August (2.14), when the unit was appropriately staffed (based on the SDR), SDR = 1.07 and 1.08, respectively. The second highest mean composite score occurred in August when the BPCU experienced the highest patient turnover (1.43) and required the third highest number of NCH provided by float staff (19.43) to maintain appropriate staffing. In the BICU, the lowest mean composite score (1.69) also occurred during September, when the mean census was the lowest (3.42) and the unit was most overstaffed (SDR = 1.31; see Table 6 on page 94). The highest mean composite score occurred during October, when the unit was understaffed (SDR = .86). This also coincided with the third highest mean census (7.77) and the highest patient turnover value (1.29).

In the current study, dichotomized scoring revealed that a high percentage of nurses left one or more elements of care unfinished in both nursing units. In the BPCU, between 85.7% and 100% of nurses rationed at least one element of necessary care during the study period; 80.9% to 100% rationed more than one element of necessary care. In the BICU, between 92.3% and 100% of nurses rationed at least one element of necessary care during the study period; 88.5% to 100% rationed more than one element of necessary care. On both units, the lowest percentage of nurses rationing care occurred during September, the month with the lowest mean census and the highest staffing levels. Despite being overstaffed during September, a high percentage of nurses (85.7% in the BPCU and 92.3% in the BICU) rationed at least one element of nursing care. Additionally, on both units, 100% of nurses rationed at least one element of nursing care in July and August.

Additionally, a high number of elements of care were left unfinished per nurse throughout the study period. In the BPCU, nurses reported leaving an average of 16 to 24 elements of care (52.3% to 77.7% of all elements of care) unfinished each month. The highest number of elements of care left unfinished occurred in July and August. The highest amount of patient turnover (1.43) and the third highest amount of NCH provided by float staff (19.43) also occurred in August. In the BICU, nurses reported leaving 16 to 22 elements of care (52.9% to 69.4% of all elements of care) unfinished during each month. The highest number of elements of care left unfinished occurred in October, which also was the month in which the BICU was the most understaffed (SDR = .85). In both units, the lowest number of elements of care left unfinished per nurse occurred in September, also coinciding with the lowest mean census and the highest staffing levels.

In total, according to three methods of estimation, the prevalence of UNC was higher in the BPCU. Another estimate (the percent of nurses rationing any element of care) suggested that a higher proportion of nurses in the BICU rationed care. Regardless of the method used to estimate the prevalence of UNC, the lowest prevalence of UNC occurred in September for both units. Interestingly, in September (as depicted in Tables 5 and 6, page 94), the BPCU and BICU experienced the lowest census, the lowest OTp, the lowest NCHs provided by float staff for both units, and were the most overstaffed.

The item-level prevalence estimates of UNC for each element of care in the PIRNCA are depicted in Tables 10, 11, 12, and 13. By considering UNC using item-level analysis of the PIRNCA, more specific patterns of care rationing can be described and potential areas for intervention can be identified (Jones et al., 2016). The data in Tables 10 and 11 (pages 107 to 110) represent the mean frequency (represented as the mean item score) with which individual nurses rationed an element of care. However, this information provided no understanding about how many nurses prioritized care in this manner. The data in Tables 12 and 13 (pages 111 to 114) represent the percent of nurses who reported rationing each element of care, which provided no understanding about how often individual nurses rationed the individual elements. By cross-referencing these item-level data, the most and least frequently rationed elements of care were identified.

Across both units, each of the 31 elements of care was left unfinished by at least 31.0% of nurses. No single element was completed 100% of the time by 100% of the nurses; every element was rationed by at least one nurse during each measurement period. Specifically, in the BPCU, 20 of 31 elements of care were left unfinished at least once by at least 50% of the nurses. If September were excluded from the analysis, this number would increase to 28 of 31 elements of care. Additionally, across all months, the elements of care most frequently left unfinished (based on mean scale responses) were: patient/family kept waiting; documenting care; changing intravenous catheters; emotional support; and teaching. The mean item score for these elements ranged from 2.28 to 2.54 (more than "rarely"). The mean proportion of nurses rationing these elements ranged from 75.0% to 85.6%. Two elements of care [routine hygiene and important conversations (internal)] also were reported as being left unfinished by a relatively high percentage of nurses [*M* = 72.6% for routine hygiene; *M* = 73.7% for important conversations (internal)] but were rationed less frequently [*M* = 2.00 for routine hygiene; *M* = 2.25 for important conversations (internal)]. The elements of care least frequently left unfinished were consistent based on both estimates: enteral nutrition; medication administration; changing linens; infection control adherence; wound care; and monitoring safety. The mean item score for these elements ranged from 1.33 to 1.79. The mean proportion of nurses rationing these elements ranged from 39.3% to 57.6%.

In the BICU, 14 of 31 elements of care were left unfinished at least once by at least 50% of the nurses. If September were excluded from the analysis, this number would increase to 17 of 31 elements of care. Additionally, across all months, the elements of care most frequently left unfinished (based on mean scale responses) were: teaching; reviewing documentation; documenting care; plan of care initiation/revision; and emotional support. The mean item score for these elements ranged from 2.19 to 2.46

Table 10. *Mean Item Scores in the Burn Progressive Care Unit*

Element of Care	Month					
	Jul	Aug	Sep	Oct	Nov	Dec
Routine hygiene	2.06	1.95	1.75	2.09	2.08	2.09
Routine skin care	1.94	1.90	1.70	1.91	2.00	2.05
Change linen	1.88	1.85	1.55	1.96	1.85	1.77
Ambulation	2.35	2.30	1.80	2.30	2.38	2.00
Mobilization/ position change	2.06	2.15	1.80	2.22	2.08	2.05
Elimination	1.82	2.10	1.65	2.04	1.92	2.05
Eating/drinking	1.76	1.95	1.70	2.09	2.00	1.91
Physical comfort	2.35	2.15	1.90	1.96	1.85	1.91
Medication administration	1.88	1.85	1.80	1.70	1.54	1.55
Enteral/parenteral nutrition	1.41	1.25	1.35	1.48	1.15	1.36
Wound care	2.12	1.70	1.70	1.78	1.69	1.86
Change intravenous catheters	2.65	2.35	2.15	2.09	2.38	2.18
Safe patient handling	2.29	1.95	1.50	1.96	1.92	1.86
Infection control adherence	2.12	1.55	1.45	1.74	1.77	1.68
Teaching	2.53	2.40	2.05	2.35	2.62	2.27
Patient preparation	2.41	2.05	1.85	2.17	2.54	1.95
Emotional support	2.76	2.55	2.05	2.22	2.69	2.45
Monitoring physiology	2.35	2.10	1.70	1.87	2.15	2.05
Monitoring behavior	2.53	2.25	1.80	1.96	2.23	2.05
Monitoring safety	2.00	1.90	1.65	1.83	1.85	1.68
Follow-up	2.41	1.90	1.75	1.87	2.08	2.09
Patient/family kept waiting	2.71	2.60	2.25	2.48	2.69	2.55
Important conversations (internal)	2.47	2.45	1.95	2.13	2.15	2.36
Important conversations (external)	2.00	2.00	1.75	1.78	1.92	1.82
Important conversations (patient/family)	2.53	2.25	1.75	2.48	2.00	2.09

(continued)

Table 10. *Mean Item Scores in the Burn Progressive Care Unit* (continued)

Element of Care	Month					
	Jul	Aug	Sep	Oct	Nov	Dec
Supervision	2.35	2.40	1.90	2.09	2.08	2.05
Review documentation	2.76	2.35	1.90	2.09	2.46	2.14
Plan of care initiation/revision	2.47	2.25	1.75	2.09	1.92	1.86
Document assessment & monitoring	2.29	2.35	1.75	1.87	1.92	2.09
Document care	2.94	2.85	2.00	2.22	2.54	2.41
Plan of care evaluation	2.18	2.35	1.75	1.91	2.08	2.05

Note. A mean score of: 1 = never; 2 = rarely; 3 = occasionally; 4 = often.

(more than "rarely"). The mean proportion of nurses rationing these elements ranged from 71.3% to 78.5%. One element of care [important conversations (internal)] also was reported left unfinished by a high percentage of nurses (*M* = 73.9%) but was rationed slightly less frequently (*M* = 2.09). Another element of care (patient/family kept waiting) was reported as being frequently left unfinished (*M* = 2.29) but was reported as rationed by slightly fewer nurses (*M* = 67.7%). The elements of care least frequently left unfinished were: important conversations (patient/family); important conversations (external); eating/drinking; and monitoring safety. The mean item score for these elements ranged from 1.32 to 1.49 (less than "rarely"). The mean proportion of nurses rationing these elements ranged from 42.1% to 45.5%. Two elements of care (ambulation and elimination) were rationed less frequently (*M* = 1.36 for ambulation; *M* = 1.47 for elimination) but were reported left unfinished by a slightly higher percentage of nurses (*M* = 46.5% for ambulation; *M* = 48.3% for elimination). Another element of care (enteral/parenteral nutrition) was rationed by fewer nurses (*M* = 45.0%) but was reported left unfinished more frequently (*M* = 1.56).

Table 11. *Mean Item Scores in the Burn Intensive Care Unit*

Element of Care	Month					
	Jul	Aug	Sep	Oct	Nov	Dec
Routine hygiene	1.96	2.11	1.78	1.95	1.58	2.05
Routine skin care	1.67	1.78	1.52	1.68	1.58	1.75
Change linen	1.85	1.85	1.78	1.84	1.58	1.75
Ambulation	1.33	1.26	1.43	1.53	1.11	1.20
Mobilization/ position change	2.00	1.67	1.83	1.89	1.79	1.75
Elimination	1.63	1.37	1.39	1.47	1.42	1.55
Eating/drinking	1.44	1.44	1.35	1.42	1.42	1.40
Physical comfort	1.93	1.81	1.65	1.89	1.58	1.65
Medication administration	1.96	1.78	1.52	1.63	1.74	1.70
Enteral/parenteral nutrition	1.63	1.48	1.52	1.74	1.47	1.40
Wound care	1.67	1.48	1.39	1.63	1.63	1.30
Change intravenous catheters	2.07	2.00	1.65	2.00	1.84	1.60
Safe patient handling	1.85	1.89	1.65	2.21	2.16	1.60
Infection control adherence	2.04	1.70	1.61	1.95	2.00	1.55
Teaching	2.22	2.41	2.13	2.63	2.37	2.15
Patient preparation	1.70	2.00	1.61	1.89	1.89	1.75
Emotional support	2.22	2.22	2.00	2.58	2.32	2.20
Monitoring physiology	1.96	1.52	1.43	2.05	1.74	1.40
Monitoring behavior	1.78	1.56	1.43	2.00	1.79	1.65
Monitoring safety	1.48	1.44	1.35	1.68	1.58	1.30
Follow-up	2.07	1.74	1.65	2.11	1.95	1.65
Patient/family kept waiting	2.52	2.15	1.91	2.47	2.26	2.35
Important conversations (internal)	2.22	2.11	1.96	2.16	2.11	2.00
Important conversations (external)	1.22	1.33	1.48	1.05	1.58	1.15
Important conversations (patient/family)	1.33	1.07	1.13	1.63	1.42	1.10

(continued)

Table 11. *Mean Item Scores in the Burn Intensive Care Unit* (continued)

Element of Care	Month					
	Jul	Aug	Sep	Oct	Nov	Dec
Supervision	1.85	1.78	1.70	2.16	1.68	1.70
Review documentation	2.11	2.52	2.17	2.58	2.32	2.15
Plan of care initiation/revision	2.04	2.44	2.09	2.16	2.11	2.10
Document assessment & monitoring	2.15	2.00	1.78	2.21	1.95	1.65
Document care	2.48	2.56	2.22	2.68	2.32	2.20
Plan of care evaluation	2.07	2.15	1.83	2.16	1.84	1.75

Note. A mean score of: 1 = never; 2 = rarely; 3 = occasionally; 4 = often.

INFLUENCE OF PREDICTORS OF UNC

The influence of the proposed predictors on nurse reports of UNC were examined using nurse self-report data from the PIRNCA instrument, indicators of *nursing staff supply* (time-invariant) from the demographic portion of the self-report survey, and indicators of *management of working conditions* (time-variant and time-invariant) from self-report surveys and the administrative records of the nursing leaders at the USABC. Because of the natural clustering of repeated measures within the individual participants, multilevel modeling was used to identify the influence of the predictors on nurse estimates of UNC. Generalized linear modeling was used due to the continuous nature of the dependent variable (UNC). Prior to building the multilevel model, for ease of interpretation, the following variables were recoded: employment category (a nominal measure) was dummy coded to separate the categories government civilian and contract employee (military category was the reference); SDR was centered on 1.0, representing an ideal balance between nursing care supply and nursing care demand; and patient turnover was centered on 1.0, representing no patient turnover. The other nominal and

Table 12. *Percentage of Nurses Leaving Elements of Care Unfinished in the Burn Progressive Care Unit (> Never)*

Element of Care	Month					
	Jul	Aug	Sep	Oct	Nov	Dec
Routine hygiene	88.9	71.4	61.9	69.6	78.6	65.2
Routine skin care	77.8	66.7	52.4	65.2	71.4	73.9
Change linen	55.6	61.9	42.9	65.2	57.1	56.5
Ambulation	77.8	81.0	47.6	82.6	71.4	69.6
Mobilization/ position change	66.7	76.2	52.4	78.3	71.4	69.6
Elimination	55.6	76.2	42.9	65.2	71.4	69.6
Eating/drinking	55.6	61.9	52.4	69.6	64.3	60.9
Physical comfort	72.2	71.4	57.1	60.9	57.1	73.9
Medication administration	61.1	57.1	52.4	47.8	35.7	47.8
Enteral/parenteral nutrition	38.9	38.1	42.9	43.5	28.6	43.5
Wound care	83.3	47.6	42.9	47.8	50	65.2
Change intravenous catheters	83.3	85.7	61.9	69.6	85.7	73.9
Safe patient handling	77.8	66.7	42.9	56.5	57.1	60.9
Infection control adherence	72.2	42.9	38.1	52.2	57.1	52.2
Teaching	83.3	85.7	61.9	69.6	71.4	78.3
Patient preparation	83.3	71.4	52.4	69.6	78.6	69.6
Emotional support	94.4	90.5	57.1	69.6	78.6	69.6
Monitoring physiology	88.9	71.4	47.6	60.9	64.3	73.9
Monitoring behavior	88.9	71.4	52.4	65.2	78.6	69.6
Monitoring safety	72.2	66.7	52.4	52.2	50	52.2
Follow-up	88.9	71.4	52.4	56.5	71.4	73.9
Patient/family kept waiting	88.9	85.7	76.2	82.6	92.9	87.0
Important conversations (internal)	88.9	81.0	57.1	69.6	71.4	73.9

(continued)

Table 12. *Percentage of Nurses Leaving Elements of Care Unfinished in the Burn Progressive Care Unit (> Never)* (continued)

Element of Care	Month					
	Jul	Aug	Sep	Oct	Nov	Dec
Important conversations (external)	61.1	71.4	57.1	65.2	64.3	56.5
Important conversations (patient/family)	83.3	76.2	52.4	65.2	71.4	65.2
Supervision	83.3	81.0	52.4	73.9	71.4	60.9
Review documentation	83.3	81.0	61.9	60.9	78.6	65.2
Plan of care initiation/revision	88.9	76.2	47.6	73.9	64.3	65.2
Document assessment & monitoring	88.9	71.4	47.6	56.5	50	69.6
Document care	94.4	95.2	52.4	78.3	85.7	78.3
Plan of care evaluation	77.8	81.0	47.6	60.9	71.4	65.2

ordinal measures (nurse licensure, shift worked, and unit type) were dummy coded from the beginning because they each consisted of only two categories.

The parameter estimation methods used in multilevel modeling (maximum likelihood or restricted maximum likelihood) operate on an assumption of large sample sizes. Maximum likelihood estimation is a common, robust and efficient method of estimation. Restricted maximum likelihood provides a less biased estimate and is better for smaller sample sizes (Hox, 2010; Luke, 2004; Raudenbush & Bryk, 2002). To achieve at least 80% power, Huta (2014) suggested that a sample of at least 60 individuals was required in a study that measured participants at least twice. The current study resulted in 95 unique participants; 65 participated at least twice, exceeding Huta's assertion. However, Singer and Willet (2003) suggested that at least three months were appropriate for longitudinal study. In the current study, 55 nurses participated at least three times. Therefore, to reduce the risk of bias related to the relatively small sample size, restricted maximum likelihood estimation was used.

Table 13. *Percentage of Nurses Leaving Elements of Care Unfinished in the Burn Intensive Care Unit (> Never)*

Element of Care	Month					
	Jul	Aug	Sep	Oct	Nov	Dec
Routine hygiene	65.5	75.9	57.7	77.3	54.5	71.4
Routine skin care	55.2	62.1	46.2	68.2	50	61.9
Change linen	55.2	69.0	61.5	63.6	54.5	61.9
Ambulation	44.8	41.4	50.0	59.1	40.9	42.9
Mobilization/ position change	69.0	62.1	65.4	63.6	68.2	61.9
Elimination	44.8	41.4	42.3	59.1	50	52.4
Eating/drinking	37.9	41.4	46.2	40.9	45.5	42.9
Physical comfort	58.6	55.2	42.3	72.7	59.1	57.1
Medication administration	58.6	55.2	38.5	50	50	52.4
Enteral/parenteral nutrition	44.8	44.8	42.3	54.5	45.5	38.1
Wound care	48.3	44.8	42.3	54.5	50	33.3
Change intravenous catheters	58.6	72.4	53.8	72.7	63.6	52.4
Safe patient handling	41.4	62.1	38.5	77.3	72.7	57.1
Infection control adherence	62.1	58.6	50.0	81.8	68.2	42.9
Teaching	72.4	82.8	80.8	77.3	86.4	71.4
Patient preparation	51.7	69.0	50.0	72.7	54.5	61.9
Emotional support	72.4	79.3	65.4	81.8	72.7	71.4
Monitoring physiology	62.1	48.3	42.3	77.3	54.5	38.1
Monitoring behavior	55.2	51.7	42.3	68.2	45.5	47.6
Monitoring safety	34.5	41.4	38.5	63.6	45.5	33.3
Follow-up	65.5	55.2	46.2	77.3	59.1	52.4
Patient/family kept waiting	75.9	65.5	61.5	72.7	63.6	66.7
Important conversations (internal)	75.9	72.4	73.1	68.2	72.7	76.2

(continued)

Table 13. *Percentage of Nurses Leaving Elements of Care Unfinished in the Burn Intensive Care Unit (> Never)* (continued)

Element of Care	Month					
	Jul	Aug	Sep	Oct	Nov	Dec
Important conversations (external)	37.9	48.3	57.7	36.4	54.5	38.1
Important conversations (patient/family)	44.8	31.0	38.5	54.5	45.5	38.1
Supervision	58.6	65.5	50.0	72.7	50	57.1
Review documentation	69.0	82.8	73.1	86.4	81.8	66.7
Plan of care initiation/revision	75.9	79.3	65.4	86.4	59.1	61.9
Document assessment & monitoring	72.4	65.5	57.7	81.8	59.1	47.6
Document care	82.8	86.2	65.4	90.9	68.2	66.7
Plan of care evaluation	72.4	75.9	57.7	86.4	63.6	57.1

The sequential building of the multilevel model progressed using the SAS procedure (PROC) MIXED sample code provided by Singer (1998) as a template. A three-level unconditional means model with an unstructured covariance matrix was initially evaluated to determine the appropriate model structure for the data. An unconditional means model contains no specific predictor variables within levels. Therefore, the resulting variance estimates for the outcome variable (UNC) were aggregated by level and did not reveal the effects of any specific conditions (i.e., nursing staff supply or management of working conditions). The intercept and standard error for this model were 1.938 and .10, respectively. The resulting variance estimates for each level were: Level 1 (within-nurse) = .1254, SE = .01; Level 2 (between-nurse) = .3230, SE = .06; Level 3 (between-unit) = .0123, SE = .03. The between-unit variance estimate was insignificant, suggesting that a two-level model structure was most appropriate for the data. Therefore, a two-level unconditional means model (Model 1) was evaluated to examine within- and between-nurse variation.

Model 1 produced an intercept (β_{00}) of 1.93, $SE = .064$, $p < .0001$. The intercept value represented a predicted PIRNCA mean composite score of slightly less than "rarely" (scored as "2" on the PIRNCA) in the first month, without the influence of any predictor variables. The variance in UNC estimated by Model 1 was portioned for levels 1 and 2 based on intraclass correlations (ICCs). The ICCs for Level 1 (within-nurse) and Level 2 (between-nurse) were .1255 and .3288, respectively. Therefore, in the current study sample, most of the variance in UNC was explained by Level 2 (between-nurse) factors. The two-level unconditional means model (Model 1) served as the baseline against which subsequent models that include specific predictor variables were compared to establish a model of best fit.

Table 14. *Model of Best Fit Scores for Covariance Matrices*

	Unstructured	Compound Symmetry	Heterogeneous Compound Symmetry
-2LL	363.8	396.7	390.9
AIC	405.8	400.7	404.9
BIC	459.4	405.8	422.8

Note. -2LL = -2 log likelihood.

To achieve the best estimates of residual variance, three covariance matrices (unstructured, compound symmetry, heterogeneous compound symmetry) were considered. The matrices were assessed using the -2LL, Akaike's, and Bayesian information criteria scores (Littell et al., 2006; Singer, 1998; Singer & Willet, 2003). The results can be found in Table 14. Although the unstructured matrix provided the lowest -2LL, use of this matrix was not feasible because it provided no estimates of residual covariance. Additionally, this matrix tends to produce the most complex models (Littell et al., 2006). Instead, the BIC was used to identify the model of best fit (Littell et al., 2006; Singer & Willet, 2003). The compound symmetry matrix resulted in the lowest

BIC score and provided estimates of residual variance. Therefore, compound symmetry was selected as the covariance matrix for subsequent modeling.

RESEARCH QUESTION 2

Research Question 2 was "what is the relationship between *nursing staff supply* and UNC in the USABC?" To determine which indicators to include in the model of the effects of *nursing staff supply* on nurse estimates of UNC, each variable was modeled. These indicators represented Level 2, time invariant predictors and included: experience in nursing, experience in burn care, education, and licensure. The results are presented in Table 15. None of the individual predictors explained a significant portion of the variance in UNC. Therefore, to answer Research Question 2, a second model with all four indicators of *nursing staff supply* was considered (Model 2). In Model 2, the intercept

Table 15. *Effects of Predictors of Nursing staff supply on Nurse Estimates of Unfinished Nursing Care*

Predictor	Parameter Estimate	*SE*	*p*	*CS (PGID)*	*Var(r)*	R^2
Level-2, time invariant predictors						
Experience (nursing)	-.0005	.0007	.4974	.3313	.1254	-.007
Experience (burn)	-.0002	.0010	.8736	.3329	.1255	-.011
Education	-.0371	.0715	.6049	.3321	.1254	-.009
Licensure	-.2068	.1639	.2104	.3273	.1253	.004

Note. The individual predictors were modeled separately. Each parameter estimate is the raw value and represents the relationship between the individual predictor and instrument mean scores. *CS(PGID)* = between-nurse variance; NCH = nursing care hours; *Var(r)* = residual variance.

was 2.07, $p < .001$ and the resulting R^2 was -.075, which represented an increase in prediction error. Model fit was determined by comparing the difference in BIC of Model 1 and Model 2 to a χ^2 distribution, where the degrees of freedom equaled the difference in the number of parameters added to the model (Singer & Willett, 2003). A significantly lower BIC indicated a better model fit. The BIC for Model 2 was significantly higher than Model 1, $\Delta = 26.8$, $df = 3$, $p < .005$, indicating a worse model fit. None of the indicators of *nursing staff supply* explained a significant portion of the variance in UNC. The results of all modeling processes are depicted in Table 17 (on page 117).

RESEARCH QUESTION 3

Research Question 3 was "what are the relationships between working conditions and UNC in the USABC?" To determine which indicators to include in the model of the effects of *management of working conditions* on nurse estimates of UNC, each variable was modeled separately. Four indicators (SDR, patient turnover, OTp, and NCH provided by float staff) represented Level 1, time varying predictors. Four indicators [employment category (government civilian), employment category (contract), shift worked and unit worked] represented Level 2, time invariant predictors. Nursing care hours by float staff was the only predictor to explain a statistically significant portion of the variance in nurse estimates of UNC, $R^2 = .021$, $p = .048$. Because no Level-2 predictors were significant (to include indicators of *nursing staff supply*), no interaction effects were tested. The results are presented in Table 16.

Model 3 considered the predicted PIRNCA mean composite score while controlling for the mean NCH provided by float staff. This was the only statistically significant predictor identified in previous models; it remained statistically significant, $\beta_{40} = .008$, $p < .05$ and resulted in a R^2 of .021. The BIC for Model 3 was significantly higher than Model 1, $\Delta = 5.40$, $df = 1$, $p < .025$, indicating a worse model fit.

Model 4 predicted the PIRNCA mean composite score while controlling for all of the indicators representing *management of working conditions*: SDR, patient turnover, OTp, NCHs provided by float staff, employment category (government civilian), employment category (contract), shift worked, and unit worked. The addition of these predictors resulted in a R^2 of .027. However, no predictors explained a statistically significant

Table 16. *Effects of Predictors of Management of Working Conditions on Nurse Estimates of Unfinished Nursing Care*

Predictor	Parameter Estimate	*SE*	*p*	*CS (PGID)*	*Var(r)*	R^2
Level-1, time variant predictors						
Supply/demand ratio	-.1843	.1188	.1226	.3250	.1251	.009
Patient turnover	-.0392	.5142	.9393	.3302	.1259	-.004
Overtime paid	.0267	.0207	.1999	.3215	.1262	.015
NCH provided by float staff *	.0078	.0039	.0484	.3197	.1250	.021
Level-2, time invariant predictors						
Employment category (contract)	.0117	.1212	.9234	.3314	.1257	-.007
Employment category (government civilian)	.0835	.1237	.5004	.3314	.1254	-.007
Shift (night)	-.0564	.0983	.5671	.3309	.1256	-.006
Unit	-.2031	.1290	.1187	.3323	.1254	-.009

Note. The individual predictors were modeled separately. Each parameter estimate is the raw value and represents the relationship between the individual predictor and instrument mean scores. *CS(PGID)* = between-nurse variance; NCH = nursing care hours; *Var(r)* = residual variance.
* $p < .05$.

portion of the variance in UNC; the significant influence of NCHs provided by float staff was reduced in the model. The BIC for Model 4 was significantly higher than Model 1, $\Delta = 16.3$, $df = 7$, $p < .025$, indicating a worse model fit. Model 5 contained all of the major predictors considered in the current study. Again, none of the predictors explained a statistically significant portion of the variance in UNC. The addition of these predictors resulted in a R^2 of -.001. The BIC for Model 5 was significantly higher than Model 1, $\Delta = 42.4$, $df = 11$, $p < .005$, indicating a worse model fit.

Table 17. *Effects of Predictors on Participant Composite Scores (n = 269)*

	Model 1	Model 2	Model 3	Model 4	Model 5
Solution for Fixed Effects					
Intercept	1.93** (.06)	2.07** (.22)	1.87** (.07)	1.84** (.35)	1.87** (.40)
Supply/demand ratio				-.035 (.22)	-.027 (.22)
Patient turnover				-.088 (.71)	-.095 (.72)
Overtime paid				.022 (.03)	.022 (.03)
NCH provided by float staff			.008* (.00)	.005 (.01)	.006 (.01)
Employment category (government civilian)				.201 (.18)	.289 (.20)
Employment category (contract)				.143 (.18)	.155 (.18)
Shift (night)				-.092 (.10)	-.086 (.11)
Unit				-.136 (.17)	-.116 (.19)
Experience (nursing)		-.000 (.00)			-.000 (.00)
Experience (burn)		-.001 (.00)			-.001 (.00)
Education		.049 (.10)			.091 (.10)
Licensure		-.269 (.24)			-.280 (.25)
Solutions for Random Effects					
CS(PGID)	.329** (.08)	.337** (.06)	.320** (.06)	.314** (.06)	.320** (.06)
Var(r)	.126** (.01)	.126** (.01)	.125** (.01)	.128** (.01)	.128** (.01)
R^2		-.075	.021	.027	-.001
Measure of Model Fit					
-2LL	396.7	423.4	402.0	413.0	439.1
BIC	405.8	432.6	411.2	422.1	448.2

Note. Values in parentheses are standard errors. -2LL = -2 log likelihood; *CS(PGID)* = between-nurse variance; NCH = nursing care hours; *Var(r)* = residual variance.
* p < .05; ** p < .001

After assessing the measures of model fit, the unconditional means model (Model 1) was determined to be the model of best fit. However, Model 3 was the second-best fitting model and the only model to explain a significant portion of the variance in UNC. Therefore, for the purpose of answering Research Question 3, Model 3 was deemed the best fitting model. The equation representing the final model was:

$$UNC_{ij} = \beta_{00} + \beta_{40}(Float)_{ij} + u_{0j} + r_{ij}$$

where UNC_{ij} represented the predicted PIRNCA mean composite score reported on the *i*-th month by the *j*-th nurse, after controlling for the effect of mean NCHs provided by float staff. In the final model (Model 3), the PIRNCA composite mean score for a nurse at the USABC was predicted to be 1.87 (less than "rarely") and was predicted to increase by .008 for every hour of nursing care provided by float staff. The significant variation in nurse estimates of UNC at the USABC (represented by the PIRNCA mean composite score) was not significantly accounted for by any indicators of *nursing staff supply* or by the indicators of *management of working conditions*. The remaining variance indicated that between-nurse and within-nurse variations influenced nurse estimates of UNC due to factors not accounted for in the current study.

Post Hoc Analysis

Prior to accepting the findings of multilevel modeling, assumptions of linearity, normality, and homoscedasticity must be met (Hox, 2010; Singer & Willett, 2003). To test the assumptions of linearity and normality, quantile (Q-Q) plots of the residuals were inspected (Field, 2013; Hox, 2010; Singer & Willet, 2003). In Q-Q plots, residuals that have a linear relationship and are normally distributed residuals will fall on the diagonal (Field, 2013). Plots of the residuals were constructed and assessed using the RESIDUAL command in PROC MIXED (Littell et al., 2006; SAS, 2015). For all models considered in the current study, the Q-Q plots of the residuals approximated normality. Therefore, the assumptions of linearity and normality were met.

The assumption of homoscedasticity holds that residual variability was approximately equal at every predictor value (Singer & Willett, 2003). Plots of standardized residuals were used to assess this assumption. In these plots, the distribution of the standardized residual values should be approximately even on either side of the mid-point (often zero) on the graph (Field, 2013; Singer & Willett, 2003). For all models considered in the current study, the distribution of the standardized residuals occurred evenly on either side of the zero line. To support these findings, an assessment of heteroscedasticity was conducted for each of the models in the current study using the PROC AUTOREG procedure in SAS/ETS (2016a, 2016b). The Q statistic (Engle, 1982) and the Lagrange multiplier (McLeod & Li, 1983) tests were used to determine whether significant changes in variance occurred across time; statistically significant values indicated the presence of heteroscedasticity (SAS, 2016b). No values could be determined for the unconditional means models since the model contained no predictors. For the remaining models, no Q statistic or Lagrange multiplier tests were significant, $p < .05$, indicating that there was no significant heteroscedasticity. Therefore, the assumption of homoscedasticity was met.

Researchers also have expressed concern about autocorrelation, which is the unexplained portion of the variance in the dependent variable that is correlated across the repeated measures (Schonfeld & Rindskopf, 2010; Singer & Willett, 2003). Autocorrelation was assessed using the Durbin-Watson test. In this test, a value of 2.0 indicates zero autocorrelation. A value significantly less than 2.0 indicates positive correlations and a value significantly more than 2.0 indicates negative correlations (Field, 2013). Durbin-Watson tests also were conducted using the PROC AUTOREG procedure in SAS/ETS (SAS, 2016a). No values could be determined for the unconditional means models since the model contained no predictors. The Durbin-Watson values were 1.92-2.03, $p > .05$ for the remaining models. Therefore, autocorrelation did not appear to influence the findings of the current study.

Littell et al. (2006) also suggested identifying individual participants who might influence the multilevel model more than others. In doing so, the researcher may identify outlying participants whose responses may introduce bias into the analysis. The presence of undue influence may require a re-examination of the data for data entry errors. Researchers also might consider excluding surveys or participants that exert undue influence on study findings (Field, 2013). Cook's distance (Cook's D) is an indicator of the overall influence a participant had on a model; values greater than 1.0 may need further assessment and consideration (Field, 2013). Cook's D was measured for each participant, for each model using the INFLUENCE command in PROC MIXED (Littell et al., 2006; SAS, 2015). The maximum value for Cook's D, across all participants and all models, was .14 in Model 4. Because no value approached 1.0, it was determined that no participant exerted undue influence on the findings of the current study.

CHAPTER SUMMARY

The conceptual framework that guided the current study was the Nursing Care Performance Framework (Dubois et al., 2013). This repeated measures, descriptive study examined the monthly variation in UNC at the USABC as indicators of *nursing staff supply* and *management of working conditions* changed over time. In doing so, the prevalence and patterns of UNC on each nursing unit were identified by month before assessing the relationships between UNC and the indicators of *nursing staff supply* and *management of working conditions*. The findings of the current study included the identification of the most and least frequently rationed elements of nursing care, as well as the model of best fit for predicting UNC at the USABC.

After excluding eight surveys, a total of 269 surveys were used for data analysis. After exclusions, the mean response rate was 44.9%. Of the remaining surveys, missing data ranged from 0-4.8% and individual item omission ranged from 0-3%. The surveys represented 95 unique participants, which represented 80.5% of all nurses scheduled during the study period. Of these, 55 nurses participated three times or more.

Analysis of nurse responses to the PIRNCA revealed that the mean composite score ranged from 1.71 (less than "rarely") to 2.27 (more than "rarely") across all months on both nursing units. Additionally, 85.7% to 100% of participating nurses reported leaving at least one necessary element of care unfinished. The mean number of elements of care left unfinished per nurse ranged from 16.2 to 24.1 (52.3% to 77.7% of all elements) across all six months on both nursing units. To identify the elements of care most and least frequently left unfinished per nursing unit, the item mean scores and the percent of nurses who reported the element as unfinished were analyzed. In the BPCU, the most frequently unfinished elements of care were: patient/family kept waiting; documenting care; changing intravenous catheters; emotional support; and teaching. The least frequently unfinished elements of care were: enteral nutrition; medication administration; changing linens; infection control adherence; wound care; and monitoring safety. In the BICU, the most frequently unfinished elements of care were: teaching; reviewing documentation; documenting care; plan of care initiation/revision; and emotional support. The least frequently unfinished elements of care were: important conversations (patient/family); important conversations (external); eating/drinking; and monitoring safety.

Multilevel modeling revealed that only the mean NCHs provided by float staff significantly predicted nurse estimates of UNC. The resulting model predicted the nurse composite score at the USABC was 1.87, $SE = .07$, $p < .001$, which would increase by

.008 for every hour of nursing care provided by float staff, $SE = .001$, $p < .05$. No other indicators of *nursing staff supply* or *management of working conditions* were significantly related to nurse estimates of UNC. In Chapter 5, the implications of these findings and their relation to the science of UNC are discussed.

Chapter 5: Discussion

The purpose of the current study was to determine the prevalence and describe the patterns of unfinished nursing care (UNC) at the US Army Burn Center (USABC) over time. This repeated measures, descriptive study was conducted in the context of the Nursing Care Performance Framework (NCPF; Dubois et al., 2013) and was designed to describe the relationships between USABC nursing care system structures (**acquiring, deploying, and maintaining resources)** and processes (**transforming resources into services**) over time. Indicators of *nursing staff supply* and *management of working conditions* represented system structures. Unfinished nursing care represented *nursing processes*. The presence of UNC at the USABC reflected the disruption of nursing processes due to time scarcity and indicated that inefficiencies existed preventing nursing care system resources from being translated into nursing care.

This was the first study to identify the prevalence and patterns of UNC at the USABC, as well as the first known study to describe UNC at any burn center in the US or in any US military hospital. Additionally, this was the first study to describe the monthly variation of nurse estimates of UNC in any setting. Furthermore, this was the first study to demonstrate the utility of the Perceived Implicit Rationing of Nursing Care (PIRNCA) instrument in the burn or military environments. It is important to consider the findings within the context of the previous literature about UNC. In this chapter, the findings of the study in relation to the current literature about UNC are described. The implications of the findings as they relate to nursing practice, policy, research, and education also are discussed.

PARTICIPATION

The sample of nurses in the current study was representative of the entire population of USABC bedside nurses. In survey-based studies, representative samples cannot be achieved when respondents differ significantly from non-respondents according to personal characteristics (non-response error). Assuming there is minimal coverage or sampling error, a larger survey response rate supports the likelihood that the sample actually represented the population of interest (Dillman et al., 2009). Coverage and sampling errors were minimized in the current study because every member of the population of interest was afforded the opportunity to participate. Therefore, an adequate response rate was considered indicative of a representative sample. A 100% response rate is ideal but is considered unrealistic for most studies (Groves, 2006); researchers expect that some potential participants will opt not to participate. The monthly response rates in the current study (37.9-51.0%) were consistent with other studies using paper surveys among nursing populations, which resulted in response rates of 32% to 87% (Cook, Dickinson, & Eccles, 2009; Kramer et al., 2009; Laschinger, 2008). Additionally, the monthly response rates achieved in the current study were consistent with response rates achieved in four other studies of UNC, 42.4% to 52% (Gravlin & Bittner, 2010; Hessels et al., 2015; Kalisch, 2009; Lucero et al., 2010). Furthermore, at least five previous studies of UNC achieved response rates that were lower than those in the current study, 7% to 29% (Castner et al., 2014; Jones, 2015; Jones et al., 2016; Tubbs-Cooley et al., 2015; Winsett et al., 2016). Considering the achieved response rates, it is likely that the sample in the current study was representative of the bedside nurses at the USABC.

Although a representative sample of the USABC nursing staff was achieved, the findings reported here may have been influenced by differences between participant and non-participant nurses Some nurses may have elected not to participate in the current study for other reasons not identified in the current study. Any differences between participants and non-participants (and the influence of those differences) could not be identified in the current study due to participant anonymity. Therefore, despite achieving a sample that was consistent with other studies of UNC, it is necessary to acknowledge that these findings may not represent the entire population of nurses at the USABC.

UTILITY OF THE INSTRUMENT

The PIRNCA was shown to be a reliable instrument for estimating UNC in the military burn environment. As previously noted, the Cronbach's alpha values ranged from .96 to .98 across both units and across all months, indicating a high level of internal consistency for the PIRNCA. These values were in keeping with values reported in previous studies of UNC using the PIRNCA (Jones, 2014, 2015; Jones et al., 2016). The PIRNCA was deemed acceptable for use at the USABC because of the low occurrence of missing data (0% to 2.2%), also consistent with previous studies using the PIRNCA in other populations (Jones, 2014, 2015). The utility of the PIRNCA for this environment was supported by the low occurrence of "not needed" ratings across all surveys. For any month, less than 1.5% of the items contained in the PIRNCA were categorized as "not needed" on either nursing unit. This value was less than the 2.8% found in a previous study using the PIRNCA in other populations (Jones et al., 2016). Additionally, 100% of the individual items were reported as necessary and rationed on at least 69% of the completed surveys across all months. This finding indicated that the items contained in the PIRNCA represented necessary elements of care appropriate for patient care on the burn progressive care unit (BPCU) and the burn intensive care unit (BICU). Therefore, the PIRNCA was a reliable, acceptable and useful instrument for estimating UNC in military and burn environments.

PREVALENCE OF UNFINISHED NURSING CARE

Disruptions in nursing processes (as represented by UNC) were highly prevalent at the USABC during the current study. When UNC was assessed using the dichotomized PIRNCA scores, at least 85.7% of nurses reported rationing care due to time scarcity. Additionally, nurses left an average of at least 16.2 elements of care unfinished (52.3% of the elements in the PIRNCA) each month. When assessed according to PIRNCA mean composite scores, the prevalence of UNC was approximately "rarely" (1.71 to 2.27). This generally low reported prevalence of UNC (according to the mean composite score) must be considered within the context of the hospitalized patient because patients receive care from multiple nurses during a hospitalization (Jones, 2015). Each item may be rationed with a low frequency as indicated by the mean composite score. However, if a high percentage of nurses rationed care or a high mean number of items were rationed per nurse, this would indicate that patients were at a higher risk of experiencing UNC than the mean composite score alone might indicate. In the current study, the collective frequency with which nurses rationed across all elements of care reflected a high overall prevalence of UNC. Given these findings, it was evident that the USABC nursing care system did not reliably translate nursing resources into nursing care.

The prevalence of UNC at the USABC must be considered within the context of previous research about UNC. To do so, one also must consider the instruments used to measure UNC and the methods used to score the instruments (Jones et al., 2016). The high prevalence of UNC identified in the current study (when the PIRNCA was scored using the dichotomized methods) may be related to the number of elements of care included in the instrument inventory. For example, in the current study, 85.7% to 100% of nurses reported leaving one or more elements of care unfinished. Similarly, four previous studies that also followed the implicit rationing approach used instruments with larger inventories [the PIRNCA or Basel Extent of Rationing of Nursing Care (BERNCA)] and reported results that were similar (82% to 98%) to the current study (Cho et al., 2016; Jones, 2015; Schubert et al., 2009, 2013). In contrast, four studies using smaller inventories (from the tasks undone and MISSCARE approaches) found that fewer nurses (52% to 74%) reported leaving at least one element of care unfinished (Al-Kandari & Thomas, 2009; Ball et al., 2016; Lake et al., 2015; Tubbs-Cooley et al., 2015). Similarly, Jones and colleagues (2016) found that when estimates of UNC were based on the sum of dichotomized scores, prevalence estimates from the PIRNCA were higher (by six elements of care) than estimates from the MISSCARE instrument. The PIRNCA inventory included seven more elements of care than the MISSCARE inventory (Jones et al., 2016).

The prevalence of UNC at the USABC, when reported as the mean composite score (less than "rarely"), also was consistent with other studies that used the PIRNCA or the BERNCA instruments to assess UNC (Jones et al., 2016; Schubert et al., 2008, 2013). However, the prevalence of UNC in the current study was lower than reported in studies that derived the mean composite score (more than "rarely") from the MISSCARE instrument (Kalisch, 2009; Kalisch & Lee, 2012a, 2012b; Kalisch, Tschannen, & Lee, 2011a, 2012; Kalisch, Tschannen, Lee et al., 2011). These inconsistencies may be attributable to the presence of time references (e.g., "answering a call light within five minutes") in the descriptions of the necessary elements of care. The MISSCARE instrument contains eight items with a time reference, compared to three in the PIRNCA. In a study that compared the instruments, the presence of a time reference resulted in consistently higher estimates of UNC for each item and, because the MISSCARE instrument contained more items with a time reference, it may have resulted in higher estimates (Jones et al., 2016).

In general, the most frequently rationed elements of care at the USABC were consistent with the findings from previous studies of UNC. Jones and colleagues (2015) identified that the elements of care most frequently left unfinished fell into five categories: emotional support; education; care coordination/discharge planning; care planning; and timeliness of care. Four more recent studies also reported UNC frequencies that were consistent with this list (Ball et al., 2016; Papastavrou et al., 2016; Roche et al., 2016; Winsett et al., 2016). In the BPCU, the following elements of care were the most frequently left unfinished and were consistent with the previous literature (Jones et al., 2015): patient/family kept waiting; emotional support; teaching; and important conversations (internal). In the BICU, the following elements of care also were consistent with the previous literature (Jones et al., 2015): teaching; reviewing documentation; plan of care initiation/revision; important conversations; patient/family kept waiting; and emotional support.

The frequent rationing of changing intravenous catheters (in the BPCU) was consistent with one previous study of UNC (Winsett et al., 2016). This finding at the USABC may be due to the time required to complete the element of care. The elements of care most frequently left unfinished tend to require more time (or, an unpredictable amount of time) to complete (Jones et al., 2015). In the burn environment, intravenous catheter changes require more time than in other care environments due to the frequent need to place the catheters through burned skin. For example, peripherally placed intravenous catheters are at times inserted through scarred burn wounds that make locating and cannulating veins by palpation difficult. At other times, because peripheral placement may not be an option due to a lack of skin in the surrounding area, providers (physicians, physicians assistants or advanced practice nurses) are required to place intravenous catheters more centrally under sterile conditions. This requires time to coordinate with care team members outside of the bedside nursing team and flexibility to assist with central placement when the provider is available. Once placed, the intravenous catheter must be secured carefully to prevent damage to the healing tissues around the site. This may include specialized dressings or wrapping techniques that require more time than in other care environments. And finally, nurses invest time to carefully remove the old catheter in order to prevent tearing of fragile, healed burn wounds that might surround the old catheter site.

Jones and colleagues (2015) identified that the elements of care least frequently left unfinished fell into the following categories: infection control; nutrition; elimination; and treatments, tests, and procedures. In the BPCU, the following elements of care were the least frequently left unfinished and were consistent with the previous literature (Jones et al., 2015): enteral nutrition; medication administration; changing linens; infection control adherence; and wound care. In the BICU, the following elements of care also were consistent with the previous literature (Jones et al., 2015): eating/drinking; enteral/parenteral nutrition; and elimination.

Across the USABC, four elements of care were left unfinished less frequently than previously identified in the UNC literature: monitoring safety; ambulation; important conversations (external); and important conversations (patient/family). It is likely that these elements of care were among the least frequently left unfinished because of the emphasis placed on them by the USABC leadership team and the processes in place to facilitate their completion. For example, the USABC employs a large number of dedicated physical therapy technicians to assist with patient ambulation (Renz et al., 2012). Additionally, burn patients are at high risk for injury from falls due to the need for high dose opiate medications and other sedation-inducing medications. As such, frequent rounding and frequent use of monitoring devices (such as bed alarms) facilitate patient safety monitoring. Finally, to facilitate the prolonged wound care required for the burn patient after discharge, USABC nurses must have frequent important conversations with external agencies (such as home health or skilled nursing facilities) and with the patient's family members (Price & Milner, 2012; Renz et al., 2012). These conversations may include topics such as care coordination, providing wound care instruction, or (in the case of external agencies) nursing report prior to transferring the patient to the agency. This is particularly important at the USABC (a regional burn center) because many of the patients are transported to the USABC from far away and cannot return to the burn center for post-discharge follow-up care. Additionally, because of the military status of the USABC, civilian patients (some of whom are undocumented immigrants) may be restricted from returning for follow-up care. Thus, the inclusion of these items among the least frequently unfinished elements of care was not surprising.

In the BICU, wound care was not among the elements of care least frequently left unfinished. In the current study, rationing of wound care was reported by 33.3-54.5% of BICU nurses, with item scores of 1.30-1.63 (less than "rarely"). This finding was surprising given that care of the burn patient was centered on wound care. In an attempt to identify the cause of this anomaly, the data were explored further. No causes were identified in the data. Wound care is the cornerstone of patient care at the USABC; it is one of the major reasons patients are brought to a burn center. At the USABC, wound care is a time consuming, labor intensive process that is generally accomplished in multiple steps: removal of old dressings; gross debridement (shower); fine debridement (scalpel or scissors); reapplication of dressings; and repeated wetting of the dressings with antimicrobial solutions. For many patients, this process occurs twice daily. If the wound is colonized with an invasive fungus, this process occurs more frequently (such as every four hours). Given the extreme importance of wound care in this environment, it seems unlikely that this entire process was frequently left unfinished. Rather, it seems more likely that the nurses were reporting that only a portion of the multi-step process was rationed. This is not surprising because wound care can occur multiple times per day, and some aspects of the process (such as wetting of the dressing) occur multiple times after the rest of the process is complete, introducing numerous opportunities to ration any portion of this multi-step process. A reexamination of the individual surveys revealed no indications (such as hand written notes in the margins of the survey) that only particular aspects of wound care were being reported as unfinished. Without a more in-depth investigation, the cause of this finding remains unclear.

INFLUENCE OF NURSING STAFF SUPPLY AND MANAGEMENT OF WORKING CONDITIONS

Nursing care hours (NCHs) provided by float staff, an indicator of *management of working conditions*, was the only significant predictor of UNC identified in the current study. The model containing NCH provided by float staff (Model 3) accounted for 2.1% of the total variance in nurse reports of UNC. Although statistically significant, this value did not reflect a significant clinical effect. Rather, this finding indicated that the USABC nursing care system needed to increase nursing care supply (using float nurses) to meet the demand for nursing care but was unable to effectively do so, resulting in UNC.

This was the first study of UNC to demonstrate a significant relationship between float nurse usage (in hours) and nurse estimates of UNC. Six previous studies of UNC considered the influence of temporary nurses (as an employment category or status) on nurse estimates of UNC (Ausserhofer et al., 2014; Kalisch et al., 2013; Kalisch & Lee, 2010, 2012a; Kalisch et al., 2011a; Tschannen et al., 2010). None found a significant relationship between temporary nurses and nurse reports of UNC. In the larger context of nursing care quality, the use of temporary nurses has been inconsistently linked to nursing care quality. Previously, the use of temporary nurses was shown to increase the likelihood of medication errors (Roseman & Booker, 1995), central venous-associated blood stream infections (Alonso-Echanove et al., 2003), and 30-day patient mortality (Estabrooks et al., 2005). Conversely, one study found that the use of temporary nurses did not significantly influence rates of central-line associated blood stream infections or ventilator-associated pneumonia (Bae et al., 2015). Another study by Bae and colleagues (2010b) found that nursing units that used temporary nurses for 5-15% of all nursing care experienced fewer medication errors than nursing units that used no temporary nurses. Finally, in a single study, researchers found opposing results about Army Reserve nurses used in US Army hospitals to temporarily replace active duty Army nurses deployed overseas. Fewer Army Reserve nurses was predictive of higher medication administration error rates, $\beta = -2.907$ to -4.080, $p < .05$. At the same time, a higher proportion of Army Reserve nurses was predictive of patient falls, $\beta = 4.921$, $p < .05$ (Breckenridge-Sproat et al., 2012). The findings from the current study lend support to the idea that the need to use temporary nurses to meet nursing care demand influences nursing care quality.

The use of temporary nurses (such as float nurses) to meet nursing care demand may have influenced nurse estimates of UNC because the temporary nurses, although competent to provide care consistent with their normal clinical environment (i.e., a medical or surgical unit), required supervision or assistance from experienced USABC nurses to provide burn-specific care to their assigned patients. Being a competent nurse involves the following attributes: integrating knowledge into practice, experience, critical thinking, skill proficiency, caring, communication, environment, motivation, and professionalism (Smith, 2012). Developing these attributes in a nurse requires an investment of time, education, and collegial relationships among nursing peers (Benner, 1982; Smith, 2012). To achieve a minimum level of unit-specific nurse competence at the USABC, newly assigned nurses participate in an evidence-based precepting program

(Robbins, 2014). Nurses from San Antonio Military Medical Center (SAMMC) who float to the USABC during periods of increased nursing care demand do not participate in this precepting program and therefore may lack the burn-specific competencies to independently meet the nursing care demand of their assigned burn patients. Consequently, the USABC nurses may have been required to assist the float nurses with burn-specific competencies, which in turn resulted in increased time scarcity for the USABC nurse.

Across all of the models tested, no significant relationships were identified between the indicators of *nursing staff supply* and nurse estimates of UNC. This was consistent with previous studies of UNC. In four previous studies of UNC, researchers identified no significant relationships between nurse estimates of UNC and nurse education (Al-Kandari & Thomas, 2009; Castner et al., 2014; Schubert et al., 2013; Tschannen et al., 2010). Similarly, researchers found no significant differences in nurse reports of UNC between registered nurses (RNs) and licensed vocational nurses (LVNs; Jones, 2014; Orique et al., 2015). Furthermore, five studies found no significant relationship between nurse experience and nurse estimates of UNC (Al-Kandari & Thomas, 2009; Bragadottir et al., 2016; Kalisch, 2009; Kalisch & Lee, 2012a; Schubert et al., 2013).

In contrast to previous studies of UNC, the current study revealed no significant relationships between six indicators of *management of working conditions* [supply/demand ratio (SDR), patient turnover, overtime paid (OTp), shift worked, unit worked, and employment category] and nurse estimates of UNC. In particular, the relationship between the SDR and nurse estimates of UNC was not significant. Previously, measures that represented the balance between nursing care supply and nursing care demand (such as nurse-to-patient ratio or NCHs per patient day) were shown to have significant relationships with nurse estimates of UNC. Six studies of UNC reported that the nurse-to-patient ratio was significantly related to nurse estimates of UNC (Al-Kandari & Thomas, 2009; Ausserhofer et al., 2014; Cho et al., 2016; Orique et al., 2015; Schubert et al., 2008; Sochalski, 2004). Three other studies of UNC reported that NCHs per patient day were significantly related to nurse estimates of UNC (Dabney & Kalisch, 2015; Kalisch, Tschannen et al., 2012; Tschannen et al., 2010).

Only two previous studies of UNC considered patient turnover as a predictor of nurse estimates of UNC. The findings were mixed. Both studies operationalized patient turnover in a manner that was similar to the operationalization used in the current study (based on counts of admissions, discharges, transfers and deaths). One represented patient turnover as a series of whole numbers and found that discharges, transfers, and deaths were significantly related to nurse reports of UNC, r = .07 to .12, $p < .05$ (Al-Kandari & Thomas, 2009). The other study represented patient turnover as a ratio, similar to the current study, and found no significant relationship between patient turnover and nurse reports of UNC (Orique et al., 2015).

Overtime was considered in five previous studies of UNC. No study operationalized overtime as OTp, as was done in the current study. Instead, all previous studies of UNC operationalized overtime as overtime worked. Overtime worked represents the hours nurses worked beyond their scheduled shift. Overtime worked could represent time that nurses stayed at work past their scheduled shift to complete some aspects of care but was not authorized as overtime by nursing leaders (therefore, unpaid). Overtime worked also could represent time beyond a scheduled shift to meet nursing care demand that was authorized by a nursing leader and for which the nurse was compensated. Overtime paid refers only those hours worked by nurses beyond the 80 hours normally worked in a pay period, for which the nurse is compensated in some manner (in the form of payment or compensatory time). At the USABC, nursing care system leaders must authorize the overtime before the nurse works the additional time. Two studies found that working overtime resulted in increased odds of reporting UNC, *OR* = 1.29 to 1.86 (Cho et al., 2016; Griffiths et al., 2014). However, consistent with the findings of the current study, three studies found no significant relationship between overtime and nurse estimates of UNC (Bragadottir et al., 2016; Kalisch et al., 2013; Kalisch & Lee, 2010).

The relationship between OTp and nurse estimates of UNC may have been confounded by nurse competence, which was not measured in the current study. As a member of the USABC nursing staff, the nurse who worked overtime would have an established level of unit- and burn-specific nurse competence. Unlike nurses floated from SAMMC who may have required assistance with unit and burn-specific elements of care, USABC nurses working overtime may have required less (if any) assistance providing the necessary elements of care for their assigned USABC patients. Consequently, the nurse working overtime may have relieved some of the time scarcity experienced by other nurses on the nursing unit rather than imposing more time scarcity, as may have occurred with float nurses.

Shift worked, an indicator of *management of working conditions* modeled at Level-2, was considered in six previous studies of UNC. In two studies, nurses who worked day or evening shifts reported higher levels of UNC, $\beta = .721$ to 1.776, $p < .001$ (Ball et al., 2014, 2016). In two of these studies, working night shift was predictive of lower reported levels of UNC, $\beta = -.052$ to -.08, $p < .05$ (Kalisch et al., 2011a, 2013). However, consistent with the current study, two studies found no significant relationships between shift worked and nurse estimates of UNC (Kalisch & Lee, 2010; Tschannen et al., 2010).

Unit worked, also an indicator of *management of working conditions* modeled at Level-2, was considered in eight previous studies of UNC. Of particular interest to the current study, two studies found that nurses who worked on critical care units reported less UNC than other units, $p \leq .01$ (Bradagottir et al., 2016; Castner et al., 2014) and one study found that rehabilitation units reported more UNC than critical care units, $\beta = .17$, $p = .019$ (Kalisch et al., 2013). Two more studies also found that nursing units were significantly related to nurse estimates of UNC (Friese et al., 2013; Kalisch, Landstrom, & Williams, 2009). Conversely, but consistent with the current study, three studies found no significant relationship between the unit worked and nurse estimates of UNC (Kalisch, 2009; Kalisch & Lee, 2012b; Kalisch, Tschannen, Lee et al., 2011).

Employment category was modeled at Level-2 as two separate variables (government civilian and contract). Five previous studies considered the influence of full-time, part-time, or temporary employment on nurse estimates of UNC. Those studies reported no significant relationship between employment category and nurse estimates of UNC (Kalisch et al., 2013; Kalisch & Lee, 2010, 2012a; Kalisch et al., 2011a; Tschannen et al., 2010).

Given the inconsistent findings in the previous literature about UNC and these indicators of *management of working conditions*, those findings were not entirely unexpected. It is possible that a significant relationship does not exist. It is also possible that a significant relationship went undetected. This may be the result of an underpowered statistical test or a lack of measure sensitivity (Cohen, 1988; Field, 2013). Both of these potential limitations are discussed later in this chapter.

Patterns Over Time

The patterns identified in the current study highlighted the complex nature of the USABC nursing care system. Nurse leaders at the USABC distribute the nursing resources to meet the demand for nursing care. However, across the entire study, the nursing care supply [reflected in the NCH (available)] remained relatively consistent from month to month, regardless of the demand. During months of understaffing, the

USABC nursing care system did not increase the supply of nursing resources to meet the demand for nursing care. In fact, when nurse leaders increased nursing care supply (using overtime or NCHs provided by float staff) the nursing care supply did not always meet the nursing care demand.

The inability to meet the demand for nursing care at the USABC may be the result of a limited capacity to surge. Surge capacity is the ability of the nursing care system to rapidly increase nursing care supply to meet a sudden increase in nursing care demand. The term "surge capacity" was previously used in the context of hospital responses to disasters and sudden surges in emergency department admissions (Hick, Barbera, & Kelen, 2009; Kaji, Koenig, & Bey, 2006). The term can easily be applied to non-emergency inpatient settings as well. The difference between the surge capacity in disaster situations and surge capacity related to daily changes in health care demand, however, lies in the notion that individual care can be compromised during a disaster for the good of the larger population (Kaji et al., 2006). Such a compromise is not acceptable in day-to-day patient care operations. Interestingly, the same effect seen in disaster management is also seen in nursing care systems that experience time scarcity; nurses prioritize the elements of care to achieve the best results for the population of patients assigned. Based on the current study findings, there is a limited surge capacity in USABC nursing care system and the care of the individual may be compromised for the good of the larger population of patients.

When nursing care demand surpasses nursing care supply at the USABC, nurse leaders have two options to temporarily increase the supply of nursing staff: overtime or float staff from SAMMC. Overtime is not ideal because the amount of overtime allowed is limited by Military Health System (MHS) budgeting restrictions. Military personnel can be on overtime without additional cost to the MHS. However, military personnel make up a small portion of the USABC work force. Given their small numbers and their sporadic unavailability due to other military requirements (such as training), relying on military overtime to meet increased nursing care demand is not an optimal solution. Furthermore, overtime has been linked to negative patient outcomes that make overtime an undesirable surge option (Kunaviktukul et al., 2015; Rogers et al., 2004; Stimpfel & Aiken, 2013; Trinkoff et al., 2011; Wu et al., 2013).

The use of float staff from SAMMC also limits the surge capacity at the USABC. First, because SAMMC is a large trauma center that is administratively separate from the USABC, nurse leaders at SAMMC must meet their own nursing care demands before providing nursing resources to the USABC. Additionally, the administrative separation dictates (through regulatory mechanisms) that nursing personnel cannot be freely floated between the organizations to support temporary increases in nursing care demand. Furthermore, the use of temporary nurses (such as float nurses) was shown to increase rates of UNC (Ausserhofer et al., 2014) and has been associated with increased rates of adverse patient events (Alonso-Echanove et al., 2003; Dunton et al., 2004; Estabrooks et al., 2005; Pham et al., 2011; Roseman & Booker, 1995). Therefore, reliance on float staff from SAMMC also limits the surge capacity at the USABC.

Limitations

There were limitations in the current study that may prevent generalizations outside of the USABC. These limitations include concerns about statistical power, measure sensitivity, the use of nursing experience as an indicator of *nursing staff supply*, survey fatigue and survey burden, the potential for common source bias, and the possibility that other potential influencing factors of the nursing care system (confounding variables) were not captured in the current study.

The absence of significant relationships among indicators of *nursing staff supply* and *management of working conditions* must be viewed with caution because the current study did not achieve the desired sample size (60 participants for 3 months). As such, it is possible that the analytic test was underpowered. Power is the "probability that a given test will find an effect assuming that one exists in the population" (Field, 2013, p. 69). Power is a function of the chosen α (probability of making a Type I error), the effect size (the importance of an effect on the dependent variable), and the sample size (Cohen, 1988; Field, 2013). When one factor prevents the analysis from achieving the desired power, compensations must be made with the other factors. Typically, researchers set the α at .05 and the desired power to at least .8 (Field, 2013). As such, only changes in effect size or sample size could alter the power of a statistical test (Cohen, 1992; Field, 2013). Underpowered tests are not sensitive to small effects that some predictors have on the dependent variable (Cohen, 1992; Field, 2013). And, in the science about UNC, the effect sizes for indicators of *nursing staff supply* and *management of working conditions* were generally small (Jones et al., 2015). Given the probable effect size of these insignificant indicators, a larger sample may have been needed to improve the power of the statistical test used in the current study.

The absence of significant relationships between UNC and the other time varying indicators of *management of working conditions* (SDR, patient turnover, and overtime) also may be due to the measures used. Measurement of these indicators occurred at the unit level. As such, the measures were not sensitive to the individual nurse's experience of time scarcity. Conceptually, the nurse's decision to ration care in periods of time scarcity was dependent upon the individual nurse's experience within the context of a given nursing unit (Jones, 2016). Nurses work to meet nursing care demand within their available time (a nursing shift) while balancing other demands placed on them within the nursing unit context. In the current study, although nursing care at the USABC was provided as a team, it was likely that individual nurses experienced time scarcity differently depending on a multitude of work-related, time varying factors. For example, the overall patient turnover value for the nursing unit may have been low, giving the impression of stable working conditions on the unit. However, if one nurse experienced all of the patient turnover events, this individual may have experienced a great deal of time scarcity and reported a high prevalence of UNC. Conversely, the other nurses on the unit may have experienced little time scarcity and reported a much lower prevalence of UNC.

In the current study, when the nurses estimated their rationing of care (and the resulting UNC), they did so within the context of their individual experience of working conditions on the nursing unit. However, because the *management of working conditions* was measured as the unit level mean, variations experienced by the individual nurse were not detected. Consequently, the time varying indicators of *management of working conditions* (measured at the unit level) were scored the same for every nurse on a given unit during a given month, regardless of their individual experience. This resulted in an indication of *management of working conditions* that did not reflect the variety of individual nurse experiences in the nursing unit.

Additionally, measuring *management of working conditions* at the unit level resulted in a loss of sensitivity during statistical analyses. Sensitivity is the ability of a measure to identify small variations in the concept being measured (Powers & Knapp, 2011). In this case, when the indicators of *management of working conditions* were coded into the statistical software programs, the same values were entered for every nurse participant from the same nursing unit. This resulted in no between-nurse variations on that unit for that month. Regression analysis of a linear model (to include multilevel modeling) requires variation among the predictors in order to detect significant changes in the dependent variable in relation to the predictor (Field, 2013; Littell et al., 2006). Because only two units were considered in the current study, there was little between-unit variation per month for each indicator of *management of working conditions*. There were only two nursing units in the USABC and so increasing between-unit variability was not possible. Therefore, measuring these indicators at the individual level may have increased variability among the participants and improved the sensitivity of the measures.

The use of nurse experience as an indicator of *nursing staff supply* also may have limited the current study. Nurse experience is one of the attributes of nurse competence (Smith, 2012) and may have been used as a proxy indicator for the phenomenon in other studies of UNC (Al-Kandari & Thomas, 2009; Ausserhofer et al., 2014; Bragadottir et al., 2016; Castner et al., 2014; Kalisch, 2009; Kalisch et al., 2013; Kalisch & Lee, 2010, 2012a, 2012b; Kalisch, Tschannen et al., 2011a; Lucero et al., 2009; Schubert et al., 2013; Tschannen et al., 2010). However, a nurse with many years of experience may not possess one or more of the other attributes of a competent nurse. Therefore, using nurse experience as a proxy indicator of nurse competence was not ideal. Data derived from the evidence-based precepting program in place at the USABC (Robbins, 2014) may have been a more complete indicator of nurse competence. This was not possible, however, because obtaining individual-level competency data would have required knowing the identity of each participant, compromising the anonymity of the participant. Therefore, nurse experience was the most feasible indicator of nurse competence for the current study.

The current study also may have been limited by survey fatigue and the burden of the survey on the population of interest (Olson, 2014). Survey fatigue is the number of survey contacts (Porter, 2004). Nurses at the USABC previously participated in survey-based studies and have a history of high participation (Robbins, 2014). However, just prior to data collection for the current study, the USABC nurses were asked to participate in at least one other survey-based study. This fact, coupled with the multiple participation points in the current study, may have resulted in survey fatigue that reduced participation rates over the entire study period. Survey burden is related to the length of the survey, the difficulty answering the questions, and respondent's perception of the importance of the survey topic (Kramer et al., 2009; McCarthy, Beckler, & Qualey, 2006; Olson, 2014; Sharp & Frankel, 1983). In the current study, the 50-item survey was expected to take 15-30 minutes to complete. At the USABC, this represents a significant time cost that may have prevented some nurses from participating. When coupled with the survey fatigue that may have been exacerbated by the repeated nature of the current study, the repeated investment of 30 minutes may have overburdened the USABC nurses. Therefore, participation in the current study may have been limited by survey fatigue and survey burden that resulted in monthly response rates that may have been lower than if the survey had been administered only once.

Furthermore, given the amount of unexplained variance in the multilevel model, it is likely that there were other significant factors within the nursing care system related to UNC that were not captured in the current study. For example, at least four time-and-motion studies identified that nurses spend time on non-patient care tasks (such as clerical needs, attending meetings, or searching for equipment) that were not captured in the current study (Abbey et al., 2012; Cornell et al., 2010; Henrich & Lee, 2005; Webster et al., 2011). The amount of time spent on these types of non-patient care tasks would vary by nurse and so these items could have been included as time-varying, within-nurse indicators of *management of working conditions*. Additionally, other between-nurse factors that may have influenced nurse estimates of UNC (such as specialty certification) were not captured in the current study (Boyle, Cramer, Potter, & Staggs, 2015). Assuming that the limitations related to power and measurement were corrected, inclusion of measures such as these may have reduced the amount of unexplained variance in the multilevel model and resulted in a more complete understanding about the influence of *nursing staff supply* and *management of working conditions* on nurse estimates of UNC.

The current study also may be limited by the use of instruments relying on nurse-self report for indicators of independent and dependent variables; estimates of NCHs (required) and UNC were derived from nurse self-report. The use of the same source to acquire data about independent and dependent variables has been criticized (Favero & Bullock, 2014; Meier & O'Toole, 2012), indicating that use of such instruments introduces the potential for common source bias. This bias is believed to artificially inflate the relationship between the variables, potentially leading to Type I errors (Conway & Lance, 2010). In the current study, nurses who completed the PIRNCA also were responsible for estimating the number of NCHs (required) for all of their assigned patients. However, the estimates of NCHs (required) were entered into WMSNi before estimates of UNC were acquired, limiting the possibility that the nurses might have artificially changed the estimates of NCHs (required) to coincide with their reported levels of UNC. Therefore, it was anticipated that the influence of common source bias was limited in the current study.

The current study also may be limited because the study conceptual model did not include all of the dimensions of the nursing care system identified in the NCPF that could influence UNC. These missing elements represent potential confounding variables that may have influenced UNC. Specifically, nursing staff maintenance, economic sustainability, and the nurse practice environment also were conceptualized in the NCPF to influence *nursing processes* (Dubois et al., 2013). In order to focus on the research questions, items related to these dimensions were omitted from the conceptual model for the current study. Studies that directly consider the influence of these dimensions of the nursing care system are underrepresented in the nursing literature (Dubois et al., 2013). However, previous studies of UNC have used instruments that assess organizations across these dimensions. For example, nurse perceptions of their work environment were assessed by the Essentials of Magnetism II (Schmalenberg & Kramer, 2008) and the Nursing Work Index-Revised (Aiken & Patrician, 2000) and were moderately correlated with estimates of UNC, r = -.28 to -.53, $p < .001$ and r = -.26 to -.67, $p \leq .01$, respectively (Jones, 2014; Schubert et al., 2008; Schubert et al., 2007). In the current study, the dimensions of nursing staff maintenance, economic sustainability, and the nursing practice environment may account for a portion of any unexplained variance in the reported levels of UNC. Therefore, the influence of these dimensions of the nursing care system on UNC cannot be discounted.

Another potential confounding variable was the presence of precepting dyads in the sample. Precepting dyads (made up of a new burn nurse undergoing approximately six weeks of evidence-based precepting with an experienced burn nurse) were included in the sample because individual participants could not be eliminated from the sample without breaching participant anonymity. Inclusion of the precepting dyads may have confounded these findings because during the precepting period, the dyad is assigned fewer patients than other nurses working on the shift in order to facilitate training the new burn nurse. This may have resulted in an overestimation of nursing care hours (available) and a higher SDR. Additionally, the effects of being in a precepting dyad on nurse estimates of UNC are unknown. The smaller patient load may have facilitated completion of the necessary elements of care for their assigned patients. However, the educational needs of the orienting nurse may have resulted in increased time scarcity for the dyad. Based on the number of precepting dyads that existed during the study period (12; obtained from USABC nursing leaders), it is estimated that not more than 8.9% (24) of the retained surveys contained data from a precepting dyad.

Finally, the effects of nursing leader judgment on decisions about the *management of working conditions* also may have confounded these findings. Specifically, nurse leader decisions about when and how to surge were not based solely on the SDR. Using their professional experience, knowledge of the available nursing staff, and knowledge of the USABC nursing care system, nursing leaders may have decided to surge (or not) based on triggers or inputs that were not captured in this study. In turn, the individual nurse's decision to ration care was based on their experience working in the setting and conditions managed by the nurse leader. Consequently, it must be acknowledged that nursing leader judgment may have indirectly influenced nurse reports of UNC in a manner that was not captured in the current study.

IMPLICATIONS

The findings from the current study have implications for nursing practice at the USABC and have broader implications for the healthcare policy in the MHS and for nursing education. Furthermore, findings from the current study provided insight into the direction of future research about UNC across the MHS, burn environments, and the broader science about UNC.

Practice

Patients at the USABC may be at risk of experiencing an adverse event due to the presence of UNC. The findings of the current study revealed that time scarcity existed and disruptions in the nursing processes occurred at the USABC with a high frequency.

Therefore, every patient who received care at the USABC may have been at risk of experiencing UNC-related adverse events. Based on the findings of previous studies, the presence of UNC at the USABC could lead to increased occurrence of adverse patient events, such as increased rates of infection, patient falls, or 30-day readmissions (Brooks-Carthon et al., 2015; El-Jardali & Lagace, 2005; Sochalski, 2004). Furthermore, the risk of experiencing UNC may be higher at burn centers such as the USABC because burn patients remain hospitalized longer than other patient populations, thereby increasing their potential to experience UNC. Because previous studies have demonstrated associations between UNC and adverse patient events, it is imperative that efforts are taken to minimize UNC in the USABC.

Presumably, by reducing time scarcity, one reduces the potential for UNC. The current study did not identify the potential causes of time scarcity for patient care at the USABC. Therefore, in response to these findings, nurse leaders should work with the nursing staff to identify the potential causes of time scarcity at the USABC and develop interventions to give bedside nurses more time to complete their nursing processes. Few potential interventions to decrease UNC were posited in the literature; only one study demonstrated that an intervention (teamwork training) might help reduce UNC (Kalisch & Lee, 2010). Therefore, nurse leaders and members of the USABC nursing staff must work together to identify the potential causes of time scarcity and identify potential means of reversing the disruptive effects of time scarcity on the nursing processes.

Additionally, nurses and nurse leaders at the USABC need to be aware of the elements of care most and least frequently left unfinished on each nursing unit. For both, this information could help determine if the elements of care were prioritized in manner that was in keeping with the needs of the USABC patient population. For example, frequent UNC related to wound care and changing intravenous catheters (cornerstones of burn care and infection control) might stimulate a discussion among the USABC nurses about patient care priorities. Additionally, nurse leaders could use this information to gain insight into the decision-making processes of bedside nurses and focus any potential intervention efforts on processes that maximize the completion of elements of care most important to the USABC patient population.

Policy

Policy makers in the MHS should consider using UNC as an additional indicator of supply/demand balance. The presence of UNC at the USABC indicated instability or inefficiency in the nursing care system that was not identified when assessed using the standard USABC measure (SDR). Current methods of analyzing the balance between nursing care supply and nursing care demand at the USABC are based on unit-level measures that are aggregated by the week or month. As previously discussed, this level of analysis limits the sensitivity of these measures and may provide policy makers a false sense that nursing care supply and nursing care demand are balanced. The presence of UNC may indicate an undetected imbalance between nursing care supply and nursing care demand. Monitoring UNC represents an effort to continuously improve patient care in the MHS journey toward high reliability; significant changes in the prevalence or patterns of UNC could be identified and investigated to determine the need for and mechanisms of potential interventions to relieve nurse time scarcity at the USABC. VanFosson and colleagues (2016) previously recommended an initial period of frequent assessments (perhaps monthly) to develop a baseline understanding of UNC, followed by less frequent (perhaps yearly) surveillance to monitor for significant changes over time. For the USABC, the current study would serve as the baseline against which any future assessments could be compared. If the nursing care system were to undergo major changes in structure or processes, it was recommended that more frequent assessment be completed for a period of time (VanFosson et al., 2016).

Policy makers at the USABC and the MHS also should consider developing a surge capacity in order to rapidly mobilize nursing staff when the demand for nursing care exceeds the supply of nurses available (i.e., when understaffing occurs). Ideally, rapid mobilization should occur as soon as the increased demand was recognized and would last for the duration of the increased demand. Waiting to increase the available nursing resources until the next shift (or the next day) could result in UNC that leads to an adverse patient event. Given the nature of nursing work, and the fact that UNC was reported even during months with nearly perfect SDR (1.0), it is reasonable to infer that understaffing occurred at times and was not captured by the indicators of *management of working conditions*. Surging soon after the demand for care exceeds the supply of nurses would minimize time scarcity and reduce the potential for UNC and UNC-related adverse events. The capacity to surge to meet these temporary increases in nursing care demand may be limited, however. As previously discussed, the use of overtime and float nurses may not be optimal. Therefore, policy makers at the USABC and the MHS should consider identifying other means of surging during periods of understaffing.

One approach to increasing surge capacity might be to cross train as many potential float nurses as possible. Presumably, increased familiarity with the environment and a minimum level of nurse competence will minimize the level of UNC when surging is necessary. This is particularly important if float nurses are to remain a primary means of surging at the USABC. Cross training should be completed using an evidence-based precepting program. An evidence-based precepting program was previously implemented at the USABC to ensure that all assigned nurses were competent to provide necessary nursing care to the patient population (Robbins, 2014). Such a program would help to ensure that the potential pool of float nurses are familiar with the USABC environment and have achieved the minimum level of competence to provide care to the patient population.

In addition to increasing the surge capacity, policy makers at the USABC and the MHS also should consider mechanisms to reduce time scarcity for the individual nurse. Presumably, decreasing the nursing care demand for which the individual nurse is responsible could reduce the time scarcity experienced by USABC nurses. This could be accomplished by increasing the presence of other members of the patient care team. For example, an increased number of unlicensed assistive personnel may allow nurses to delegate more patient care tasks and invest more time in the elements of care that cannot be delegated. Additionally, an increased presence of other professionals (e.g., chaplains, mental health nurses, or physical and occupational therapists) might reduce the number of elements of care for which the nurse is solely responsible. By distributing the nursing care demand among a larger pool of care team members, nurses may experience less time scarcity and ration fewer necessary elements of care.

Education

As evidenced by the current study and the previous literature about UNC, the phenomenon of UNC occurs in all inpatient care environments. Therefore, nurses who intend to work in the inpatient setting need to be educated about the antecedents and consequences of UNC. Nurses who are aware of the phenomenon of UNC may be more aware of the need to ration care. This increased awareness may stimulate more open discussions about care rationing among nursing peers and leaders. Additionally, nurses who are aware of the phenomenon also may be more alert to drivers of time scarcity in their work environment and communicate about the effects of time scarcity on patient care. Nurses could then work with their nursing leaders to develop interventions to reduce or mitigate the effects of time scarcity in their particular environment.

Nurse leaders also should be educated about the phenomenon of UNC. Given the prevalence of UNC, every nurse leader will be exposed to the effects of UNC on their patients, staff, and organization. Educating nurse leaders about these effects may motivate leaders to proactively monitor for, and take steps to prevent, periods of time scarcity. In doing so, nurse leaders may limit the potential for negative patient and nurse outcomes previously associated with UNC.

Research

The current study advanced the science of UNC by demonstrating the prevalence and patterns of UNC at the USABC. These findings were representative of the USABC. However, given the potential differences in nursing unit context among the burn care community when compared to the USABC, it would be inappropriate to generalize these findings to all burn centers across the US. To expand the knowledge about UNC for use in other American Burn Association-verified burn centers, future studies should explore the prevalence and patterns of UNC across a broader sample of burn centers. Additionally, given the unique patient care requirements at the USABC, it is inappropriate to assume that these findings are consistent with other inpatient environments across the MHS. To expand the knowledge about UNC in the MHS, future research should consider the prevalence and patterns of UNC across a broader sample of MHS inpatient environments.

The PIRNCA was useful for estimating UNC in the military environment. The instrument was previously demonstrated to be valid and reliable in the medical/surgical and critical care environments (Jones, 2014; Jones et al., 2016). Therefore, future research about UNC in other MHS medical/surgical and critical care environments can be completed using the PIRNCA. Additionally, as the only instrument to estimate UNC used in a burn environment, the PIRNCA also can be used in future studies of UNC in other burn environments.

Furthermore, because rationing of care depends on the contextual experience of the nurse making that decision, future studies of UNC should consider the individual context of nurses who ration care using quantitative and qualitative methods. In quantitative studies, all time varying indicators of nursing unit context (such as those indicating the *management of working conditions*) should be measured at the level of the individual nurse. Understanding the individual nurse's context is paramount to identifying those elements of the nursing unit context that might predict one's decision to leave nursing care unfinished. However, time varying indicators of nursing unit context that are aggregated at the unit level (or higher) omit the individual nurse's experience of time scarcity as they prioritize care. Qualitative assessments of the individual nurse's experience during periods of time scarcity may provide information about contextual influences of UNC that have not been identified previously or that are unique to that nursing care system.

Additionally, future studies should consider the influence of nurse competence on nurse estimates of UNC. Previous studies of UNC (including the current study) have considered only the influence of specific aspects of nurse competence (such as nurse experience or education) on UNC (Smith, 2012). However, because of the complex nature of nurse competence, a nurse's experience and education do not adequately represent the phenomenon (Smith, 2012). Benner (1982) posited that a nurse moves through five phases of clinical skill development: novice, advanced beginner, competent, proficient, and expert. As the nurse moves through these phases, they gain perspective and concrete experiences on which to base their nursing judgment. Consequently, nurses of increasing competence are likely to approach patient care with different care priorities (Benner, 1982). As such, within the context of UNC, the competent nurse may experience time scarcity differently than the proficient or expert nurse, which may result in varying reports of UNC under similar nurse working conditions. Therefore, future studies of UNC should consider the influence of the larger phenomenon of nurse competence on nurse estimates of UNC. This could be accomplished using data derived from competency assessment tools such as those used in the evidence-based precepting program at the USABC (Robbins, 2014).

Finally, future studies of UNC should seek to describe the relationships between UNC and patient, nurse, and organization outcomes at the USABC. The current study did not seek to identify these relationships. However, previous research demonstrated that UNC increased a patient's risk of experiencing an adverse event (El-Jardali & Lagace, 2005; Sochalski, 2004) or readmission within 30 days of discharge (Brooks-Carthon et al., 2015). Previous research also indicated that UNC negatively influenced nurse job satisfaction (Jones, 2014; Kalisch et al., 2011b), decreased nurse occupation satisfaction (Jones, 2014), increased intent to leave, and increased nursing turnover (Tschannen, Kalisch, & Lee, 2010). Therefore, future studies of UNC at the USABC should consider these outcomes in relation to the prevalence of UNC.

Chapter Summary

Nurses at the USABC experienced time scarcity that resulted in disruptions of their nursing processes (represented by nurse estimates of UNC). The presence of UNC of the USABC indicated that the nursing care system was unable to effectively transform nursing resources into beneficial nursing care. Because the nursing care system could not provide safe patient care reliably across the entire study period, the USABC cannot be considered a highly reliable organization. These findings were consistent with more than

36 studies, representing over 111,000 nurses from 23 countries, which demonstrated the presence of UNC in various nursing care systems. However, this is the first study to identify the prevalence and patterns of UNC at the USABC and the first study to identify the prevalence and patterns of UNC at any burn center in the US or in any US military hospital. Additionally, this is the first study to identify the monthly variation of nurse estimates of UNC in any setting. Furthermore, this is the first study to demonstrate the utility of the PIRNCA in the burn or military environments. Results from the current study can be used to inform nursing leaders at the USABC about the quality of nursing care in their organization. Additionally, MHS leaders can use the results from the current study to develop policies that might curtail time scarcity in other MHS hospitals. Finally, the results of the current study can be used to inform future research and education about UNC.

Appendix

The following supplemental files accompany the online file of this text:

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