THE MILITARY NURSING PRACTICE ENVIRONMENT'S ASSOCIATION WITH PATIENT OUTCOMES

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ABSTRACT

In the United States, preventable medical errors account for many avoidable patient deaths per year. A favorable nursing practice environment, characterized by factors that improve or enhance a nurse's ability to practice professional nursing, is a potential mechanism for promoting a culture of safety and enhancing the quality of care in hospitals. The Practice Environment Scale of the Nursing Work Index (PES-NWI) is the national standard for measuring the nursing practice environment, and its importance has been validated repeatedly in civilian nurse populations around the world.

For the last several years, the scores on the PES-NWI in military facilities have met or exceeded those found in Magnet® hospitals, facilities known for having exemplary support of nurses and for providing high quality care. However, we do not know to what extent the associations between PES-NWI scores and patient outcomes observed in Magnet® hospitals, such as fewer patient falls and improved patient experiences, also exist within the military system.

The purpose of this dissertation was three-fold. First, a comprehensive review of the literature surrounding the PES-NWI was conducted to fully understand the instrument's current use. Next, the psychometric properties of the instrument were evaluated using a military nurse sample to confirm satisfactory function in this population and identify implications for future use. Finally, the associations between the subscale

scores on the PES-NWI and patient falls with and without injury, medication errors with and without harm, and patient experience were tested.

The resulting body of work confirmed that use of the PES-NWI remains high and that this instrument functions well in a military setting. This research adds to a large body of evidence demonstrating associations between a favorable nursing practice environment and fewer adverse events. In addition, this analysis augments past research by identifying the *specific aspects* of the nursing practice environment that matter most for *particular outcomes* in the military setting. By identifying these relationships, we increase the actionable nature of the PES-NWI survey results, particularly with respect to nurse-administered medication errors and patient fall rate data.

Keywords: nursing work environment, Practice Environment Scale of the Nursing Work Index, PES-NWI, military nursing, medication administration errors, patient falls.

DEDICATION

To

Eric, Brittany, Lauren, Elizabeth, and Lillian

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ES, I run faster and longer with you by my side. Thank you for letting me lean on your strength when I needed it and for propping me up on my own two feet when you knew I had all the strength I needed within me.

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Thank you to the nurses who took time out of their busy schedules to complete the survey used in this work. We ask a lot of you and say thank you less than we should. Lastly, for providing this experience, thank you to the Army Nurse Corps. I vow to use this gift of an education to the very best of my ability.

DISCLAIMER

The views expressed in this dissertation are those of the author and do not reflect the official policy or position of the Department of the Army, Department of Defense, or the U.S. Government.

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LIST OF ABBREVIATIONS

ADT	Admission, discharge, and transfer
AIC	Akaike Information Criterion
CNPR	Collegial Nurse-Physician Relations (Practice Environment Scale of the Nursing Work Index Subscale #5)
CNA	Certified Nurse's Assistant
DMHRSi	Defense Medical Human Resources System-internet
EN	Enrolled Nurse (used in Australia)
FDR	False Discovery Rate
GEE	Generalized estimating equations
GVIF	Generalized Variable Inflation Factor
HCAHPS	Hospital Consumer Assessment of Healthcare Providers and Systems
ICC(2)	Intraclass Correlation Coefficient (2)
LPN/LVN	Licensed Practical Nurse/Licensed Vocational Nurse
MHS	Military Health System
MTF	Military Treatment Facility
NA	Nurse's Aid
NFQC	Foundations for Quality of Care (Practice Environment Scale of the Nursing Work Index Subscale #2)

NMA	Nurse Manager Ability, Leadership, and Support of Nurses (Practice Environment Scale of the Nursing Work Index Subscale #3)
NPE	Nursing practice environment
NPHA	Nursing Participation in Hospital Affairs (Practice Environment Scale of the Nursing Work Index Subscale #1)
PES-NWI	Practice Environment Scale of the Nursing Work Index
PSR	Patient safety reports
QHOM	Quality Health Outcomes Model
QIC	Quasi information criterion
RN	Registered Nurse
SRA	Staffing and Resource Adequacy (Practice Environment Scale of the Nursing Work Index Subscale #4)
TNCHPPD	Total nursing care hours per patient day
TRISS	The TriCare Inpatient Satisfaction Survey
VIF	Variable Inflation Factor
WMSNi	Workload Management System for Nursing-internet

CHAPTER 1

INTRODUCTION

The purpose of this introductory chapter is to describe the problem, significance, background, and research aims that guide and inform this dissertation which is comprised of three papers. This chapter will discuss the major topics under study and offer definitions for the key terms that will be used throughout the remaining chapters. Each of the three papers contributes to body of nursing knowledge in a unique way, but combined, the papers form a complete dissertation. The first paper focuses on the Practice Environment Scale of the Nursing Work Index (PES-NWI), the instrument most commonly used to measure the nursing practice environment. This paper provides a comprehensive review of the literature surrounding use of the PES-NWI and associated outcomes and was used to inform and guide the two subsequent papers. The second paper presents the psychometric testing of the PES-NWI in a military sample (Swiger, Raju, Breckenridge-Sproat, & Patrician, 2017). Testing the psychometrics of the instrument in this environment of interest provides useful information that contributes to the interpretation of results generated in the third paper. This paper presents the results of the analysis conducted to address two research aims focused on identifying the subscales and individual items most associated with specific patient outcomes in a military sample. Additionally, the third paper discusses implications of the findings and limitations of the study. The final chapter of this dissertation incorporates the information discovered in

the review of the PES-NWI, the psychometric testing of the instrument, and the results of the analysis presented in the third paper to provide a comprehensive and integrated interpretation of the findings and suggests future research recommendations related to all three papers.

Preventable medical errors account for between 44,000 and 98,000 deaths per year in the United States according to the Institute of Medicine (IOM) report, To Err is Human (2000). A more recent study estimates that as many as 440,000 Americans die each year from preventable errors in health care (James, 2013). According to the recent Military Health System (MHS) review, an acceptable level of quality care is being delivered to the military's 9.6 million beneficiaries in military hospitals, yet the review panel described the need for a continued focus on improving care quality and patient safety. The overarching recommendations provided to the MHS leadership focused on improving quality and safety through leadership engagement, leadership development, and implementing changes to ensure a culture of safety and continuous process improvement (Department of Defense, 2014).

A favorable nursing practice environment, described as factors that contribute to or detract from a nurse's ability to practice expert nursing, is a potential means to develop a culture of safety and improve care quality in hospitals (Institute of Medicine, 2003; Lake, 2002; McClure & Hinshaw, 2002; Patrician, Shang, & Lake, 2010). In the current healthcare environment, nursing care is the primary form of patient management during in-hospital stays; therefore, it is understandable that high quality nursing care would significantly contribute to improved patient safety and the provision of high quality care. For example, Magnet® hospitals, known for their favorable nursing practice

environments, have been shown to have fewer adverse patient safety events than hospitals without the Magnet designation (Kutney-Lee et al., 2015; McHugh, Aiken, Eckenhoff, & Burns, 2016; McHugh et al., 2013).

The Practice Environment Scale of the Nursing Work Index (PES-NWI) is the national standard for measuring the nursing practice environment (Lake, 2002; Warshawsky & Havens, 2011). Many studies have associated higher composite scores on the PES-NWI with better nurse-reported patient outcomes, such as nurse-perceived care quality, medication administration errors, and patient falls, as well as better patient-reported experiences of care (Friese, 2005; Kutney-Lee, Lake, & Aiken, 2009; Laschinger & Leiter, 2006; Manojlovich & DeCicco, 2007; McCusker, Dendukuri, Cardinal, Laplante, & Bambonye, 2004; Patrician, Shang, et al., 2010). In contrast, Flynn and colleagues (2010) found no significant associations between the composite PES-NWI and medication errors. A study using adverse events calculated from organizational data, as opposed to nurse-reported outcomes, also found no associations between adverse events and characteristics of the nursing practice environment (Manojlovich, Antonakos, & Ronis, 2009).

These contradictory findings make it difficult for end users to determine the potential value of interventions aimed at improving the nursing work environment. Additional evidence is needed to understand why these relationships exist and to determine whether they are stable over time. Therefore, more studies need to be conducted using longitudinal designs to further understand the associations between the PES-NWI and patient outcomes (Lake, 2007; Warshawsky & Havens, 2011). In addition, as most researchers aggregate the PES-NWI subscales to the composite score,

associations due to the loss in variability caused by averaging high and low subscale scores may be masked (Cho, 2003; Patrician et al., 2011). Therefore, research focused on analyzing data at the subscale-level of the PES-NWI may yield more meaningful and useful results.

Problem Statement

For the last several years, the scores on the PES-NWI in military facilities have met or exceeded those found in Magnet hospitals. However, we do not know if the associations between PES-NWI scores and patient outcomes found in Magnet hospitals, such as fewer patient falls and improved patient experience, also exist within the military system (Department of Defense, 2014; Petit Dit Dariel & Regnaux, 2015; Stimpfel, Sloane, McHugh, & Aiken, 2016).

Background

This dissertation addresses the aforementioned problem statement by conducting a secondary analysis of data compiled for a program evaluation of the Army Nurse Corps' care delivery framework, the Patient CaringTouch System (PCTS) (TSNRP Grant # N13-P13). The PCTS was implemented in every Army medical treatment facility in 2011. This care delivery framework was built, in part, to improve patient outcomes and decrease practice variation by promoting team communication, healthy work environments, evidence-based practices, patient advocacy, and leadership capabilities (Horoho, 2011). Thus far, the initial program evaluation of the PCTS has shown improvements in the practice environment (Breckenridge-Sproat et al., in press), but more research needs to be conducted to determine which specific aspects of the practice environment are related to improvements in patient outcomes (Breckenridge-Sproat et al.,

2015). Therefore, the overall aim of this dissertation is to identify the associations of the PES-NWI *subscales* and *individual items* with the following nursing-sensitive patient outcomes: medication administration errors, medication administration errors with harm, patient falls, patient falls with injury, and patient experience.

Guiding Conceptual Framework

The conceptual framework that grounded this study was the Quality Health Outcomes Model (QHOM), derived from Donabedian's structure, process, and outcome framework (Donabedian, 1966; Mitchell, Ferketich, & Jennings, 1998). Within Donabedian's framework, structure and process are predictors of outcomes (Best & Neuhauser, 2004). This framework has been used extensively in health care research and by the American Nurses Association to develop indicators aimed at measuring nursing care quality (Gallagher & Rowell, 2003). Donabedian posits that each component of the model influences the proceeding one in a linear fashion: structure influences processes and processes influence outcomes (Gardner, Gardner, & O'Connell, 2014). The QHOM enhances Donabedian's time tested model, and aided control variable selection in this study. This model considers the complex context of the health care environment by identifying the unit level workload indicators and the nursing practice environment, both of which impact outcomes (Mitchell et al., 1998). Therefore, variables such as hospital size, staffing, skill mix, workload intensity, and patient acuity have been considered during this analysis. In contrast, client/patient aspects of the QHOM are not represented in this study. The inclusion of the QHOM is important when direct measures of processes of care are not available and can facilitate an understanding of why the nursing practice environment influences patient outcomes. This study hypothesizes that all

nursing processes take place within the context of the nursing practice environment, and, therefore, the nursing practice environment influences outcomes sensitive to changes in the quality of nursing care (Breckenridge-Sproat, Johantgen, & Patrician, 2012). The relationships tested in this study are depicted in Figure 1.

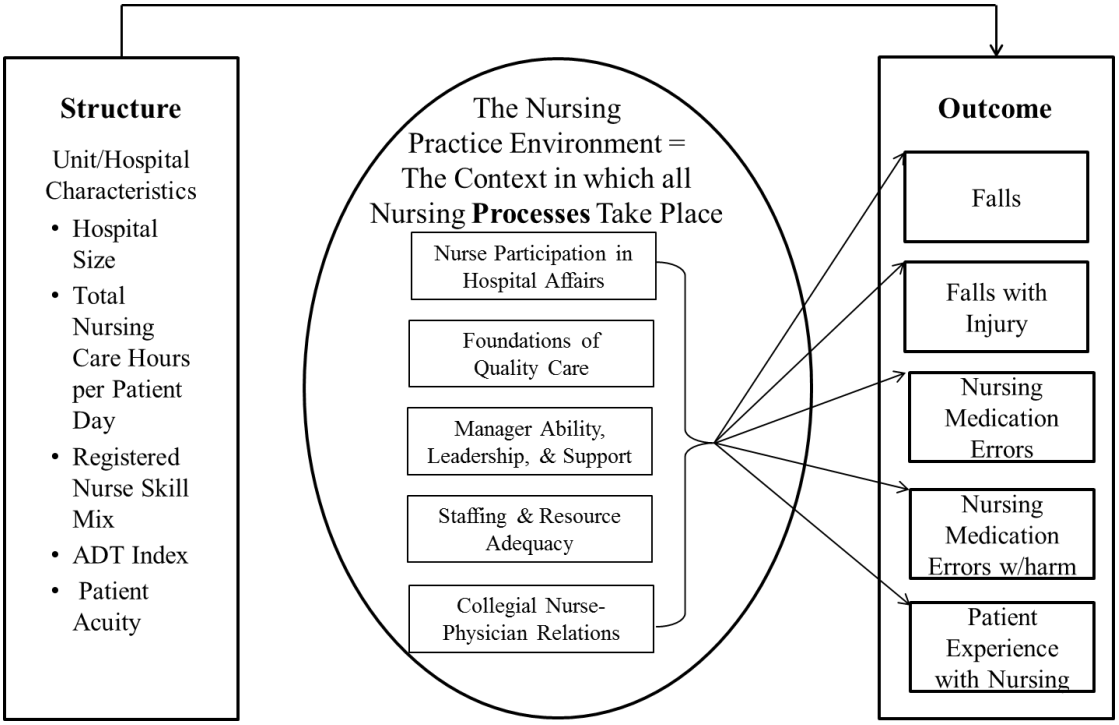

Figure 1. Conceptual framework depicting the various relationships that were tested between the subscales of the nursing practice environment and patient outcomes. The hospital and unit characteristics were used as control variables. ADT Index = the admission, discharge, and transfer index – a measure of workload intensity.

Significance of the Nursing Practice Environment

Recognition of the key role that the nursing work environment plays in hospital care began in the 1980s. During this era, there was a critical shortage of nurses, and many hospitals struggled to find enough qualified and professional nursing staff to provide care to their patients (McClure, Poulin, Sovie, & Wandelt, 1983). While some hospitals struggled with recruiting nursing staff, others did not, particularly those with reputations for institutional excellence (Kramer & Schmalenberg, 1988; McClure & Hinshaw, 2002; McClure et al., 1983). To analyze the reasons underlying the disparities between hospitals in retaining qualified staff, and in the hope of establishing successful approaches to end the nursing shortage, the American Academy of Nursing appointed a task force in 1981 to identify and study these Magnet hospitals (McClure & Hinshaw, 2002). One hundred and sixty-five hospitals were nominated by nursing leaders as Magnet hospitals, 65 were selected, and 16 were visited during the original Magnet hospital studies. Qualitative data were gathered from these 16 hospitals through focus-group interviews with staff and one-on-one interviews with nursing leaders. Criteria for selection as a Magnet hospital included: adequate nurse staffing, a reputation for providing quality care and for being a favorable place to work, and a high retention rate with low nurse vacancy and turnover rates (McClure et al., 1983).

Findings from these studies identified key factors that were present in Magnet hospitals regardless of size or location. The administration in Magnet hospitals was made up of quality leaders that: 1) listened carefully and openly to staff concerns; 2) responded to the needs of nurses and patients; 3) supported the nursing staff; 4) treated nurses professionally and with respect; 5) and were knowledgeable (McClure & Hinshaw,

2002). Today, Magnet designation is still associated with many benefits, such as improved nurse, patient, and facility-level outcomes (American Nurses Credentialing Center, n.d.). Negative patient outcomes, such as mortality and hospital-acquired infections, are less frequent, and patients report a better overall experience when receiving care in Magnet hospitals (Barnes, Rearden, & McHugh, 2016; McHugh et al., 2013; Stimpfel et al., 2016). Improved outcomes are credited, at least in part, to the supportive and superior nursing practice environment that is a key precursor to obtaining Magnet certification (American Nurses Credentialing Center, 2005).

Military-specific Considerations

Several unique aspects of the military system must be considered when planning an evaluation of the nursing practice environment in military settings. First, despite the often-reported negative consequences of the hierarchical nature and rigid structure of the military (Moskop, 1998; Spence, 2007), there are also positive benefits to these features. Military structure is believed to foster *esprit de corps*, communication, and teamwork. For example, military nurses consistently rate working relationships with physicians favorably and report a strong sense of teamwork in the health-care setting (Raju, Su, & Patrician, 2014; Zangaro & Kelley, 2010). These positive relationships and enhanced teamwork may be related to the way in which the rank structure can serve "as an equalizer among different professional groups" in military health-care settings (Zangaro & Kelley, 2010, p. 36).

Next, as there are many circumstances when nurses and physicians are of equal rank, military rank may mitigate the powerlessness that some nurses feel within a work

environment (Dubrosky, 2013). This equality may free nurses to speak up about care concerns, ask questions, and have input into the overall patient plan of care.

Lastly, the military nursing practice environment may vary more over time than in civilian institutions. Military nursing staff and nursing leaders transition from one job to another about every three to four years (Zangaro & Kelley, 2010). Furthermore, civilian nurses working for the military may also move as they may be related to a service member. Both the frequent turnover of staff and potentially dynamic nature of the military nursing practice environment point to the need for longitudinal studies to be undertaken when possible.

Measurement of the Nursing Practice Environment

The PES-NWI was empirically developed as a result of several iterations of research aimed at measuring perceptions of quality of nursing care and organizational traits of hospitals (Aiken & Patrician, 2000; Kramer & Hafner, 1989; Lake, 2002). Lake (2002) developed the PES-NWI using two different samples of surveys completed by registered nurses that were collected for the original Magnet studies of the 1980s. Exploratory factor analysis of the first sample yielded five subscales consisting of 31 individual items; the subscales were then confirmed with the second sample. The PES-NWI instructs nurses to indicate, on a four-point Likert scale, their degree of agreement that each of the 31 items are present in their current work environment. The responses are coded as: *strongly disagree* = 1, *somewhat disagree* = 2, *somewhat agree* = 3, or *strongly agree* = 4. Each of the subscales are scored separately by calculating the mean of the items within the subscale. These subscale means are then averaged to create an overall composite practice environment score. The score is then aggregated to the unit or

hospital level. The midpoint of the instrument scale, 2.5, differentiates between poor and favorable practice environments; above the midpoint is considered a favorable environment, and below the midpoint is unfavorable (Lake, 2002). The individual items included in each subscale and the subscale names can be found in Appendix A.

Relationship of the PES-NWI Constructs to Patient Outcomes

Hospitals with good nursing practice environments have lower rates of patient mortality, failure to rescue, nurse medication administration errors, infections, patient complaints, and patient falls, and higher reported care quality and patient satisfaction (Aiken, Clarke, Sloane, Lake, & Cheney, 2008; Kim, Capezuti, Boltz, & Fairchild, 2009; Kutney-Lee et al., 2009; Laschinger & Leiter, 2006; Patrician, Shang, et al., 2010). The constructs of the nursing practice environment as measured by the subscales of the PES-NWI are: Nurse Participation in Hospital Affairs; Nursing Foundations for Quality Care; Nurse Manager Ability, Leadership, and Support of Nurses; Staffing and Resource Adequacy; and Collegial Nurse-Physician Relations (Lake, 2002). These constructs have been empirically linked to improved care quality, increased safety related activities, and/or improved patient outcomes. Additionally, the Nurse Participation in Hospital Affairs and Nursing Foundations for Quality Care subscales have been associated with increased error interception practices (Flynn et al., 2012). Participation by nurses in organizational priority-setting and decision-making may also support the creation of an environment that supports the delivery of high quality care (Friese, Siefert, Thomas-Frost, Walker, & Ponte, 2016). A decrease in adverse events may be attributed to the nursing profession's ability to influence hospital-wide processes and policies. This relationship has been demonstrated by an association between improved scores on the

Nursing Foundations for Quality Care with more error reporting (Jafree, Zakar, Zakar, & Fischer, 2016) and better organizational support of a safety culture (Friese et al., 2016).

Managerial support reduces adverse events because it facilitates an environment in which mistakes are used as learning opportunities and in which nursing leaders support accountability, autonomy, and responsibility for the provision of care (McClure & Hinshaw, 2002). For example, increased scores on the Nurse Manager, Leadership, Ability, and Support of Nurses subscale have been associated with increased error interception practices ($\beta = 0.64$, p value < 0.05) (Flynn et al., 2012). In facilities with adequate staffing and resources, nurses perform fewer routine non-professional tasks, and instead, have more time to provide attentive surveillance of patients and to act when a patient needs an intervention (Kutney-Lee et al., 2009). Low patient experience ratings have been described as indicators "of quality deficiencies in structures and processes of nursing care" within hospitals (Bruyneel et al., 2015, p. 9).

The presence of Collegial Nurse to Physician Relationships is important for fostering open communication about patient needs and changes in condition. Nurses place a high level of value on open and clear communication with physicians (House & Havens, 2017). Positive nurse-physician collaboration leads to problem solving, joint decision-making, increased care coordination, and cooperative actions that meet the needs of the patient, potentially improving a patient's experience with nursing care.

Until recently, most research using the PES-NWI has focused on the overall (composite) score; few analyses have been conducted using the individual subscales or individual items, especially in military facilities. Identification of the subscales or individual PES-NWI items that have the strongest association with particular patient

outcomes could provide more actionable targets for leaders who aim to improve outcomes via improvements in the practice environment. Thus, the information collected for the Army Nurse Corps via the PES-NWI subscales could be used to: 1) identify specific aspects of the nursing practice environment in need of improvement, 2) focus effort and resources toward those identified areas, and 3) improve patient outcomes through positive development of the nursing practice environment.

Nursing-sensitive Indicators and Patient Outcome Measures

The American Nurses Association (1996) defined nursing-sensitive indicators as gauges that quantify quality of care and the outcomes most affected by nursing care. Nursing-sensitive indicators are measured to assess nursing quality, to identify areas in need of improvement, and to measure the success of patient safety improvement programs (Burston, Chaboyer, & Gillespie, 2014). These indicators must have a high degree of specificity to the input of nursing care (Gallagher & Rowell, 2003) and must be reliable and valid measures that can be used to evaluate care quality and nursing performance in acute care hospital settings (Patrician, Loan, McCarthy, Brosch, & Davey, 2010).

Analysis of the relationship between the nursing practice environment and nurse-sensitive indicators is most informative at the unit level because data aggregated at the hospital level may reduce the variability in the data and, therefore, may mask relationships (Patrician et al., 2011). For example, in a study of over 3,000 Korean nurses working in 60 inpatient hospitals, researchers found that certain practice environment factors correlated with adverse patient events when analyzed at the nurse level and unit level, but not when analyzed at the hospital level (Kang, Kim, & Lee,

2014). In addition, results at the unit level are often more specific and, therefore, more actionable for nurse leaders. Patient falls, falls with injury, medication administration errors, medication administration errors with harm, and patient satisfaction/experience are among the most frequently studied nursing-sensitive indicators (Heslop & Lu, 2014). In the military, patient falls, falls with injury, medication administration errors, and medication administration errors with harm are reported through electronic patient safety reports (PSRs).

Medication administration errors. A systematic review of 54 studies examining the causes of medication administration errors provides some insight into the importance of measuring the practice environment with regards to medication administration errors. Among the articles reviewed, inadequate communication between nurses and physicians; problems with supply, storage, and equipment; and staff stress were indicative of an "error-provoking" environment (Keers, Williams, Cooke, & Ashcroft, 2013). The PES-NWI measures aspects of nurse-physician communication, resource adequacy, and staff support and, therefore, may help to identify at-risk nursing practice environments. In a study measuring error interception practices, nurses from units with favorable nursing practice environments reported more time spent conducting error surveillance and prevention activities, both of which were associated with fewer medication administration errors (Flynn et al., 2012). In addition, the nursing practice environment has been shown to mediate the relationship between staffing and medication administration errors, supporting the theory that the nursing practice environment influences the rate of medication administration errors beyond those caused by staffing alone (Breckenridge-Sproat et al., 2012).

Patient falls. Independent of staffing variables, Magnet hospitals have been shown to have 5% fewer falls than non-Magnet hospitals, indicating that factors other than staffing influence patient fall rates (Lake, Shang, Klaus, & Dunton, 2010). Lopez and colleagues (2010) suggest that increased nursing knowledge and improved safety culture may decrease patient falls. Nursing knowledge is thought to increase awareness of patients at risk for falling, an insight that allows for the implementation of prevention strategies. Additionally, a safety culture is thought to decrease falls through incident reporting and implementation of related system level improvements in facility fall prevention strategies (Lopez, Gerling, Cary, & Kanak, 2010).

Patient experience with nursing care. Patient experience has become a focus of health-care organizations because it is linked to financial reward or penalty (Stanowski, Simpson, & White, 2015). More importantly, patient experience and patient-centered care, a method for delivering care that is credited with enhancing patient safety, may be directly related to other indicators for quality care such as Magnet status (Stimpfel, Sloane, McHugh, & Aiken, 2015). Just as nurses are excellent organizational informants about the quality of care provided in hospitals, so can patients provide important feedback (Aiken & Patrician, 2000). Importantly, patients and nurses often agree about the quality of care provided in a hospital (Aiken et al., 2012). In addition, Aiken and colleagues (2012) found that improved work environments and staffing were associated with increased care quality and patient satisfaction.

In this study, patient experience data have been collected using the TriCare Inpatient Satisfaction Survey (TRISS), a survey containing many of the standard Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) items that aim to

capture the patient's perspective of hospital care. Although the TRISS has satisfaction in its title, it is more reflective of patient experience, as is the HCAHPS (Stimpfel et al., 2015).

Nurse Staffing and Adverse Events

An association is often found between decreased nurse staffing and increased adverse patient events, such as medication administration errors, patient falls, and hospital-acquired pressure ulcers (Aydin, Donaldson, Stotts, Fridman, & Brown, 2014; Breckenridge-Sproat et al., 2012; Cho, Chin, Kim, & Hong, 2016; Patrician et al., 2011; West, Patrician, & Loan, 2012). Therefore, it is important to also consider staffing requirements when studying the relationships between the nursing practice environment and patient outcomes. For example, a 10% decrease in registered nurse skill mix (the proportion of registered nurses that comprise the total nursing staff) or in the percentage of experienced nurses on a shift, increases the probability of a fall or medication error occurring on that shift (West et al., 2012). In another study, for each decrease of one hour of nursing care available per shift, a 15% to 51% increase in falls with injury was found (Patrician et al., 2011). However, unlike the results observed in favorable nursing practice environments, the benefit of increased staffing does not result in decreased adverse events in poorer nursing practice environments (Aiken et al., 2011).

Workload Intensity and Patient Acuity

Nursing workload can vary in intensity and complexity from unit to unit (Baernholdt, Cox, & Scully, 2010). Although numerous factors impact nursing workload, (Swiger, Vance, & Patrician, 2016) patient turbulence, or turnover, as measured by admissions, discharges, and transfers, increases nursing workload intensity

(Jennings, 2008). This increased work demand on nurses is not well reflected in patient count or census measures; therefore, in addition to staffing requirements, workload intensity is an important variable to consider when studying patient outcomes (Unruh & Fottler, 2006). Additionally, patients who are more acutely ill require more nursing care and vigilance, thereby increasing the workload demand on nursing staff. Importantly, a significant ($p < 0.001$) increase in errors occurs when nurses become busy or rushed (Harkanen, Ahonen, Kervinen, Turunen, & Vehvilainen-Julkunen, 2015). A systematic review of 54 articles published between 1985 and 2013, found that high perceived workload was associated with failing to administer medications and other errors (Keers et al., 2013).

Overview of the Three Papers

Paper One – The Practice Environment Scale of the Nursing Work Index: An Updated Review and Recommendations for Use

The purpose of the first paper is to provide a current review of the Practice Environment Scale of the Nursing Work Index's use and to provide recommendations that may be helpful to nursing leaders and researchers who plan to use this instrument. Using PubMed, EMBASE, and the Cumulative Index to Nursing & Allied Health Literature, 46 articles were identified that investigated associations between PES-NWI and patient, nurse, or organizational outcomes. The findings from the narrative review indicate that use of the instrument, with few modifications, remains high.

This paper provides PES-NWI scoring ranges by specific categories (i.e., combined reported hospital, clinic, Magnet, and non-Magnet scores), allowing for homogeneous comparisons for those conducting research in these specific practice

settings. In the last review of the PES-NWI, several recommendations were made for future research (Warshawsky & Havens, 2011). This paper provides an evaluation on the progress made regarding those recommendations. In addition, the use of the PES-NWI with non-RN staff, and across practice settings, is discussed.

Recommendations for use are provided for research design and methods, sampling, scoring, reporting of results, and future instrument modification. The paper concludes by acknowledging that while the instrument is still commonly used in its original form, the PES-NWI may benefit from further psychometric testing, updating, and development.

Paper Two – Adaptation of the Practice Environment Scale for Military Nurses: A Psychometric Analysis

The purpose of the second paper was to confirm the psychometric properties of Practice Environment Scale of the Nursing Work Index in a military population and compare survey responses based on care setting and nurse type. This analysis was important because, although the instrument has been widely used in diverse settings (Warshawsky & Havens, 2011), the reliability and validity of the instrument has not been comprehensively evaluated. Importantly, the developer of the instrument calls for further evaluation, potential development of a shorter version, and testing of the instrument in different settings and with different populations (Lake, 2007). In particular, the literature is lacking confirmatory evaluation of the subscale factors with large data sets, individual item analysis, evaluation of the instrument's performance in the outpatient setting, and evaluation of use with non-registered nurse staff (Gajewski, Boyle, Miller, Oberhelman, & Dunton, 2010).

Multiple psychometric analysis techniques were used to answer the following research questions:

RQ1) Does the PES-NWI function well in the military setting?

RQ2) Are there any individual items (questions) on the PES-NWI that do not contribute to the overall measurement of the construct?

RQ3) Do survey responses on the PES-NWI vary by care setting or nurse type?

The results of these analyses indicate that responses differ between groups and demonstrate that several individual items could be removed without altering the psychometric properties of the instrument. In addition, the analyses demonstrate that the instrument functions moderately well in a military population; however, researchers may want to consider nurse type and care setting during analysis to identify any meaningful variation in responses.

Paper Three – Discovering relationships between the military nursing practice environment and patient outcomes

The purpose of this study was to explore the association between aspects of the military nursing practice environment and patient outcomes. Specifically, this study focused on the five subscales of the PES-NWI and their associations with patient falls with and without injury, medication administration errors with and without harm, and patient experience associated with nursing care. This study also explored the association of the individual items on the PES-NWI with patient falls with and without injury and medication administration errors with and without harm.

A longitudinal study design was ideal for assessing changes over time and enhancing interpretability of these research results (Polit & Beck, 2012). Data for this

study was available from 2010, 2011, 2013, and 2014. The data source for this secondary analysis included four years of data collected from 45 individual acute care units in ten military hospitals. The types of units included in the dataset were either medical, surgical, stepdown, or intensive care units. The data were compiled as part of an extensive program evaluation aimed at examining the effects of implementing a nursing care delivery framework that was put into effect primarily in Army military hospitals (Breckenridge-Sproat et al., 2015). To assess the associations between the PES-NWI subscales and patient outcomes, generalized estimating equations (GEE) analysis was used to account for the hierarchal nature of the data. GEE is a modeling technique that uses population averages to estimate associations between independent and dependent variables (Hubbard et al., 2010).

Four significant associations were found between the PES-NWI subscales and patient outcomes. The subscale Staffing and Resource Adequacy, was significantly (b = - 0.618, $p < .05$) associated with patient falls; the Collegial Nurse Physician Relations subscale was significantly (b = - 3.43, $p < .05$) associated with the rate of medication administration errors; and both the Nursing Foundations for Quality Care and Collegial Nurse Physician Relations subscales were significantly (b = 0.033 and b = 0.028, $p < .01$) associated with patient experience of nursing care. Findings portrayed in the tree algorithms indicate that units with the lowest fall rates with and without injury had nurse survey responses indicating their unit had care plans for their patients, increased staffing levels, and care assignments that foster continuity of care (falls only).

Implications for both research and practice were identified and discussed in this paper. In addition, this study supports the large body of research demonstrating the

associations between a favorable nursing practice environment and lower adverse events. Importantly, this analysis adds information about the *specific aspects* of the nursing practice environment matter most for *particular outcomes*.

Summary

The overall aim of this dissertation was to determine if associations with higher scores on the PES-NWI, such as fewer patient falls, medication administration errors, and improved patient experience, also exist within the military health-care system. This first chapter has introduced the problem, significance, and background, as well as provided an overview of each paper included in this dissertation. The last chapter of the dissertation will combine the evidence discovered in all three papers to provide a comprehensive interpretation and evaluation of the findings, offer conclusions, and provide future research recommendations related to all three papers.

Definitions of Key Terms

In this section, key terms used throughout this dissertation are defined. The variable definitions below reflect those of the program evaluation from which the data used for this study were obtained (TSNRP Grant # N13-P13).

General Terms

"*Magnet hospital*" is a term that was coined in the 1980s to describe facilities that recruited and retained high quality nurses during a nursing shortage (Kramer & Schmalenberg, 1988). These facilities are also known for providing high quality care (McClure & Hinshaw, 2002).

The *Military Health System* (MHS) is a healthcare delivery system that provides healthcare to military service members (Army; Navy; Marine corps, and Air Force), retirees, and eligible family members (Department of Defense, 2014).

A *Military Treatment Facility* (MTF) is any health-care facility (hospital, ambulatory care clinic, and/or dental clinic) that provides health care within the MHS and can be located inside or outside of the United States (Department of Defense, 2014).

The *nursing practice environment* (NPE) is described as factors that contribute to or detract from a nurse's ability to practice professional nursing, nurses' control over nursing practice, and nurses' ability to provide high quality care (Aiken & Patrician, 2000; Lake, 2002; McClure & Hinshaw, 2002).

The *Practice Environment Scale of the Nursing Work Index* (PES-NWI) is an instrument used to empirically measure the nursing practice environment (Lake, 2002).

Predictor Variables

These are the independent variables in this study. In the dataset used in this study, unit-level annual aggregates of the PES-NWI subscales were available. The names and descriptions of each subscale were developed by Dr. Eileen Lake (2002).

Nursing Participation in Hospital Affairs (Subscale #1 – 9 items) is one of the two subscales thought to reflect nursing involvement in forming the hospital-wide care environment.

Foundations for Quality of Care (Subscale #2 – 10 items) is reflective of the hospital-wide structural support of nursing.

Nurse Manager Ability, Leadership, and Support of Nurses (Subscale #3 – 5 items) is a unit specific measure that describes the abilities of the nurse manager to lead the unit, manage, and support nursing staff.

Staffing and Resource Adequacy (Subscale #4 – 4 items) refers to whether there are sufficient staff, resources, and support services to do the work.

Collegial Nurse-Physician Relations (Subscale #5 – 3 items) refers to good working relationships between physicians and nurses on the unit.

Individual items are the 31 individual questions that comprise the subscales of the PES-NWI.

The *Composite Score* is the mathematically-derived overall score for the PES-NWI. The self-reported instrument instructs nurses to indicate their degree of agreement that each of the items listed is present in their current work environment using a four-point Likert scale. The responses are coded as: *strongly disagree* = 1, *somewhat disagree* = 2, *somewhat agree* = 3, or *strongly agree* = 4. The subscale items are averaged to create the subscale score. Using the mean value prevents the weighting of subscales that contain more items than others (Lake, 2002).

Outcome Variables

The adverse outcome variables were collected via electronic patient safety reports, which are standardized across Army Military Treatment Facilities. In the dataset used for this study, medication administration errors and patient falls were available as unit-level monthly aggregates, and patient experience was reported as an annual hospital-level aggregate.

Medication administration errors are defined as a deviation from the physician's written order, committed by nursing staff, and include errors with or without harm to the patient (Mosby, 2012; Patrician et al., 2011).

Medication administration errors with harm are defined as a deviation from the physician's written order, committed by nursing staff, resulting in some level of harm to the patient; for this study, harm was either present or absent, the level of harm was not considered (Mosby, 2012; Patrician et al., 2011).

Patient experience was calculated based on four questions from the *TriCare Inpatient Satisfaction Survey* (TRISS). The TRISS is a Defense Health System survey containing many of the standard Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) questions (Centers for Medicare & Medicaid Services, 2013). Four questions were selected to measure patient experience with nursing care (TSNRP Grant # N13-P13). These questions are: 1) During this hospital stay, how often did nurses treat you with courtesy and respect? 2) During this hospital stay, how often did nurses listen carefully to you? 3) During this hospital stay, how often did nurses explain things in a way you could understand? and 4) During this hospital stay, after you pressed the call button, how often did you get help as soon as you wanted it? (Centers for Medicare & Medicaid Services, 2013). These items aim to measure the patient's experience with communication and with responsiveness of nursing staff (Data Recognition Corporation, 2011).

Patient falls are defined as an "unplanned descent to the floor" with or without injury to the patient (Dunton, Gajewski, Taunton, & Moore, 2004, p. 55; National Quality Forum, 2004).

Patient falls with injury are defined as an "unplanned descent to the floor" with minor, moderate, or severe injury (Dunton et al., 2004, p. 55; National Quality Forum, 2004).

Control Variables

These variables were used to determine if the relationships discovered between the PES-NWI subscales and the patient outcomes change when they are present in the models. Staffing, skill mix, workload intensity (ADT), and patient acuity were available as unit-level monthly aggregates, and hospital size was a dichotomous variable (small, <100 inpatient beds and large, >100 inpatient beds). Census, admissions, discharges, transfers (ADT), and patient acuity data were recorded immediately after each shift by trained nursing staff, and the information was entered into the Workload Management System for Nursing-internet (WMSNi) systems using standard procedures. Staffing information was tracked through the Defense Medical Human Resources System-internet (DMHRSi), a business database used for workhour accounting.

Hospital size serves as an excellent proxy for high-technology and teaching status within the military; larger hospitals have a teaching mission, care for more complex patients, and generally have more technology (Patrician et al., 2011).

Patient acuity is another workload measure that is expressed through a categorical or point-range system based on the amount of nursing care required by a particular patient (Molter, 1990).

Registered nurse skill mix is the proportion of total nursing care hours worked by registered nurses (Patrician et al., 2011).

Total nursing care hours per patient day (TNCHPPD) is the total number of care hours worked by all nursing personnel (RN, LPN, and Paraprofessionals) divided by the total number of patients on that day (Patrician et al., 2011).

ADT Index, also called *workload intensity,* is the amount of work, measured by tracking the number of admissions, discharges, and transfers (ADTs), that occur, on average, on a unit divided by the average of total patient days on that same unit (Patrician et al., 2016).

THE PRACTICE ENVIRONMENT SCALE OF THE NURSING WORK INDEX: AN UPDATED REVIEW AND RECOMMENDATIONS FOR USE

by

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PAPER 1

THE PRACTICE ENVIRONMENT SCALE OF THE NURSING WORK INDEX: AN UPDATED REVIEW AND RECOMMENDATIONS FOR USE

Abstract

Objectives: The Practice Environment Scale of the Nursing Work Index (PES-NWI) is an instrument, which measures the nursing practice environment – defined as factors that enhance or attenuate a nurse's ability to practice nursing skillfully and deliver high quality care. The purpose of this paper is to provide an updated review of the Practice Environment Scale of the Nursing Work Index's use to date and provide recommendations that may be helpful to nursing leaders and researchers who plan to use this instrument.

Design: A narrative review of quantitative studies.

Data Sources: PubMed, EMBASE, and the Cumulative Index to Nursing & Allied Health Literature were searched to identify relevant literature using the search terms, *Practice Environment Scale of the Nursing Work Index* and *PES-NWI*.

Review Methods: Studies were included if they were published in English between 2010 and 2016 and focused on the relationship between the Practice Environment Scale of the Nursing Work Index and patient, nurse, or organizational outcomes. Data extraction focused on the reported survey scores and the significance and strength of the reported associations.

Results: Forty-six articles, from 28 countries, were included in this review. The majority reported significant findings between the nursing practice environment and outcomes. Although some modifications have been made, the instrument has remained primarily unchanged since its development. Most often, the scores regarding staffing and resource adequacy remained the lowest.

Conclusion: The frequency of use of this instrument has remained high. Many researchers advocate for a move beyond the study of the connection between the Practice Environment Scale and nurse, patient, and organizational outcomes. Research should shift toward identifying interventions that improve the environment in which nurses practice and determining if changing the environment results in improved care quality.

Keywords: narrative review, nursing work environment, Practice Environment Scale of the Nursing Work Index, PES-NWI

Introduction

The Practice Environment Scale of the Nursing Work Index (PES-NWI) is an instrument which measures the nursing practice environment – defined as factors that enhance or attenuate a nurse's ability to practice nursing skillfully and deliver high quality care (Lake, 2002). Many studies have associated higher composite scores on the PES-NWI with better nurse reported patient outcomes such as care quality, medication errors, and patient falls, as well as better patient reported experiences of care (Friese, 2005; Kutney-Lee, Lake, & Aiken, 2009; Laschinger & Leiter, 2006; Manojlovich & DeCicco, 2007; McCusker, Dendukuri, Cardinal, Laplante, & Bambonye, 2004; Patrician, Shang, & Lake, 2010). Although there are other instruments that measure the nursing practice environment, the PES-NWI is most commonly used because of its low respondent burden, satisfactory psychometric performance, opportunity for comparison across studies, and high discriminant ability (Lake, 2002; Warshawsky & Havens, 2011). It is also free to use. The discriminant ability of the PES-NWI demonstrates that the instrument is sensitive enough to detect differences in the nursing practice environment between known groups such as Magnet® and non-Magnet hospitals (Bonneterre, Liaudy, Chantellier, Lang, & Gaudemaris, 2008). Thirty-one items make up five empirically derived subscales which are: Nurse Participation in Hospital Affairs; Nursing Foundations of Quality Care; Nurse Manager, Leadership, and Support of Nurses; Staffing and Resource Adequacy; and Collegial Nurse-Physician Relations (Lake, 2002).

In 2011, Warshawsky and Havens reviewed the global use of the PES-NWI providing an overview of the instrument's utilization across practice settings and countries. In addition, the review identified PES-NWI scoring ranges, instrument

modifications, associations with various outcomes, and recommendations for future research. The original review covered a time period beginning with when the instrument was first published in 2002 and concluded with the first quarter of 2010 (Warshawsky & Havens, 2011). More than five years have passed since the Warshawsky & Havens (2011) paper was published, which has been cited upwards of one hundred times (Google Scholar, 2016; Scopus, 2016). Therefore, this review includes articles published in the second quarter of 2010 through the first quarter of 2016. The Warshawsky & Havens (2011) review included research conducted in five countries; however, searching with similar criteria now results in a pool of 46 articles with research conducted in at least 28 countries. The purpose of this paper is to provide an updated review of the PES-NWI's use to date and provide practical recommendations that may be helpful to nursing leaders and researchers who would like to use this instrument. This updated review identifies recent PES-NWI scoring ranges and associated effect sizes; evaluates progress on research recommendations outlined in the original article; identifies modifications and scoring variations; and illuminates the use of the PES-NWI with non-registered nurse populations.

Search Strategy

PubMed, EMBASE, and the Cumulative Index to Nursing & Allied Health Literature were searched to identify relevant literature using the search terms, *Practice Environment Scale of the Nursing Work Index* and *PES-NWI*, resulting in 200 total articles. Similar to the inclusion criteria used by Warshawsky and Havens (2011), the search was limited to articles published in English that focused on the relationship between the PES-NWI and outcomes or reported scores on the PES-NWI for particular

groups (e.g., by unit type, by care setting, or Magnet designation). Magnet hospitals are those facilities known for being favorable places for nurses to work and for providing high quality care (Kramer & Schmalenberg, 1988; McClure & Hinshaw, 2002). During the title and abstract screen of the retrieved articles, 27 were excluded because they were found to be review articles, dissertations, focused only on instrument translation, or measured the nursing practice environment with instruments other than the PES-NWI. A full text screen was conducted on the remaining 84 articles by the first author to determine if the inclusion criteria were met. During the full text screen, 11 articles were excluded because they did not meet the previously specified inclusion criteria, were unavailable in full text, or used considerable non-standard PES-NWI scoring techniques. Lastly, during data extraction, articles were re-read by the primary author and the key findings were entered into categorized evidence tables. To enhance critical appraisal of the data extracted, findings were discussed among the co-authors until consensus was reached regarding inclusion of the article and the meaning of the findings. Throughout this process, another 26 articles were excluded, resulting in the inclusion of 46 publications. The diagram in Figure 1 depicts this process.

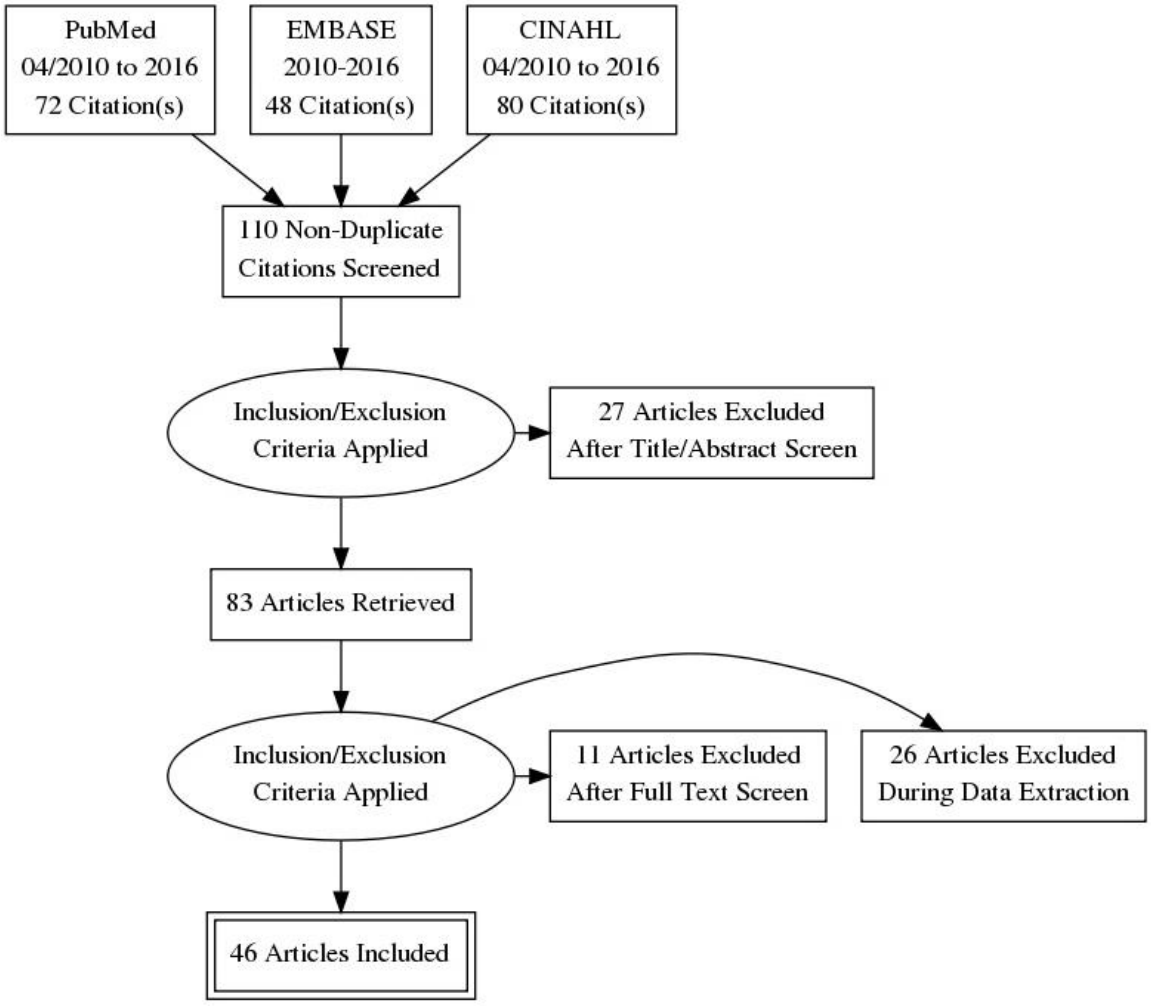

Figure 1. PRISMA diagram depicting PES-NWI article selection.

Review Findings

The 46 included articles were published in 25 peer-reviewed journals; almost half of the articles (43%) were published in international journals.

Study Designs and Samples

Like the Warshawsky and Havens (2011) review, only one current article was found that described an experimental study. The study investigated the impact of nursing grand rounds on the nursing practice environment, identifying both pre and post

differences in the nursing practice environment. Although no statistically significant differences in the PES-NWI scores were seen after the intervention, the authors note that the lack of change may be due to a lack of sensitivity in the environment or a weak intervention (Aitken, Burmeister, Clayton, Dalais, & Gardner, 2011). The most frequently used study design was cross-sectional (93%). The experimental study used a pretest-posttest study design (Aitken et al., 2011), one study used a longitudinal design (Boev, 2012), and another used a retrospective two panel study design (Kutney-Lee et al., 2015). Primary data collection occurred in 25 of the studies; the remaining 22 studies analyzed secondary data with the earliest reported year of collection occurring in 1999 and latest occurring in 2014. A few articles shared the same or similar samples. Two articles utilized data from the Vermont Oxford Network database collected in 2008 (Hallowell et al., 2016; Hallowell, Spatz, Hanlon, Rogowski, & Lake, 2014) and three articles reported use of the international Registered Nurse Forecasting (RN4CAST) data; however different years were analyzed (Kirwan, Matthews, & Scott, 2013; Li et al., 2013; Smeds Alenius, Tishelman, Runesdotter, & Lindqvist, 2014). At least two studies utilized data collected in the Multistate Nursing Care and Patient Safety Survey (Kutney-Lee et al., 2015; Shang, Friese, Wu, & Aiken, 2013). Three studies conducted in Australia shared part of all of their data sources (Roche et al., 2016; Roche, Duffield, & White, 2011; Roche & Duffield, 2010) and two Swiss studies utilized data from the Swiss Nursing Home Human Resources Project (Schwendimann, Dhaini, Ausserhofer, Engberg, & Zuniga, 2016; Zuniga et al., 2015). Nurse sample size ranged from 133 to 33,845 nurses and 59% of the articles include registered nurse (RN) responses only. In the remaining 41%, other nurse types such as advanced practice nurses, licensed

practical/vocational nurses (LPN/LVN), enrolled nurses (EN - Australia), certified nurse's assistants (CNA), nurse's aides/technicians, and primary, junior, and senior nurses (China) were included in the analysis (Boev, 2012; Friese, 2012; Friese & Manojlovich, 2012; Friese, Siefert, Thomas-Frost, Walker, & Ponte, 2016; Hegney, Eley, Osseiran-Moisson, & Francis, 2015; Lavoie-Tremblay, Paquet, Marchionni, & Drevniok, 2011; Mainz, Baernholdt, Ramlau-Hansen, & Brink, 2015; Perez-Campos, Sanchez-Garcia, & Pancorbo-Hidalgo, 2014; Prezerakos, Galanis, & Moisoglou, 2015; Roche et al., 2016; Roche et al., 2011; Schwendimann et al., 2016; Tei-Tominaga & Sato, 2016; Topcu et al., 2016; Walker, Middleton, Rolley, & Duff, 2010; Y. Wang et al., 2015; Zhou et al., 2015; Zuniga et al., 2015). Only a few studies included nurse managers and leaders in the sample (Anzai, Douglas, & Bonner, 2014; Jafree, Zakar, Zakar, & Fischer, 2016; Parro Moreno et al., 2013); many included only direct care nurses and/or nurses with employment of three, six, or twelve months in their current positions (Blake, Leach, Robbins, Pike, & Needleman, 2013; Hallowell et al., 2016; Havens, Warshawsky, & Vasey, 2012; Havens, Warshawsky, & Vasey, 2013; Ma & Park, 2015; Mainz et al., 2015; Topcu et al., 2016; Wang, Liu, & Wang, 2015). Excluding nurses who have worked very few months at their current job, and may not be familiar with their new nursing practice environment, ensures a more accurate assessment with the PES-NWI (Hallowell et al., 2016; Havens et al., 2012; Havens et al., 2013; Hegney et al., 2015; Ma & Park, 2015; Mainz et al., 2015; Parro Moreno et al., 2013; Y. Wang et al., 2015). One study, which included nurse managers, found that managers perceived the work environment to be significantly better than the direct care nurses, with the exception of the staffing and resource adequacy subscale (Anzai et al., 2014).

Methods Utilized

Warshawsky and Havens (2011) recommended the increased use of multilevel modeling to better reflect the nursing practice environment and increased attention to the performance of the subscales. About one third of the studies reviewed used multilevel modeling techniques because the data were hierarchical, about half reported internal consistency of the instrument at both the composite and subscale levels, and 76% reported associations between the outcome of interest and at least one subscale. One study used a descriptive mixed methods approach by analyzing the variance in PES-NWI means between groups which were identified through thematic analysis of nursing survey comments (Friese & Manojlovich, 2012).

Reported Reliability Analysis

Most articles reported the use of instrument evaluation methods to delineate PES-NWI performance. Seven of the studies (15%) reported only the Cronbach's alpha from other studies, some which were conducted several years before and with samples from other countries, not with their own study sample (Aitken et al., 2011; Havens et al., 2013; Parro Moreno et al., 2013; Perez-Campos et al., 2014; Topcu et al., 2016; Y. Wang et al., 2015; Zhou et al., 2015) and two did not report any measure of reliability (Li et al., 2013; Walker et al., 2010). Thirty-seven (80%) of the included studies reported a sample-derived Cronbach's alpha or other measure of reliability. The lowest reported Cronbach's alpha for a subscale (nursing foundations for quality care) was 0.53. This study was conducted in Australia and had a relatively low sample size (n = 149 registered and enrolled nurses) (Roche et al., 2011). All but two studies report subscale or

composite Cronbach's alphas equal to or greater than 0.70 (Boev, 2012; Roche et al., 2011). Scores on the PES-NWI from Magnet facilities were significantly higher than non-Magnet facilities (Kutney-Lee et al., 2015; Ma & Park, 2015; Walker et al., 2010), demonstrating the continued discriminant ability of the instrument.

Use Across Practice Settings and Countries

Data were aggregated for analysis at the nurse, unit, hospital, and group (e.g., Magnet and non-Magnet) levels, with eighteen (39%) of the studies reporting at least some of the results at the unit level (Aitken et al., 2011; Boev, 2012; Choi & Boyle, 2014; Choi & Staggs, 2014; Flynn, Liang, Dickson, Xie, & Suh, 2012; Friese, 2012; Friese et al., 2016; Gabriel, Erickson, Moran, Diefendorff, & Bromley, 2013; Hallowell et al., 2016; Hallowell et al., 2014; Kirwan et al., 2013; Li et al., 2013; Liu et al., 2012; Ma & Park, 2015; Mainz et al., 2015; Prezerakos et al., 2015; Roche & Duffield, 2010; Zuniga et al., 2015). These studies were conducted using information from at least 28 different countries and 80% reflected the acute care hospital setting. Studies of the nursing practice environment in outpatient clinics occurred in ambulatory oncology clinics (Friese, 2012; Friese & Manojlovich, 2012; Friese et al., 2016), primary health care clinics (Parro Moreno et al., 2013), and a hospital-based hemodialysis clinic (Prezerakos et al., 2015). One study's inclusion criteria were nurses who were active on the internet and working in any health or care center. This study analyzed responses from at least five countries (Spain, Mexico, Argentina, Peru, Venezuela, Colombia, and other) and likely included many care settings (Perez-Campos et al., 2014). The nursing practice environment in long term elder care settings was represented in three studies from two countries, China and Switzerland (Schwendimann et al., 2016; Y. Wang et al., 2015;

Zuniga et al., 2015). In the acute care setting, the nursing practice environment has been assessed in many unit types such as: intensive care units (adult, neonatal, and pediatric); medical, surgical and combined medical-surgical care units; oncology; orthopedics; mental health; gastroenterology; the emergency room; and the operating room. Seven studies did not specify the included unit types and two studies represented rural and remote acute care units (Havens et al., 2012; Havens et al., 2013). The PES-NWI was found to be valid (with regard to content, construct, and criterion validity) and reliable in ambulatory care settings in the United States and in Spain (De Pedro-Gomez et al., 2012; Friese, 2012) and internally consistent when used in nursing homes in Switzerland, China, Germany, France, and Italy (Schwendimann et al., 2016; Y. Wang et al., 2015; Zuniga et al., 2015).

Modifications and International Use

As was found in the first review, some modifications were made to instrument items, such as nursing leadership titles, to keep consistent with the titles used in a given country or setting. Boev (2012) removed the nurse-physician collaborative subscale from the PES-NWI when merging the instrument with another that included a collaborative practice subscale already. Four of the studies conducted in Australia dropped at least one item, "the use of nursing diagnosis" with one study stating that this item is not relevant for Australian nurses (Roche et al., 2016; Roche et al., 2011; Roche & Duffield, 2010; Walker et al., 2010). The international Registered Nurse Forecasting (RN4CAST) studies use a modified version of the PES-NWI containing 32 items and 5 subscales. It appears that although the instrument in the RN4CAST study is called the PES-NWI, named by Lake (2002), some of the individual survey items were dropped, modified,

and/or added. A complete description of the RN4CAST protocol can be found elsewhere (Sermeus et al., 2011) although a published copy of the modified instrument was not found. Three of the included articles report use of data from the RN4CAST using this modified PES-NWI (Kirwan et al., 2013; Li et al., 2013; Smeds Alenius et al., 2014). Lastly, in an effort to make the instrument more applicable to an outpatient ambulatory oncology setting, Friese (2012) modified the PES-NWI by adjusting the wording of individual items to better reflect the outpatient care setting, removing some of the original items, and incorporating items into the existing subscales to measure the presence of medical assistant support in the nursing practice environment. The revised subscales had acceptable internal consistency and model fit with Cronbach alphas ranging from 0.80 to 0.90, a comparative fit index (CFI) of 0.95, and a root mean-square error of approximation (RMSEA) of 0.057 (Friese, 2012).

Scoring

The PES-NWI uses a 4-point Likert scale, ranging from 1 = *strongly disagree* to 4 = *strongly agree,* to identify factors present in the work environment that support nursing's ability to deliver high quality care; a higher score, represents a favorable nursing practice environment. Scores above the midpoint of 2.5 indicate a favorable practice environment and those below the midpoint are considered to be unfavorable (Lake, 2002). In 2006, Lake and Friese enhanced the scoring of the PES-NWI by creating categorical references for poor, mixed, and favorable nursing practice environments. A favorable environment receives scores of > 2.5 on all or four out of 5 subscales, mixed receives scores of > 2.5 on two or three out of 5 subscales, and unfavorable receives scores of > 2.5 on one or none of the 5 subscales (Lake & Friese,

2006). In some of the articles reviewed, modifications were made to the Likert scale. A few authors added points to the scale when merging the PES-NWI with other instruments (to maintain consistency across all measures) and in other cases the coding of the scale was reversed (and then recoded), or reversed (without recoding) (Aitken et al., 2011; Blake et al., 2013; Boev, 2012; Friese, 2012; Friese & Manojlovich, 2012; Friese et al., 2016; Goh & Lopez, 2016; Jafree et al., 2016; Parro Moreno et al., 2013). Two studies elected to sum the respondent scores for each individual item (Parro Moreno et al., 2013; S. Wang et al., 2015).

Reported PES-NWI scores. Sixteen articles (35%) reported composite PES-NWI scores, based on the 4-point Likert scale, which ranged from 2.30 to 3.07. The lowest composite score came from a study with a relatively low sample size (n = 301) investigating turnover intention of registered nurses in the Eastern Caribbean who worked on medical, surgical, medical-surgical, or obstetric units (Lansiquot, Tullai-McGuinness, & Madigan, 2012). The highest score came from a hospital in Australia that was in the process of seeking Magnet recognition (Walker et al., 2010). In studies where a sample was identified as having been collected from nurses working in Magnet facilities, the reported composite score ranged from 2.92 to 3.00 (Kutney-Lee et al., 2015; Ma & Park, 2015). Collective subscale and composite score ranges from 3 studies reporting scores from Magnet, emerging or aspiring Magnet, and non-Magnet facilities can be found in Table1; the Staffing and Resource adequacy remains the lowest subscale for all three groups, confirming the finding from the Warshawsky and Havens (2011) review.

Table 1

Reported Score Ranges (n = 3 articles)

PES-NWI Measure		Reported Mean Score Range (SD)		
Subscale		Non-Magnet Scores	Emerging/Aspiring Magnet Scores	Magnet Hospital Scores
1	Nurse Participation in Hospital Affairs	2.34 (0.22) - 2.87 (0.26)	2.49 (0.19) - 3.06 (0.47)	2.76 (0.47) - 3.01 (0.24)
2	Nursing Foundations for Quality of Care	2.82 (0.20) - 3.11 (0.19)	2.98 (0.11) - 3.19 (0.39)	3.09 (0.39) - 3.20 (0.19)
3	Nurse Manager Ability, Leadership, & Support of Nurses	2.41 (0.26) - 3.00 (0.34)	2.48 (0.20) - 3.17 (0.53)	2.72 (0.18) - 3.07 (0.31)
4	Staffing and Resource Adequacy	2.07 (0.56) - 2.62 (0.36)	2.31 (0.20) - 2.88 (0.58)	2.65 (0.18) - 2.88 (0.62)
5	Collegial Nurse-Physician Relations	2.78 (0.16) - 2.99 (0.24)	2.85 (0.08) - 3.06 (0.52)	2.99 (0.52) - 3.07 (0.24)
Composite		2.51 (0.17) - 2.92 (0.24)	2.62 (0.13) – 3.07 (0.40)	2.92 (0.16) - 3.00 (0.23)

Note. PES-NWI = Practice Envionment Scale of the Nursing Work Index; This table depicts those studies that reported scores for non-Magnet, Magnet, or emerging/aspiring Magnet hospitals.

The Associations between the PES and Outcomes

Of the 46 articles retrieved, the majority of studies associated the PES-NWI with organizational, nurse, or patient outcomes. Most studied more than one outcome. Unfortunately, almost half (21) of these studies reported only significance of the associations and no evidence that could be used to determine the strength of the identified association. In the reviewed studies that reported effect sizes, they ranged from small, identified as a very weak Spearman rank order correlation of 0.147 (Perez-Campos et al., 2014), to large ($\beta = 0.63$) (Roche et al., 2011).

A few of the retrieved studies (17%) compared the practice environment between groups (e.g., Magnet and non-Magnet or by specific unit types), removed the PES-NWI as a predictor variable due to multicollinearity, or described changes in the practice environment over time. Therefore, these studies did not investigate the associations between the PES-NWI and an outcome variable (Choi & Boyle, 2014; Friese, 2012; Havens et al., 2012; Kutney-Lee et al., 2015; Parro Moreno et al., 2013; Roche et al., 2016; Roche & Duffield, 2010; Walker et al., 2010). Appendix A provides a brief summary of the main findings for each included study.

Nurse outcomes. Twenty-four studies (52%) investigated nurse outcomes (e.g., job satisfaction, intent to leave, burnout, error interception practices, and work engagement) with the majority of the studies finding a significant association between the nursing outcomes of interest in at least one of the PES-NWI subscales and/or the composite score. In nine of the studies (20%), at least one of the nursing outcomes of interest had either mixed findings (significant associations with the composite score or one or more subscales but not all) or non-significant findings (with the composite or subscale scores) (Gabriel et al., 2013; Goh & Lopez, 2016; Lavoie-Tremblay et al., 2011; Li et al., 2013; Roche et al., 2011; Shang et al., 2013; Yurumezoglu & Kocaman, 2016; Zhou et al., 2015; Zuniga et al., 2015). Some associations were found to be significant at one level of analysis but not another. For example, emotional exhaustion was significantly negatively associated with nurse participation in hospital affairs at the individual level but not at the unit level; no effect sizes were reported (Gabriel et al., 2013). Several studies found significant negative associations with burnout (Li et al., 2013; Liu et al., 2012; Shang et al., 2013; Wang & Liu, 2015), intent to leave (Blake et

al., 2013; Lavoie-Tremblay et al., 2011; Yurumezoglu & Kocaman, 2016) and job dissatisfaction (Shang et al., 2013; Zhou et al., 2015). Five of the studies reporting nurse outcomes used odds ratios (OR) to demonstrate the strength of the associations discovered. For example, nurses on units with good environments (in this study, units with four of five subscales above the sample generated median were considered to be good environments) were less likely to report burnout (by 33% –- OR of 0.67) and job dissatisfaction (by 50% –- OR of 0.50) than poor environments (Liu et al., 2012).

Patient outcomes. Fourteen (30%) articles reported patient related outcomes (e.g., patient satisfaction, medication errors, or hospital acquired pressure injuries). Two studies focused on the associations between the nursing practice environment and medication errors on medical-surgical units; however, their findings were not consistent. One found a significant inverse association between better nursing work environments and fewer cases of administration of the wrong medicine or dose (OR = 0.55, 95% CI = 0.40–0.76) and the other found no significant association between the practice environment and medication errors (Cho, Chin, Kim, & Hong, 2016; Flynn et al., 2012). New patient outcomes, not present in Warshawsky's (2011) review – such as infant feeding of human milk at discharge and the provision of breastfeeding support – have now been significantly positively associated with the nursing practice environment (Hallowell et al., 2016; Hallowell et al., 2014). The majority of the studies investigating nurse reported quality of care measures found significant associations between the nursing practice environment and nurse rated quality of care (Anzai et al., 2014; Friese & Manojlovich, 2012; Friese et al., 2016; Shang et al., 2013). Kutney-Lee and colleagues (2015) conducted a retrospective, two stage panel design study, which compared the

changes over time in surgical mortality between hospitals that emerged as Magnet hospitals and those that remained non-Magnet during the two time periods. The results indicated that Magnet hospitals had 2.4 fewer deaths per 1000 patients in the first panel of the study and 6.1 fewer patient deaths per 1000 in the second panel of the study, than non-Magnet hospitals (Kutney-Lee et al., 2015).

Organizational variables. Eight studies (17%) focused on organizational outcomes, such as overall safety climate, morale, deficiency citations, and error reporting (Anzai et al., 2014; Flynn, Liang, Dickson, & Aiken, 2010; Friese et al., 2016; Hegney et al., 2015; Jafree et al., 2016; Kirwan et al., 2013; Smeds Alenius et al., 2014). Three studies found significant positive associations between the nursing practice environment and measures of organizational safety and error reporting (Friese et al., 2016; Jafree et al., 2016; Kirwan et al., 2013). In one study, a higher score on the Safety Organizing Scale (a measure of organizational safety), was associated with higher scores on the nursing foundation for quality of care (Beta coefficient 0.64, SE 0.10, $p < .001$), nurse participation in hospital affairs (Beta coefficient 0.18, SE 0.07, $p = .01$), and collegial nurse-physician relationships (Beta coefficient 0.26, SE 0.10, $p = .01$) subscales (Friese et al., 2016). Additionally, a lower subscale score on the nurse foundations of quality care was negatively associated with being a rural or remote hospital (Hegney et al., 2015).

Discussion and Recommendations

The following section describes recommendations for use of the PES-NWI. These recommendations are based on the findings described above, the developer instrument, Lake's original guidance, and the Warshawsky and Havens review conducted in 2010.

Design and methods. The increased use of longitudinal and quasi-experimental study designs would strengthen the evidence generated from studying the nursing practice environment. For example, longitudinal studies allow for the study of effects over time (Shadish, Cook, & Campbell, 2002) and the use of case-control studies, where units are matched based on multiple attributes, may reveal causal connections and yield more widely accepted findings than the common correlational evidence that currently exists (Lake, 2014; Shadish et al., 2002). To increase the rigor of the study of the nursing practice environment, researchers should strive for the use of these more robust study designs when practical.

The continued use of multi-level modeling is recommended because this accounts for the hierarchical, nested data configuration typically seen when studying the nursing practice environment (Warshawsky & Havens, 2011). The most common method to describe the reliability of the PES-NWI is still Cronbach's alpha; however, many authors report the Cronbach's alpha provided by Lake during the development of the instrument instead of that of their population. This is inappropriate as the reliability of an instrument varies with each population to which it is administered and under the conditions it is used (Polit & Beck, 2012). Therefore, we recommend that, at a minimum, authors report internal consistency statistics for the sample they are studying and consider additional techniques to fully evaluate instrument performance (Swiger, Raju, Breckenridge-Sproat, & Patrician, 2017). In addition, authors could consider conducting a confirmatory factor analysis to test the model fit of the PES-NWI with their sample and assess the relationship between the measured variables and the latent variables (subscales) of the

instrument (Tabachnick & Fidell, 2013). This is especially important when using this instrument in different populations than those for which it was originally intended.

Sampling. Differences between the rating of the nursing practice environment by managers and direct care nursing staff have been noted (Anzai et al., 2014); therefore, we recommend including only direct care staff nurses. The alternative to exclusion of nurse managers would be to assess the differences between managers and staff nurse groups, identify significant variation between groups, and then determine if these groups should be analyzed separately. At the hospital level, Aiken and colleagues (2011) require a minimum of 10 nurse respondents as inclusion criteria for the hospital. To our knowledge, this minimum number was not empirically derived and has not shown to achieve consensus or demonstrate reliability. Additionally, there is no recommendation for the minimum number of raw unit-level responses in the literature to our knowledge at this time. One study excluded units with fewer than 5 nurse responses per unit which seems reasonable (Kirwan et al., 2013); however, this inclusion criteria may have been selected as an attempt to protect the anonymity of respondents versus an attempt to reach an acceptable level of consensus. Both of these recommendations, using 10 responses at the hospital level and 5 at the unit level, should be empirically tested to determine if they are sufficient. In addition, other measures can be assessed to ensure the obtained survey results are representative of the nursing practice environment in a hospital or on a unit. A response rate of at least 40% has shown to yield appropriate measures of agreement such as an Intraclass Correlation Coefficient 2 (ICC [2]) greater than 0.60 (Kramer, Schmalenberg, Brewer, Verran, & Keller-Unger, 2009). An ICC (2) can be used to demonstrate how closely members of a group resemble each other. This information may

be used as a reliability statistic to measure how similarly individuals in a group rate a group characteristic, such as the practice environment, thus providing a measure of representativeness or group consensus (Aiken, Clarke, Sloane, Lake, & Cheney, 2008; Choi & Boyle, 2014; Verran, Gerber, & Milton, 1995). When measuring group level attributes, such as the nursing practice environment, an adequate measure of consensus may be as important to report as the response rate.

The PES-NWI was developed using RN only samples from the 1980s Magnet studies (Lake, 2002), yet 14 recent studies included other licensed and non-licensed personnel (e.g., LPNs, CNAs, and technicians). In the studies that included non-RN staff, the Cronbach's alpha of the subscales ranged from 0.53 to 0.90 for the subscales (Friese, 2012; Roche et al., 2011) and from 0.86 to 0.94 for the composite score (Choi & Boyle, 2014; Prezerakos et al., 2015). None of these studies reported reliability statistics grouped by nurse type or subgroup. Report of the complete sample reliability would help to demonstrate if the internal consistency of the instrument remains high when including non-RN staff and report of the reliability by subgroup (e.g., RN, LPN, or non-RN staff) would determine if there are any notable differences in the function of the instrument when used with non-RN staff. Further analysis of the differences in the scoring of nursing practice environment between these groups may be meaningful. In addition, researchers have not generally reported measures that would support concurrent validity, such as the association between the PES-NWI composite score and job satisfaction. One study used qualitative comments to determine favorable construct validity by comparing the qualitative themes to the quantitative PES-NWI scores (Friese & Manojlovich, 2012).

Additionally, although some modifications have been made for specific care settings, little has been done to update the PES-NWI for contemporary nursing practice, which has changed since the instrument was developed in the 1980s. Changes in methods of care delivery, nursing workload, teamwork focus, and technology have likely impacted practice and are unmeasured by the current instrument (Ebright, 2014; Myny et al., 2011; Suter et al., 2012; Swiger, Vance, & Patrician, 2016). Therefore, we recommend updating the instrument, beginning with qualitative work, to determine if the instrument remains relevant to nurses today.

Use across practice settings, modifications, and scoring. With minor modifications, the PES-NWI has been used in non-hospital settings such as clinics, ambulatory oncology care, and nursing homes. The instrument functions well across practice setting with reported Cronbach's alphas ranging from 0.74 to 0.94. One author modified the instrument by adding a medical assistant support subscale, citing the impact these professionals have on the provision of high-quality care in the ambulatory oncology setting, and reduced the number of items to improve model fit. The modified instrument demonstrated favorable content, criterion, and construct validity (CFI = 0.95 and RMSEA = 0.057), as well as strong internal consistency (Cronbach's alphas from 0.80 to 0.90) (Friese, 2012). Another study added a nursing information technology subscale to the instrument which consisted of five items ($\alpha = 0.86$) and was found to be significantly correlated with the work environment ($r = -0.097$, $p = < .01$) (Goh & Lopez, 2016); however, this subscale explained very little variance and the clinical importance of this measure is unknown.

Thoughtful and well-supported modifications of the instrument, beyond changes in terms specific to a population, country, or setting, are appropriate, providing the modified instrument is tested appropriately. One caution however, would be modification of the instrument's scoring method. Changing the scoring (e.g., increasing from a 4-point Likert scale to a 6-point Likert scale, using the sum of the items instead of the mean, reverse scoring, or adding *not applicable* categories) or sweeping changes to the instrument's structure would result in a loss of comparability between studies and may hinder meta-analyses. However, Warshawsky and Havens (2011) recommended shortening the scale. In seven studies, items were purposefully dropped based on national variations (e.g., a translated version in which items were dropped or the absence of the use of nursing diagnoses in Australia) (Cho et al., 2016; Roche et al., 2016; Roche et al., 2011; Walker et al., 2010); to match items with another instrument (NWI-R) (Roche & Duffield, 2010); or based on psychometric analyses (Friese, 2012; Friese et al., 2016). In one study, an item was inadvertently dropped (Havens et al., 2012).

Eight of the articles reviewed used variations in item response options (Boev, 2012; Friese & Manojlovich, 2012; Friese et al., 2016; Goh & Lopez, 2016; Jafree et al., 2016; Li et al., 2013; Parro Moreno et al., 2013; S. Wang et al., 2015). One changed the agree statements from *strongly agree, agree, disagree* and *strongly disagree* to *totally agree, agree, not agree*, and *totally not agree.* This same study used data from the RN4CAST project. This project employs a modified version of the PES-NWI in which the number of items in each subscale is different than the original instrument developed by Lake but maintains the five factor structure (Li et al., 2013). The instrument modifications can be traced back to the development and testing of the International

Hospital Outcomes Study (IOHS) questionnaire that was created in anticipation of the RN4CAST study. Researchers tested the factor structure of the original Nursing Work Index (NWI) using three factor solutions proposed by subsequent researchers: the Nursing Work Index–Revised (NWI-R) (Aiken & Patrician, 2000); the PES-NWI (Lake, 2002), and the practice environment index (PEI) (Estabrooks et al., 2002). Both the NWI-R and the PES-NWI factor structures were confirmed and the IOHS questionnaire was deemed a "robust and psychometrically sound instrument that will be used in the RN4CAST project" (Bruyneel, Van den Heede, Diya, Aiken, & Sermeus, 2009, p. 209). It is unclear whether the IOHS contains a version of the PES-NWI or the NWI-R. Articles using the RN4CAST dataset often refer to the PES-NWI and discuss the five subscales developed by Lake (2002) yet the subscales contain more individual items than Lake's instrument, adding to the confusion. For example, in one study, the Collegial Nurse Physician Relationship subscale was described as having seven items but Lake's PES-NWI contains only three items (Lake, 2002; Li et al., 2013). The recommendation is that authors need to clearly specify what instrument they are using and if a modified instrument is being used, they should support the modification with measures of reliability and validity obtained from the modified instrument in their sample.

Two of the studies reviewed used a summary or cumulative PES-NWI score, where the score for each individual item was added together to obtain a total score (Parro Moreno et al., 2013; Wang & Liu, 2015). Using the sum versus the average score for each subscale inadvertently weights the subscales that have more individual items (Lake, 2002). Employing the three category scoring method (which identifies favorable, mixed, and unfavorable environments) developed by Lake and Friese (2006) may not be

appropriate for small sample sizes. When the sample size is small, the number of observations in one or more category may be insufficient to support analysis. In addition, the variation in the PES-NWI scores may be reduced by creating a categorical variable. In addition, the variation in the PES-NWI scores may be reduced by creating a categorical variable. For these reasons, researchers may elect to use the three categorical classifications for descriptive purposes and the continuous scores for regression modeling (McHugh & Ma, 2014). As per the recommendation of Warshawsky and Havens (2011), more study of the individual subscales has been conducted and should continue. This is important to understanding the linkages between specific aspects of the nursing practice environment and specific outcomes. This may also help to move the science forward by teasing out the mechanisms by which the practice environment influences the outcome under study. One study used sample-derived medians and means to determine the cut off points for the scoring categories identified by Lake and Friese (2006) instead of the midpoint of the scale. The sample-derived median (instead of the midpoint of 2.5) drove the categorical placement into poor, mixed, or better nursing practice environments. Better practice environments had lower odds of administering wrong medications, pressure ulcers and falls (Cho et al., 2016). There are pros and cons to this scoring method; for homogeneous groups this method could improve variability for analysis, but could also reduce comparability with other practice environment studies. In addition, using the sample-derived median to assign the practice environment categories could mask associations because the categorical differences may be very small, thereby representing very little actual variability.

Reporting associations. When studying the nursing practice environment and its association with nurse, patient, and organizational outcomes, it is typical to compute many tests. This can lead to an increased likelihood of a Type 1 error, an error in which the finding is due to chance fluctuations and not a true association (Keselman, Cribbie, & Holland, 2002; Polit & Beck, 2012). To avoid misinterpreting these statistically significant, yet incorrect results, false discovery rates (FDR) can be calculated and reported. The FDR reduces the odds of reporting a result as statistically significant that is truly just a Type 1 Error (Jones, Ohlssen, & Spiegelhalter, 2008).

The frequency of calculation and report of effect sizes also needs to increase as just over half of the studies reviewed reported effect sizes. As more intervention and prospective studies are conducted in the future, evidence of PES-NWI effect sizes will help investigators determine an appropriate sample size and support identification of the most effective interventions aimed at improving the nursing practice environment. A recently conducted meta-analysis by Lake and colleagues (2016) of the associations between the nursing practice environment and outcomes identified all studies from 2007 to 2015, which reported odds ratios. The findings of this analysis further support the importance of the nursing practice environment with regard to nurse job outcomes, patient outcomes, patient satisfaction, adverse events, and nurse rated quality of care. Interestingly, the strongest associations were between the nursing practice environment and nurse reported measures of quality care (Lake, Sanders, Rui, & Yong, 2016). This finding could indicate common-source bias, which is a type of bias that results when one data source (i.e., nurse report) is used to collect information on both the independent and dependent variables under study (e.g., nurses may overestimate the effect of the nursing

practice environment on outcomes) (Griffiths et al., 2016). However, another explanation could be that since nurses have been shown to be good organizational informants (Aiken & Patrician, 2000), they provide more accurate estimates of care outcomes than some of our existing measures. Nurses may even be conservative reporters of adverse incidents. In one study, the hospital acquired infections reported by nurses appeared to be conservative estimates when compared to national estimates (Kelly, Kutney-Lee, Lake, & Aiken, 2013). Nurses have been shown to be good predictors of patient outcomes as well. For example, the Global Activities for Daily Living measure, derived from routine nursing assessment of functional status, better predicted patient mortality than three other mortality predictors which did not incorporate nursing data (Justice, Aiken, Smith, & Turner, 1996).

Limitations

Although this review includes 46 articles, the inclusion criteria was relatively narrow and only the search terms, *Practice Environment Scale of the Nursing Work Index* and *PES-NWI* were used to identify articles. Adding search terms such as *nursing practice environment* and *care environment* would have broadened the search, however using these terms resulted in almost 5,000 articles to review which was beyond the scope of this paper. The use of such specific search terms may lead to the omission of articles that describe associations between the nursing practice environment and patient, nurse, or organizational outcomes but do not have the name of the instrument in the abstract or key words (Carthon, Lasater, Sloane, & Kutney-Lee, 2015; Kelly et al., 2013; McHugh & Ma, 2014). In addition, no method was used to standardize results that did not use the 4-

point Likert scale and then compare these to the outcomes in the studies which did use the 4-point Likert scale.

Conclusion

The PES-NWI remains a commonly used and reliable instrument with which to measure the nursing practice environment. However, the instrument may still benefit from further psychometric testing, updating, and development. Researchers advocate for a move beyond the study of the association between the nursing practice environment and nurse, patient, and organizational outcomes. These researchers call for study of the mechanisms by which the nursing practice environment impacts these outcomes so that nursing leaders will have targets for which to aim when they are striving to improve the environment and outcomes alike (Bruyneel et al., 2009; Lake et al., 2016). More longitudinal and intervention research would reveal these mechanisms and may identify actions that can be taken to proactively improve the environment in which nurses practice. In addition, intervention studies would help determine if purposeful improvement in the nursing practice environment will yield the anticipated improvements in nurse, patient, and organizational outcomes.

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ADAPTATION OF THE PRACTICE ENVIRONMENT SCALE FOR MILITARY NURSES: A PSYCHOMETRIC ANALYSIS

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PAPER 2

ADAPTATION OF THE PRACTICE ENVIRONMENT SCALE FOR MILITARY NURSES: A PSYCHOMETRIC ANALYSIS

Abstract

Aim: The aim of this study was to confirm the psychometric properties of Practice Environment Scale of the Nursing Work Index in a military population. This study also demonstrates association rule analysis, a contemporary exploratory technique.

Background: One of the instruments most commonly used to evaluate the nursing practice environment is the Practice Environment Scale of the Nursing Work Index. Although the instrument has been widely used, the reliability, validity and individual item function are not commonly evaluated. Gaps exist with regard to confirmatory evaluation of the subscale factors, individual item analysis and evaluation in the outpatient setting and with non-registered nursing staff.

Design: This was a secondary data analysis of existing survey data.

Methods: Multiple psychometric methods were used for this analysis using survey data collected in 2014. First, descriptive analyses were conducted, including exploration using association rules. Next, internal consistency was tested and confirmatory factor analysis was performed to test the factor structure. The specified factor structure did not hold; therefore, exploratory factor analysis was performed. Finally, item analysis was executed using item response theory. The differential item functioning technique allowed the comparison of responses by care setting and nurse type.

Results: The results of this study indicate that responses differ between groups and that several individual items could be removed without altering the psychometric properties of the instrument.

Conclusion: The instrument functions moderately well in a military population; however, researchers may want to consider nurse type and care setting during analysis to identify any meaningful variation in responses.

Keywords: Association rules, item response theory, Practice Environment Scale of the Nursing Work Index, psychometric analysis, military nursing

Introduction

One of the instruments most commonly used to evaluate the nursing practice environment, defined as organizational characteristics that contribute to or detract from a nurse's ability to practice professional nursing, is the Practice Environment Scale of the Nursing Work Index (PES-NWI) (Cummings, Hayduk, & Estabrooks, 2006; Lake, 2002). Evaluation of the practice environment is important because it has been associated with patient outcomes such as patient mortality (Aiken, Clarke, Sloane, Lake, & Cheney, 2008). In addition, the practice environment has been identified as a potential mechanism for improving the overall patient safety culture in an environment (Institute of Medicine, 2003). The PES-NWI was developed based on the 1980s Magnet hospital studies (facilities known for providing high quality care and for recruiting and retaining nursing staff) and has been used by researchers in many countries such as Australia, Canada, Iceland and Taiwan (Lake, 2002; McClure & Hinshaw, 2002; Warshawsky & Havens, 2011). In addition, the PES-NWI was used to evaluate the practice environment in 12 European countries through the survey of almost 34,000 nurses (Aiken, Sloane, Bruyneel, Van den Heede, & Sermeus, 2013). Although the instrument has been widely used in diverse settings, the reliability, validity and individual item analysis of the instrument has not been comprehensively evaluated; in fact, the developer of the instrument calls for further evaluation, creation of a shorter version and testing of the instrument in different settings and with different populations (Lake, 2007). In particular, gaps exist in the confirmatory evaluation of the subscale factors with large data sets, individual item analysis, evaluation of the instrument's performance in the outpatient

setting and evaluation of use with non-registered nurse staff (Gajewski, Boyle, Miller, Oberhelman, & Dunton, 2010).

Background

The PES-NWI was constructed using the Nursing Work Index (NWI) survey, which was developed based on focus group interviews with nurses working in Magnet hospitals during the 1980s. The NWI consisted of 65 individual survey items aimed at evaluating, work values, perceived productivity, job satisfaction and nurses' perception of an environment which contributes to the provision of high quality care. For each item, registered nurses answered three questions which rated: 1) how important the item is for their job satisfaction; 2) how important the item is for providing high quality care; and 3) the degree that the item is present in their current job setting using a 4 point Likert scale (Kramer & Hafner, 1989). The NWI was revised by ~~Drs.~~ Aiken and Patrician (2000) and renamed the Nursing Work Index Revised (NWI-R). Most of the NWI-R revisions were based on high correlations between the 'important for job satisfaction,' and two other questions: 'present in current job' and 'important for quality of care' (correlations ranged from 0.89 to 0.95, $p < .001$ in 16 Magnet hospitals). Therefore, the NWI-R reduced the number of responses required for each item from three to one, 'present in current job.' In addition, four conceptually derived subscales were developed, which described distinct aspects of the work environment (autonomy, control, nurse-physician relationships and organizational support) (Aiken & Patrician, 2000).

In 2002, Lake developed the PES-NWI and its empirically derived subscales, which were quite similar to those that had been conceptually derived, using two different samples of NWI surveys from the late 1980s and early 2000s. The resulting five

subscales are: Nurse Participation in Hospital Affairs (NPHA); Nursing Foundations for Quality Care (NFQC); Nurse Manager Ability, Leadership and Support of Nurses (NMAL); Staffing and Resource Adequacy (SRA); and Collegial Nurse-Physician Relations (RNMD) (Lake, 2002). The first sample Lake (2002) used was obtained from registered nurses (RNs) in 16 Magnet hospitals (n = 2,336). Surveys were only collected from RNs and at the time, many of these hospitals were transitioning to all RN staffs (Kramer & Schmalenberg, 1988). An exploratory factor analysis was conducted on 48 items that were conceptually related to the nursing practice environment, with the goal of identifying latent factors. The individual items that did not contribute to the overall construct were removed and the final PES-NWI consisted of 31 items. The 31 individual items in the PES-NWI, the subscale names and groupings and accompanying acronyms that will be used throughout this article can be found in Appendix A.

Using the first sample of nurse surveys, individual reliability of the subscales was examined using Cronbach's Alpha, which was 0.80 or above for all subscales except Collegial Nurse-Physician Relations, which was 0.71. Subscale reliability coefficients of 0.70 or greater are adequate for group level comparisons and those above 0.80 are considered desirable (Polit & Beck, 2012). The correlations between the subscales were explored and the highest correlation (r = 0.65) was found between the subscale measuring Nurse Participation in Hospital Affairs (NPHA) and subscale measuring Nursing Foundations for Quality Care (NFQC). The high correlation between these two subscales could indicate that they measure similar aspects of the nursing practice environment. All other correlations were 0.60 or lower indicating adequate independence between the subscales. Construct validity was confirmed by comparing random samples of Magnet

and non-Magnet facilities to determine if the PES-NWI could distinguish between these two groups. As anticipated, the PES-NWI scores were found to be consistently higher in the Magnet facilities (Lake, 2002). Lastly, confirmatory factor analysis was conducted on a second sample of RNs (n = 11,636) from Pennsylvania hospitals to validate the tool. Only one individual item migrated to a different subscale, confirming the exploratory structure (Lake, 2002).

When assessing the psychometric properties of the PES-NWI, researchers have often relied on Cronbach's alpha alone (Yurumezoglu & Kocaman, 2015; Zuniga et al., 2015). However, Cronbach's alpha is only a measure of internal consistency reliability, or how much items measuring the same construct co-vary (Polit & Beck, 2012). The PES-NWI performs well for reliability analysis using Cronbach's alpha, however for testing factors using structural equation modeling (SEM) the results are not always as favorable as the nursing data collected does not fit the measurement model specified (Cummings et al., 2006). Other methods, such as principal components analysis (PCA), could be used to perform a more complete analysis of the instrument (Parker, Tuckett, Eley, & Hegney, 2010); however, the instrument is rarely evaluated in this way. More comprehensive psychometric evaluations could yield information with which to assess and improve the instrument. For example, in a study introducing the use of item response theory models (a method of psychometric analysis), the PES-NWI was used to demonstrate how such techniques can be used to evaluate a tool by focusing on individual item performance (Raju, Su, & Patrician, 2014).

The PES-NWI has been widely used in the inpatient area with many types of nurses, not just RNs on whom this tool was developed. Additionally, it has been used in

settings such as hospital-based hemodialysis clinics with only a standard report of the Cronbach's Alpha (Prezerakos, Galanis, & Moisoglou, 2015). Unfortunately, this type of analysis does not provide any information that researchers could use to improve the tool and therefore, opportunities to better future versions are lost. Occasionally, the PES-NWI has been evaluated with factor analyses but the authors of this paper are unaware of any studies that compare item performance based on care setting (inpatient vs outpatient) and licensure type (registered nurses [RN] versus licensed practical nurses [LPN]). One exploratory factor analysis, using a Veterans Health Administration personnel, suggested a four factor, 21 item model best fit the data. The four factors described were Manager Support/Advancement Opportunity, Collegial Nurse-Physician Relations, Staff and Resource Adequacy and Nurse Manager Leadership. The first two factors of Lakes (2002) PES-NWI make up most of the items falling into the Manager Support/Advancement Opportunity subscale. The Staffing and Resource Adequacy and Nurse Manager Leadership subscale contain a smaller number of the same items and the Collegial Nurse-Physician subscale contains more items, some of which were borrowed from the NWI-R and not the PES-NWI (Li et al., 2007). Despite the instrument being used globally, the factor structure of the instrument is not well confirmed (Bonneterre, Liaudy, Chantellier, Lang, & Gaudemaris, 2008).

Aim

Considering this instrument's varied testing and application, the purpose of this study was to confirm the psychometric properties of Practice Environment Scale of the Nursing Work Index in military population and compare responses based on care setting and nurse type.

Methodology

The psychometric methods used for this analysis constitute an adequate test of the overall reliability and validly of the PES-NWI and also explore individual item usefulness in measuring the overall construct of the practice environment in a military setting. The first steps in the psychometric analysis of PES-NWI consisted of descriptive analysis, using association rules (a data mining approach) and reliability analysis using an internal consistency measure. Association rule analysis originated in retail business to boost sales of products by identifying which items consumers would purchase together. As an example, consumers usually purchase crackers and peanut butter together; therefore, storing such products close together would ensure higher sales of each item (Agrawal, Imielinski, & Almaden, 1993). Similarly, these rules can be used in during instrument analysis with categorical data, for example with a survey using a Likert Scale such as the PES-NWI. The result is a rule based on the pairing of individual items and their corresponding categorical responses. These rules can be used to identify the item pairs that occur most frequently in the dataset, which can inform instrument modification when combined with other psychometric analyses. Association rule analysis will be further explained throughout this article. Wilcoxon ranked-sum testing was used to identify differences in group responses to the PES-NWI because of the dependent, non-parametric nature of these data (Polit & Beck, 2012). Next, a confirmatory factor analysis was performed to test the factor structure. Because the specified factor structure did not hold, an exploratory factor analysis was also performed. Finally, item analysis was performed using an item response theory technique, the Partial Credit Model (Polit & Yang, 2015; Reeve & Fayers, 2005). The differential item functioning technique allowed

the comparison of responses by care setting (inpatient and outpatient) as well as nurse type (RN and LPN). The goal of conducting such an analysis and comparing these groups, is to determine if there is a difference in the way the instrument functions in these groups and to identify ways to improve the psychometric properties of the instrument for use in the military setting (Raju et al., 2014).

We began this process by conducting an exploratory data analysis using descriptive statistics, outlier identification, reliability analysis and association rule testing. All analyses were performed using the R statistical software and conducted on survey data collected in 2014 (R Core Team, 2014). The R package '*mokken*' was used to generate Cronbach's alpha coefficient to measure the internal consistency of the instrument (van der ark, 2012). Alpha coefficients of 0.70 are acceptable (particularly for subscales) and those of 0.80 or higher are very desirable (Polit & Beck, 2012). Association rules, a data mining technique, seek patterns that occur in the data frequently. This data mining technique uses an algorithm to determine a set of 'rules' for situations (Agrawal et al., 1993). The association analysis was conducted using the R package '*arules*' (Hahsler, Buchta, Gruen, & Hornik, 2014) to provide three measures: support, confidence and lift. Support and confidence measure the strength of the association. Support refers to the percentage of times that the rule was true in the dataset and confidence refers to the probability that an individual chose the second item identified in the rule after selecting the first item. Lift measures the general association between the two items and depicts this by showing how many times confidence is greater than expected; therefore, a value greater than one is desired (Agrawal et al., 1993). Association rules are descriptive and dependent on the data in the sample.

An analysis of the instrument structure was tested using confirmatory and exploratory factor analyses. Confirmatory factor analysis (CFA) was conducted to test the five factor model fit of the PES-NWI results with the military sample (Lake, 2002). CFA identifies how well the individual items measure the latent factors that have been previously established through examination of goodness of fit and root mean square error of approximation; adequate fit indices demonstrate a good internal structure of the instrument (Azuero, Su, McNees, & Meneses, 2013). Goodness of fit was assessed using the common indices; comparative fit index (CFI) and root mean square error of approximation (RMSEA). CFI can range from 0-1 but a score of near 0.95 is considered a good fit and a value greater than 0.90 is considered an adequate fit. For Root Mean Square Error of Approximation (RMSEA) a score less than or equal to 0.06 is indicative of a good fit and 0.08 is indicative of a reasonable fit (Browne & Cudeck, 1993; Polit & Yang, 2015; Tabachnick & Fidell, 2013). The results of the five factor CFA, demonstrated a poor to moderate fit at best; therefore, an exploratory factor analysis (EFA) was conducted using varimax rotation. The EFA provided an opportunity to explore the underlying dimensionality of the items without presetting a specific model structure (Polit & Yang, 2015). This was undertaken to explore the latent constructs as they exist in this military sample (Reid, Courtney anderson, & Hurst, 2015).

Lastly, individual item analysis was conducted using Partial Credit Model, an item response theory technique. The item response theory unidimensionality assumption was tested using Mokken scale analysis, principal component analysis and Kendall's rank-order correlation coefficient. When testing unidimensionality for item response theory, we were looking at whether or not each item contributes to the measurement of

the overall construct. Mokken Scale Analysis, conducted using the R package '*mokken,*' is a non-parametric test that determines the dimensionality of a scale and provides information regarding reliability in addition to the information provided from Cronbach's alpha. The result of this test is a homogeneity coefficient which indicates the strength of correlation between the items on a scale; H = 0 would indicate no relationship among the test items, whereas H = 1 would indicate a perfect relationship (Stochl, Jones, & Croudace, 2012). A weak scale is indicated by a score between 0.3-0.4; a scale of medium strength scores between 0.4-0.5; and a strong scale is greater than or equal to 0.5. If the score is less than 0.3, it is considered unscalable (Mokken, 1971; van der ark, 2012). In addition to Mokken Scale Analysis, principal component analysis was also conducted to test unidimensionality using the base R package (R Core Team, 2014). This analysis compresses a scale into smaller sets of linear combinations, known as factors, in order to identify the underlying dimensions of the construct being measured. The result is a measure of each factor's independent variation, or contribution, to the overall measurement of the construct (Polit & Beck, 2012).

After establishing unidimensionality, the use of item response theory (IRT), in this case the Partial Credit Model (PCM) was used to understand individual item characteristics, how they contribute to the measurement of latent constructs and further assess the function of the instrument (Polit & Yang, 2015; Reeve & Fayers, 2005). IRT takes chance associations into consideration and provides information about item-level performance. These statistics assist in diagnosing 'misfit' items that do not contribute to the measurement of the overall construct. The infit and outfit statistics provide information about the degree to which that item meet the expectations of the model; the

higher score, the poorer the fit. Previous testing has shown that PCM performed well with the PES-NWI and it was chosen for this analysis because if its ease of interpretation. Along with the infit and outfit statistics, the IRT model can be used to identify differences the performance of items between groups (Raju et al., 2014). In this analysis, the Differential Item Functioning (DIF) statistic was used to compare responses between groups: care setting (inpatient versus outpatient) and nurse type (RN versus LPN). In addition to the discussion of the results, suggestions have been made to begin instrument improvement in the military setting. These analyses were conducted using the R packages '*eRm*', '*difR*' and '*lordif*' (Choi, Gibbons, & Crane, 2011; Magis, et al., 2010; Mair & Hatzinger, 2007).

Sample

The data used for this analysis came from 16,677 PES-NWI responses contained in an international sample from 42 different USA Military treatment facilities. Of those facilities, 32 (76%) were located in the USA and 10 (24%) were located in various other countries such as Germany, Italy and Korea. The PES-NWI survey, written in English, was conducted once a year for four years. For this study, we used staff nurses' responses to a survey completed in 2014 (n = 3286) following exempt approval by the University of Alabama at Birmingham Institutional Review Board. We excluded cases that did not respond to all 31 items on the PES-NWI and where the respondents did not identify their work setting as inpatient or outpatient. Those who reported working in non-patient care areas, such as hospital training departments, were also excluded (final n = 2608). Table 1 shows the summary statistics (means and standard deviations) for the individual items of the PES-NWI and the subscales. Inpatient responses (n = 1312) made up 51% of the

dataset and outpatient responses (n = 1296) accounted for the remaining 49%. The highest percentage of respondents were RNs (66%), followed by LPNs (23%), nursing assistants/medics/technicians (10%), medical support assistants/clerks (< 1%) and Corpsmen (< 1%). Medics and corpsmen are unlicensed members of the medical care team who provide care in both inpatient and outpatient care settings. As seen in Table 1, the Wilcoxon rank-sum test indicated there was a significant difference ($p < 0.05$) in PES-NWI subscale 1 (Nurse Participation in Hospital Affairs), subscale 2 (Nursing Foundations of Quality Care) and subscale 5 (Collegial Nurse-Physician Relations) between the inpatient and outpatient areas. In addition, 14 of the 31 individual items also showed a significant ($p < 0.05$) difference between the inpatient and outpatient areas. The composite PES-NWI score showed no significant difference between the inpatient and outpatient area. For the nurse type groups (RN or LPN) the Wilcoxon rank-sum test indicated there was a significant difference ($p < 0.05$) in PES-NWI subscale 1 (Nurse Participation in Hospital Affairs) and subscale 2 (Nursing Foundations of Quality Care). Seventeen of the 31 individual items also showed a significant ($p < 0.05$) difference between the RN and LPN responses. Again, the composite PES-NWI score showed no significant difference between these two groups. False discovery rates were calculated, giving similar results and effect sizes were small to moderate. The subscales indicated that a favorable work environment persists in the military whether grouped by care setting or nurse type. The lowest subscale score (2.61) was on subscale 1 (Nurse Participation in Hospital Affairs), in the LPN subgroup.

Table 1

Summary Statistics of the Practice Environment Score by Care Setting and Position

	Cronbach's Alpha	Complete PES (n = 2608)		Inpatient (n = 1312)		Outpatient (n = 1296)		Wilcoxon Rank Sum	RN (n = 1722)		LVN (n = 594)		Wilcoxon Rank Sum
		Mean	SD	Mean	SD	Mean	SD	*p*	Mean	SD	Mean	SD	*p*
Career Development or clinical ladder		2.37	0.98	2.40	0.97	2.34	1.00	0.10	2.38	0.98	2.22	0.94	< 0.05 *
Policy-making involvement by staff		2.60	0.95	2.61	0.94	2.59	0.96	0.66	2.62	0.94	2.42	0.97	< 0.05 *
A highly visible/accessible chief nurse		2.83	1.00	2.84	0.99	2.81	1.01	0.57	2.80	1.01	2.83	0.98	0.52
A chief nurse with equal power		3.01	0.88	3.08	0.84	2.93	0.90	< 0.05 *	3.04	0.86	2.90	0.91	< 0.05 *
Opportunities for advancement		2.30	0.98	2.34	0.96	2.26	0.99	< 0.05 *	2.34	0.96	2.06	0.94	< 0.05 *
A responsive administration that listens		2.62	0.99	2.61	0.98	2.64	1.00	0.40	2.59	0.99	2.61	0.96	0.84
Staff nurses involved in governance		2.78	0.92	2.85	0.90	2.71	0.93	< 0.05 *	2.83	0.89	2.58	0.98	< 0.05 *
Opportunity to serve on committees		3.19	0.79	3.26	0.74	3.11	0.84	< 0.05 *	3.24	0.76	3.05	0.86	< 0.05 *
Administration that consults staff		2.76	0.94	2.75	9.60	2.77	0.93	0.69	2.71	0.96	2.78	0.91	0.14
Subscale 1 - Nurse Participation in Hospital Affairs (NPHA)	**0.90**	**2.72**	**0.71**	**2.75**	**0.69**	**2.69**	**0.72**	**< 0.05 ***	**2.73**	**0.70**	**2.61**	**0.70**	**< 0.05 ***
Continuing education for nurses		2.74	0.95	2.75	0.94	2.74	0.95	0.82	2.68	0.94	2.83	0.96	< 0.05 *
High standards are expected		3.44	0.79	3.41	0.76	3.46	0.73	0.07	3.41	0.76	3.51	0.71	< 0.05 *
Clear nursing philosophy		3.03	0.83	3.03	0.84	3.02	0.82	0.53	2.98	0.84	3.10	0.79	< 0.05 *
Clinically competent nurses		3.27	0.78	3.27	0.75	3.26	0.80	0.59	3.26	0.76	3.29	0.78	0.31
Performance improvement program		2.88	0.87	2.91	0.86	2.86	0.89	0.24	2.89	0.86	2.82	0.90	0.1
A preceptor program		2.95	0.96	3.13	0.91	2.76	0.98	< 0.05 *	3.00	0.97	2.78	0.96	< 0.05 *
Nursing care based on a nursing model		2.91	0.85	3.00	0.83	2.81	0.86	< 0.05 *	2.97	0.83	2.68	0.87	< 0.05 *
Nursing care plans for all patients		2.99	0.88	3.13	0.81	2.85	0.92	< 0.05 *	3.00	0.87	2.89	0.91	< 0.05 *
Patient assignments foster continuity		3.04	0.86	3.18	0.78	2.89	0.91	< 0.05 *	3.10	0.82	2.86	0.94	< 0.05 *
Use of nursing diagnosis		2.92	0.87	3.05	0.80	2.79	0.92	< 0.05 *	2.94	0.87	2.87	0.86	0.06
Subscale 2 Nursing Foundations for Quality Care (NFQC)	**0.87**	**3.02**	**0.59**	**3.09**	**0.56**	**2.95**	**0.60**	**< 0.05 ***	**3.02**	**0.58**	**2.96**	**0.58**	**< 0.05 ***
Supportive supervisory staff		2.93	0.97	2.88	0.99	2.99	0.94	< 0.05 *	2.90	0.98	2.93	0.94	0.63
Mistakes used as learning opportunities		2.88	0.95	2.86	0.96	2.89	0.95	0.41	2.87	0.96	2.88	0.94	0.96
A good nurse manager and leader		2.98	1.03	2.96	1.04	2.99	1.02	0.47	2.96	1.04	2.93	0.99	0.34
Praise and recognition for good work		2.61	1.01	2.59	1.00	2.63	1.02	0.20	2.61	1.01	2.59	1.03	0.65
Nurse manager who backs nursing staff		2.99	1.00	2.99	1.00	2.98	1.01	0.78	3.02	1.00	2.86	1.03	< 0.05 *
Subscale 3 Nurse Manager Ability, Leadership, and Support of Nurses (NMAL)	**0.90**	**2.88**	**0.84**	**2.86**	**0.85**	**2.90**	**0.82**	**0.30**	**2.87**	**0.85**	**2.84**	**0.81**	**0.19**
Adequate support services		2.92	0.90	2.92	0.90	2.92	0.90	0.93	2.88	0.91	2.93	0.87	0.36
Enough time to discuss patient care		3.05	0.82	3.13	0.79	2.96	0.84	< 0.05 *	3.08	0.81	2.94	0.85	< 0.05 *
Enough RNs to provide quality care		2.70	1.03	2.70	1.02	2.69	1.04	0.91	2.64	1.03	2.82	1.02	< 0.05 *
Enough staff to get the work done		2.52	1.01	2.55	1.00	2.49	1.02	0.22	2.52	1.00	2.45	2.45	0.14
Subscale 4 Staffing and Resource Adequacy (SRA)	**0.81**	**2.80**	**0.76**	**2.83**	**0.75**	**2.77**	**0.76**	**0.07**	**2.78**	**0.77**	**2.78**	**0.73**	**0.87**
A lot of teamwork (nurse and physicians)		3.17	0.79	3.13	0.77	3.22	0.80	< 0.05 *	3.16	0.77	3.22	0.78	< 0.05 *
Collaboration (nurses and physicians)		3.09	0.78	3.06	0.75	3.13	0.80	< 0.05 *	3.07	0.77	3.12	0.77	0.19
Nurses-physicians work well together		3.31	0.73	3.26	0.72	3.36	0.73	< 0.05 *	3.30	0.71	3.36	0.71	< 0.05 *
Subscale 5 Collegial Nurse-Physician Relations (RNMD)	**0.86**	**3.19**	**0.68**	**3.15**	**0.66**	**3.24**	**0.69**	**< 0.05 ***	**3.18**	**0.67**	**3.24**	**0.66**	**0.08**
Composite	**0.96**	**2.92**	**0.59**	**2.93**	**0.57**	**2.91**	**0.60**	**0.39**	**2.92**	**0.58**	**2.89**	**0.58**	**0.24**

Note. The titles of the individual items have been shortened; please see Appendix A for the entire wording of the individual item. Items with p value of < 0.05 are indicated by an asterisk. Inpatient and outpatient groups include responses from RNs, LPNs, nursing assistants/medics/technicians, medical support assistants/clerks, and Corpsman who report working in direct care settings.

Instrument

The PES-NWI is a self-report instrument that instructs nurses to indicate how much they agree that each of the 31 items is present in their current work environment on a four point Likert scale. The responses are coded as: strongly disagree = 1; somewhat disagree = 2; somewhat agree = 3; or strongly agree = 4. The subscales scores are derived by calculating a mean of the items in the subscale, rather than the sum. Using the mean prevents the weighting of subscales that contained more items than others. These subscale means are then averaged to create a composite score which is aggregated to the unit or hospital level. Originally the midpoint of the instrument scale, 2.5, was the only scoring reference; above the midpoint was considered a favorable environment and below the midpoint was unfavorable (Lake, 2002). Later, interpretation of the PES-NWI scoring was enhanced by creating criteria to discern favorable (> 2.5 on four out of 5 subscales), mixed (> 2.5 on two or three out of 5 subscales) and unfavorable (> 2.5 on one or none of the 5 subscales) practice environments (Lake & Friese, 2006).

Ethical Considerations

The responses to this survey were gathered anonymously. The survey data was de-identified by the Army Nurse Corps Chief's Office before providing the survey results to the investigators. The results of all analyses conducted are presented as aggregated groups such as with nurse type or care setting. The results cannot be linked to any particular treatment facility, specific unit, or individual nurse. No information linking the respondent to the survey responses is contained in the dataset therefore the risk associated conducting this secondary data analysis is low.

Results

Internal consistency reliability was tested using Cronbach's alpha which is reported by subscale in Table 1. The subscale reliability coefficients are ranged from 0.81-0.90 and the overall reliability coefficient is 0.96, indicating excellent instrument internal consistency. Kendall's rank order, a non-parametric correlation technique resulted (not shown but available in an online supplement) in correlation coefficients ranging between 0.27 (physicians and nurses have good working relationships and active staff development or continuing education program for nurses) and 0.62 (enough staff to get the work done and enough registered nurses on staff to provide quality care) indicating that the individual items measure different aspects of the practice environment. The correlation between subscales was highest ($r = 0.62$) between subscale 1(Nurse Participation in Hospital Affairs) and subscale 2 (Nursing Foundations for Quality Care), which is consistent with Lake's (2002) findings during instrument development. A correlation around 0.60 between subscales indicates sufficient independence (Lake, 2002). Kendall's rank order was selected because of the ordinal nature of these data (Polit & Beck, 2012).

Table 2 shows the top seven association rules generated with a support score of at least 30% confidence. This means that the rule must be present in at least 30% of the responses (which is about 800 surveys) to be included in Table 2. The first rule statistic, support, indicates the percentage of occurrence of the rule in the entire sample. In the first rule shown in Table 2, the antecedent is the response to the statement 'A lot of team work between nurses and physicians' occurs in the work environment and the consequent is 'Physicians and nurses have good working relationships.' Support indicates that the

nurses who strongly agreed that ‘A lot of team work between nurses and physicians’ also strongly agreed that ‘Physicians and nurses have good working relationships’ 31% of the time. Confidence indicates that 84% of respondents who strongly agree that teamwork is present in their work place also strongly agree that nurses and physicians have good working relationships. Finally, nurses who strongly agreed that there was ‘A lot of team work between nurses and physicians’ were 1.89 times more likely to also strongly agree that ‘Physicians and nurses have good working relationships’ as indicated by the ‘lift’. Similarly, the rest of the seven rules below can be interpreted using the support, confidence and lift statistics.

Table 2

Association Rule Analysis Results

	First Item		Second Item	Support	Confidence	Lift
1	A lot of teamwork = *Strongly Agree*	=>	Good working relationships = *Strongly Agree*	0.31	0.84	1.89
2	Good working relationships = *Strongly Agree*	=>	A lot of teamwork = *Strongly Agree*	0.31	0.71	1.89
3	Competent nurses = *Strongly Agree*	=>	High standards = *Strongly Agree*	0.34	0.78	1.38
4	Good working relationships = *Strongly Agree*	=>	High standards = *Strongly Agree*	0.32	0.73	1.30
5	Good working relationships = *Agree*	=>	A lot of teamworkr = *Agree*	0.33	0.72	1.53
6	Good working relationships = *Agree*	=>	Nurse/physician collaboration = *Agree*	0.33	0.72	1.38
7	A lot of teamwork = *Agree*	=>	Nurse/physician collaboration = *Agree*	0.36	0.78	1.49

Note. The titles of the individual items have been shortened; please see Appendix A for the entire wording of the individual item.

Factor Structure

Confirmatory Factor Analysis. The dataset was split by random sampling; two different samples of 1,304 responses were used for the conducting the following factor analyses. Creating two random samples from the original dataset was important because this allowed for the factor analyses to be run on independent samples. The first random subsample of PES-NWI data indicates a CFI of 0.87, a Tucker-Lewis Index of 0.86 and a RMSEA of 0.07 all indicating a moderate to poor fit (Browne & Cudeck, 1993; Polit & Yang, 2015; Tabachnick & Fidell, 2013). Three more random subsamples were drawn from the original dataset to verify the findings of the confirmatory factor analysis. All

three random samples were similar with CFIs of 0.87, TLIs from 0.86 to 0.87 and RMSEAs of 0.07. These findings prompted the team to conduct an exploratory factor analysis to determine how many factors were sufficient in the other random sample.

Exploratory Factor Analysis. The results of the exploratory factor analysis (EFA) indicated 57% of the variance could be explained by a five factor model, which is consistent with Lake's development of the PES-NWI where 20-40% of the variance was accounted for by each subscale and five factors were sufficient (Lake, 2002). However, this is only slightly better than the four factor model which accounts for 54% of the variance, shown in Table 3. In this sample, four factors were sufficient as only 3% more of the variance was explained by the fifth factor.

The factor loadings in Table 3 show how the individual items load into a four factor model. The individual items from the PES-NWI's first original subscale, Nurse Participation in Hospital Affairs, load into two of the four factors revealed by the new EFA. The items from the original subscale two, Nursing Foundations for Quality Care, load together and with six of the nine items from subscale one, Nurse Participation in Hospital Affairs. Items from the original subscale three, Nurse Manager Ability, Leadership and Support of Nurses, load together and also with three of the items from subscale one, Nurse Participation in Hospital Affairs. Three of the four items from the original subscale four, Staffing and Resource Adequacy, load together and one item migrates to the first factor. Lastly, the three original items from subscale Five, Collegial Nurse-Physician Relationships, continue to load together.

Table 3

Factor Loadings in a Four Factor Model

PES-NWI Item	Subscale	Factor1	Factor2	Factor3	Factor4
A responsive administration that listens	1		0.61		
Staff nurses involved in governance	1	0.62			
Opportunity to serve on committees	1	0.54			
Career development or clinical ladder	1	0.53			
Opportunities for advancement	1	0.57			
Policy-making involvement by staff	1	0.58			
A highly visible chief nurse	1		0.44		
A chief nurse with equal power	1	0.48			
Administration that consults with staff	1		0.52		
Clear nursing philosophy	2	0.52			
Nursing care based on a nursing model	2	0.63			
Nursing care plans for all patients	2	0.63			
Patient assignments that foster continuity	2	0.52			
Use of nursing diagnosis	2	0.57			
Continuing education for nurses	2	0.46			
High standards are expected	2	0.42			
Clinically competent nurses	2	0.32			
Active performance improvement program	2	0.55			
A preceptor program	2	0.49			
Supportive supervisory staff	3		0.78		
Mistakes are used as learning opportunities	3		0.67		
A good nurse manager and leader	3		0.78		
Praise and recognition for good work	3		0.54		
Nurse manager who backs up nursing staff	3		0.74		
Enough RNs on staff to provide good care	4				0.74
Enough staff to get the work done	4				0.80
Adequate support services	4				0.50
Enough time do discuss patient care with others	4	0.46			
A lot of teamwork (nurses and physicians)	5			0.81	
Collaboration between nurses and physicians	5			0.69	
Nurses and physicians work well together	5			0.75	

Note. The titles of the individual items have been shortened; please see Appendix A for the entire wording of the individual item. Subscale 1 = Nurse Participation in Hospital Affairs; Subscale 2 = Nursing Foundations for Quality Care; Subscale 3 = Nurse Manager Ability, Leadership, and Support of Nurses; Subscale 4 = Staffing and Resource Adequacy (SRA); and Subscale 5 = Collegial Nurse-Physician Relations.

Individual Item Analysis using IRT

Mokken. The homogeneity coefficients resulting from this set of PES-NWI data range from 0.46-0.84; of the 31 individual items, 5 (16%) are medium strength items and 26 (84%) are strong items. Overall, Mokken scale analysis showed that all items contributed to the unidimensionality of the final construct; the nursing practice environment. These scores are depicted in Table 4 along with the item fit statistics discussed below.

Table 4

Results of the Individual Item Analyses

	Mokken H	Chi Squared	p-value	Outfit	Infit	DIF 1 In & Out Patient (n = 2,608)	DIF 2 RN & LVN (n = 2,316)
Career Development or clinical ladder	0.84	2308.67	1.00	-3.60	-3.67	FALSE	TRUE
Policy-making involvement by staff	0.67	2258.24	1.00	-4.33	-5.95	FALSE	TRUE
A highly visible/accessible chief nurse	0.57	2582.68	0.34	0.35	-0.06	FALSE	FALSE
A chief nurse with equal power	0.54	2504.85	0.75	-0.61	-0.45	TRUE	TRUE
Opportunities for advancement	0.84	2361.60	1.00	-2.80	-3.40	FALSE	TRUE
A responsive administration that listens	0.64	1868.33	1.00	-10.40	-12.14	TRUE	FALSE
Staff nurses involved in governance	0.59	2233.21	1.00	-4.50	-4.39	TRUE	TRUE
Opportunity to serve on committees	0.58	2449.92	0.93	-1.19	-0.54	TRUE	TRUE
Administration that consults staff	0.62	2054.64	1.00	-7.22	-7.43	TRUE	TRUE
Supportive supervisory staff	0.63	1912.90	1.00	-8.37	-9.39	TRUE	FALSE
Mistakes are used as learning opportunities	0.62	2186.24	1.00	-4.87	-5.22	TRUE	FALSE
A good nurse manager and leader	0.60	2370.29	1.00	-1.99	-2.41	TRUE	FALSE
Praise and recognition for good work	0.63	2157.06	1.00	-5.66	-7.22	TRUE	FALSE
Nurse manager who back up nursing staff	0.60	2281.32	1.00	-3.06	-3.22	FALSE	TRUE
A lot of teamwork (nurse and physicians)	0.52	2648.99	0.09	1.09	1.77	TRUE	TRUE
Collaboration (nurses and physicians)	0.55	2262.60	1.00	-3.69	-3.16	TRUE	TRUE
Nurses-physicians work well together	**0.51**	**3237.11**	**0.00**	**6.74**	**4.12**	TRUE	TRUE
Continuing education for nurses	0.58	2388.31	0.99	-2.30	-2.59	FALSE	TRUE
High standards are expected	0.54	2297.92	1.00	-2.20	-0.21	TRUE	TRUE
Clear nursing philosophy	0.61	1787.42	1.00	-10.57	-10.11	TRUE	TRUE
Clinically competent nurses	**0.51**	**2821.37**	**0.00**	**2.75**	**3.23**	FALSE	FALSE
Active performance improvement program	0.61	1946.67	1.00	-8.75	-8.53	FALSE	TRUE
A preceptor program	**0.47**	**3819.07**	**0.00**	**13.05**	**9.45**	TRUE	TRUE
Nursing care based on a nursing model	0.56	2381.61	0.99	-2.30	-2.83	TRUE	TRUE
Nursing care plans for all patients	**0.50**	**2779.57**	**0.00**	**2.70**	**3.85**	TRUE	TRUE
Patient assignments foster continuity	**0.49**	**2976.98**	**0.00**	**4.85**	**4.66**	TRUE	TRUE
Use of nursing diagnosis	**0.47**	**3076.55**	**0.00**	**6.26**	**6.46**	TRUE	TRUE
Adequate support services	**0.53**	**2749.37**	**0.00**	**2.44**	**1.63**	FALSE	FALSE
Enough time to discuss patient care	0.57	2222.54	1.00	-4.30	-4.34	TRUE	TRUE
Enough RNs to provide quality care	**0.46**	**4040.77**	**0.00**	**16.20**	**13.64**	FALSE	TRUE
Enough staff to get the work done	**0.48**	**3521.43**	**0.00**	**11.94**	**9.49**	FALSE	TRUE

Note. Bold type indicates a significant difference other than what is specified by the partial credit model. DIF = Difference Item Functioning. The titles of the individual items have been shortened; please see Appendix A for the entire wording of the individual item.

Principal Component Analysis (PCA). The results of the principal component analysis indicate that unidimensionality holds true because a high level of variance (44.7%) was explained by the first component compared with the second component (5.0%). The first 4 components explain 59% of the variance. The Mokken scale

analysis, principal component analysis and Kendall's tau confirmed unidimensionality assumption for fitting the partial credit model. Although the subscales of the PES-NWI measure several different aspects of the nursing practice environment, each subscale contributes to the overall measurement of this construct (Lake, 2002), so it is not surprising that unidimensionality holds true.

Item Response Theory – Partial Credit Model. After establishing unidimensionality, a partial credit model (PCM) was fitted to the data. The fit of the PCM for individual items is depicted in Table 4 by using chi-square statistics. Items which result in a significant chi-square statistic ($p < .001$) are considered significantly different than those specified by the PCM (Raju et al., 2014). Items with high 'misfit' score are those that do not contribute to the overall measurement of the construct in this sample. These items are boldfaced in Table 4 and, in descending order of 'misfit', are: enough registered nurses on staff to provide quality care; a preceptor program for newly hired RNs; enough staff to get the work done; physicians and nurses have good working relationships; use of nursing diagnosis; patient care assignments that foster continuity of care; working with nurses who are clinically competent; written up to date nursing plans for all patients; and adequate support services to allow me to spend time with my patients. Table 4 also contains the differential item functioning (DIF) for each item which examines the differences in the items performance across groups. In this case, DIF 1 is depicting the care setting (inpatient versus outpatient) and DIF 2 is depicting the nurse type (RN versus LPN). When the DIF entry is 'TRUE' there is a difference in the item performance between the specified groups. In these subgroups, 20 out of 31 show differences in care setting and 23 out of 31 show differences by nurse type.

Discussion

The PES-NWI functions moderately well in a military setting, however the responses to individual items and subscales differ based on care setting and nurse type ($p < 0.05$) and some individual items could be removed without altering the psychometric properties of the instrument. When the sample is divided by care setting, inpatient staff rate ten of the individual items significantly higher than outpatient staff and three of the items lower. In addition, three of the five subscales are also rated differently. When the sample is divided by nurse type, more differences emerge. RNs rate thirteen items significantly higher than LPNs and six items lower; two of the five subscales are significantly different. However, once the subscales are aggregated into the composite score, there are no significant differences between these groups.

There are several ways to interpret these findings. One is that the care settings with in military facilities could have two distinctly different practice environments. This would infer the need to evaluate PES-NWI responses by care setting when surveying a facility that has both inpatient and outpatient services. Similarly, analysis should be broken down by nurse type to identify different perceptions of the care environment by these groups. It may be that by aggregating all groups together, the variability in the way the groups rate the practice environment is lost, particularly when the research concerns the subscales and not the composite score. The aggregation of the composite score could obscure factors in the practice environment that are in need of improvement for a particular group. For example, perhaps RNs have an opportunity to participate in hospital affairs but LPNs do not. If these differences were identified, leaders may choose to address them in an effort to reduce the variance.

The other option for interpretation is that the questions on the PES-NWI may have different meaning or applicability in particular areas. For example, *nursing care is based on a nursing rather than medical model,* may be easier to implement and more applicable, in the inpatient versus the outpatient care setting. These differences could also come from systematic differences in the personality or expectations of the nurses that work in these two care areas. The differential item functioning (DIF) results support these finding as well in that several of the individual items are significantly different from what is expected when care setting and nurse type are considered. These findings also indicate that a PES-NWI designed for specific settings and nurse types could be helpful for accurate and specific measurement the practice environment in military samples.

With regard to the structure of the instrument, the CFA indicates that the five factor model is not a good fit with this sample. EFA demonstrates that four versus five factors may be sufficient. Factors one and two are highly correlated and partially join into one latent factor. During the development of the PES-NWI, these two subscales were also found to be highly correlated ($r = 0.65$). This correlation was higher than the .60 criterion which would indicate sufficient independence among the subscales (Lake, 2002). Based on the items that load together on the first factor and those that load in the second factor (Table 3) it appears that the latent variables emerging are conceptually different than the original five subscales of the PES-NWI. Li (2007) also found a high correlation ($r = 0.93$) between subscales one, two and three and found a four factor model to be sufficient after conducting an exploratory factor analysis on a sample of nurse surveys from the Veterans Health Administration ($n = 11,378$). She identified new subscales as ‘Collegial Nurse–Physician Relations’, ‘Nurse Manager Leadership’, ‘Staff

and Resource Adequacy' and named a new factor 'Support/Advancement Opportunity' (Li et al., 2007). In the current military sample, the first factor present appears to be 'Structural Support of Quality Nursing Care' and as such, individual items related to policy, shared governance, service on committees, time to discuss patient problems with other nurses, continuity of nurse assignments and the presence of nursing philosophy in the facility make up this latent variable. The second factor appears to be 'Leadership Support of Nursing Staff' both at the unit and facility level and contains items such as: an administration that listens; supervisors that are supportive; a chief nurse that is accessible; and a head nurse that is a good manager and leader.

The last two factors describe 'Staff and Resource Adequacy' and 'Collegial Nurse-Physician Relationships' just as the factors specified in the PES-NWI. Although these last two subscales perform well on the factor analysis, conceptually they could be enhanced. In military hospitals, nurses and physicians have traditionally had good working relationships (Raju et al., 2014). The three items that make up the Collegial Nurse-Physician Relationship subscale are highly correlated ($r = 0.66$, .064 and 0.57) and also occur together frequently in the dataset based on the association rule analysis. In this study, the information obtained from the association rule analysis provides insight into items that occur together in particular patterns and may also assisted in identifying items that should be removed. For example, three of the association rules identified, demonstrate that 'there is a lot of teamwork present' and 'physicians and nurses have good working relationships' were paired together and given the same score on the Likert scale by respondents, 95% of the time in this dataset. Removing the item contained in the rule that contributes least to the measurement of the overall construct based on the infit

(4.12) and outfit (6.74) statistics, ‘physicians and nurses have good working relationships’ and replacing it with a question regarding teamwork among nursing staff and/or adding a question regarding collegial relationships between departments could enhance this subscale. Here, the removal of the item is based on the association rule and the fit statistics instead of expert opinion alone. Replacement items would be identified during further instrument development. Potential new items could be based on existing research (regarding teamwork and interdisciplinary collaboration for example), expert opinion, or staff nurse focus groups which may identify be important aspects of the practice environment that are unmeasured by the current instrument (Suter et al., 2012).

The subscale, Staffing and Resource Adequacy, also has two items that are highly correlated, ‘enough staff to get the work done’ and ‘enough registered nurses on staff to provide quality care’ ($r = 0.62$) as well as ‘enough time and opportunity do discuss patient care problems with other nurses and adequate support services to allow me to spend time with my patients’ ($r = 51$). Technology has had an impact on nursing work and workflow since the 1980s and some studies report an increase in overall workload and the complexity of work associated with advances in technology (Ebright, 2014; Myny et al., 2011). An item regarding technology, such as ‘the technology present facilitates the delivery of care to my patients’ could replace one of the redundant items in subscale 4, Staffing and Resource Adequacy. A technology subscale could also be added based on a previously developed subscale used to assess the impact of technology on the practice environment in Veterans Administration Hospitals (Moorer, Meterko, Alt-White, & Sullivan, 2010). In addition to these suggestions, there may be other important aspects of the work environment in military settings which are currently unmeasured using the

PES-NWI. For example, the impact of military operations, such as mandated training or preparation for deployment, may remove nurses from the care setting and have an impact on their ability to provide quality care. The frequent movement of staff could also be an important latent construct to be measured when studying the military nursing practice environment. Future research is needed to identify the contemporary factors that nurses identify as having the greatest impact on their work environment in the military setting. This would require a both qualitative inquiry and further instrument development to fully update the PES-NWI to reflect contemporary military nursing. As indicated by this study, development of PES-NWI for specific groups and/or tailoring the instrument to specific populations may also be warranted.

The removal of a few individual items is further supported when viewing the remaining item fit statistics in Table 4. The individual items with the highest 'misfit' score were: enough registered nurses on staff to provide quality care; a preceptor program for newly hired RNs; and enough staff to get the work done. These items and three more: physicians and nurses have good working relationship; patient care assignments that foster continuity of care; and written up to date nursing plans for all patients, were identified as 'misfit' items in this analysis and a previous analysis of the PES-NWI with military respondents (Raju et al., 2014). Therefore, these six items could be removed from the instrument to decrease respondent burden or make way for more important items, without significantly altering the measurement of the overall construct in a military setting. If these items were removed from the PES-NWI, but the five factor structure maintained, the instrument could still function as a tool for comparison between the composite score of military treatment and Magnet facilities because the analysis shows

these items are not contributing to the overall measurement of the practice environment. These remaining 25 items, found in Appendix B, should serve as a foundation for conducting the level of inquiry necessary to support a full modification of the PES-NWI. The Cronbach's alpha and model fit were tested with Lake's (2002) factor structure on another sample of military nurses (n = 4,724) collected in 2010. The reduced set of items yielded acceptable Cronbach's alphas ranging from 0.71-0.91 for the subscales and 0.96 for the composite. The CFI improved to 0.90 and the RMSEA was unchanged. However, we do not recommend these items be used without further testing and continued instrument development. As discussed above, the instrument improvement would start with qualitative inquiry to obtain staff nurse's input regarding these 25 items and identify other factors that nurses at the bedside feel an impact their work environment and are not included in the scale. This model of psychometric analysis would then be repeated to further the development of the instrument.

If, after further instrument development, the five factor (subscale) structure was not maintained, comparability among civilian Magnet facilities that use the five factor structure could be lost. However, for many years, military treatment facilities have ranked above civilian Magnet hospitals with regard to the practice environment. In the 2014 Military Health System Review Final Report, military treatment facilities rated above civilian Magnet facilities on most subscales of the PES-NWI (Department of Defense, 2014). Now that military treatment facilities continually rate as having a favorable work environment, it may be more meaningful for military hospitals to compare internally, against top performers and low performers, than to compare with civilian Magnet facilities.

The determination that analysis of the practice environment is influenced by care settings and nurse type, suggests a computer adaptive PES-NWI may be useful. An adaptive instrument would respond to the demographic characteristics of the respondent and provide precise and meaningful evaluation of the particular work environment, which could enhance the utility of the instrument. For example, this specificity would allow military leadership to identify areas where RNs and LPNs are assessing the practice environment differently which would prompt investigation into why this difference exists. Perhaps in some cases, the care setting does not allow for certain activities such as participation in shared governance or for the advancement of specific professional groups due to an unrealized system constraint. A computer adaptive PES-NWI would be more beneficial than developing unique instruments for each group, particularly when you do not have a pre-defined homogenous target sample of nurses. For example, it could be useful for hospital level practice environment surveillance or for use in national nursing datasets.

Limitations

This study relied on secondary data which may limit the accuracy of the data. In addition, there are limitations due to the PES-NWI itself, many of which have been discussed in this paper. The samples used for the original exploratory and confirmatory factor analyses were all registered nurse samples however; in this study the instrument has been completed by RNs and LPNs. This study was conducted for the purposes of testing the instrument's function in a military only sample and therefore this expectedly limits the generalizability of these findings. However, following this in-depth testing in

other non-military populations may reveal similar findings regarding the differences in responses based on nurse type and care setting.

Conclusion

In conclusion, although the PES-NWI functions moderately well in the military setting this analysis indicates that the instrument could be refined. In addition, future research is needed to ensure the contemporary nursing practice environment is represented by the PES-NWI. This analysis can serve as a model for conducting a systematic psychometric analysis during the continued development of the PES-NWI and with other unique sample types. Lastly, this analysis supports the recommendation that researchers should consider and test for, differences based on care setting and nurse type to identify any meaningful variation in the responses in these groups. The testing of other large samples in this way is needed to determine if the differences seen in this study are present in survey responses from other hospital systems and in other countries.

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Appendix A - Key Terms and Definitions

General Terms	Definition
Item	A question in a scale
Subscale	A latent factor which contributes to an overall construct
Subscale Acronyms	Subscale Definitions
Subscale 1 / NPHA	Nurse Participation in Hospital Affairs
Subscale 2 / NFQC	Nursing Foundations for Quality Care
Subscale 3 / NMAL	Nurse Manager Ability, Leadership, and Support of Nurses
Subscale 4 / SRA	Staffing and Resource Adequacy
Subscale 5 / RNMD	Collegial Nurse-Physician Relationships
Composite	Combined score of the subscales, the median score is 2.5
Individual Item Acronyms	Individual Item Questions and Subscales
developr	Career development/clinical ladder opportunity
policyr	Opportunity for staff nurses to participate in policy decisions
drimrsr	A chief nurse who is highly visible and accessible to staff
nrsexcer	A chief nurse officer equal in power and authority to other top level hospital executives
advancer	Opportunities for advancement
admilis	Administration that listens and responds to employee concern
nrsgovr	Staff nurses are involved in the internal governance of the hospital
commitr	Opportunity to serve on hospital and nursing committees
consultr	Nursing administrators consult with staff on daily problems and procedures
Subscale 1	*Nurse Participation in Hospital Affairs*
cntinedr	Active staff development or continuing education for nurses
stndrdsr	High standards of nursing care are expected by the administration
nrsphilr	A clear philosophy of nursing that pervades the patient care environment
nrscompr	Working with nurses who are clinically competent
qualiyr	An active performance improvement program
precepr	A preceptor program for newly hired RNs
nursemod	Nursing care is based on a nursing rather than medical model
careplnr	Written, up to date nursing plans for all patients
samenrsr	Patient care assignments that foster continuity of care
nursdxr	Use of nursing diagnosis
Subscale 2	*Nursing Foundations for Quality Care*
supervr	A supervisory staff that is supportive of the nurses
mistaker	Supervisors use mistakes as learning opportunities, not criticism
headnrsr	A nurse manager who is good manager and leader
praiser	Praise and recognition for a job well done
headsupr	A nurse manager who backs up nursing staff, even if the conflict is with a physician
Subscale 3	*Nurse Manager Ability, Leadership, and Support of Nurses*
supportr	Adequate support services allow me to spend time with my patients
problemr	Enough time and opportunity to discuss patient care problems with other nurses
enoughr	Enough registered nurses on staff to provide quality care
staffr	Enough staff to get the work done
Subscale 4	*Staffing and Resource Adequacy*
teamworkr	A lot of teamwork between nurses and physicians
jntpracr	Collaboration (joint practice) between nursing personnel and physicians
dmsr	Physicians and nurses have good working relationships
Subscale 5	*Collegial Nurse-Physician Relationships*

Note. Those who are familiar with the PES-NWI may notice a small change in the way some of the management titles are noted in the individual items. This survey was given to military personnel and so the item titles were change to represent the corresponding

titles used in the military. For example, the item “a director of nursing highly visible and accessible to staff” was change to “a chief nurse who is highly visible and accessible to staff”. In this population, the term chief nurse is used to in place of director of nursing though the positions are equivalent.

Appendix B – A 25 Item Practice Environment Scale-Nursing Work Index

General Terms	Definition
Subscale Acronyms	Subscale Definitions
Subscale 1 / NPHA	Nurse Participation in Hospital Affairs
Subscale 2 / NFQC	Nursing Foundations for Quality Care
Subscale 3 / NMAL	Nurse Manager Ability, Leadership, and Support of Nurses
Subscale 4 / SRA	Staffing and Resource Adequacy
Subscale 5 / RNMD	Collegial Nurse-Physician Relationships
Composite	Combined score of the subscales, the median score is 2.5
Individual Item Acronyms	Individual Items
developr	Career development/clinical ladder opportunity
policyr	Opportunity for staff nurses to participate in policy decisions
drimrsr	A chief nurse who is highly visible and accessible to staff
nrsexcer	A chief nurse officer equal in power and authority to other top level hospital executives
advancer	Opportunities for advancement
admilis	Administration that listens and responds to employee concern
nrsgovr	Staff nurses are involved in the internal governance of the hospital
commitr	Opportunity to serve on hospital and nursing committees
consultr	Nursing administrators consult with staff on daily problems and procedures
Subscale 1	*Nurse Participation in Hospital Affairs*
cntinedr	Active staff development or continuing education for nurses
stndrdsr	High standards of nursing care are expected by the administration
nrsphilr	A clear philosophy of nursing that pervades the patient care environment
nrscompr	Working with nurses who are clinically competent
qualiyr	An active performance improvement program
nursemod	Nursing care is based on a nursing rather than medical model
nursdxr	Use of nursing diagnosis
Subscale 2	*Nursing Foundations for Quality Care*
supervr	A supervisory staff that is supportive of the nurses
mistaker	Supervisors use mistakes as learning opportunities, not criticism
headnrsr	A nurse manager who is good manager and leader
praiser	Praise and recognition for a job well done
headsupr	A nurse manager who backs up nursing staff, even if the conflict is with a physician
Subscale 3	*Nurse Manager Ability, Leadership, and Support of Nurses*
supportr	Adequate support services allow me to spend time with my patients
problemr	Enough time and opportunity to discuss patient care problems with other nurses
Subscale 4	*Staffing and Resource Adequacy*
teamworkr	A lot of teamwork between nurses and physicians
jntpracr	Collaboration (joint practice) between nursing personnel and physicians
Subscale 5	*Collegial Nurse-Physician Relationships*

Note. These 25 items should serve as a foundation for conducting the level of inquiry necessary to support a full modification of the PES-NWI.

DISCOVERING RELATIONSHIPS BETWEEN THE MILITARY NURSING PRACTICE ENVIRONMENT AND PATIENT OUTCOMES

by

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PAPER 3

DISCOVERING RELATIONSHIPS BETWEEN THE MILITARY NURSING PRACTICE ENVIRONMENT AND PATIENT OUTCOMES

Abstract

Introduction and Background: The nursing practice environment has been significantly associated with lower patient mortality, failure to rescue, nurse-administered medication errors, infections, patient complaints, and patient falls. Favorable environments have also been associated with higher nurse-reported care quality and patient satisfaction in civilian hospitals. Limited information exists to support these relationships in military facilities.

Methods: Using four years of secondary data collected from military hospitals, generalized estimating equations were used to test the associations between scores on the Practice Environment Scale of the Nursing Work Index and patient outcomes (falls with and without injury, medication administration errors with and without harm, and patient experience). Additionally, regression tree analysis was utilized to test associations between individual questions on the instrument and patient outcomes.

Results: Four significant associations were found between the PES-NWI subscales and the patient outcomes under study. The Staffing and Resource Adequacy subscale was significantly associated (b = -0.618, $p < .05$) with patient falls, the Collegial Nurse Physician Relations subscale was significantly (b = - 3.43, $p < .05$) associated with the

rate of nurse-administered medication errors, and the Nursing Foundations for Quality Care and Collegial Nurse Physician Relations subscales were both significantly (b = 0.033 and b = 0.028, $p < .001$) associated with patient experience with nursing care. Results from the decision tree analysis demonstrate potentially influential predictors for patient falls; however, the pseudo R-squares for these models were low.

Discussion: This study demonstrates that, like civilian hospitals, associations between favorable nursing practice environments and improved patient outcomes exist within these military nursing units.

Keywords: Organizational structure, quality assurance/patient safety, staffing/scheduling/turnover, supervisor/administration/leadership

Introduction

Preventable medical errors account for between 44,000 and 98,000 deaths per year in the United States according to the Institute of Medicine (IOM) report, To Err is Human (2000). A more recent study estimated that as many as 440,000 Americans die each year from preventable errors in health care (James, 2013). According to the recent Military Health System (MHS) review, an acceptable level of quality care is being delivered to the 9.6 million beneficiaries in military hospitals; however, the review panel raised concerns and offered recommendations for improvement. The overarching recommendations provided to the MHS leadership focused on improving care quality through leadership engagement and leadership development, while simultaneously implementing changes to ensure a culture of safety and continuous process improvement (Department of Defense, 2014).

One proven method to increase the quality of care in hospitals is to improve the nursing practice environment, described as factors that contribute to, or detract from, a nurse's ability to practice professional nursing (Institute of Medicine, 2003; Lake, 2002; McClure & Hinshaw, 2002; Patrician, Shang, & Lake, 2010). A favorable nursing practice environment has been significantly associated with lower levels of patient mortality, failure to rescue, nurse-administered medication errors, infections, patient complaints, and patient falls, and associated with higher nurse-reported care quality and patient satisfaction (Aiken, Clarke, Sloane, Lake, & Cheney, 2008; Kim, Capezuti, Boltz, & Fairchild, 2009; Kutney-Lee, Lake, & Aiken, 2009; Laschinger & Leiter, 2006; Patrician, Shang, et al., 2010; Tei-Tominaga & Sato, 2016). Measuring patient experience can provide more information about how to improve health care delivery and

quality than measuring patient satisfaction (Jenkinson, Coulter, Bruster, Richards, & Chandola, 2002). In addition, hospitals with good nursing practice environments, such as Magnet® hospitals, are consistently associated with the retention of professional nurses, higher levels of nursing job satisfaction, and greater empowerment of nurses (Kramer & Schmalenberg, 1988; Manojlovich, Antonakos, & Ronis, 2009). Until recently, most research using the Practice Environment Scale of the Nursing Work Index (PES-NWI), an instrument designed to measure the nursing practice environment (Warshawsky & Havens, 2011), focused on the instrument's composite score, with very little analysis conducted using the individual subscales or individual items, especially in military hospitals. Despite the fact that scores on the PES-NWI in military facilities have met or exceeded the scores found in Magnet hospitals, we do not know if the associations found in Magnet hospitals, such as fewer patient falls and improved patient experience, also exist within the military system (Department of Defense, 2014; Petit Dit Dariel & Regnaux, 2015; Stimpfel, Sloane, McHugh, & Aiken, 2016). Identification of which subscales or individual PES-NWI items have the strongest association with particular patient outcomes could provide more actionable targets for nursing leaders who aim to improve outcomes by enhancing the nursing practice environment.

The purpose of this study was to discover the association between aspects of the military nursing practice environment and patient outcomes. Specifically, this study focused on the five subscales of the PES-NWI and their associations with patient falls with and without injury, nurse-administered medication errors with and without harm, and patient experience associated with nursing care. This study also explored the association of the individual items on the PES-NWI with patient falls with and without

injury and nurse-administered medication errors with and without harm. It is important to study the military nursing environment because the influence of the environment on adverse patient outcomes may be enhanced or constrained by the hierarchal nature of the military. For example, differences in status between nurses and physicians may inhibit a nurse's comfort in expressing concerns regarding a patient's care (Thomas, Sexton, & Helmreich, 2003). However, despite the often-reported negative consequences of the hierarchical nature and rigid structure of the military (Moskop, 1998; Spence, 2007), there are also positive benefits. For example, military nurses consistently rate working relationships with physicians favorably and also report a strong sense of teamwork in the health-care setting (Raju, Su, & Patrician, 2014; Zangaro & Kelley, 2010). These positive relationships may be related to the way in which the rank structure can serve "as an equalizer among different professional groups" in military healthcare settings (Zangaro & Kelley, 2010, p. 36). Additionally, compared to civilian nurses, Army nurses have reported higher scores on the PES-NWI subscales for nurse participation in hospital affairs and nursing foundations for quality care (Patrician, Shang, et al., 2010).

Background

The constructs of the nursing practice environment, which are measured by the subscales of the PES-NWI, are: Nurse Participation in Hospital Affairs; Nursing Foundations for Quality Care; Nurse Manager Ability, Leadership, and Support of Nurses; Staffing and Resource Adequacy; and Collegial Nurse-Physician Relations (Lake, 2002). These constructs have been empirically linked to improved care quality, increased safety related activities, and/or improved patient outcomes. The subscales for nurse participation in hospital affairs and nursing foundations for quality care have been

associated with increased error interception practices (Flynn, Liang, Dickson, Xie, & Suh, 2012). Participation by nurses in organizational priority setting and decision making may also support the creation of an organizational environment that supports the delivery of high quality care (Friese, Siefert, Thomas-Frost, Walker, & Ponte, 2016). A decrease in adverse events may be attributed to nurses' professional capacity to influence and improve hospital-wide processes and policies. For example, improved scores on the nursing foundations for quality care are associated with more error reporting (Jafree, Zakar, Zakar, & Fischer, 2016) and better organizational support of a safety culture (Friese et al., 2016). Managerial support reduces adverse events because it facilitates the creation of an environment in which mistakes are used as learning opportunities and in which nursing leaders support accountability, autonomy, and responsibility for the provision of care (McClure & Hinshaw, 2002). In facilities with adequate staffing and resources, nurses perform fewer non-professional tasks and instead, have more time to provide attentive surveillance of patients, allowing them to take immediate action when a patient needs an intervention (Kutney-Lee et al., 2009). Importantly, low patient experience ratings have been described as indicators "of quality deficiencies in structures and processes of nursing care" within hospitals (Bruyneel et al., 2015, p. 9). The presence of collegial nurse-to-physician relationships is important for fostering open communication about patient needs and changes in condition. Nurses place a high level of value on open and clear communication with physicians (House & Havens, 2017). Positive nurse-physician collaboration leads to problem solving, joint decision making, increased care coordination, and cooperative actions that meet the needs of the patient, which may improve a patient's experience with nursing care.

Theoretical Framework

The conceptual framework that grounded this study was the Quality Health Outcomes Model (QHOM) derived from Donabedian's structure, process, and outcome framework (Donabedian, 1966; Mitchell, Ferketich, & Jennings, 1998). Within Donabedian's framework, structure and process are predictors of outcomes (Best & Neuhauser, 2004). This framework has been used extensively in health-care research and by the American Nurse Association to develop indicators aimed a measuring nursing care quality (Gallagher & Rowell, 2003). In this study, the QHOM enhanced Donabedian's time-tested model and aided control variable selection. This model considers the complex context of the health-care environment by identifying unit-level workload indicators and considering the nursing practice environment, both of which impact outcomes (Mitchell et al., 1998). The client aspects of the QHOM are not represented in this study. This study posits that all nursing processes take place within the context of the nursing practice environment and, thereby, the nursing practice environment influences outcomes sensitive to changes in the quality of nursing care (Breckenridge-Sproat, Johantgen, & Patrician, 2012).

The use of a model illustrates how the presence of the PES-NWI subscale constructs within a nursing practice environment contributes to improved patient outcomes. In addition, a model helps to specify important factors that need to be considered when studying health outcomes (Kane & Radosevich, 2011). Using a model format, Figure 1 depicts the organizational inputs, PES-NWI constructs, processes, an intermediate outcome, and final outcomes of the described relationships. The inputs, processes, and outcomes shown in the model are simplified; select processes have been

placed in the model to signify potential mechanisms of action (Aiken, Clarke, & Sloane, 2002; Aiken & Patrician, 2000). There may be other processes that impact patient outcomes that are not represented here.

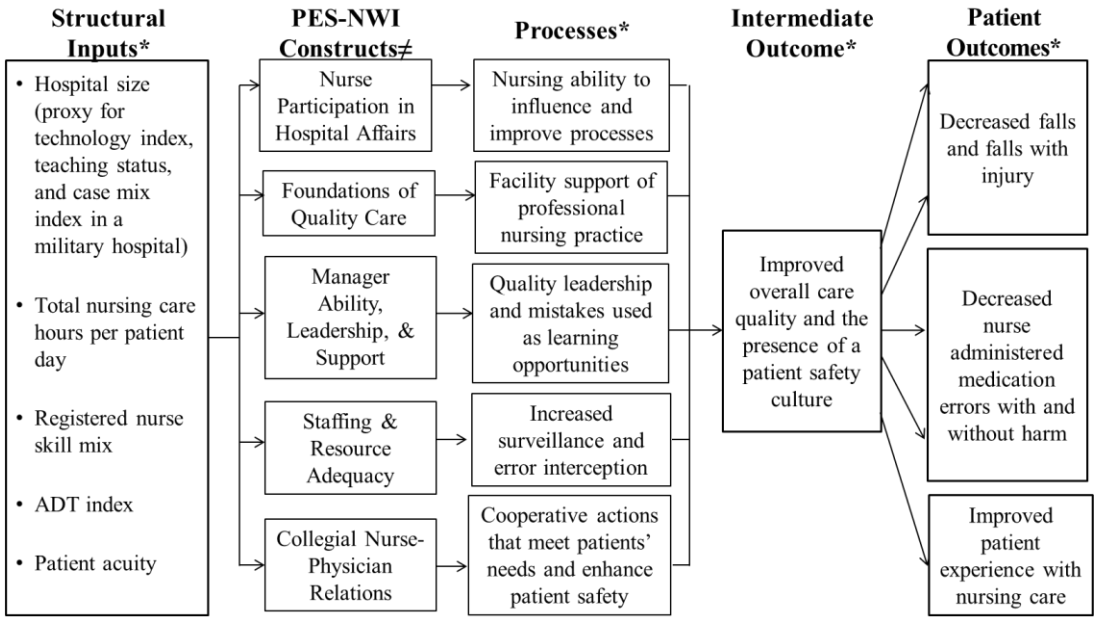

Figure 1. Model depicting the mechanisms of action that link factors associated with the nursing practice environment to improved overall quality of care and improved patient outcomes. These processes are supported by the empirical evidence discussed above. PES-NWI≠ = Practice Environment Scale of the Nursing Work Index, a construct representing the context in which care is provided (Mitchell et al., 1998); * = Inclusion of structure, process, and outcome was based on Donabedian's framework (Donabedian, 1996); ≠ = Constructs representing the context of care.

Methods

Design

A longitudinal study design was chosen for assessing changes over time and enhancing the interpretability of the research results (Polit & Beck, 2012). Data used in this study was available from 2010, 2011, 2013, and 2014. No PES-NWI survey data was available for 2012; therefore, this year was excluded from this study. The University of Alabama at Birmingham's Internal Review Board approved this study.

Setting and Sample

The data source for this secondary analysis included four years of data from 45 individual acute care units in ten military hospitals. The types of units included in the dataset were either medical, surgical, combined medical-surgical, orthopedic, stepdown, or intensive care units. The data were compiled as part of an extensive program evaluation aimed at examining the effects of implementing a nursing care delivery framework that was primarily utilized in Army military hospitals (Breckenridge-Sproat et al., 2015). There were 1,710 available and complete annual PES-NWI surveys, of which, 1,251 or 85% were registered nurse (RN) respondents. All nurse types (registered nurses, licensed vocational nurses, and nursing aids) were invited to participate in the study and are included in this sample. The unit-level response rate ranges between 0% and 91% across the four years included in this study (e.g. a unit may not have had any nurses return the survey one out of four of the survey years), and the average unit response rate was 21%. In the original evaluation, all units, regardless of response rate, were included in the analysis (Breckenridge-Sproat, 2017). Patient experience with nursing care ratings

were represented as hospital-level aggregates within the dataset. All other variables were represented as unit-level monthly aggregates.

A representative subset of the original dataset was selected for further analysis after meeting inclusion criteria. A unit was included in this analysis if at least five nurses of any type responded to the annual PES-NIW survey and there was a suitable measure of consensus among the survey responses. Consensus between the unit response was considered satisfactory when the Intraclass Correlation Coefficient (2) [ICC(2)] reached at least 0.60 (Glick, 1985; Polit & Yang, 2015). A response rate greater than 40% is often used as inclusion criteria for survey research (Kramer, Schmalenberg, Brewer, Verran, & Keller-Unger, 2009). However, ICC (2) provides a more direct measure of the representative nature of the group-level attribute and supports the reliability of the aggregate measure (Ginsburg & Gilin Oore, 2016). Nurses on the 45 units had an opportunity to take the survey each year, for four years, totaling 180 potential unit-years of data for inclusion in this study.

Instruments

PES-NWI. The Practice Environment Scale of the Nursing Work Index (PES-NWI) PES-NWI measures factors in the environment that either support, or detract from, a nurse's ability to provide quality care by asking nurses to score 31 items on a one-to-four point Likert scale (Cummings, Hayduk, & Estabrooks, 2006; Lake, 2002). A score >2.5 indicates a favorable nursing practice environment (Lake, 2002). In a recent psychometric analysis, the subscale reliability coefficients ranged from 0.81 to 0.90, with an overall reliability coefficient of 0.96 (Swiger, Raju, Breckenridge-Sproat, & Patrician, 2017). In the parent study, Cronbach's alpha was calculated for each year using the full

sample. The reliability coefficients in this similar sample ranged from 0.79 to 0.91 for the subscales and from 0.94 to 0.95 for the composite score (TSNRP Grant # N13-P13 final report). A copy of the instrument subscales and individual items can be found in Appendix A.

TriCare Inpatient Satisfaction Survey (TRISS) - Patient Experience with Nursing Care. Patient experience data were collected using the TriCare Inpatient Satisfaction Survey (TRISS), a randomly distributed, voluntary survey containing many of the standard Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) questions (Centers for Medicare & Medicaid Services, n.d.). The TRISS aims to capture the patients' *experience* of hospital care, not necessarily *satisfaction* with that care (Stimpfel, Sloane, McHugh, & Aiken, 2015). For example, a question would ask "During your hospital stay, how often did the nurse…." Four questions specific to nursing care were aggregated to obtain the score for patient experience with nursing care to enhance the statistical reliability of the measure (Centers for Medicare & Medicaid Services, 2013). Although the validity and reliability of patient satisfaction survey instruments has been called into question in the past, the HCAHPS survey has demonstrated acceptable reliability and validity (Keller et al., 2005; Sitzia, 1999). Surveys are collected at the hospital level and are separated by service line (e.g., medical surgical or obstetrics). The data in this study was previously aggregated; therefore, the number of patient responses is unknown.

Outcome and Control Variables

Falls, Falls with Injury, Nurse-administered Medication Errors, and Nurse-administered Medication Errors with Harm. The outcomes selected for program

evaluation were chosen because they are sensitive to the quality of nursing care provided (Burston, Chaboyer, & Gillespie, 2014). The outcomes (falls, falls with injury, nurse administered medication errors, and nurse administered medication errors with harm) were measured at the unit level to avoid the loss in variability that may be caused by aggregating at the hospital level (Patrician et al., 2011). These data are compiled in a military database for decision support, but originate from electronic patient safety reports using standardized reporting mechanisms and definitions of injury categories used across the Army military medical system. Patient falls are defined as an "unplanned descent to the floor" with or without injury to the patient, and falls with injury are defined as an "unplanned descent to the floor" with minor, moderate, or severe injury (Dunton, Gajewski, Taunton, & Moore, 2004, p. 55; National Quality Forum, 2004). Nurse administered medication errors were defined as a deviation from the physician's order in which the incorrect administration of a medication occurred due to incorrect dosage, drug, patient, time, route of administration, or interaction between incompatible medications with or without harm to the patient (Mosby, 2012; Patrician, Loan, McCarthy, Brosch, & Davey, 2010). Nurse-administered medication errors with harm were defined as the incorrect administration of a medication due to incorrect dosage, drug, patient, time, route of administration, or interaction between incompatible medications with minor, moderate, or severe harm to the patient (Mosby, 2012).

Hospital Size. Hospital size is an important variable for consideration in this study because, in addition to the size of the facility, this variable serves as an excellent proxy for high-technology and teaching status. Large military hospitals (>100 beds) are often academic medical centers with more robust technology (Patrician et al., 2011). In

addition, as with small rural civilian institutions (Hatten & Connerton, 1986), small military hospitals tend to have a lower case mix than large hospitals.

Nurse Staffing, Workload Intensity, and Unit Patient Acuity. Staffing information was tracked through the Defense Medical Human Resources System-internet (DMHRSi), a business database used for workhour accounting. Census; admissions, discharges, and transfers (ADT); and patient acuity data were recorded immediately after each shift by trained nursing staff, and these data were entered into the Workload Management System for Nursing-internet (WMSNi) systems using standard procedures. WMSNi uses a quantitative formula that assesses a patient's care needs to project the amount of nursing time required to care for an individual patient. This time is defined as WMSNi required nursing care hours (Molter, 1990), and calculations are performed at least once daily. It is from these systems that total nursing care hours per patient day (TNCHPPD), skill mix, ADT, and patient acuity were drawn. To determine workload intensity, the monthly average number of ADTs were summed and then divided by the average monthly census to calculate an ADT index. The following two definitions were drawn from Patrician and colleagues' (2011). TNCHPPD was defined as the total number of care hours worked by all nursing personnel (RN, Licensed Practical Nurses [LPNs], and Paraprofessionals) divided by the total number of patient days. Registered nurse skill mix was defined as the proportion of total nursing care hours worked by registered nurses. Patient acuity is another workload measure that is expressed through a categorical or point-range system based on the amount of nursing care required by a particular patient (Molter, 1990). Each military hospital is responsible for monitoring and reporting the reliability and validity of these data.

Data Analysis

Dataset Preparation. For this study, the outcome data from two months before and two months after each PES-NWI survey period were included for analysis. In addition, each time it was administered, the PES-NWI survey remained open for approximately 2 months. Therefore, this 2-month time period was also included for analysis, resulting in a 6-month segment of time (the 2 months preceding, 2 months during, and 2 months following the PES-NWI survey) for each of the four years under evaluation. The outcome and staffing data was matched to the same 6-month time period for each unit. This six-month timeframe was selected to best capture outcomes corresponding to the time period in which the practice environment was measured. In military hospitals, approximately one-half of nurses transition from one geographic location to another every three to four years (Zangaro & Kelley, 2010)and often change jobs within a hospital. Therefore, this alignment was particularly important for studying military nurses and inpatient units because the frequent turn-over of military staff and leadership within the facilities may cause fluctuations in the nursing practice environment.

Analysis. Analysis began with descriptive statistics, identification of the proportion of missing data, and testing of normality assumptions. Relationships between the predictors (PES-NWI subscale scores), outcomes (nurse-administered medication errors, nurse-administered medication errors with harm, falls, falls with injury, and patient experience) and control variables (hospital size, TNCHPPD, RN skill mix, ADT index, and patient acuity) were examined using bivariate correlations. Multicollinearity was assessed using the variable inflation factor (VIF) (O'Brien, 2007).

To assess associations between the PES-NWI subscales and patient outcomes, generalized estimating equations (GEE) analysis was used to account for the hierarchical nature of the data. GEE is a modeling technique that uses population averages to estimate associations between independent and dependent variables (Hubbard et al., 2010). Analysis began by assessing the main effects of the PES-NWI subscales on each outcome; the unit identification variable was considered the random effect. If there was no association, the pair was dropped from further analysis. If a significant association (i.e., $p < .05$) was found, a model was built including all control variables. The subsequent models were then built by backwards elimination. As each variable was dropped, the quasi information criterion (QIC) was calculated to assess model fit. To aid in model selection, averaging across least squares estimates from the set of models was used to rank order them (Barton, 2016). Generalized linear modeling was used in place of GEE to assess relationships for outcomes measured at the hospital level (e.g., patient experience) because no hierarchical structure was present. Akaike Information Criterion (AIC) was used to assess the fit of these models. The goal of this portion of the analysis was to identify which subscales of the PES-NWI were related to patient outcomes and determine if these relationships changed when controlling for hospital size, TNCHPPD, RN skill mix, ADT index, and patient acuity and to determine whether the relationships remained constant from year to year. Multiple hypothesis testing was corrected using the false discovery rates (FDR) (Glickman, Rao, & Schultz, 2014).

To explore the associations of individual items of the PES-NWI with patient outcomes, decision tree-structured analysis was used (Azuero, Benz, McNees, & Meneses, 2014; Hothorn & Everitt, 2009). This type of analysis identifies predictors of

subpopulations with high or low adverse event rates (Raju, Su, Patrician, Loan, & McCarthy, 2015). Decision tree analysis was conducted with the annual PES-NWI individual items and the corresponding 6-month aggregates for the control and outcome variables. The resulting tree is a graphical representation of the predictors and controls as they relate to the outcomes within this particular dataset and are purely exploratory and descriptive in nature. The goal of this analysis was to explore the associations *independent* of year or unit.

For the decision tree analysis, the dataset was randomly split. Seventy percent of the data was used as a training dataset to build the tree and the remaining 30% was used to validate it with a process that generates a pseudo R-square (Berry, 2011; Williams, 2011). The minimum split for the decision tree analyses was set at 15, approximately 20% of all observations, meaning each group (node) must have at least 15 unit-years within it to be further split. The level of significance for the tree analysis was set at $p <$ .001, meaning that the difference within the split groups must be no higher than .001. Because of the non-normality in the data, spline regression and random forest were also used to identify important predictors (Andriani, Wibowo, & Rahayu, 2015; Liaw & Wiener, 2002)

All analyses were performed using R statistical software (R Core Team, 2014). For the GEE analysis, the R packages ‘geepack’ and ‘MESS’ were utilized (Ekstrøm, 2016; HÃjsgaard, Halekoh, & J., 2006). Model selection was conducted using the R package ‘MuMIn’ (Barton, 2016), and the tree-based analysis was conducted using the R Package ‘rattle,’ a graphical interface for data mining (Williams, 2011). Spline

regression was conducted using the R package ‘gam’ and random forest was run using the R package ‘randomForest’ (Hastie, 2016; Liaw & Wiener, 2002).

Findings

Out of 180 potential unit-years, 79 were included based upon response rate and ICC(2). For each unit-year, 6 months of nested data were retained in the dataset, resulting in 474 observations. Descriptive statistics and percentage of missing data for each variable can be found in Table 1. Based on histograms and Quantile-Quantile plots, nearly all variables were non-normally distributed; therefore, the outcomes were log transformed. However, transforming the variables did not improve the histograms or quantile-quantile plots. Therefore, to more easily interpret the data, the analyses were conducted using the non-transformed variables. There were no significant associations between the PES-NWI subscales and falls with injury or medication errors with harm; these outcomes are omitted from further discussion.

Table 1

Descriptive Statistics for Outcome and Control Variables

	Missing**	Included Units	
Hospital Size	0.00%	Small (<100 beds) = 10 unit-years (13%)	
	0.00%	Large (>100 beds) = 69 unit-years (87%)	
		Mean	SD
NPHA	0.00%	2.79	0.27
NFQC*	0.00%	3.14	0.20
NMA*	0.00%	2.87	0.43
SRA*	0.00%	2.97	0.39
CNPR*	0.00%	3.07	0.27
Falls*	6.33%	1.53	2.54
Falls with Injury	6.33%	0.17	0.70
Nurse-administered Medication Errors	6.33%	4.72	7.33
Nurse-administered Medication Errors with Harm	6.33%	0.16	0.79
Patient Experience ±*	37.97%	3.72	0.05
TNCHPPD	7.38%	22.63	10.78
RN Skill Mix	7.38%	0.72	0.13
Average Acuity	5.70%	3.58	0.78
ADT	6.33%	0.80	0.25

Note. NPHA = Nurse Participation in Hospital Affairs, NFQC = Nursing Foundations for Quality Care; NMAL = Nurse Manager Ability, Leadership, and Support of Nurses; SRA = Staffing and Resource Adequacy; CNPR = Collegial Nurse-Physician Relationships; SD = standard deviation; TNCHPPD = total nursing care hours per patient day; RN = Registered Nurse; ADT = Admission, Discharge, and Transfer workload index; ± = Patient Experience with nursing care is a hospital-level variable and was not collected in 2010; Unit-years is a number that represents the number of unique units responding within that category (e.g., one unique unit, represented in the dataset for four

separate years would equal four unit-years). There are 180 possible unit-years in the dataset; * = independent sample T-Test shows a significant difference between means in the included and excluded units; ** Percentage missing is reported for the included units only.

Bivariate correlations were assessed with both Pearson's (results not shown) and Kendall's (see Appendix B) correlation coefficients. None of the correlations exceeded the cutoff value of .85 for potential collinearity. The Pearson's correlations ranged from 0.66 to 0.86, supporting the decision to include only one subscale in each model, along with the staffing and patient intensity covariates.

Subscale Findings

Four significant associations were found between the PES-NWI subscales and patient outcomes. The Staffing and Resource Adequacy subscale was significantly (b = - 0.618, $p < .05$) associated with patient falls, the Collegial Nurse Physician Relations subscale was significantly (b = - 3.43, $p < .05$) associated with the rate of nurse-administered medication errors, and both the Nursing Foundations for Quality Care and Collegial Nurse Physician Relations subscales were significantly (b = 0.033 and b = 0.028, $p < .01$) associated with patient experience with nursing care. The generalized variable inflation factors (GVIFs) ranged between 1.21 and 2.94, indicating no multicollinearity (O'Brien, 2007).

Tables 2–4 depict the backwards selection models, the QICs and the FDRs. Falls were significantly associated with Staffing and Resource Adequacy when TNCHPPD was not included in the model, but was no longer significant when TNCHPPD was present. Hospital size was significantly associated with patient falls; larger hospitals experienced more patient falls. These findings were stable across years.

Table 2

Staffing and Resource Adequacy and Patient Falls

		Model 1 *b*	Model 1a *b*	Model 1b *b*	Model 1c *b*	Model 1d *b*	¥Model 1e *b*	Model 1f *b*	FDR *p* value
Subscale 4 - Staffing and Resource Adequacy		-0.618*	-0.339	-0.268	-0.262	-0.254	-0.288	-0.613*	0.413
±Hospital Size			1.100*	1.106*	1.112*	1.033**	1.004**	1.061**	0.007
TNCHPPD			-0.030*	-0.032*	-0.031*	-0.029**	-0.031**		0.007
RN Skill Mix			-1.183	-1.214	-1.099	-1.087			
Workload Intensity			0.277	0.284	0.249				
Patient Acuity			-0.007	0.046					
Survey Year	2010		Base Year						
	2011		-0.168						
	2013		0.465						
	2014		0.060						
QIC - Individual		2858.32	2647.80	2663.26	2661.12	2662.82	2671.78	2792.88	
QIC - Model Selected		813.00	814.00	808.00	806.00	805.00	801.00	824.00	-

Note. TNCHPPD = Total nursing care hours per patient day; RN = Registered Nurse; * = $p < .05$; ** = $p < .01$; QIC = Quasi Information Criterion; For hospital size, 0 = small and 1 = large; ¥ = best model fit as assessed by QIC model selection; ± = In the military, hospital size is a proxy for high-technology and teaching status; FDR = false discovery rates calculated for the best fitting model as assessed by QIC.

Improved scores on Collegial Nurse-Physician Relations subscale were associated with a significant decrease in nurse-administered medication errors across all models. This relationship was stable across all four years included in this analysis.

Table 3

Collegial Nurse-Physician Relations and Nurse-Administered Medication Errors

		Model 2 *b*	Model 2a *b*	Model 2b *b*	Model 2c *b*	Model 2d *b*	¥Model 2e *b*	Model 2f *b*	FDR *p* value
Subscale 5 - Collegial Nurse-Physician Relations		-3.43*	-4.695*	-3.913*	-3.823*	-3.888*	-3.7712 *	-3.346*	0.055
±Hospital Size			0.882	0.995	1.031	0.460	0.499	0.543	0.704
TNCHPPD			0.038	0.014	0.021	0.035	0.037		0.381
RN Skill Mix			0.175	0.191	0.683	0.834			
Workload Intensity			1.836	1.971	1.802				
Patient Acuity			-0.1253	0.212					
Survey Year	2010		Base Year						
	2011		-0.586						
	2013		3.374						
	2014		0.254						
QIC - Individual		23669.32	22474.70	22994.37	22988.30	23162.51	23162.47	23673.31	
QIC - Model Selected		1773.00	1768.00	1762.00	1760.00	1760.00	1754.00	1777.00	

Note. TNCHPPD = Total nursing care hours per patient day; RN = Registered Nurse; * = $p < .05$; ** = $p < .01$; QIC = Quasi Information Criterion; For hospital size, 0 = small and 1 = large; ¥ = best model fit as assessed by QIC model selection; ± = In the military, hospital size is a proxy for high-technology and teaching status; FDR = false discovery rates calculated for the best fitting model as assessed by QIC.

The Nursing Foundations for Quality Care subscale was significantly and positively associated with patient experience with nursing care ratings across all models. TNCHPPD and hospital size were also significantly associated; patients in large hospitals rated their experience with nursing care lower. Increased staffing, measured as

TNCHPPD, was positively associated with improved ratings, but the estimate was very small across all models ($b = 0.001$). The Collegial Nurse-Physician Relations subscale was significantly and positively associated with ratings of patient experience with nursing care in the absence of TNCHPPD. Again, hospital size was negatively associated with ratings of patient experience with nursing care; patients in larger hospitals rated their experience with nursing care lower.

Table 4

Nursing Foundations for Quality Care and Collegial Nurse-Physician Relations and Patient Experience with Nursing Care

		Model 3 *b*	Model 3a *b*	Model 3b *b*	Model 3c *b*	Model 3d *b*	¥Model 3e *b*	Model 3f *b*	FDR *p* value
Subscale 2 - Nursing Foundations for Quality		0.0331**	0.0582***	0.059***	0.057***	0.055***	0.051***	0.030*	$p < .01$
±Hospital Size			-0.022*	-0.025**	-0.026**	-0.022**	-0.023**	-0.021*	$p < .01$
TNCHPPD			0.001**	0.001***	0.001***	0.001***	0.001**		$p < .01$
RN Skill Mix			-0.013383	-0.010	-0.020	-0.025			
Workload Intensity			-0.020	-0.021	-0.015				
Patient Acuity			-0.005781	-0.006					
Survey Year	2011		Base Year						
	2013		-0.003						
	2014		0.004						
AIC		-955.60	-936.30	-939.50	-940.60	-941.20	-942.20	-960.20	

		Model 4 *b*	Model 4a *b*	Model 4b *b*	Model 4c *b*	Model 4d *b*	¥Model 4e *b*	Model 4f *b*	FDR *p* value
Subscale 5 - Collegial Nurse-Physician Relations		0.028**	0.012	0.012	0.011	0.010	0.010	0.024*	0.314
±Hospital Size			-0.023*	-0.026**	-0.027**	-0.024**	-0.024**	-0.020**	0.010
TNCHPPD			0.001*	0.001*	0.001**	0.001*	0.001**		0.011
RN Skill Mix			0.003	0.009	0.005	0.002			
Workload Intensity			-0.013	-0.013	-0.011				
Patient Acuity			-0.003	-0.002					
Survey Year	2011		Base Year						
	2013		-0.003						
	2014		0.007						
AIC		-956.20	-919.70	-922.10	-924.00	-925.30	-927.30	-959.80	

Note. Three years of data only; TNCHPPD = Total nursing care hours per patient day; RN = Registered Nurse; * = $p < .05$; ** = $p < .01$; *** = $p < .001$; AIC = Akaike Information Criterion; For hospital size, 0 = small and 1 = large; ¥ = best model fit as assessed by AIC; ± = In the military, hospital size is a proxy for high-technology and

teaching status; FDR = false discovery rates calculated for the best fitting model as assessed by AIC.

Individual Item Findings

Further investigation of the associations between the individual items and patient outcomes was conducted to determine which items were the most influential for each outcome. When cross-validated, the tree-based models only achieved the following, low pseudo R-squares: Patient falls = 0.04, Falls with injury = 0.10, Nurse-administered medication errors = 0.07, and Nurse-administered medication errors with harm = 0.004. The individual items on the PES-NWI, hospital size, TNCHPPD, registered nurse skill mix, average patient acuity, and ADT index were included as potential predictors in the tree models. Due to the low pseudo R-square values, two more techniques, random forest and spline regression were used to identify important predictors for each outcome to determine whether there was any consistency with the decision tree models. The spline models did not converge, but the top three predictors identified via random forest were fit to a linear model. The adjusted R-Squares for nurse administered medication errors with and without harm were <1%, consistent with the tree-based models. The adjusted R-squares for falls and falls with injury indicate that the model explains 20% and 17% of the variance, respectively. There was little consistency in the predictors for medication errors. The PES-NWI item consistently identified as an influential predictor for falls was 'written up to date nursing plans for all patients.'

Figure 2 depicts the decision tree for patient falls, and each box in the figure represents a node, or group of observations. The number of observations and the rate of falls for that group are indicated in each box. To interpret a decision tree, the algorithm

is followed from the top and then down the branches to the terminal nodes, which are groups of unit-years with low or high falls rates. The node containing observations with the lowest fall rate (bottom left) has a score >3 on the individual item 'written up-to-date nursing plans for all patients,' a monthly TNCHPPD average >17, and a score >3.3 on the individual item 'patient care assignments that foster continuity of care.' The nodes moving from left to right along the bottom of the figure have an increasing fall rate. On the far right, the highest fall rate of 2.7 falls per 1000 patient days is seen for a group of 17 unit-years. These units score <3 on the PES-NWI item, 'written and up-to-date nursing care plans for all patients.'

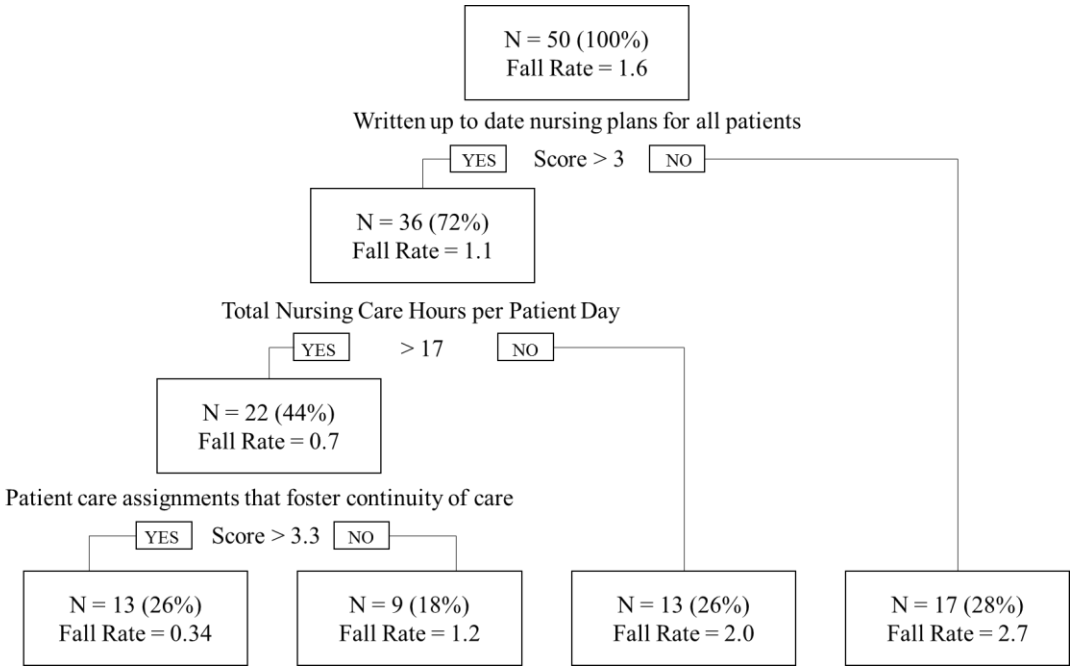

Figure 2. A decision tree for patient fall rates per 1000 patient days. N = the number of unit months represented in each group. The number following 'Fall Rate =' notes the

average fall rate for that group. PES-NWI individual items are scored from 1 to 4 on Likert scale. A score >2.5 considered a favorable rating (Lake, 2002).

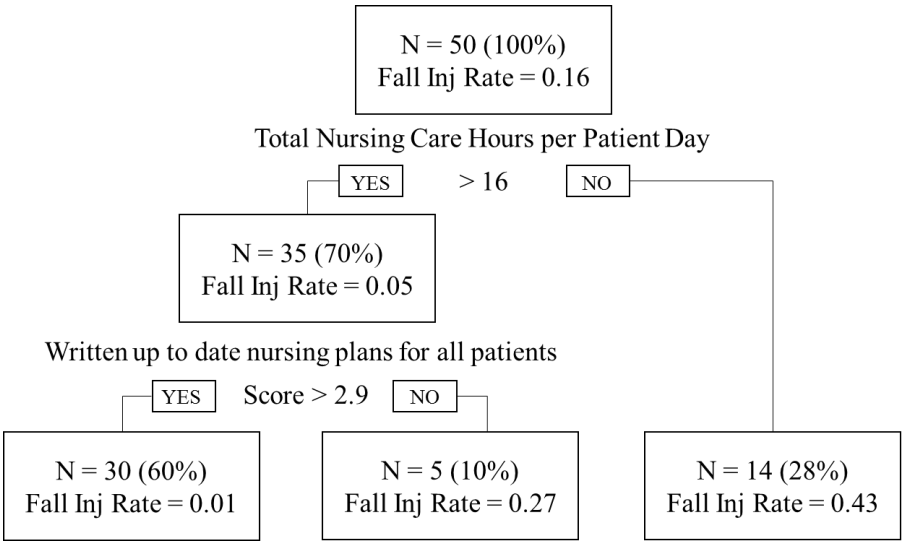

Figure 3. A decision tree for falls with injury rates per 1000 patient days. N = the number of unit months represented in each group. The number following 'Fall Inj Rate =' notes the average falls with injury rate for that group. PES-NWI individual items are scored from 1 to 4 on Likert scale. A score above 2.5 considered a favorable rating (Lake, 2002).

The same steps are followed to interpret the decision tree for falls with injury (Figure 3). In this sample, total nursing care hours per patient day greater than 16 may represent the intensive care units in the sample. This finding would indicate that, in this sample, intensive care units have fewer falls than medical surgical units. The decision trees for nurse-administered medication errors with and without harm are not shown.

Discussion

The findings from this study support the mechanisms depicted in the model we generated (Figure 1). Improved scores on the Staffing and Resource Adequacy subscale were associated with fewer falls; higher scores on Collegial Nurse-Physician Relations subscales were associated with fewer medication errors. Likewise, improved scores on the Nursing Foundations for Quality Care and Collegial Nurse-Physician Relations subscales were associated with a higher ratings of patient experience with nursing care. Although this study cannot confirm that these particular mechanisms are responsible for the improved patient outcomes, these improved outcomes may have been achieved through enhanced surveillance, an increase in meeting the needs of patients' care, and the presence of organizational foundations and processes that support the delivery of high quality care (Kutney-Lee et al., 2009; Mark, Sayler, & Smith, 1996; McClure & Hinshaw, 2002).

Patient Falls

The Staffing and Resource Adequacy subscale was significantly associated with patient falls. Based on the QIC, the model including subscale four, hospital size, and TNCHPPD, a measure of all nursing staff caring for patients on a unit was the best fitting model. This analysis supports the viewpoint that all staffing levels, not just registered nurse staffing, are important for preventing falls. The interventions commonly used to prevent falls, such as early mobility, increased surveillance, regular toileting, and conducting safety rounds (Agency for Healthcare Research and Quality, 2003), can be accomplished by any nursing staff member. Improved staffing has frequently been associated with lower fall rates (Dunton et al., 2004; Schuelke, Young, Folkerts, &

Hawkins, 2014). Along with TNCHPPD, hospital size was also a covariate in the best fitting model. This finding is not surprising given that larger military hospitals generally have a teaching mission and more complex patients. Hospital size and TNCHPPD were significant predictors across all models. The inclusion of year in the model did not change the relationships, demonstrating that these relationships were stable over time.

The models for the Staffing and Resource Adequacy subscale and patient falls also display an interesting pattern. When the staffing measure, TNCHPPD, is included in the model, subscale four, 'Staffing and Recourse Adequacy,' becomes non-significant. This observation may support the use of this subscale when staffing measures are not available. In addition, the PES-NWI subscale responses demonstrate that nurses are accurate reporters of staffing levels.

Nurse-administered Medication Errors

Regardless of the covariates included in the models, an improved score on the Collegial Nurse-Physician Relations subscale was associated with a significant decrease in nurse-administered medication errors. Although not significant, the best fitting model also included hospital size and TNCHPPD as covariates. The individual items in this subscale speak to teamwork, collaboration, and good working relationships (Lake, 2002), demonstrating that these factors play a part in medication error prevention. Alternatively, these results could indicate that improved nurse-physician relations lead to decreased reporting of nurse-administered medication errors. However, previous research supports the premise that nurses who report good working relationships with physicians are more comfortable reporting errors (Patrician & Brosch, 2009). This study supports existing research that the relationship between physicians and nurses is key in preventing nurse-

administered medication errors because good relationships improve open communication about patients' needs, leading to joint decision making, problem solving, and care coordination (Mark et al., 1996). Nurses who have collegial relationships with physicians may also be more likely to ask for clarity or changes in medication orders.

Patient Experience with Nursing Care

Interestingly, patient ratings of their experience with nursing care were significantly associated with two subscales of the PES-NWI. The Nursing Foundations for Quality Care subscale includes items such as, 'high standards of nursing care are expected by the administration,' 'working with nurses who are clinically competent,' and 'patient care assignments foster continuity' (Lake, 2002). From the perspective of a patient's experience with nursing care, it is not surprising that this subscale was significantly associated with the patient's subsequent scoring of their care experience. The patient's rating of their experience with nursing care was also significantly associated with subscale five, Collegial Nurse-Physician relations. This finding may indicate that nurses and physicians who work well together are better able to meet the needs and expectations of patients. In the best fitting models for each of these subscales, hospital size was also a significant predictor of higher ratings; patients were less satisfied at larger facilities.

Decision Tree Analysis

Findings portrayed in the tree algorithms indicate that units with the lowest fall rates with and without injury had care plans for their patients, increased staffing levels, and care assignments that foster continuity of care (falls only). The individual item indicating that nursing care plans were present on the unit and the staffing control

variable, TNCHPPD, were important in the tree-based model and were also selected as two of the top three most important predictors using random forest. Although the pseudo R-square value for this tree-based model is low (0.04), the path seems reasonable for these outcomes and is supported by previous research conducted by Healey and colleagues (2004). Specifically, implementation of nursing care plans was used as the intervention in a randomized controlled trial aimed at reducing falls in acute care inpatient units. The care plan focused on identifying risks, removing environmental obstacles, and providing access to assistance with the nurse call bell and room position within the ward. Following implementation, patients on the intervention ward had a significantly reduced relative risk of falling (Healey et al., 2004). The TNCHPPD finding is supported by studies that have shown an association between increased staffing and decreased patient falls (Lake, Shang, Klaus, & Dunton, 2010; Patrician et al., 2011).

Some single item measures are found to be reliable in nursing studies (Aiken et al., 2001; Kutney-Lee et al., 2009) and can provide nursing leaders with important information regarding aspects of care that are potential targets for interventions to improve outcomes. More research is needed to conclusively show that increasing the use of 'written up to date nursing plans for all patients' would result in lower patient falls on military inpatient care units. The tree-based algorithms for nurse-administered medication errors and errors with harm are more difficult to follow and appear less useful, likely because the model fit was very poor.

Limitations

In this study, 6 months of outcome and staffing data were aligned with an annual PES-NWI survey. The survey response is a cross-sectional glimpse of the nursing

practice environment at a single point in time that was being used to predict outcomes for a much larger period of time. This approach may have limited this study in that fluctuations in the practice environment, which theoretically result in changes in patient outcomes, went undetected. In addition, the patient experience with nursing care data was aligned with the rest of the dataset based on the patient's discharge date from the hospital. The patient could have been treated during a time period outside of the intended 6-month window, and this misalignment may have masked existing associations. Lastly, previous psychometric testing of the PES-NWI with a military sample demonstrated that responses differ between RNs and LPNs (Swiger et al., 2017); however, the small sample size in this study did not allow for analysis by nurse type, an approach that may have yielded different results.

It is also important to note that the pseudo R-squares for the decision tree analyses were extremely low. These results may indicate that the sample size was too small for this type of analysis, especially given the need to subset the data further for model validation. Although the tree algorithms are interesting to visualize, they are merely descriptive of the data at hand and have limited use apart from exploration of this particular dataset, and perhaps, the elucidation of highly influential predictor variables.

Implications for Research

Obtaining a reliable and representative sample is critical to the quality of research when analyzing nursing surveys. A response rate of at least 40% is often considered the gold standard as inclusion criteria when studying groups; however there are other, more direct, measures of within-group consensus (Kramer et al., 2009). ICC(2) may be an effective way to include as many survey responses as possible while maintaining data

reliability and may be particularly useful for salvaging useful information when response rates are poor. In this study, using the ICC(2) as inclusion criteria led to a larger sample than would have been possible if only the response rate had been considered. Had a 40% response rate on the annual nursing survey been selected as the unit-level inclusion criteria, only 40 unit-years would have been included in the sample, as opposed to the 79 that were retained. It is unknown whether the results of an analysis with only units that had a greater than 40% response rate would yield the same results.

Using only the PES-NWI composite score may cause researchers to miss important findings. Previous researchers have cautioned against data aggregation because associations may be masked due to the loss in variability caused by averaging high and low subscale scores (Cho, 2003; Patrician et al., 2011); this study supports this recommendation. The composite score was not significantly related to any of the outcomes under study; however, the subscales showed significant associations. Had inquiry stopped at the composite score, important information would have been lost.

Implications for Practice

This analysis provides important implications for nurses and nursing leaders. First, all nursing staff members, not just those with RN skill mix, and adequate levels of staff, (i.e., total nursing care hours per patient day) are important for the prevention of patient falls. These findings indicate that in military hospitals, increasing TNCHPPD may result in fewer patient falls. Secondly, health-care systems should continue to promote teamwork, physician communication, and collegial relationships between nurses and physicians. Lastly, if we want to improve patient experience with nursing care, improving the nursing practice environment is an important endeavor. While patients are

in the hospital, they become part of the environment of care. In this environment, it appears that they experience their care differently when nurses are supported with the foundations necessary to provide high quality care and when physicians and nurses are working well together.

Minimal implications can be drawn from the tree analysis because this technique was exploratory, the pseudo R-squares were low, and the sample size was small. However, the findings were consistent with theories that support the use of care plans and continuity of care to keep patients safe by responding to needs and changes in condition (Haggerty et al., 2003).

Conclusion

This study supports the large body of research demonstrating associations between a favorable nursing practice environment and lower adverse events. However, this analysis adds information about which *specific aspects* of the nursing practice environment matter most for *particular outcomes*. These results may help guide future intervention research targeted at reducing adverse events by improving the nursing practice environment and may provide insight into the interpretation of results in practice settings. In addition, these findings increase the actionable nature of the PES-NWI survey results with regards to nurse-administered medication errors and patient fall rate data.

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Appendix A

The Practice Environment Scale of the Nursing Work Index

	Individual Item Questions and Subscale Names
Subscale 1	*Nurse Participation in Hospital Affairs*
	Career development/clinical ladder opportunity
	Opportunity for staff nurses to participate in policy decisions
	A chief nurse who is highly visible and accessible to staff
	A chief nurse officer equal in authority to other top level hospital executives
	Opportunities for advancement
	Administration that listens and responds to employee concern
	Staff nurses are involved in the internal governance of the hospital
	Opportunity to serve on hospital and nursing committees
	Nursing administrators consult with staff on daily problems and procedures
Subscale 2	*Nursing Foundations for Quality Care*
	Active staff development or continuing education for nurses
	High standards of nursing care are expected by the administration
	A clear philosophy of nursing that pervades the patient care environment
	Working with nurses who are clinically competent
	An active performance improvement program
	A preceptor program for newly hired RNs
	Nursing care is based on a nursing rather than medical model
	Written, up to date nursing plans for all patients
	Patient care assignments that foster continuity of care
	Use of nursing diagnosis
Subscale 3	*Nurse Manager Ability, Leadership, and Support of Nurses*
	A supervisory staff that is supportive of the nurses
	Supervisors use mistakes as learning opportunities, not criticism
	A nurse manager who is good manager and leader
	Praise and recognition for a job well done
	A nurse manager who backs up nursing staff, even if the conflict is with a physician
Subscale 4	*Staffing and Resource Adequacy*
	Adequate support services allow me to spend time with my patients
	Enough time and opportunity to discuss patient care problems with other nurses
	Enough registered nurses on staff to provide quality care
	Enough staff to get the work done
Subscale 5	*Collegial Nurse-Physician Relationships*
	A lot of teamwork between nurses and physicians
	Collaboration (joint practice) between nursing personnel and physicians

Physicians and nurses have good working relationships

Note. The management title names were changed to represent the corresponding titles used in the military setting.

Appendix B

Kendall's Correlation Coefficients

Kendall's Correlation Coefficients	Rate_fall	Rate_ fallinj	Rate_ mederror	Rate_ mederror inj	tnchppds	RN_ Skillmx	Avg_ Acuity	ADT	Nurs4_ Mean	Composite	Subscale_ 1	Subscale_ 2	Subscale_ 3	Subscale_ 4	Subscale_ 5
Rate_fall	1.00														
Rate_fallinj	0.26	1.00													
Rate_mederror	0.28	0.08	1.00												
Rate_mederrorinj	0.05	0.18	0.10	1.00											
tnchppds	-0.20	-0.15	-0.07	-0.12	1.00										
RN_Skillmx	-0.14	-0.01	-0.03	0.04	0.19	1.00									
Avg_Acuity	-0.09	-0.04	-0.04	-0.05	0.33	0.35	1.00								
ADT	-0.05	-0.05	0.04	0.00	0.14	0.11	-0.08	1.00							
Nurs4_Mean	-0.25	-0.08	-0.20	-0.09	0.09	0.11	0.14	-0.03	1.00						
Composite	-0.06	0.01	-0.12	0.00	0.10	0.30	0.24	-0.03	0.10	1.00					
Subscale_1 - NPHA	0.07	0.02	-0.09	0.02	-0.03	0.14	0.07	0.01	-0.02	0.66	1.00				
Subscale_2 - NFQC	-0.02	-0.01	-0.11	0.02	-0.01	0.15	0.10	0.01	0.13	0.67	0.63	1.00			
Subscale_3 - NMA	-0.04	0.04	-0.11	0.00	0.03	0.25	0.26	-0.03	0.17	0.61	0.48	0.43	1.00		
Subscale_4 - SRA	-0.11	-0.04	0.01	0.00	0.31	0.25	0.29	-0.06	0.06	0.51	0.27	0.35	0.24	1.00	
Subscale_5 - NPR	-0.08	-0.04	-0.08	-0.03	0.24	0.29	0.25	0.07	0.07	0.57	0.39	0.40	0.30	0.41	1.00

CHAPTER 5

CONCLUSIONS

The purpose of this dissertation was to determine whether the associations between a favorable nursing practice environment and improved patient outcomes found in Magnet® hospitals, such as fewer patient falls and improved patient experience, also exist within the military system (Department of Defense, 2014; Petit Dit Dariel & Regnaux, 2015; Stimpfel et al., 2016). This goal was accomplished in a step-wise manner, resulting in the production of three manuscripts. The first paper provides a comprehensive review of the use of the Practice Environment Scale of the Nursing Work Index (PES-NWI). The second paper describes the psychometric properties of the PES-NWI in a large military sample. Lastly, the third paper discusses the results of an analysis designed to discover associations between the subscales of the PES-NWI and patient outcomes sensitive to nursing care. The objective of this final chapter is to present a brief overview of the findings from each paper and to provide an integrated interpretation of the results generated from the completed analyses. In addition, the limitations of this study will be addressed.

To review of the use of the PES-NWI, 46 articles published in English between 2010 and 2016 were included in the study. Articles collected by searching the PubMed, EMBASE, and Cumulative Index to Nursing & Allied Health Literature databases were included if they reported results analyzing the relationships between the nursing practice

environment and patient, nurse, or organizational outcomes. The review demonstrated that, although use of the instrument is still used often in studies across the globe, very few modifications or improvements to the instrument have been made since its initial publication in 2002. In addition, the methods and designs used to study the nursing practice environment remain primarily cross-sectional in nature. Specific recommendations regarding the instrument's use are offered throughout the second half of the paper. The review concludes by echoing the call for further study of the mechanisms by which the nursing practice environment influences nursing-sensitive outcomes (Bruyneel, Van den Heede, Diya, Aiken, & Sermeus, 2009; Lake, Sanders, Rui, & Yong, 2016). These studies may provide nursing leaders with actionable targets for efforts to improve the nursing practice environment and outcomes alike.

Psychometric testing of the PES-NWI in the military setting demonstrated that the instrument functions moderately well with a military sample. However, the analyses also revealed that responses differ between nurse types (registered nurses versus licensed vocational nurses) and care settings (inpatient versus outpatient). Therefore, this paper points to the need for researchers to consider nurse type and care setting during data collection and analysis. For example, when studying the hospital nursing practice environment, inpatient and outpatient responses should be assessed by group to identify meaningful variations between settings. Similarly, when surveying a nursing unit, responses may vary based on nurse type. This paper also supports the conclusion that there is a need for further instrument modification to ensure the PES-NWI is as parsimonious as possible and that the instrument measures important aspects of the contemporary nursing practice environment (Swiger et al., 2017).

Using four years of secondary data, the third paper describes a study exploring the associations between both the subscales of the PES-NWI and patient outcomes and the individual items of the PES-NWI and patient outcomes. Generalized estimating equations (GEE) were used to test the associations between the subscale scores of the PES-NWI and patient outcomes (falls with and without injury, medication administration errors with and without harm, and patient experience) (Hubbard et al., 2010). Additionally, regression tree analysis was utilized to test associations between individual items on the instrument and patient outcomes. Decision trees are advantageous because they identify predictors of subpopulations with high or low adverse event rates (Raju, Su, Patrician, Loan, & McCarthy, 2015).

Four significant associations between the PES-NWI subscales and patient outcomes resulted from the GEE analysis. The Staffing and Resource Adequacy subscale was significantly associated (b = -0.618, $p < .05$) with patient falls, the Collegial Nurse Physician Relations subscale was significantly (b = - 3.43, $p < .05$) associated with the rate of nurse-administered medication errors, and both Nursing Foundations for Quality Care and Collegial Nurse Physician Relations subscales were significantly (b = 0.033 and b = 0.028, $p < .01$) associated with patient experience with nursing care. Results from the decision tree analysis demonstrate potentially influential predictors for patient falls and medication errors; however, the pseudo R-square for these models was very low indicating poor model fit. For example, the findings portrayed in the tree algorithms (Figure 2, paper 3) for patient falls indicate that units with the lowest fall rates (both with and without injury) had increased staffing levels, nurse survey responses conveying that care plans were in place for their patients, and care assignments that fostered continuity

of care. Although the pseudo R-square for the resulting tree-based model is low (0.04), the path seems reasonable for these outcomes, and it is supported by previous research (Healey, Monro, Cockram, Adams, & Heseltine, 2004). Most importantly, this dissertation demonstrated that associations between favorable nursing practice environments and improved patient outcomes exist within the military nursing units that were studied.

Together the first two papers contributed valuable information for the design, analysis, and interpretation of the results from paper three, which provided recommendations for future research. The review of the PES-NWI revealed that the instrument is frequently used with populations other than registered nurses (RN), the population from which it was developed (Lake, 2002). Studies generally reported acceptable reliability statistics within the non-RN population; subscale Cronbach's alpha scores ranged from 0.53 to 0.90 for the subscales (Friese, 2012; Roche, Duffield, & White, 2011) and from 0.86 to 0.94 for the composite score (Choi & Boyle, 2014; Prezerakos, Galanis, & Moisoglou, 2015). However, psychometric testing of the PES-NWI with a military sample in our second paper showed that RNs and non-RNs may respond differently (Swiger et al., 2017). Unfortunately, in the third paper we found that the response rate to the PES-NWI survey for many units was low, precluding analysis by nurse type. However, the knowledge obtained from the second paper, regarding the potential differences between the way in which RNs and non-RNs responded to the PES-NWI, provided valuable information about a limitation of the study described in paper three. The knowledge gained from our studies also prompted the use of a novel criterion for unit selection to assure reliable measurement of the nursing practice environment for

each unit included. This criterion limited inclusion to units that achieved a measure of consensus (an Intraclass Correlation Coefficient [2] ≥ 0.60) between the respondents for that unit (Glick, 1985; Polit & Yang, 2015).

There are several limitations to this body of work, some of which are inherent in research using secondary data. First, the variables are often proxy measures that may not fully capture the originally targeted concept (Smith et al., 2011). For example, in this study hospital size was a proxy measure for teaching status and technology availability. However, this dichotomous variable may not fully capture subtle differences between the units included in this study. Next, underreporting of adverse events is also a potential confounder of these results and may occur more frequently in poor practice environments (Patrician & Brosch, 2009). However, evidence suggests that when nurses recognize that a medication error has occurred, they are likely to report the error (Hung, Chu, Lee, & Hsiao, 2015). Lastly, data aggregation is common in research studying the nursing practice environment and patient outcomes alike. Aggregating data may mask associations that would be evident if analysis was conducted at a level closer to the time point in which the associations occurred (S. H. Cho, 2003; Patrician et al., 2011). For this work, data were available as monthly, unit-level aggregates that were aligned in six-month blocks with the annual PES-NWI survey scores to facilitate congruence between the measures. During the time period included in this study, a potentially confounding, historical policy change occurred. In 2013, the Federal Administration Furlough sequestration resulted in projected mandatory reductions in work hours (Shanker, 2013); this change may have impacted aspects of the nursing practice environment that, in turn, affected patient outcomes. However, these effects were not measured by the PES-NWI.

Overall, despite the limitations of the study, this work provides support for the hypothesis that aspects of a favorable nursing practice environment in the military are associated with improved outcomes. The subscale "Staffing and Resource Adequacy" was significantly associated with patient falls. The best fitting model, based on quasi-information criterion, included total nursing care hours per patient day, a measure of all nursing staff caring for patients on a unit. Therefore, this analysis also supports the premise that all staffing levels, not just RN staffing, are critical to preventing falls in a unit.

Higher Collegial Nurse-Physician scores were associated with a significant decrease in nurse administered medication errors. The individual items in this subscale address teamwork, collaboration, and good working relationships (Lake, 2002), and higher scores demonstrate that these factors likely play a part in medication error prevention. This work supports existing research showing that the relationship between physicians and nurses is key to preventing nurse-administered medication errors. Favorable relationships may improve open communication about patients' medication needs, thereby improving joint problem solving, error interception, and care coordination (Mark, Sayler, & Smith, 1996).

This study also adds to a large body of research demonstrating the associations between a favorable nursing practice environment and lower adverse events. Specifically, this analysis augments past research by providing information about which *explicit aspects* of the nursing practice environment are crucial for *particular outcomes*. By identifying these subscale/outcome relationships, we increase the actionable nature of

the PES-NWI survey results with regard to nurse-administered medication errors and patient fall rate data.

Decision tree analysis is not widely used in nursing research; yet this method is popular in other fields due to the ease with which the results can be interpreted and missing data can be managed (Raju et al., 2015). In addition, tree modeling aids in the detection of complex interactions and yields graphical displays of the results (Azuero, Benz, McNees, & Meneses, 2014). A drawback of this technique is that the model generated using a single sample is exploratory because it can be over fit to the data at hand. This limitation means that for a model to be useful and valuable, it must be successfully tested with many samples (Raju et al., 2015). The tree-based models generated in this dissertation had low pseudo R-squares; however, they may provide a valuable comparison for others using this technique with these same predictors and outcomes. Furthermore, our third paper demonstrates the use of decision tree analysis in the field of nursing research.

Overall, this dissertation contributes to the body of nursing knowledge in many ways. The three published articles may help future researchers aiming to use the PES-NWI by providing specific recommendations for the use of the instrument and for which methods to utilize in the study of the nursing practice environment. The psychometric analysis of the PES-NWI provides an example of novel methods, such as association rules, that can be used for more comprehensive testing of survey instruments (Swiger et al., 2017). Lastly, this work may help guide future intervention research designed to reduce adverse events by improving aspects of the nursing practice environment and may aid in the interpretation of results in different practice settings.

Nurses make up the largest proportion of hospital staff; consequently, they have more contact with patients than any other providers, (American Association of Colleges of Nursing, 2017). When they are adequately trained, staffed, and supported by their leaders and facilities, nurses deliver care, closely observe and react to changes in patients' conditions, and intercept errors (Flynn et al., 2012; Kutney-Lee et al., 2009; West et al., 2012). Improved nursing practice environments result in better outcomes, a result that is undoubtedly important to the Military Healthcare System. Paramount to patient care is that improved nursing practice environments help to keep our patients safer while they are in our care and that patients leave our hospitals healthier and more pleased with their care experience.

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APPENDIX A

PAPER ONE - SUMMARY OF MAIN FINDINGS FOR EACH INCLUDED STUDY

Author(s) (Year)	Title	N	Country(s)	Nurse Outcome	Patient Outcome	Organizational Outcome
Aitken, L. M., Burmeister, E., Clayton, S., Dalais, C., & Gardner, G. (2011)	The impact of Nursing Rounds on the practice environment and nurse satisfaction in intensive care: pre-test post-test comparative study.	244 nurses, 2 units	Australia	Intervention Study - Nursing Grand Rounds		
Anzai, E., Douglas, C., & Bonner, A. (2014)	Nursing practice environment, quality of care, and morale of hospital nurses in Japan.	233 nurses, 12 units	Japan	N/A	Nurse reported quality of care and NFQC (+, β = 0.26) SRA (+, β = 0.18); Nurse reported quality of care and composite (+, *r* = 0.36); Ability to provide quality care and composite (+, *r* = 0.20); and Ability to provide quality care and NPHA (-, β = -0.24)	Ward morale and SRA (+, β = 0.17); Ward morale and composite (+, *r* = 0.44)
Blake, N., Leach, L. S., Robbins, W., Pike, N., & Needleman, J. (2013)	Healthy work environments and staff nurse retention: the relationship between communication, collaboration, and leadership in the pediatric intensive care unit.	415 nurses, 10 units	United States	Intent to leave and NMA (-, β = -0.287) and CNPR (ns)	N/A	N/A

Boev, C. (2012)	The relationship between nurses' perception of work environment and patient satisfaction in adult critical care	671 nurses, 4 units	United States	N/A	Patient Satisfaction and NMA (+, β = 0.424)	N/A
Cho, E., Chin, D. L., Kim, S., & Hong, O. (2016)	The Relationships of Nurse Staffing Level and Work Environment With Patient Adverse Events.	4864 nurses, 58 randomly selected hospitals, 113426 patients	South Korea	N/A	Medication errors and composite (-, OR = 0.55); pressure ulcers and composite (-, OR = 0.61); falls with injury and composite (-, OR = 0.68)	N/A
Choi, J., & Boyle, D. K. (2014)	Differences in nursing practice environment among US acute care unit types: a descriptive study.	5322 units, 519 US acute care hospitals	United States	Medical-Surgical units had the least favorable scores on the PES-NWI and SRA was the lowest scoring subscale. There are differences by the 11 different unit types and Magnet status. Overall most US hospital units have favorable practice environments		
Choi, J., & Staggs, V. S. (2014)	Comparability of nurse staffing measures in examining the relationship between RN staffing and unit-acquired pressure ulcers: a unit-level descriptive	2397 nurses, 409 acute care hospitals	United States	N/A	Unit acquired pressure ulcers SRA (-, OR = 0.78)	N/A
Flynn, L., Liang, Y., Dickson, G. L., Xie,	Nurses' practice environments, error	686 nurses, 82 units, 14	United States	Nursing error interception practices	Medication errors (ns)	N/A

M., & Suh, D. C. (2012)	interception practices, and inpatient medication errors.	hospitals		and NPHA(+, β = 1.03); NFQC (+, β = 1.56); NMA (+, β = 0.64); SRA (ns); CNPR(+, β = 1.33)		
Flynn, L., Liang, Y., Dickson, G. L., & Aiken, L. H. (2010)	Effects of nursing practice environments on quality outcomes in nursing homes.	340 nurses, 63 nursing homes	United States	N/A	Pressure Ulcers and composite (-, β = 0.37)	Number of Deficiency Citations and composite (-, β = 0.44) and NFQC (-, β = -0.38); NPHA (-, β = -0.31); NMA (ns); SRA (-, β = -0.35); CNPR(-, β = -.024); Number of Deficiency Citations and composite (-, β = -.044) and NFQC (-, β = -.036); NPHA (-, β = -0.38); NMA(-, β = -0.37); SRA (-, β = -0.43); CNPR (-, β = -0.31)
Friese, C. R., Siefert, M. L., Thomas-Frost, K., Walker, S., & Ponte, P. R. (2016)	Using Data to Strengthen Ambulatory Oncology Nursing Practice.	319 nurses	United States	Intent to stay and NPHA(+, OR = 3.68) CNPR(+, OR = 1.83); Job Satisfaction and NMA(+, OR = 1.73); NPHA(+, OR = 2.59); CNPR(+, OR = 1.99) and SRA (+, OR = 2.23)	Nurse Rated Quality Care and NFQC (+, OR = 3.32); CNPR (+, OR = 3.11)	Organizational Support of a Safety Culture and NFQC (+, β = 0.64); NPHA (+, β = 0.18); CNPR (+, β = 0.26)
Friese, C. R., &	Nurse-physician	345 nurses	United States	Favorable nurse	Nurse perceived	N/A

Manojlovich, M. (2012)	relationships in ambulatory oncology settings.			reported physician behaviors and SRA (+, ANOVA= 3.46, 2 df) CNPR (+, ANOVA= 12.40, 2 df)	quality of care (+, qualitative and quantitative finding)	
Friese, C. R. (2012)	Practice environments of nurses employed in ambulatory oncology settings: measure refinement.	1339 nurses	United States	Measure refinement for the ambulatory oncology setting		
Gabriel, A. S., Erickson, R. J., Moran, C. M., Diefendorff, J. M., & Bromley, G. E. (2013)	A multilevel analysis of the effects of the Practice Environment Scale of the Nursing Work Index on nurse outcomes.	699 nurses, 79 units, 9 branches of a hospital system	United States	See below		
-	-	-	-	Individual level - Emotional Exhaustion and NPHA (-, β = -0.24); SRA (-, β = -0.70); NMA (ns) or CNPR (ns); Turnover intention and NPHA (-, β = -0.30); SRA (-, β = -0.10); NMA (-, β = -0.17) or CNPR (ns); Job Satisfaction and NPHA (+, β = 0.15); SRA (+, β = 0.27); NMA (+, β = 0.15); or CNPR (+, β = 0.17); Total variance in the nurse outcomes explained by the PES-NWI = 39.71%	N/A	N/A
-	-	-	-	Unit level - Emotional	N/A	N/A

				Exhaustion and NPHA (ns); SRA (-, β = -0.84); NMA (ns); or CNPR (ns); Turnover intention and NPHA (ns); SRA (-, β = -0.16); NMA (-, β = -0.19); or CNPR (-, β = -.16); Job Satisfaction and NPHA (ns); SRA (+, β = 0.24); NMA (+, β = 0.18); or CNPR (+, β = 0.16)		
Goh, Y. S., & Lopez, V. (2016)	Acculturation, quality of life and work environment of international nurses in a multi-cultural society: A cross-sectional, correlational study.	814 nurses	Singapore	Acculturation and NPHA (-, r = -0.111); NFQC (ns); NMA (ns); SRA (ns); CNPR (ns); information technology subscale (-, r = -0.097)	N/A	N/A
Hallowell, S. G., Rogowski, J. A., Spatz, D. L., Hanlon, A. L., Kenny, M., & Lake, E. T. (2016)	Factors associated with infant feeding of human milk at discharge from neonatal intensive care: Cross-sectional analysis of nurse survey and infant outcomes data.	5614 nurses, 97 NICUs, 6779 infants (low birthweight)	United States	N/A	Discharge on human milk and composite (+, β = 0.04) = Adjusted R^2 = 0.37	N/A
Hallowell, S. G., Spatz, D. L., Hanlon, A. L., Rogowski, J. A., & Lake, E. T. (2014)	Characteristics of the NICU work environment associated with breastfeeding support.	6060 nurses, 104 NICUs	United States	N/A	Breastfeeding support and SRA (+, β = 0.02) NMA (ns)	N/A
Havens, D. S., Warshawsky, N., & Vasey, J. (2012)	The nursing practice environment in rural hospitals: Practice Environment Scale of the	1128 nurses, 6 hospitals	United States	Provides reference scores for rural hospitals		

	Nursing Work Index assessment.					
Havens, D. S., Warshawsky, N. E., & Vasey, J. (2013)	RN work engagement in generational cohorts: the view from rural US hospitals.	747 nurses, 5 rural hospitals	United States	Nursing work engagement (+)	N/A	N/A
Hegney, D., Eley, R., Osseiran-Moisson, R., & Francis, K. (2015)	Work and personal well-being of nurses in Queensland: Does rurality make a difference?	1608 nurses	Australia	N/A	N/A	Variance between major cities and remote hospital status NFQC (-); NPHA (ns); SRA (ns); NMA (ns); CNPR (ns)
Jafree, S. R., Zakar, R., Zakar, M. Z., & Fischer, F. (2016)	Nurse perceptions of organizational culture and its association with the culture of error reporting: a case of public sector hospitals in Pakistan.	309 nurses	Pakistan	N/A	N/A	Error reporting and NFQC (+, OR = 4.83); NPHA (+, OR = 5.08); NMA (+, OR = 2.61); SRA (+, OR = 7.95); CNPR (+, OR = 5.58)
Kirwan, M., Matthews, A., & Scott, P. A. (2013)	The impact of the work environment of nurses on patient safety outcomes: a multi-level modelling approach.	1397 nurses, 108 wards, 30 hospitals	Ireland	N/A	N/A	Nurse rated patient safety (+), Total formal adverse event reports (+)
Kutney-Lee, A., Stimpfel, A. W., Sloane, D. M., Cimiotti, J. P., Quinn, L. W., & Aiken, L. H. (2015)	Changes in patient and nurse outcomes associated with magnet hospital recognition.	136 hospitals	United States	No outcome modeled with PEW-NWI scores because of collinearity with the Magnet facilities, dropped PES-NWI.		
Lansiquot, B. A., Tullai-McGuinness, S., & Madigan, E.	Turnover intention among hospital-based registered nurses in the Eastern	301 nurses	English speaking Eastern	Intent to leave and NFQC (+, R^2 = 0.029)	N/A	N/A

(2012)	Caribbean.		Caribbean countries			
Lavoie-Tremblay, M., Paquet, M., Marchionni, C., & Drevniok, U. (2011)	Turnover intention among new nurses: a generational perspective.	145 "new" generation X or Y nurses	Canada (Quebec)	Intent to quit current position and NPHA (-); NFQC (-); NMA (ns); SRA (ns); or CNPR (-) Intent to quit profession and NPHA (-); NFQC (-); NMA (-) SRA(-); and CNPR (-); Correlations ranged between -.15 and -.24 (calculated R^2 between 0.02 and 0.06 - indicating a small effect size)	N/A	N/A
Li, B., Bruyneel, L., Sermeus, W., Van den Heede, K., Matawie, K., Aiken, L., & Lesaffre, E. (2013)	Group-level impact of work environment dimensions on burnout experiences among nurses: a multivariate multilevel probit model	23446 nurses, 2087 nursing units, 352 hospitals, 11 countries	Belgium, England, Finland, Germany, Greece, Ireland, the Netherlands, Norway, Poland, Spain, and Switzerland	Emotional exhaustion - CNPR (- [unit level only]) NMA (ns) NFQC(- [hospital level only]), depersonalization CNPR (- [unit level only])NMA (ns) NFQC(- [hospital level only]) and personal accomplishment CNPR (- [unit level only]) NMA (ns) NFQC(- [hospital level only])	N/A	N/A
Liu, K., You, L. M., Chen, S. X., Hao, Y. T., Zhu, X. W.,	The relationship between hospital work environment and nurse outcomes in	1104 nurses, 89 units, 21 hospitals	China	Burnout and composite (-, OR = 0.67); Job	N/A	N/A

Zhang, L. F., & Aiken, L. H. (2012)	Guangdong, China: a nurse questionnaire survey.			dissatisfaction and composite (-, OR = 0.50)		
Ma, C., & Park, S. H. (2015)	Hospital Magnet Status, Unit Work Environment, and Pressure Ulcers.	33845 nurses, 373 units	United States	N/A	Hospital acquired pressure ulcers and composite (-, OR = 0.73)	N/A
Mainz, H., Baernholdt, M., Ramlau-Hansen, C. H., & Brink, O. (2015)	Comparison of nurse practice environments in Denmark and the USA.	127 nurses, 4 units	Denmark	Nurses in Denmark rated their nurse work environment more favorable than United States nurses in non-Magnet hospitals and the same level as United States Magnet hospitals.		
Parro Moreno, A., Serrano Gallardo, P., Ferrer Arnedo, C., Serrano Molina, L., de la Puerta Calatayud, M. L., Barbera Martin, A., . . . de Pedro Gomez, J. (2013)	Influence of socio-demographic, labor and professional factors on nursing perception concerning practice environment in Primary Health Care.	331 nurses	Spain	N/A	N/A	N/A
Prezerakos, P., Galanis, P., & Moisoglou, I. (2015)	The work environment of hemodialysis nurses and its impact on patients' outcomes.	133 nurses	Greece	N/A	Hypotension (-, OR = 0.3), venous needle disconnection (-, OR = 0.14), patient falls (-, 0.02) and composite	N/A
Perez-Campos, M. A., Sanchez-Garcia, I., & Pancorbo-Hidalgo, P. L. (2014)	Knowledge, Attitude and Use of Evidence-Based Practice among nurses active on the Internet.	314 nurses	Spain, Mexico, Argentina, Peru, Venezuela, Colombia, and "other"	Evidence-Based Practice Competence (+, "weak" association)	N/A	N/A

Roche, M., Duffield, C., & White, E. (2011)	Factors in the practice environment of nurses working in inpatient mental health: A partial least squares path modeling approach.	149 nurses, 6 units, five hospitals	Australia	Role support and NFQC (+, β = 0.54); Role competency and NMA (+, β = -0.30); NPHA (+, β = 0.38); Therapeutic commitment (ns, composite or subscales)	N/A	N/A
Roche, M. A., Duffield, C., Friedman, S., Twigg, D., Dimitrelis, S., & Rowbotham, S. (2016)	Changes to nurses' practice environment over time.	1604 nurses, 6 hospitals	Australia	Comparison of two waves of PES-NWI results - found a significant decline in scores overtime – except SRA which remained constant		
Roche, M. A., & Duffield, C. M. (2010)	A comparison of the nursing practice environment in mental health and medical-surgical settings.	2556 nurses, 102 units, 24 hospitals	Australia	Comparison of medical-surgical and psychiatric units - Significant differences between groups on subscale scores but not on composite score		
Schwendimann, R., Dhaini, S., Ausserhofer, D., Engberg, S., & Zuniga, F. (2016)	Factors associated with high job satisfaction among care workers in Swiss nursing homes - a cross sectional survey study.	4145 nurses, 162 Nursing Homes	Switzerland	Job Satisfaction and NMA (+, OR = OR 3.76); SRA (+, OR = OR 1.42)	N/A	N/A
Shang, J., Friese, C. R., Wu, E., & Aiken, L. H. (2013)	Nursing practice environment and outcomes for oncology nursing.	4047 oncology nurses and 9236 med-surg nurses, 282 hospitals, 3 U.S. States	United States	Oncology nurses in favorable environments = Burnout and NFQC (-); composite (-, OR = 0.31); job dissatisfaction and NFQC (-); composite (-, OR = 0.24); intent to leave and NPHA (-) composite (ns)	Oncology nurses in favorable environments = Report of fair-to-poor quality of care and CNPR (-); composite (-, OR = 0.29)	N/A
Smeds Alenius, L.,	Staffing and resource	9236 nurses,	Switzerland	N/A	NA	RN reported

Tishelman, C., Runesdotter, S., & Lindqvist, R. (2014)	adequacy strongly related to RNs' assessment of patient safety: a national study of RNs working in acute-care hospitals in Sweden.	79 hospitals				patient Safety grade and SRA (+, OR = 2.74); NMA (+, OR = 1.49); CNPR (+, OR = 1.43)
Tei-Tominaga, M., & Sato, F. (2016)	Effect of nurses' work environment on patient satisfaction: A cross-sectional study of four hospitals in Japan.	425 nurses, 379 patients from 19 units	Japan	N/A	Patient Satisfaction and NPR (+, OR = 0.144)	N/A
Topcu, I., Turkmen, E., Badir, A., Goktepe, N., Miral, M., Albayrak, S., . . . Ozcan, D. (2016)	Relationship between nurses' practice environments and nursing outcomes in Turkey.	2592 nurses, 49 hospitals	Turkey	Mixed or unfavorable environment and composite score: emotional exhaustion (-, OR = 3.81); depersonalization (-, OR = 2.30); personal accomplishment (-, OR = 2.14); Intent to leave (-, OR = 1.26)	N/A	N/A
Walker, K., Middleton, S., Rolley, J., & Duff, J. (2010)	Nurses report a healthy culture: results of the Practice Environment Scale (Australia) in an Australian hospital seeking Magnet recognition.	384 nurses	Australia	Comparison between groups		
Wang, S., Liu, Y., & Wang, L. (2015)	Nurse burnout: personal and environmental factors as predictors.	717 nurses, 6 hospitals	China	Burnout and composite (-, β = -0.129); personal accomplishment NFQC (+, β = 0.258); Depersonalization and composite (-, β = 0.145)	N/A	N/A
Wang, S., & Liu, Y.	Impact of professional	218 nurses,	China	Burnout and	N/A	N/A

(2015)	nursing practice environment and psychological empowerment on nurses' work engagement: test of structural equation modelling.	2 hospitals		composite (-, β = -0.129); personal accomplishment NFQC (+, β = 0.258); Depersonalization and composite (-, β = 0.145)		
Wang, Y., Dong, W., Mauk, K., Li, P., Wan, J., Yang, G., . . . Hao, M. (2015)	Nurses' Practice Environment and Their Job Satisfaction: A Study on Nurses Caring for Older Adults in Shanghai.	444 nurses, 22 elderly care facilities	China	Job satisfaction and composite (+, β = 0.494)	N/A	N/A
Yurumezoglu, A.H., & Kocaman, G. (2016)	Predictors of nurses' intentions to leave the organization and the profession in Turkey.	564 nurses, 16 hospitals	Turkey	Intent to leave the organization and SRA (-, β = -.0446); CNPR (-, β = -0.483); Intent to leave the profession and SRA (ns); CNPR (ns)	N/A	N/A
Zhou, W., He, G., Wang, H., He, Y., Yuan, Q., & Liu, D. (2015)	Job dissatisfaction and burnout of nurses in Hunan, China: A cross-sectional survey.	1100 nurses, 20 hospitals	China	Job dissatisfaction (-, OR = 1.717)	N/A	N/A
Zuniga, F., Ausserhofer, D., Hamers, J. P., Engberg, S., Simon, M., & Schwendimann, R. (2015)	The relationship of staffing and work environment with implicit rationing of nursing care in Swiss nursing homes--A cross-sectional study.	4307 nurses, 402 Units	Switzerland	Implicit care rationing and SRA [activities of daily living (β = -0.104); caring (β = -0.065); documentation (β = -0.282); and social care (β = -0.164)]; Implicit care rationing and NMA was (ns)	N/A	N/A

Note. PES-NWI = Practice Environment Scale of the Nursing Work Index; NFQC = Nursing Foundations for Quality Care; NPHA = Nurse Participation in Hospital Affairs; NMA = Nurse Manager Ability and Support of Nurses; SRA = Staffing and Resource Adequacy; CNPR = Collegial Nurse-Physician Relationships; *r* = correlation; OR = Odds Ratios; β = Beta Coefficient; R^2 = R squared.

APPENDIX B

UNIVERSITY OF ALABAMA INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM
Institutional Review Board for Human Use

DATE: July 14, 2016

MEMORANDUM

TO: Pauline Swiger
Principal Investigator

FROM: Sally Blake Headley, CIP Sally Blake Headley, CIP
Assistant Director
Institutional Review Board for Human Use (IRB)

RE: Request for Determination—Human Subjects Research
IRB Protocol N160708008: The Military Nursing Practice Environment's Association with Patient Outcomes

A member of the Office of the IRB has reviewed your Exempt application with the above title. It was determined that the application **qualifies for the designation of Not Human Subjects Research**.

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

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