ASSOCIATION BETWEEN NURSE BURNOUT AND PATIENT OUTCOMES IN U.S. HOSPITALS

Amelia Ellen Schlak

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Supervisor of Dissertation

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Matthew McHugh, PhD, JD, MPH, RN, FAAN

Professor of Nursing, University of Pennsylvania School of Nursing

Graduate Group Chairperson

_____

Nancy A. Hodgson, PhD, RN, FAAN

Professor of Nursing, University of Pennsylvania School of Nursing

Dissertation Committee

Linda Aiken, PhD, RN, FAAN	Professor of Nursing and Sociology
Connie Ulrich, PhD, RN, FAAN	Professor of Nursing

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DEDICATION

For my Grandma who would be so proud.

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ABSTRACT

ASSOCIATION BETWEEN NURSE BURNOUT AND PATIENT OUTCOMES IN U.S. HOSPITALS

Amelia Ellen Schlak

Matthew McHugh

Burnout is an occupational phenomenon affecting 35% to 45% of hospital nurses. While nurses are equipped with the knowledge and skill to care for sick patients, lacking the infrastructure and support to provide high quality care (e.g. a poor work environment, inadequate staffing) strains nurses and leads to burnout. In the acute care setting, nurses provide the majority of bedside care. Research has linked burnout to higher rates of medical errors, missed care, and poor quality, thus drawing attention to the potentially life-threatening consequences of burnout for patients.

The National Academy of Medicine has called for more evidence to determine the impact of clinician burnout on patient outcomes. This study addresses this call by determining the relationship between nurse burnout and objective patient outcomes including 30-day in-hospital mortality, failure to rescue, adverse events, length of stay, and readmissions (Aim 1). Our study also evaluated whether the effect of nurse burnout on patient outcomes was attenuated by the quality of the nurse work environment and nurse staffing (Aim 2).

This was a secondary data analysis of 2015-2016 cross-sectional data from 4 large states. The final sample included 1,939,878 adult surgical patients across 523 U.S. hospitals. Multilevel logistic regression and zero truncated negative binomial regression were used to determine the association between hospital-level nurse burnout and patient outcomes. After adjustments for patient and hospital characteristics, patients in hospitals

with higher nurse burnout scores were associated with higher odds of 30-day in-hospital mortality (OR=1.05, p=.023), failure to rescue (OR=1.05, p=.038), and longer length of stay (OR=1.01, p=.035). The nurse work environment attenuated the relationship between nurse burnout and patient outcomes, lowering the odds of 30-day in-hospital mortality (OR=0.82, p=.001) and failure to rescue (OR=0.82, p=.003). Nurse staffing was not found to attenuate the relationship between nurse burnout and 30-day in-hospital mortality or between nurse burnout and failure to rescue. For the analysis of length of stay, the nurse work environment and nurse staffing attenuated the effect of nurse burnout, although neither were significant in the final model. No significant associations were found between nurse burnout and the odds of readmissions (OR=1.01, p=.314) or adverse events (OR=0.99, p=.537).

We conclude that higher nurse burnout in hospitals is a risk for preventable mortality, failure to rescue, and prolonged length of stay. Improving hospital work environments holds promise as a strategy for reducing nurse burnout and its associated adverse outcomes such as preventable mortality. Together, these findings suggest that hospitals can simultaneously effect positive change in nurse well-being and patient outcomes through systematic investments in the nurse work environment.

Contents

LIST OF TABLES

LIST OF FIGURES

Chapter 2

CHAPTER 1: INTRODUCTION

In 2020, the onslaught of the COVID-19 pandemic made health care provider burnout a topic of mainstream media (Grant, 2020; Hoffman, 2020; Roy, 2020; Ulrich, 2020), but it is not a new problem affecting nurses (Dolan, 1987; Maslach & Jackson, 1981; Schwartz & Will, 1953; Shinn, Rosario, Mørch, & Chestnut, 1984). Among nurses, the causes and symptoms of burnout have been widely studied (Leiter, 1991). Burnout is defined as a state of emotional exhaustion resulting from chronic workplace stressors (Maslach & Jackson, 1981; Maslach, Jackson, Leiter, Schaufeli, & Schwab, 1986). However, unlike stress, burnout cannot be adapted to any context, but instead reflects workplace strain from organizational failings around design and management (WHO, 2019; Maslach, Schaufeli, & Leiter, 2001). Rather than viewing burnout as a reflection of an individual's failure to cope or a byproduct of working with severely ill and complex patients, situating burnout within a sociological perspective has enabled researchers to think about how the organizational structure and work environment affect employee well-being. The National Academy of Medicine created the Action Collaborative for Clinician Well-Being and Resilience and later released a report on clinician burnout in 2019, noting how pervasive clinician burnout is within our healthcare system. In their report, they also contend that there is a need for more research to gain a better understanding of the consequences of clinician well-being for patients (NAM, 2019).

Across occupations, burnout has consistently been found to be the consequence of a poor work environment (Lake et al., 2019; Maslach et al., 2001). Among nurses, a poor work environment is characterized by low autonomy, poor working relationships with physicians, ineffective leadership, and insufficient resources to deliver high quality patient care (Lake, 2002; Lake, 2007). Nurses are equipped to handle the needs of

critically ill patients, but when their environment becomes an obstacle, they end up spending their time managing problems related to the work environment rather than concentrating on patient care. This tension is especially apparent when nurses lack the appropriate number of staff, when they are reluctant to consult different physicians because of hostile working relationships, or when they feel unsupported because management has been unresponsive to their past concerns. These workplace stressors cannot be solved by individual nurses (Leiter, 1991; Pearlin & Schooler, 1978); thus, they accumulate and manifest in a poor work environment and contribute to burnout among nurses.

The Consequences of Burnout

Literature has extensively documented the negative personal outcomes of burnout, including poor physical and mental health for individuals across professional fields (Salvagioni et al., 2017). However, less research has attended to the effects of clinician burnout on public health. In the context of healthcare, burnout among nurses has consequences, with the most immediate consequences affecting patients.

Organizations are also negatively impacted. Burned out employees are twice as likely to take sick leave (Hallsten, Voss, Stark, & Josephson, 2009). For individuals that go to work, burnout has also been linked with presenteeism, or when employees are at work but less productive (Demerouti, Le Blanc, Bakker, Schaufeli, & Hox, 2009). Among nurses, burnout has been linked with lower levels of job satisfaction (Dolan, 1987) and organizational turnover (Leiter & Maslach, 2009). Burned out employees are more likely to reduce their work hours (Sinsky et al., 2017), leave their current job (Meeusen, Van Dam, Brown-Mahoney, Van Zundert, & Knape, 2011), and in the most extreme cases, leave their profession entirely (Sinsky et al., 2017).

Burnout among health care providers is of particular concern because it is theorized to negatively affect patient outcomes by interfering with the process of care delivery. Health care provider burnout has been linked to medical errors and lower levels of patient safety (Hall, Johnson, Watt, Tsipa, & O'Connor, 2016). Burned out nurses are five times more likely to report missing important aspects of patient care including care coordination, administering medications on time, and adequately monitoring patient status (White, Aiken, & McHugh, 2019). Furthermore, nurses and physicians that are burned out consistently report lower levels of quality and safety (Poghosyan, 2010; Salyers et al., 2017; Tawfik et al., 2019). Burnout may also complicate the nurse-patient relationship. Around half of patients report that they avoid asking questions when they notice their healthcare provider is burned out and 75% of patients worry for their safety (ASHP, 2019). Therefore, it is unsurprising that nurse burnout has been linked with lower levels of patient satisfaction (Brooks-Carthon et al., 2020; Leiter, Harvie, & Frizzell, 1998; Vahey, Aiken, Sloane, Clarke, & Vargas, 2004).

Burnout has been linked to higher rates of workarounds (Halbesleben, 2010), or behavior subverting policy due to an obstacle in one's work, most often related to the work environment (Debono et al., 2013). This could be interpreted to mean that nurses either engage in workarounds because they are burned out or that they are burned out because they must come up with workarounds to maneuver through a poor work environment. In the latter case, burnout presents as a symptom of a poorly designed system that translates into difficulty carrying out complex patient care safely and without error. For nurses, this means excessive workloads as well as poor management, systemic breakdowns necessitating workarounds, limited autonomy, and excessive bureaucracy. These poor work conditions among nurses have consistently been shown

to be related to the development of burnout as well as negative patient outcomes such as mortality (Aiken, Clarke, Sloane, 2002; L. H. Aiken, Clarke, Sloane, Lake, & Cheney, 2008) and failure to rescue (Friese, Lake, Aiken, Silber, & Sochalski, 2008). In 1999, a landmark study of patient safety by the National Academy of Medicine (formerly known as the Institute of Medicine) concluded that safety is a property of the system, rather than the individual clinician (Donaldson, Corrigan, & Kohn, 2000). In a similar vein, a subsequent National Academy of Medicine study concluded that the environment in which healthcare providers work is largely responsible for clinician burnout, rather than the personal attributes of clinicians themselves (NAM, 2018; NAM, 2019).

There are two perspectives from which burnout is typically studied, the psychological and the sociological. The psychological understanding of burnout focuses on ways in which the experience of burnout affects an individual's capacity to do their job well, and over time, this has shifted to focus on ways in which individuals can build their personal resilience to deal with adverse work conditions. Maslach, the psychologist who empirically defined burnout, noted that it is paradoxical that most interventions to alleviate burnout focus on individuals since the research suggests that situational and organizational factors play a much greater role in burnout (Maslach et al., 2001, p. 418). In contrast, the sociological perspective situates our understanding of burnout within the organizational context that is responsible for producing it. This study is focused on the sociological understanding, or the interplay between the environment, the nurses, and the patients they care for.

Central Hypothesis

We hypothesized that patients cared for in hospitals with higher levels of nurse burnout would be more likely to experience poor outcomes, even after accounting for patient and hospital characteristics. We further hypothesized that underlying this relationship is a lack of organizational support manifesting through a poor work environment and inadequate staffing.

Overall objective

The overall objective of this study is in line with the National Academy of Medicine report, “Taking Action Against Clinician Burnout: A Systems Approach to Professional Well-Being,” which called for more research to determine the impact of clinician burnout on patient outcomes and to identify work system factors that promote well-being among clinicians (NAM, 2019). This study was in a unique position to consider both what nurse burnout means for patient outcomes (Aim 1) and the potential for work environment improvements to be a system-level intervention to address nurse burnout and improve patient outcomes (Aim 2).

Specific Aim #1

To determine hospital-level associations between nurse burnout and patient outcomes (i.e. mortality, failure to rescue, adverse events, length of stay, and readmissions).

Hypothesis 1: There will be an association between hospitals with a higher levels of nurse burnout and poor patient outcomes, including higher rates of mortality, failure to rescue, adverse events, readmissions, and longer length of stay.

Specific Aim #2

To evaluate whether the effect of hospital-level nurse burnout on patient outcomes is attenuated or explained by the quality of the nurse work environment and nurse staffing.

Hypothesis 2: The relationship between nurse burnout and patient outcomes will be attenuated by the quality of the nurse work environment and levels of nurse staffing.

Study overview

This study aims to determine the relationship between hospital-level nurse burnout and objective patient outcomes including mortality, failure to rescue, adverse events, length of stay, and readmissions. Using data from thousands of nurses and almost 2 million patients in over 500 hospitals, this study is the largest examination of nurse burnout and its impact on objective patient outcomes to date. We addressed the limitations of prior work by using a unique data set that allowed us to examine the relationship between nurse burnout, objective patient outcomes, and empirical measures of work environments in a large, representative group of hospitals.

Our study also illuminates a potential solution for nurse burnout. Specifically, we determined whether better nurse work environments (e.g. creating a more supportive management structure, increasing nurse participation in hospital affairs, facilitating professional relationships, and increasing resource support through better staffing) are associated with lower nurse burnout and better patient outcomes. Prior research has identified a poor nurse work environment (e.g. unsupportive management, low nurse autonomy, poor working relationships between nurses and physicians, and resources) and poor staffing as primary causes of nurse burnout (Lake et al., 2019). This study

builds on these findings by considering how the nurse work environment and staffing could be leveraged to simultaneously alleviate nurse burnout and improve patient outcomes.

Significance

Burnout has recaptured the attention of the National Academy of Medicine, the World Health Organization, and the Joint Commission based on two ideas: That burnout disproportionately affects healthcare providers, such as nurses and physicians, and that clinician burnout has negative implications for patient care (WHO, 2019; Brigham et al., 2018; JCAHO, 2019; NAM, 2018; NAM, 2019). In their role, nurses are the primary bedside provider, responsible for the majority of patient care. The responsibilities of nurses are numerous and include ongoing monitoring, medication and treatment administration, care coordination, patient education, and emergency response. In order for health systems to answer the Triple Aim (i.e. improve population health, reduce per capita cost, and improve patient experience), Bodenheimer and Sinsky have called for the expansion to the Quadruple Aim to support clinicians in doing their best work (Berwick, Nolan, & Whittington, 2008; Bodenheimer & Sinsky, 2014). In 2017, the National Academy of Medicine took a stance with the creation of the Action Collaborative for Clinician Well Being and Resilience and in 2019 released their report, “Taking Action Against Clinician Burnout: A Systems Approach to Professional Well-Being,” asking for more research to evaluate the impact of clinician burnout on patient care and solutions to mitigate the growing rates of burnout among clinicians (NAM, 2018; NAM, 2019). Our study provides foundational evidence concerning the relationship between nurse burnout and patient outcomes (Aim 1) and an actionable solution to alleviate nurse burnout and improve patient care (Aim 2).

CHAPTER 2: BACKGROUND AND SIGNIFICANCE

Introduction

The purpose of this study was to consider the consequences of nurse burnout on patient outcomes. Aim 1 looked at the relationships between hospital-level nurse burnout and mortality, failure to rescue, adverse events, length of stay, and readmissions. Aim 2 built on these findings by evaluating whether the nurse work environment and nurse staffing attenuated the relationship between nurse burnout and respective patient outcomes. If the nurse work environment and/or nurse staffing attenuates the relationship between nurse burnout and patient outcomes, this would suggest that interventions aimed at improving staffing and the work environment could be used to concurrently improve nurse well-being and patient outcomes. This chapter provides a review of past research from psychological and sociological perspectives. It specifically highlights sociological research that is consistent with the understanding of burnout as an organizationally produced phenomenon with consequences for patients. Lastly, it introduces the conceptual framework that guided this study.

Burnout: Conceptual and Empirical Definitions

Burnout is a state of exhaustion resulting from a chronically stressful workplace (Maslach & Jackson, 1981; Maslach et al., 2001). The pioneering and widely used Maslach Burnout Inventory (1981) describes three dimensions of burnout: emotional exhaustion, cynicism, and reduced personal accomplishment.

Emotional exhaustion is the central and defining feature of burnout and results from prolonged stress and work overload. Emotional exhaustion is more than fatigue; it is characterized by feeling drained, tired at the start of a new day, and unable to unwind

or relax after work. As a result, a person emotionally distances themselves and acquires a cynical attitude towards their work, their colleagues, and their clients. **Cynicism or depersonalization** is how a person responds to a chronically stressful situation with the goal of "protect[ing] oneself from exhaustion and disappointment" (Maslach, 1997, p. 18). Cynicism is the interpersonal dimension of burnout and is defined by the apathetic and detached attitude that a person assumes in their professional relationships. The last dimension, **low levels of personal accomplishment or self-inefficacy**, is characterized by feeling inadequate in one's professional role and overwhelmed by projects or tasks (Maslach, 1997).

Psychological Theories of Burnout

Burnout first emerged as a psychological construct with researchers focused on exploring the experience and personally mediated outcomes of burnout. Due to the psychological focus of burnout from its conception, two main theories of burnout emerged and dominated much of the burnout research: The **Six Areas of Work Life Model** (Leiter & Maslach, 1999) and the **Job Demands-Resources Model** (Demerouti, Bakker, Nachreiner, & Schaufeli, 2001). The Six Areas of Work Life Model is characterized by the mismatch between the employee and the organization around workload, control, rewards, community, fairness, and values. The Job Demands-Resources Model has similar themes, not only corresponding with physical demands or resources (e.g. too much work and not enough staff) but encompassing broader issues. For example, in addition to workload, job demands include time pressure, recipient contact, physical environment, and shift work. Job resources include feedback, rewards, autonomy, participation, job security, and supervisor support.

The Psychological Perspective of Coping with Workplace Strain

The psychological perspective focuses on individual coping mechanisms that are geared towards dealing with the effects of stress rather than directly addressing the primary source of workplace burnout. Thus, much of the psychological research on burnout has focused on coping behaviors and the ways that individuals can change to accommodate workplace stressors. Coping behaviors include actions that individuals use to adapt to stressful circumstances (Pearlin & Schooler, 1978). As outlined by Newman and Beehr (1979), there are 4 ways the individual can change to accommodate workplace stressors. **Psychological adaptions** require that individuals alter their perception through meditation, psychological withdrawal, planning, or adjusting their philosophy of life and self. **Physiologic adaptions** encourage individuals to engage in a healthy diet, exercise, and sleep**. Behavioral changes** urge individuals to use relaxation techniques, engage in less type A behavior, take time off to relax, and create a supportive network of friends. The final and most extreme option requires that individuals **change their work environment** by either shifting occupations or moving to a different organization (Newman & Beehr, 1979).

Burnout: An Occupational Phenomenon Situated within a Sociological Context

Sociological studies conceptualize burnout as a phenomenon produced within social, organizational, and environmental structures. Despite the situation of the Six Areas of Work Life Model and the Job Demands-Resources Model within a psychological context, the themes can be further examined within a sociological perspective that considers not just the individual etiology, but the influence of organizational structure and design. Such sociological themes include **workload and resources, autonomy and decision making, the support and effectiveness of**

leadership and management, and the working relationships among colleagues. This project builds upon sociological understandings of burnout as it considers the "various structural arrangements in which individuals are embedded" (Pearlin, 1989, p. 241).

In 2019, the World Health Organization defined burnout as an occupational phenomenon rather than a medical condition (WHO, 2019), highlighting its intrinsic tie to the workplace and organizational health. The concept of organizational health emerged from sociotechnical systems theory and theorizes how **organizational design and structure is inherently linked to employee health and wellness** (Cox & Thomson, 2000). "Healthy organizations are those which, among other things, not only design and effectively manage healthy systems of work, but also seek explicitly to enhance the health of their employees, encouraging healthy work behaviour" (Cox & Thomson, 2000, p. 183). Conversely, unhealthy organizations have poor work environments characterized by system mismanagement and inefficient workflows. Poor organizational design places excessive strain on employees and eventually leads to diminished commitment, substandard work, and burnout (Cox & Thomson, 2000). While it has been acknowledged that burnout is a product of these greater systemic factors rather than individual failings, frameworks for studying burnout have largely been psychologically focused. Our study takes a different approach as we are concerned not with the individual etiology of burnout, but with the pervasive social and organizational structures that lead to nurse burnout and what the public health implications are for patients.

The Sociological Perspective of Organizational Responsibility

The sociological perspective emphasizes how organizations can relieve job strain and the resulting burnout through organizational design and management of work

policies and practices. **Unlike individual coping behavior, such changes are capable of directly addressing the sources of job strain that lead to employee burnout.** Newman and Beehr (1979) summarize ways in which organizations can minimize job strain by changing organizational conditions. **Changing organizational conditions** involves structural changes such as the decentralization of decision making and the elimination of unnecessary hierarchy in positions. Further improvements can be made through the **transformation of organizational processes** like rewards systems (e.g. clinical ladders for nurses), training and development policies, transfer and rotation policies (e.g. policies for "floating" nurses to different units outside of their regular unit), participative decision making (e.g. shared governance), and development of mental and physical health services for employees. Organizations can also **change role characteristics** by redefining roles, redistributing the workload, providing more resources, and/or increasing autonomy. Employers can take greater steps by soliciting employee preference for placement and providing training programs to help employees gain new skills (Newman & Beehr, 1979).

Contrasting the Effectiveness of Individual and Organizational Interventions

In our review of the literature, **we found that individual-level coping mechanisms are not enough to overcome the system-wide failures that lead to burnout**. Such coping mechanisms may be useful in the short term, but do not have long-lasting effects as they do not address the main cause of burnout. For example, one field experiment found that when employees experienced new work demands following an individual-level intervention (e.g. psychological and behavioral adaption training), the benefits that employees initially reported were eliminated (Ganster, Mayes, Sime, & Tharp, 1982). Another study of coping mechanisms found that individual-level coping

mechanisms were effective strategies for addressing stressors within interpersonal relationships (i.e. marriage, parenting, household economics), but were not effective in resolving workplace stressors (Pearlin & Schooler, 1978). These finding were echoed in subsequent studies, which concluded that self-care and coping behaviors are not enough to overcome the organization-wide failures that lead to burnout (Leiter, 1991; Osipow & Davis, 1988; Shinn et al., 1984). Individual coping within an organizational context makes the assumption that individuals can exert some control over their environment when, in reality, such coping efforts might only be effective when supported by one's colleagues and management (Leiter, 1991). This highlights an important distinction: individual interventions can be effective in resolving issues that are within an individual's control, but system-wide failures extend beyond an individual's scope and capacity to cope. This conceptual distinction is captured in Mechanic's conclusion "that [job stressors] are not amenable to individual solutions, but depend on highly organized cooperative efforts that transcend those of any individual… no matter how well developed his personal resources" (Mechanic, 1974, p. 34).

While individual-level interventions like resilience training and mindfulness-based stress reduction have been considered as options to address clinician burnout, their effectiveness is impaired within a poor work environment and inappropriately shift the responsibility from the organization to the individual. Two systematic reviews and meta-analyses have been published comparing the effectiveness of individual-level (e.g. resilience training, mindfulness-based stress reduction) and system-level interventions among clinicians, including nurses and physicians (Panagioti et al., 2017; West, Dyrbye, Erwin, & Shanafelt, 2016). Together, these reviews echo what the sociological literature suggests: system-level solutions are more effective in reducing and eliminating clinician

burnout (Panagioti et al., 2017; West et al., 2016). This conclusion is consistent with the National Academy of Medicine's recommendation to improve work environments, noting that "while individually targeted interventions may help individual clinicians, they will not address the systemic issues that drive the burnout problem in the first place" (NAM, 2019). It is true that certain psychological stressors are inevitable, such as witnessing death, dying, or suffering. However, supporting patients and their families through these experiences is the driving motivation for why many pursue nursing and medicine as a career. Resilience building would be an appropriate avenue to alleviate unavoidable suffering among clinicians, but the issues relating to a poor work environment (e.g. poor staffing and unsupportive management) are avoidable and can be improved to prevent burnout among clinicians (Card, 2018).

How a Poor Work Environment Contributes to Burnout

The organizational conditions affected by the design and management of the larger system include workload, autonomy, leadership and management, and working relationships, all of which have a direct impact on the development of burnout. The themes (e.g. workload, autonomy, leadership, and management) raised by the Six Areas of Work Life Model and the Job Demands-Resources Model incorporate the organizational antecedents to nurse burnout and encapsulate the elastic, working relationship between nurses and the organizations in which they work. For nurses, these have been conceptualized and measured via the Practice Environment Scale of the Nursing Work Index (PES-NWI) (Lake, 2002), which has been used to empirically link the nurse work environment to nurse burnout and patient outcomes in previous research (Lake et al., 2019). The PES-NWI is based on five subscales**: Nurse Participation in Organization Affairs; Nursing Foundations for Quality of Care; Nurse Manager**

Ability, Leadership, and Support of Nurses; Staffing and Resource Adequacy; Collegial Nurse-Physician Relations (Lake, 2002). The themes of the PES-NWI are reflected in the Six Areas of Work Life Model discussed as the theoretical foundation for the antecedent to burnout (Leiter & Laschinger, 2006). In this study, we used the PES-NWI to measure the nurse work environment.

Workload

A heavy workload, or when one has "too much [work] in too little time with too few resources" has consistently been demonstrated to be predictive of developing burnout (Leiter & Maslach, 2003, p. 95). Among nurses, workload includes whether there are enough nurses, support staff, and resources to spend the necessary time with patients to deliver high-quality, safe care (Lake, 2002). Workload is most often captured in staffing levels, which refers to the number of patients that each nurse is responsible for within a hospital. A study by Leiter & Laschinger (2006) examined staffing's relationship with the three dimensions of burnout and found that it was most strongly correlated with emotional exhaustion. The body of research by Aiken and colleagues has further established the important role that staffing plays in fostering burnout among nurses. For example, even after adjustments for nurse and hospital characteristics were made, a 2002 study found that, on average, each additional patient per nurse was associated with a 23% increase in the odds of burnout among nurses (Aiken, Clarke, Sloane, Sochalski, & Silber, 2002). In a study of 30 hospitals in England, nurses under less favorable staffing conditions were 78% more likely to report feeling burned out (Rafferty et al., 2007). In 2004, California implemented staffing ratios, improving nurse to patient ratios. Following this legislation, California nurses reported that "workloads were reasonable, that they received substantial support in doing their jobs, that there were

enough nurses to get their work done and provide high-quality care, and that 30-min breaks were part of their typical workday" (Aiken et al., 2010, p. 911). These improvements were associated with significantly lower levels of nurse burnout.

Autonomy

While workload, influenced by staffing, is an important contributor to burnout, it would be an oversimplification of a complex phenomenon to attribute it as the only cause. The relationship between autonomy and workplace strain has also been established. As highlighted by Karasek, organizations "must distinguish between two important elements of the work environment… (1) the job demands placed on the worker and (2) the discretion permitted the worker in deciding how to meet these demands" (Karasek, 1979, p. 285). Karasek discovered that when employees have the autonomy to use their skills and exercise their professional judgement, there were reductions in job strains at **every level** regardless of differing job demands, suggesting that decision latitude is an important moderator of workplace strain (Karasek, 1979). For example, a common assumption is that nurses working within intensive care units (ICU) would be more prone to developing burnout given the exposure to death and dying and the intensity of their work. However, what distinguishes ICU nurses from medical surgical nurses is their relative autonomy, the opportunity to specialize in certain patient populations to gain greater expertise, close ties with like-minded physicians focusing on critical care, and improved staffing levels allowing them to spend significantly more time with each patient. Accordingly, ICU nurses have been found to have lower levels of stress (Keane, Ducette, & Adler, 1985; Maloney, 1982), which might not appear intuitive if one assumes that burnout is associated with any stressor rather than workplace stressors induced by failures in organizational design. While burnout is distinct from

stress, the research comparing job stress among ICU nurses and medical surgical nurses shows how workplace design affects worker autonomy and associated well-being. The creation of dedicated AIDS units in the 1980s is another example of the relationship between greater autonomy and lower levels of burnout. Dedicated AIDS units were characterized by much greater nurse autonomy and control than generalized medical units, which revolve around a more physician-centric model (Aiken & Sloane, 1997b). This organizational change translated into AIDS nurses having, on average, a 5-point lower score in burnout than nurses on generalized medical units, despite seeing intense suffering and death (Aiken & Sloane, 1997a).

Leadership, Management, and Working Relationships

Another way to increase autonomy among front-line workers is to promote a flat organizational structure characterized by fewer management layers between leadership and front-line employees. Such a structure encourages less supervision and oversight from management and encourages workers to participate in the decisions affecting them and their work. Although not in healthcare, a classic example in organizational psychology is an intervention introduced by Wall & Clegg (1981) that was designed to decentralize decision making and shift greater control to front-line workers. Management's role was reserved for support, coordination, and planning. The changes were met with improved employee autonomy, and resulted in enhanced motivation, performance, job satisfaction, mental health, and reduced turnover (Wall & Clegg, 1981). Echoing these findings, another study completed an organizational intervention to enhance participative decision making among nursing staff, requiring that managers hold more frequent staff meetings to reduce role conflict and role ambiguity (Jackson, 1983). Participative or shared decision-making increases opportunities for employees to

discuss problems or weigh in on decisions affecting them in their work, as opposed to limiting such decisions to upper management (Schuler, 1977, 1980). When employees have more opportunities to communicate with management, it allows employees to "remove obstacles to effective performance" (Jackson, 1983, p. 5).

Consistent with the work on autonomy, leadership, and management styles, a substantial body of research has also established the relationship between the work environment and the development of nurse burnout. An analysis of panel data by Kutney-Lee and colleagues concluded that improvements in nurse staffing and the nurse work environment were associated with decreases in burnout, job dissatisfaction, and intent to leave (Kutney-Lee, Wu, Sloane, & Aiken, 2013). They considered 137 Pennsylvania hospitals from 1999 and 2006, finding that hospitals with declining work environments had an increase in nurse burnout by 7.4%. The consistency of these findings over time gives further evidence supporting the causal nature of this relationship. The authors also found that the work environment was a stronger predictor of burnout, job dissatisfaction, and intent to leave than staffing, suggesting that nurses are the most sensitive to organizational factors centered around their autonomy as well as their working relationships with physicians and management (Kutney-Lee, Wu, Sloane, & Aiken, 2013). A similar finding was illustrated in a secondary analysis of panel data comparing Pennsylvania hospitals that had undergone the Magnet accreditation process compared to those that did not (Kutney-Lee et al., 2015). Magnet accreditation is a voluntary mechanism that hospitals can undertake to improve their nurse work environment (Lake et al., 2019; Wei, Sewell, Woody, & Rose, 2018). It emerged out of a study examining reasons why nurses stay at certain hospitals (McClure, Poulin, Sovie, & Wandelt, 1983). This study by Kutney-Lee and colleagues (2015) found that hospitals that attained Magnet status between 1999 and 2006 had almost a 10-point drop in their

percentage of burned out nurses. These findings were also demonstrated in a larger sample of hospitals from California, Florida, Pennsylvania, and New Jersey (Kelly et al., 2012). Specifically, Magnet hospitals were found to have better staffing levels and nurse work environments, which were associated with a 13-point difference in the percentage of burned out nurses (Kelly et al., 2012). These relationships among nurses have been supported in a 2019 meta-analysis that established that better work environments are associated with 18% lower odds of developing burnout (Lake et al., 2019). Together these studies highlight the relationship between the work environment and job strain, as well as the effect such interventions (e.g. participative decision making, decentralized decision making) could have on burnout. Employers can improve autonomy by empowering front-line workers to make decisions about task structure, encouraging them to participate in organizational decisions, and allowing them to exercise discretion over their work (Karasek, 1979, p. 304). While autonomy highlights the importance of the front-line workers perceptions and human capital, it also highlights that the role of management should not be to dictate, but to facilitate the work of employees.

The Link Between the Work Environment, Staffing, and Patient Outcomes

There is research linking organizational features of hospitals to nurse burnout, as well as poor patient outcomes. This suggests that nurses and patients are affected by the same organizational features of hospitals. In a seminal study of nurse staffing and the outcomes of surgical patients, Aiken and colleagues found that each additional patient per nurse was associated with a 7% increase in the odds of patient mortality within 30 days of admission as well as a 7% increase in the odds of failure to rescue (death after developing a complication within a hospital) (Aiken et al., 2002). Another study of hospitals in the U.S., Canada, England, and Scotland, found that nurses were

twice as likely to rate care as low quality when they work within understaffed hospitals that also have poor work environments (Aiken et al., 2002). These findings have been demonstrated in later studies. For example, a study of 300 hospitals across 9 European countries found that an additional patient per nurse was associated with a 7% increase in the odds of mortality (Aiken et al., 2014).

Similar improvements in patient outcomes were observed in hospitals that improved their work environments. In one panel study, hospitals that received Magnet recognition achieved more pronounced improvements in 30-day mortality rates compared to non-Magnet hospitals over time (Kutney-Lee et al., 2015). On average, the percentage of nurses rating the care provided as excellent in their hospitals increased by almost 10 points more in hospitals that achieved Magnet status over this time period compared to non-Magnet hospitals (Kutney-Lee et al., 2015). In hospitals that became Magnet certified, nurses were more confident that patients could manage their care following discharge and were confident that management would resolve patient care problems (Kutney-Lee et al., 2015). These studies demonstrate that the nurse work environment and nurse staffing have a clear effect on the development of nurse burnout. However, they also show that the same features that lead to nurses becoming burned out (e.g. low autonomy, lack of necessary resources, poor management, and hostile working relationships) also have negative implications for patients. Our study builds on this by determining the relationship between nurse burnout and patient outcomes and by suggesting if improvements in the nurse work environment and staffing could be used to mitigate any observed relationship between nurse burnout and patient outcomes.

The Consequences of Burnout for Clinicians, Hospitals, and Patients

Clinicians

Burnout has multiple implications for nurses, the organizations in which they work, and the patients they serve. From a provider standpoint, burnout is associated with poor physical and mental health outcomes, disrupting the foundation of personal and professional well-being. A 3-wave, 7-year study found that burnout was predictive of depression and lower life satisfaction (Hakanen & Schaufeli, 2012). Work by Shanafelt and colleagues found that surgeon burnout is associated with lack of work-life balance (Shanafelt et al., 2012), lower levels of career satisfaction (Shanafelt et al., 2009), and almost twice the likelihood of suicidal ideation (Shanafelt et al., 2011). A systematic review considered effects of burnout across occupations and found burnout to be predictive of cardiovascular diseases like hypercholesteremia, type 2 diabetes, coronary heart disease, and even mortality for those under 45 years of age (Salvagioni et al., 2017).

Hospitals

There are also economic implications of burnout for organizations. In addition to nurse burnout being linked with lower levels of job satisfaction (Dolan, 1987), it is linked to turnover behavior (Leiter & Maslach, 2009). Turnover is especially costly for hospitals as nurse turnover has been estimated to cost an organization between $82,000 and $88,000 for each nurse that leaves, culminating in, on average, $7.5 - $8.5 million dollars annually per hospital (Jones, 2008). For nurses that do stay in their jobs, nurse burnout has been linked with safety workarounds and occupational injuries such as needle sticks (Halbesleben, 2010). While burnout has generally been linked to higher

rates of absenteeism (Maslach et al., 2001), a study of nurses found that burnout was predictive of absenteeism related to emotional exhaustion rather than physical health issues (Parker & Kulik, 1995).

Patients

Across different occupations, burnout has been connected to lower productivity and reduced work quality (Wright & Bonett, 1997; T. A. Wright & Cropanzano, 1998). However, what is not distinguished in much of the burnout-outcomes research is whether burnout leads to poor outcomes, or whether it is the same organizational failures that cause burnout that lead to poor outcomes. There are two perspectives on how nurse burnout affects patient outcomes: (1) The psychological perspective focuses on how feelings of burnout may undermine nurses' capacity to be fully engaged in their work, leading to mistakes and lack of attention, ultimately resulting in poor outcomes. For example, one study found that burnout was associated with cognitive and attentional deficits related to executive control, meaning that burned out individuals were unable to adequately "allocate attention to action," translating into poor objective performance (Linden, Keijsers, Eling, & Schaijk, 2005). (2) The sociological perspective situates the individual within an organizational context and considers how burnout reflects systemic failures and whether it is these organizational failures that account for both burnout and poor patient outcomes.

Some of the research examining the relationship of nurse burnout on patient outcomes echoes the sociological literature discussed above. One such study found that nurses experiencing burnout were five times more likely as their counterparts to report missing important care such as adequate patient surveillance, timely administration of medications, and care coordination (White et al, 2019). However, the authors highlight

that the reasons why burned out nurses report missing care are due to a much greater source: “working in under resourced settings generates stress for nurses who realize that needed nursing care is being missed, which, in turn, generates additional stress for feeling that they cannot provide better quality care” (White et al., 2019, p. 2069). Another study examined the relationship between burnout and workarounds, or solutions employees create to finish a task when there are obstacles blocking their workflow. When work environments are littered with workarounds, it shows how poor organization of the environment directly affects the work processes of employees. Specifically, the study found that workarounds mediated the relationship between nurse burnout and higher rates of occupational injuries (Halbesleben, 2010). A sociological perspective would suggest that the organizational failures contributing to the need for nurses to engage in workarounds are also responsible for occupational injuries, rather than burnout itself.

Similar themes have emerged from the literature examining the relationship of nurse burnout with patient satisfaction. For example, studies have found that patients are less satisfied with their care when hospitalized on units where nurses report higher levels of burnout (Leiter et al., 1998; Vahey et al., 2004). Another study found that patients were less likely to give their hospital a high rating or recommend it to a friend when cared for in hospitals with higher rates of burned out nurses (McHugh et al., 2011). A recent study by Brooks-Carthon & colleagues showed that an increase in the proportion of burned out nurses was associated with a lower percentage of patients that would recommend their hospital, but further contextualize this by noting that nurses are less likely to be burned out within good work environments (Brooks-Carthon et al., 2020). These findings suggest that hospitals could target improvements in both nurse burnout and patient satisfaction ratings by improving their work environments.

The most alarming consequence is that burned out nurses consistently report lower quality of care and lower safety (Halbesleben, Wakefield, Wakefield, & Cooper, 2008; Poghosyan, 2010). Two meta-analyses conducted support this concern but also acknowledge that most of the research linking nurse burnout to patient outcomes relies on subjective measures such as nurse-perceived quality and safety (Salyers et al., 2017; Tawfik et al., 2019). Our study corroborates these findings with objective outcomes while also considering the role of system-level factors.

Nurse Burnout and Objective Patient Outcomes

Compared to most research linking nurse burnout to subjective outcomes, the research linking nurse burnout to objective patient outcomes is limited in terms of methodology and the number of studies available. When reviewing the existing literature, the results are also contradictory. For example, a 2006 study of 52 hospitals looked at the impact of organizational climate safety factors (i.e. teamwork, climate, working conditions) and burnout's relationship with risk adjusted morbidity and mortality. The authors found that none of the organizational climate safety factors, including burnout, were correlated with morbidity or mortality (Davenport, Henderson, Mosca, Khuri, & Mentzer Jr, 2007). However, the hospitals and the survey respondents were not randomly selected. Instead, researchers invited the chief of surgery at each hospital to participate, who designated which staff could participate in the survey, introducing bias in the sampling technique. In contrast with those null findings, a later study by Welp and colleagues (2015) found that across 48 hospitals, using a sample of 1425 nurses and physicians, burnout was a main predictor of mortality. Of note, this study also relied on a convenience sample for their approach (Welp, Meier, & Manser, 2015).

Similar inconsistencies have been found among studies examining the relationship between nurse burnout and adverse events, with one study finding a positive relationship between 105 nurses and 150 patients within 1 hospital (Sillero-Sillero & Zabalegui, 2019), while another study found that nurse burnout was actually associated with lower levels of adverse events across 3 hospitals (Vogus, Cooil, Sitterding, & Everett, 2014). Another unexpected relationship was observed by Schaufeli and colleagues (1995) relying on a sample of 508 nurses and 7,126 patients across 39 ICUs. They found that nurse burnout was associated with shorter length of stay (Schaufeli, Keijsers, & Miranda, 1995). However a later 2015 study did not find any association between nurse burnout and length of stay across 48 hospitals (Welp et al., 2015).

In addition to contradictory findings, the majority of these studies are limited due to their reliance on small convenience samples of hospitals and nurses as well as lack of adjustments for potential confounders (Davenport et al., 2007; Galletta et al., 2016; Garrouste-Orgeas et al., 2015; Schaufeli et al., 1995; Sillero-Sillero & Zabalegui, 2019; Vogus et al., 2014). An exception to some of the methodological limitations related to small sample size is a 2012 study by Cimiotti & colleagues, which found that emotional exhaustion mediated the relationship between nurse staffing and the prevalence of hospital-acquired infection across 161 hospitals. They estimated that the hospitals that reduced nurse burnout by 30% had over 6,000 hospital-acquired infections averted, translating to $68 million dollars saved (Cimiotti, Aiken, Sloane, & Wu, 2012).

Addressing the Methodological Limitations of Burnout Research

In the body of research examining nurse burnout's relationship to patient outcomes, there are three main limitations frequently raised: common method variance, subjective outcomes, and the absence of system controls.

(1) Common method variance is the systematic error that results from using the same measure or measurement technique. Within burnout research, self-surveys are commonly used and the respondent ends up providing information on the predictor, symptoms, and outcome, possibly inflating the relationship between the variables of interest (Jakobsen & Jensen, 2015; Podsakoff, MacKenzie, Lee, & Podsakoff, 2003; Tehseen, Ramayah, & Sajilan, 2017). Our study addressed this by aggregating the measure of nurse burnout, the nurse work environment, and nurse staffing to the hospital-level, diminishing the concern that individual bias is affecting the observed relationship (Podsakoff et al., 2003). We also take further precautions by using objective patient outcomes, rather than nurse reports.

(2) Subjective outcomes are another common concern due to the third dimension of burnout, self-inefficacy or a low level of personal accomplishment. This dimension of burnout leads researchers to wonder if burnout is linked to poor outcomes or if burned out individuals merely have a negative perception of their work (Fahrenkopf et al., 2008). A 2008 study found that burned out residents were more likely to report having made a significant error (Fahrenkopf et al., 2008). However, when the subjective reports were compared with objective error rate between non-burned out residents and burned out residents, there was no significant difference (Fahrenkopf et al., 2008). This finding suggests that burnout might not be associated with poor quality, rather that burned out residents just perceive quality and safety to be lower because they are burned out. In contrast, a study found that nurses' reports of quality and safety coincided with rates of mortality, failure to rescue, patient satisfaction, and process measures (McHugh & Stimpfel, 2012). Although this study did not directly compare the reports of burned out and non-burned out nurses directly, the finding suggests that nurses are reliable informants of hospitals' quality (McHugh & Stimpfel, 2012). Our study builds on this by linking nurse

burnout to objective outcomes to objectively evaluate what prior research has shown with subjective outcomes.

(3) There is a lack of system-level controls within burnout-outcomes research. This is in part due to the tension in burnout research between the psychological and sociological frameworks previously discussed: situating burnout from an individual's perspective or from a systems perspective. A systems approach allows us to isolate the effect of nurse burnout on patient outcomes as we control for patient characteristics (i.e. comorbidities, surgical procedure, transfer status, age, sex) and other hospital structural characteristics (i.e. teaching status, technology status, bed size, state) previously linked to patient outcomes. We also examine the relationships between nurse burnout and patient outcomes across 523 hospitals using data from almost 2 million patients, allowing us to generalize beyond a few organizations (Aim 1). In addition to a robust group of covariates, we also explore how system characteristics known to affect nurse burnout (i.e. nurse work environment, staffing) could be used to alleviate the impact of nurse burnout on patient outcomes.

Conceptual Framework

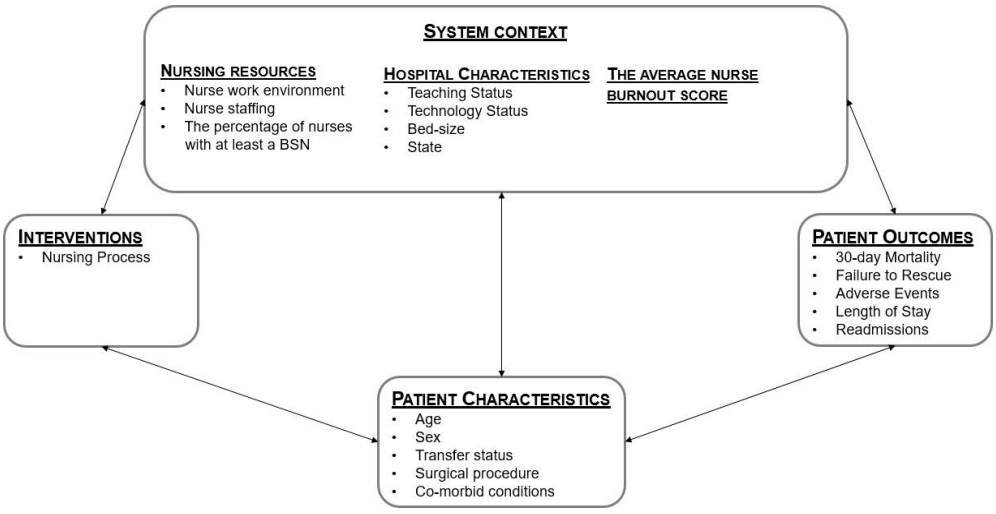

Figure 1. Theoretical Framework adapted from the Quality Health Outcomes Model (Mitchell, Ferketich, & Jennings, 1998)

The Quality Health Outcomes Model shown in Figure 1 guides this study because it considers a systems framework and the relationships among stakeholders at different levels (Mitchell et al., 1998). The system context is especially important for studying the consequences of burnout as the National Academy of Medicine report, "Taking Action Against Clinician Burnout: A Systems Approach to Professional Well-Being," notes that "clinician burnout and professional well-being occur within the context of a broader system" (NAM, 2019). To be consistent with the recommendations of the National Academy of Medicine report, our study frames nurse burnout as a hospital-level feature. We consider the relationship between the average nurse burnout score at the hospital-level and patient outcomes. This is also consistent with the fact that hospitalized patients are cared for by many nurses throughout their stay. In the context of this study,

the Quality Health Outcomes Model captures the exchanges that patients and nurses have with a larger system.

The system is comprised of a variety of nursing resources (e.g. nurse staffing, nurse work environment) as well as hospital structural characteristics (e.g. teaching status, technology status, bed size, state). For **Aim 1**, **we assessed the relationship between the system (operationalized as average nurse burnout score for each hospital) and the patient (operationalized as patient outcomes including mortality, failure to rescue, adverse events, length of stay, and readmission).** We accounted for hospital structural characteristics (i.e. teaching status, technology status, bed size, state), nurse education (i.e. the proportion of nurses with a baccalaureate degree), and patient characteristics (i.e. comorbidities, surgical procedure, transfer status, age, sex) as these variables have empirical and conceptual associations with patient outcomes (Aiken, Clarke, Cheung, Sloane, & Silber, 2003; Chen, Nallamothu, Spertus, Li, & Chan, 2013; Silber, Williams, Krakauer, & Schwartz, 1992). Controlling for these confounders helped to isolate the relationship between nurse burnout and patient outcomes, building on the limitations of previous research, which lacked such system-level controls (Tawfik et al., 2019). **In Aim 2, we considered whether the relationship between nurse burnout and patient outcomes was attenuated by the nurse work environment and/or nurse staffing**. As previously outlined, the work environment and nurse staffing have been found to be significant predictors of burnout. The Quality Health Outcomes Model allowed us to examine the relationship between nurse burnout and patient outcomes, while also including these system-level factors known to affect burnout (Aim 2).

CHAPTER 3: Methods

Introduction

This was a cross-sectional study of hospitals and patients in which we examined the relationship between hospital-level nurse burnout and patient outcomes. We built on a highly successful program of research using nurse survey data from the "Panel Study of Effects of Changes in Nursing on Patient Outcomes" (IRB protocol 819470; PI Dr. Linda Aiken). The analytic dataset was created by combining aggregated nurse survey data, hospital survey data, and patient data from four large states (CA, PA, NJ, FL). For our analysis, we examined the association between nurse burnout and patient outcomes (mortality, failure to rescue, adverse events, length of stay, and readmissions) (Aim 1) and then evaluated whether the effect of nurse burnout on patient outcomes was attenuated by the quality of the nurse work environment and/or staffing (Aim 2).

Data & Analytic Sample

Hospital Sample

In this study, we are primarily interested in nurse burnout as a hospital feature and used a sample of nurses from the 2015-2016 RN4CAST-US survey to provide information on hospital working conditions and nurse burnout. The RN4CAST-US survey was gathered as part of the parent study, "Panel Study of Effects of Changes in Nursing on Patient Outcomes" (IRB protocol 819470; PI Dr. Linda Aiken), which used a modified Dillman method and randomly sampled 30% of nurses from each state licensure mailing list for CA, PA, NJ, FL (Lasater et al., 2019). Informed consent was included on the first page of the survey and was completed as part of the parent study's protocol. The parent

study's Institutional Review (IRB) Protocol was renewed on December 17, 2018 in compliance with University of Pennsylvania's policies. The four states were chosen as part of the parent study and include diverse geographic regions of the country, accounting for roughly 20% of the US population. Responses were received from 52,510 nurses, yielding a response rate of 26% (Lasater et al., 2019).

The nurse survey offers several unique strengths to our study: **(1) Nurses as hospital informants.** In the survey, nurse respondents were asked to provide information on employment, allowing individual nurses to be linked to their respective hospital. This linkage allowed us to aggregate individual nurse responses to the hospital-level and provide summary measures of each hospital's work environment, nurse staffing, and level of nurse burnout. We required that there be at least 10 nurses per hospital to aggregate nurse responses to the hospital-level. Previous empirical work has demonstrated that a minimum of 10 nurse respondents per hospital provides an accurate assessment of nursing resources (e.g. nurse work environment, nurse education, staffing) (Linda H Aiken et al., 2003; L. H. Aiken et al., 2002; Lasater & Mchugh, 2016; McHugh et al., 2013). Our final analytic hospital sample had, on average, 39 nurses per hospital. Our inclusion criteria for nurses was that they be working in nonfederal acute care hospitals in one of the four states (CA, PA, FL, or NJ) in 2015-2016. **(2) Hospital representativeness**. As we limited our analytic sample to hospitals with at least 10 nurse respondents and our hospital sample was mostly comprised of medium to large hospitals (>90%) we had good hospital and patient representation among our sample. Specifically, among hospitals in the parent study with at least 10 respondents, the greatest representation of hospitals was achieved among those with 100-250 beds (75.4% hospital representation and 85.7% patient representation) and

hospitals with >250 beds (98.3% hospital representation and 99.6% patient representation) (Lasater et al., 2019). **(3) Evidence suggests that non-respondents were not significantly different than main survey respondents,** as no statistically significant differences were found in the majority of nurse reported hospital measures. To complete the nonresponse survey, a random sample of 1,400 nonrespondents was drawn and an abbreviated version of the original survey was sent out. Certified mail, phone calls, and financial incentives were employed to encourage response. The final response rate for the nonrespondent sample was 87%. The measures at the nurse level were examined and were not found to be significantly different from the responses in the original survey, suggesting that there is minimal concern for nonresponse bias (Lasater et al., 2019).

We also used publicly available data from the 2015-2016 American Hospital Association (AHA) Annual Survey to obtain information hospital structural characteristics. The American Hospital Association Annual Survey is a voluntary survey that most hospitals participate in, giving it a large and nationally representative sample of hospitals (AHA, n.d.). Variables derived from AHA Annual Survey included the hospital structural characteristics: teaching status, technology status, bed size, and state. Based on the inclusion criteria discussed, after merging the RN4CAST-US survey and the American Hospital Association Annual Survey, the final sample included 523 hospitals.

Patient Sample

Patient data were obtained from state-based registries for CA, PA, FL, and NJ. The state inpatient databases include FL's Agency for Health Care Administration, CA's Office of Statewide Healthcare Planning and Development, NJ's Department of Health and Senior Services, and PA's Health Care Cost Containment Council. These state

agencies provide deidentified patient discharge data, supplying information on patient outcomes as well as patient characteristics for a robust risk adjustment. A strength of using state administrative data is that it provides information on patients of all ages. These databases also have information on a large number of patients, enabling this study to observe patterns in our outcomes of interest across a sufficiently representative group of hospitals (n=523).

As mandated by the US Department of Health and Human Services, there was a transition from ICD-9 to ICD-10 coding during 2015 (CDC, 2015). As data collection for the RN4CAST-US survey spanned 2015-2016, the data used in this study includes the ICD-9 to ICD-10 transition period. To be consistent with the period of data for RN4CAST-US, our study used patient data from the last quarter of 2014 as well as from the entirety of 2015 and 2016. Therefore, both ICD-9 and ICD-10 codes are used to accommodate the transition.

We included surgical in-patients (i.e. vascular, orthopedic, general surgery) hospitalized in non-federal acute care hospitals between the ages of 18-99 across CA, PA, FL, and NJ. These surgical subgroups are used because there is well-validated risk adjustment and because these populations have common procedures across acute care hospitals (Aiken et al., 2003; Aiken et al., 2008; Aiken et al., 2002; Aiken et al., 2014; Ball et al., 2018; Brooks-Carthon, Kutney-Lee, Jarrín, Sloane, & Aiken, 2012; Kutney-Lee, Sloane, & Aiken, 2013; McHugh et al., 2013). The final sample included 1,939,878 patients.

Variables and Instruments

Explanatory Variables

Nurse Burnout: Nurse burnout is conceptualized and measured using the Maslach Burnout Inventory (MBI), the most popular instrument to measure burnout (Tawfik et al., 2019). The MBI includes 3 subscales: emotional exhaustion, cynicism, and depersonalization. This study used the emotional exhaustion subscale of the MBI for four reasons. **(1)** Of the 3 subscales, emotional exhaustion is the domain of burnout that is most frequently linked to outcomes (Tawfik et al., 2019). **(2)** There is a strong conceptual and empirical basis for using emotional exhaustion as it is identified as the core element of burnout (Bakker, Le Blanc, & Schaufeli, 2005; Maslach et al., 2001; Schabracq, Winnubst, & Cooper, 2003; Shirom, 2003). **(3)** The emotional exhaustion subscale has strong convergent validity with other measures of burnout (Bakker et al., 2005; Schabracq et al., 2003; Shirom, 2003). **(4)** This study is a secondary data analysis using nurse survey data, which collected information from nurses on emotional exhaustion rather than all 3 subscales.

The emotional exhaustion score is based on a 9-item questionnaire from the Maslach Burnout Inventory (Maslach et al., 1986) and was included in the larger RN4CAST-US survey. This portion of the survey asks nurses to rate how often they experience feelings of emotional exhaustion. The emotional exhaustion score has a possible range between 0 and 54 with higher scores indicating higher levels of burnout (Maslach & Jackson, 1981). Previous research has primarily identified nurse burnout by dichotomizing scores on the emotional exhaustion subscale (Aiken et al., 2002; Cimiotti et al., 2012; McHugh et al., 2011; Tawfik et al., 2019) so that an individual is considered burned out if their score is equal to or exceeds a threshold of 27 (Maslach et al., 1986).

Our study takes a different approach as we keep our measure of nurse burnout in a continuous form and average nurses' scores within each hospital to create a continuous hospital summary measure of burnout. Keeping burnout in its continuous form as opposed to dichotomizing has an advantage: it allows us to examine nurses below the 27-point threshold to see if lower scores on emotional exhaustion, that previously would not have qualified for burnout, are still associated with patient outcomes. For statistical modeling, we standardized this average burnout score to have a mean of zero and a variance of one so that a 1 standard deviation change in the average nurse burnout score corresponds with the odds of respective patient outcomes.

Nurse Work Environment: Our measure of the nurse work environment was derived from the RN4CAST-US survey data and measured using the validated, 31-item Practice Environment Scale of the Nursing Work Index-Revised (PES-NWI) (Aiken & Patrician, 2000; Lake, 2002). The PES-NWI has been used to empirically link aspects of the nurse work environment to nurse burnout, making it conceptually appropriate to use in this study (Aiken et al., 2008; Kutney-Lee, Wu, et al., 2013; Lake et al., 2019; Leiter & Laschinger, 2006; Swiger et al., 2017). The PES-NWI is based on five subscales: Nurse Participation in Organization Affairs; Nursing Foundations for Quality of Care; Nurse Manager Ability, Leadership, and Support of Nurses; Staffing and Resource Adequacy; Collegial Nurse-Physician Relations (Lake, 2002). The PES-NWI has been used in multiple studies and is endorsed by the National Quality Forum (NQF, 2004, 2017). In this portion of the nurse survey, nurses report their level of agreement to which certain hospital features are present on a 1-4 Likert scale.

We calculated that the Cronbach's α range from 0.84 to 0.93 for the five subscales. The intraclass correlation for the five subscales was 0.84 and greater than the 0.60 threshold indicating the acceptability of aggregating the nurse level data to the

hospital-level to create a summary measure. As we have a separate measure of staffing detailed below, we excluded the staffing and resource adequacy subscale from our composite summary measure to avoid redundancy in our statistical modeling. The hospital-level measure of the nurse work environment is created by first aggregating the results of the different subscales to the hospital-level and then averaging the different hospital-level subscale scores to create one continuous summary measure (Rousseau, 1985; Verran, Gerber, & Milton, 1995). Using the results from the PES-NWI, we can differentiate a poor, mixed, or good work environment by dividing the continuous version into 4 quartiles. A poor environment is composed of the first quartile, a mixed environment includes the second and third quartiles, and a good work environment is composed of the fourth quartile (Kutney-Lee, Wu, et al., 2013, Brooks-Carthon et al., 2020).

Nurse Staffing: Nurse staffing was derived from the RN4CAST-US study, which asks staff nurses to report the number of nurses and patients on their unit during their last shift. The staffing variable was created by dividing the average number of patients by the average number of nurses on the unit. A one-unit increase in the staffing variable reflects an additional patient, on average, for staff nurses in that hospital. Nurse staffing has been linked to the development of burnout and reflects a measure of workload (Aiken et al., 2002; Cimiotti et al., 2012). The percent of medical surgical nurses and the percent of ICU nurses were included as covariates when nurse staffing was in the model. This was to account for hospitals with higher percentages of ICU nurses that may appear to have better staffing simply because they have more ICUs.

Outcome Variables

Mortality: defined as a death in the hospital that occurs within 30 days of admission of the index hospitalization. In Appendix B, we include an additional sensitivity analysis on 30-day mortality, which includes deaths in the community in addition to hospital deaths.

Readmissions: defined as 30-day all-cause readmission with the occurrence of at least one readmission for any cause to an acute, non-federal hospital within 30 days of discharge from the index hospitalization using CMS' Risk-Standardized Readmission Measures (Keenan et al., 2008). Readmissions suggest that the care during the initial hospitalization was poor or that the discharge planning was inadequate (CMS, 2020; Ashton, Del Junco, Souchek, Wray, & Mansyur, 1997). Additionally, any hospitalization exposes patients to risk associated with experiencing a medical error or adverse event, making it an important outcome of interest to both hospitals and patients (Krumholz et al., 2011; CMS, 2019).

Length of stay: defined as the number of days a patient spent in the hospital during the index hospitalization within 30 days of admission. The date of admission for the index hospitalization is considered day one. The final day is when the patient was discharged or died. Although there are cases when longer length of stay indicates responsible hospital care, it can also indicate mismanagement and poor care (Thomas, Guire, & Horvat, 1997). Furthermore, hospitalization increases the likelihood of a patient experiencing adverse events, which is further compounded by a longer length of stay (Brennan et al., 1991; Leape et al., 1991; Philbin & Roerden, 1997). Length of stay is also an outcome of interest to hospital administrators and insurers as it reflects efficient care and cost savings (Brasel, Lim, Nirula, & Weigelt, 2007).

Adverse Events: Adverse events are defined as injuries caused by medical treatment and management (Brennan et al., 1991, p. 370). Adverse events have negative implications for patients because they can result in disability, extended length of stay, or even death. We use the Agency for Healthcare Research and Quality's (AHRQ) list of quality indicators. Specifically, this list of conditions is intended to provide an "overview of hospital-level quality as it relates to a set of *potentially preventable* hospital-related events associated with harmful outcomes for patients" (AHRQ, 2016, p. 1). Using this list, we defined an adverse event in our study as the development of at least one of the following conditions during hospitalization: pressure ulcer, iatrogenic pneumothorax, in-hospital fall with hip fracture, perioperative hemorrhage or hematoma, postoperative acute kidney injury requiring dialysis, postoperative respiratory failure, perioperative pulmonary embolism (PE) or deep vein thrombosis (DVT), postoperative sepsis rate, postoperative wound dehiscence, or unrecognized abdominopelvic accidental puncture/laceration during the index hospitalization. These are based on the ICD-9 and ICD-10 codes from AHRQ's Patient Safety Indicator 90 (PSI 90) (AHRQ, 2017, 2019).

Failure to Rescue: defined as death after development of one of the adverse events included in the Patient Safety Indicator 90. The widely used failure to rescue measure by Silber and colleagues did not have updated ICD-10 definitions available at the time of analysis (Silber et al., 2007). Therefore, a modified version using the list of adverse events from AHRQ's Patient Safety Indicator 90 was used.

Covariates

Hospital Characteristics: Existing research has substantively contributed to the evidence suggesting that hospital structural characteristics affect patient outcomes.

These structural characteristics were included in our statistical models as they may be related to nurse burnout, associated with nursing resource characteristics, and affect the quality of patient care outcomes (Ayanian & Weissman, 2002; Brennan et al., 1991; Chen et al., 2013; Hartz et al., 1989; Iwashyna, Curlin, & Christakis, 2002; Landon et al., 2006; Merchant et al., 2014; Merchant et al., 2012; Silber et al., 1992; Sinha, Chen, & Nallamothu, 2014; Thomas, Orav, & Brennan, 2000). American Hospital Association survey data provided information on hospital structural characteristics. **Bed size** was defined as the number of hospital beds and categorized as ≤100 beds, 101-249 beds, ≥ 250 beds. **Teaching status** was classified into non-teaching (no fellows or residents), minor teaching (ratio of 1:4 residents/fellows to bed), and major teaching (>1:4). **Technology status** was classified as a binary variable with hospitals identified as high technology noted for performing open-heart surgery and major organ transplants. Hospital **state** (FL, CA, PA, NJ) was also included.

Another hospital-level characteristic that has been associated with patient outcomes is **nurse education**, or the proportion of baccalaureate-prepared nurses within a hospital (Aiken et al., 2003; Blegen, Goode, Park, Vaughn, & Spetz, 2013; Johnson, 1988; Kutney-Lee et al., 2013; Torangeau, Giovannetti, Tu, & Wood, 2002; Young, Lehrer, & White, 1991). In order to isolate the effect of burnout, we control for the proportion of baccalaureate-prepared nurses as a covariate in our analysis. This was obtained from the 2015-2016 RN4CAST-US survey. For statistical modeling, we scaled our hospital-level nurse education variable so that the effect on patient outcomes would correspond with an increase of 10% in the proportion of baccalaureate-prepared nurses, which is consistent with prior research (Aiken et al., 2003; Kutney-Lee & Aiken, 2008; Kutney-Lee, Sloane, et al., 2013).

Patient Characteristics: We included patient age, sex, transfer status, comorbidities, and surgical procedure. These patient characteristics were used to create the risk adjustment for patient health status on admission. The comorbidities included were based on the Elixhauser Comorbidity Index as it is validated and commonly used with ICD-9 and ICD-10 codes, includes almost twice the comorbidities of other risk adjustment, and outperforms the Charlson Index on comorbidity identification and mortality prediction (Li, Evans, Faris, Dean, & Quan, 2008; Southern, Quan, & Ghali, 2004; Stukenborg, Wagner, & Connors, 2001).

Power Analysis

A power analysis was completed to inform this study's approach. As both Aim 1 and Aim 2 used multilevel observations, the analysis accounts for the clustering of patients within hospitals using Tests for Two Proportions in a Repeated Measures Design (Liu & Wu, 2005). Based on our inclusion criteria, the analytic sample includes **523 hospitals** with a **total of 1,939,878 surgical patients**, or **about 3,709 surgical patients per hospital**. We completed a median split to divide hospitals into high and low burnout hospitals. Based on prior work using the same nurse survey, we set our rho estimate to be 0.100, 0.200, and 0.300. **Table 3.1** shows that our sample size is adequate to detect an odds ratio as low as 1.051 (80% power; 0.05 alpha; 0.100 rho). Our power analysis was completed with PASS 16 and used an autoregressive covariance structure (NCSS Statistical Software, 2017). An autoregressive covariance structure assumes that two measurements close to each other in time will be correlated. In our case, we interpret this to mean that patients admitted around the same time period will have correlated outcomes. Additional power analyses increase the odds of

making a type 1 error and therefore, this power calculation was completed for 30-day in-hospital mortality as it was our primary outcome of interest.

Table 3.1 Power Analysis Results

Rho	Odds Ratio
0.100	1.051
0.200	1.056
0.300	1.062

Notes: power: 80%; alpha: 0.05

Data Set Construction

(1) We started by cleaning the 2015-2016 RN4CAST-US survey data and by aggregating relevant variables (nurse burnout, nurse education, nurse staffing, and the nurse work environment) to the hospital-level.

(2) The aggregated nurse data were linked and merged with the 2015-2016 American Hospital Association survey data.

(3) The combined nurse and hospital data were then merged and linked with State Administrative Patient Discharge Data. General, orthopedic, and vascular surgery patients were identified and retained for analysis using DRG codes. The final data set included hospital-level aggregations of nurse burnout, nurse staffing, the nurse work environment, and hospital characteristics (bed size, teaching status, technology status, state, and nurse education). State discharge data remained at the patient level and included patient demographics, comorbidities, surgical procedure, and outcomes (mortality, failure to rescue, adverse events, length of stay, and readmissions).

Data Analysis

Aim 1. Aim 1 used the merged data set to examine the association between hospital-level nurse burnout and 30-day in-hospital mortality, failure to rescue, adverse events, length of stay, and readmissions. We began our analysis by describing the hospital and patient sample and focused on showing the variation in burnout across hospitals. Frequencies and percentages were used for categorical variables. Means and standard deviations were used to describe continuous variables. One-way analysis of variance, ANOVA, was used for continuous outcomes and chi-square tests of significance were used for categorical outcomes.

The second phase of analysis used multivariate regression with adjustments for the clustering of patients within hospitals using Huber-White sandwich estimators. As patients in the same hospital have similar demographics and treatment experiences, there is likely a correlation between patient observations within the same hospital. Since we cannot assume that patient observations are independent, we use Huber White sandwich estimators as an adjustment on the standard deviation to ensure the variance in our sample is not underestimated and that we do not increase our chances of making a Type 1 error (Huber, 1967; Rogers, 1994; White, 1980). Logistic regression was used to consider binary outcomes. Zero truncated negative binomial (ZTNB) regression was used for the length of stay analysis as it is a regression method used when a zero value cannot occur and/or there is concern for over-dispersion (UCLA, n.d.)

We sequentially estimated models by first assessing the bivariate relationship between nurse burnout and patient outcomes (Model 1) and then stepped in patient

characteristics (Model 2) and hospital characteristics (Model 3). We stepped in nurse education as a control in Model 4.

Model 1: $\log\left(\frac{P_{ij}}{1-P_{ij}}\right) = \alpha + \boldsymbol{\beta}\mathbf{N}'j + \boldsymbol{\varepsilon}ij$

Model 2: $\log\left(\frac{P_{ij}}{1-P_{ij}}\right) = \alpha + \boldsymbol{\beta}\mathbf{N}'j + \boldsymbol{\beta}\mathbf{X}'ij + \boldsymbol{\varepsilon}ij$

Model 3: $\log\left(\frac{P_{ij}}{1-P_{ij}}\right) = \alpha + \boldsymbol{\beta}\mathbf{N}'j + \boldsymbol{\beta}\mathbf{X}'ij + \boldsymbol{\beta}\mathbf{H}'j + \boldsymbol{\varepsilon}ij$

Model 4: $\log\left(\frac{P_{ij}}{1-P_{ij}}\right) = \alpha + \boldsymbol{\beta}\mathbf{N}'j + \boldsymbol{\beta}\mathbf{X}'ij + \boldsymbol{\beta}\mathbf{H}'j + \boldsymbol{\beta}\mathbf{E}'j + \boldsymbol{\varepsilon}ij$

- P is the probability of our binary outcome for the i[th] patient in the j[th] hospital.
- α is the intercept term in the regression model.
- $\mathbf{N}'j$ is a vector of nurse burnout for the j[th] hospital, representing the effect of the nurse burnout.
- $\mathbf{X}'ij$ is a vector of characteristics for the i[th] patient in the j[th] hospital, representing the effect of patient characteristics.
- **H**'j is a vector of hospital characteristics for the j[th] hospital, representing the effect of the hospital characteristics.
- $\mathbf{E}'j$ is a vector of nurse education for the j[th] hospital, representing the effect of the nurse education.
- $\boldsymbol{\varepsilon}ij$ is the random error term of the i[th] patient in the j[th] hospital.

Aim 2. The analysis for Aim 2 builds on the findings for Aim 1 by evaluating whether the effect of nurse burnout on patient outcomes was attenuated by the nurse work environment and staffing.

As discussed in Aim 1, models were sequentially built by first looking at the bivariate relationship and then introducing patient and hospital characteristics. The nurse

work environment (Model 5) and staffing (Model 6) were stepped in separately and then together in Model 7.

Model 5: $\log\left(\frac{P_{ij}}{1-P_{ij}}\right) = \alpha + \boldsymbol{\beta}\mathbf{N}'j + \boldsymbol{\beta}\mathbf{X}'ij + \boldsymbol{\beta}\mathbf{H}'j + \boldsymbol{\beta}\mathbf{E}'j + \boldsymbol{\beta}\mathbf{W}'j + \boldsymbol{\varepsilon}ij$

Model 6: $\log\left(\frac{P_{ij}}{1-P_{ij}}\right) = \alpha + \boldsymbol{\beta}\mathbf{N}'j + \boldsymbol{\beta}\mathbf{X}'ij + \boldsymbol{\beta}\mathbf{H}'j + \boldsymbol{\beta}\mathbf{E}'j + \boldsymbol{\beta}\mathbf{S}'j + \boldsymbol{\varepsilon}ij$

Model 7: $\log\left(\frac{P_{ij}}{1-P_{ij}}\right) = \alpha + \boldsymbol{\beta}\mathbf{N}'j + \boldsymbol{\beta}\mathbf{X}'ij + \boldsymbol{\beta}\mathbf{H}'j + \boldsymbol{\beta}\mathbf{E}'j + \boldsymbol{\beta}\mathbf{W}'j + \boldsymbol{\beta}\mathbf{S}'j + \boldsymbol{\varepsilon}ij$

- $\mathbf{W}'j$ is a vector of the nurse work environment for the j[th] hospital, representing the effect of the nurse work environment.
- $\mathbf{S}'j$ is a vector of nurse staffing for the j[th] hospital, representing the effect of nurse staffing.

Sensitivity Analyses

A summary and interpretation of sensitivity analyses are outlined in the appendices. We assessed the robustness of our findings by testing another version of the nurse burnout variable based on a dichotomized score (Appendix A). We tested another version of the mortality variable using deaths in the hospital as well as deaths in the community within 30 days of admission (Appendix B). We completed quality assurance checks to assess the impact of multicollinearity on our analysis (see Appendix C) as high correlations among multiple predictor variables can risk unstable or even unreliable estimates for the regression coefficients (Allison, 2012).

Protection of Human Subjects

The protocol for this study was based on the parent study, “Panel Study of Effects of Changes in Nursing on Patient Outcomes” (IRB protocol 819470; PI Dr. Linda Aiken), which was renewed on December 17, 2018 by the University of Pennsylvania

Institutional Review Board (IRB). Our study was a retrospective, secondary data analysis that used data obtained by the parent study. Specifically, we used aggregated and de-identified data from the 2015-2016 nurse survey, RN4CAST-US. Other forms of secondary data included 2015-2016 State Inpatient Database claims data and the 2015-2016 American Hospital Association Annual Survey. **Therefore, our study did not qualify for human subject's research and received IRB exemption as there was low risk to patients and nurses as all individual-level data was retrospective and de-identified.**

CHAPTER 4: RESULTS

Introduction

This chapter presents our findings, beginning with descriptive characteristics for hospitals and patients in our sample, then transitioning to regression results. The main hypothesis was that patients in hospitals with a higher average nurse burnout score would have higher odds of 30-day in-hospital mortality, failure to rescue, adverse events, readmissions, and longer length of stay. We also hypothesized that the nurse work environment and nurse staffing would attenuate the relationship between nurse burnout and patient outcomes.

Sample Characteristics

Hospital Characteristics

Table 4.1 presents descriptive characteristics of the total hospital sample (n=523). We also present these characteristics by quartile of the hospital-level nurse burnout score. The first quartile of hospitals included those with the lowest level of nurse burnout (n=132, average nurse burnout score=16.6, range 8.3-18.6) and the fourth quartile included hospitals where nurses reported the highest level of burnout (n=130, average nurse burnout score=25.7, range 23.2-31.9).

In our sample, the average nurse burnout score was 21 with a range of 8.3 to 31.9. Overall, 168 hospitals (32.1%) had poor work environments, 258 hospitals (49.3%) had mixed work environments, and 97 hospitals (18.6%) had good work environments. Among hospitals with poor work environments, almost half of these hospitals were in the fourth quartile of burnout compared to less than 10% of hospitals in the first quartile of

burnout (p<.001). In contrast, only 1% of hospitals with good work environments were in the fourth quartile of burnout, compared to almost 60% of those hospitals, which were in the first quartile of burnout (p<.001). In mixed work environments, the difference between quartiles was less pronounced with about 18% of these hospitals in the highest quartile of burnout compared to just around 24% of these hospitals in the lowest quartile of burnout. For hospitals with the lowest staffing category (<4 patients per nurse) just 16% of these hospitals were in the fourth quartile of burnout. This is in comparison to hospitals with the highest patient loads (>6 patients per nurse), where almost 40% of these hospitals were in the fourth quartile of burnout (p<.001). Across the nursing education categories, there were also significant differences in the distribution of burnout by quartile. In hospitals that had 20% to 40% of nurses with baccalaureate degrees, just over 40% of these hospitals were in the highest quartile of burnout compared to less than 20% of these hospitals that were in the lowest quartile of burnout (p=.025). In contrast, in hospitals that had higher levels of nurse education, the difference across quartile of burnout was not as pronounced. Specifically, in hospitals that had 60% to 80% of nurses with baccalaureate degrees, just over 20% of these hospitals in the highest quartile of burnout compared to almost 28% of these hospitals in the lowest quartile of burnout (p=.025).

Approximately 40% of the hospitals studied were in CA, 11% of hospitals were in NJ, 21% were in PA, and about 29% were in FL. The hospital sample shows considerable variability across hospital characteristics. Significant differences in the distribution of burned out nurses by quartile were noted across hospitals of different bed size and teaching status. Of hospitals with less than 100 beds, almost 50% of these hospitals were in the lowest quartile of burnout compared to hospitals with more than 250 beds, where nearly 22% of such hospitals were in the lowest quartile of burnout

(p=.021). Approximately 43% of our hospital sample included nonteaching hospitals. Among nonteaching hospitals, 30% were in the first quartile of burnout compared to 21% of these hospitals, which were in the fourth quartile of burnout (p=.046).

Table 4.1 Distribution of hospital characteristics by the average score of nurse burnout

	All hospitals (n=523)	1st quartile (n=132)	2nd quartile (n=130)	3rd quartile (n=131)	4th quartile (n=130)	P[a]
Bed size, n (%)						.021
≤100	39 (7.5)	18 (46.2)	5 (12.8)	6 (15.4)	10 (25.6)	
101-250	220 (42.1)	57 (25.9)	49 (22.3)	61 (27.7)	53 (24.1)	
>250	264 (50.5)	57 (21.6)	76 (28.8)	64 (24.2)	67 (25.4)	
Teaching status, n (%)						.046
None	224 (42.8)	68 (30.4)	53 (23.7)	55 (24.6)	48 (21.4)	
Minor	250 (47.8)	54 (21.6)	60 (24.0)	61 (24.4)	75 (30.0)	
Major	49 (9.4)	10 (20.4)	17 (34.7)	15 (30.6)	7 (14.3)	
Technology Status						.596
High, n (%)	279 (53.4)	65 (23.3)	74 (26.5)	68 (24.4)	72 (25.8)	
State						.092
California	207 (39.6)	62 (30.0)	52 (25.1)	52 (25.1)	41 (19.8)	
New Jersey	57 (10.9)	15 (26.3)	19 (33.3)	13 (22.8)	10 (17.5)	
Pennsylvania	110 (21.0)	21 (19.1)	23 (20.9)	27 (24.6)	39 (35.5)	
Florida	149 (28.5)	34 (22.8)	36 (24.2)	39 (26.2)	40 (26.9)	
Staffing (mean patients/nurse)						<.001
<4	194 (37.1)	61 (31.4)	57 (29.4)	45 (23.2)	31 (16.0)	
4-<5	203 (38.8)	46 (22.7)	47 (23.2)	63 (31.0)	47 (23.2)	
5-<6	91 (17.4)	17 (18.7)	19 (20.9)	17 (18.7)	38 (41.8)	
>6	35 (6.7)	8 (22.9)	7 (20.0)	6 (17.1)	14 (40.0)	
Nurse Work Environment, n (%)						<.001
Poor	168 (32.1)	15 (8.9)	23 (13.7)	48 (28.6)	82 (48.8)	
Mixed	258 (49.3)	61 (23.6)	74 (28.7)	76 (29.5)	47 (18.2)	
Good	97 (18.6)	56 (57.7)	33 (34.0)	7 (7.2)	1 (1.0)	
Education (% nursing staff with a BSN or higher)						.025
≤20%	6 (1.2)	2 (33.3)	2 (33.3)	1 (16.7)	1 (16.7)	
20-<40%	70 (13.4)	12 (17.1)	12 (17.1)	17 (24.3)	29 (41.4)	
40-<60%	218 (41.7)	55 (25.2)	58 (26.6)	50 (22.9)	55 (25.2)	
60-<80%	205 (39.2)	57 (27.8)	47 (22.9)	57 (27.8)	44 (21.5)	
≥80%	24 (4.6)	6 (25.0)	11 (45.8)	6 (25.0)	1 (4.2)	
Average Nurse Burnout Score, mean (SD)						<.001
	21.0 (3.6)	16.6 (1.9)	19.8 (0.6)	21.9 (0.7)	25.7 (2.1)	

Abbreviations: SD = standard deviation, n = number. **Note.** Work environment measured by the PES-NWI excluding the staffing and resource adequacy subscale. Poor environments are hospitals in the bottom 25%, mixed work environments are the middle 50%, and good work environments are the top 25% of hospitals. [a]P values generated from χ^2 for categorical and ANOVA for continuous variables. 1st quartile mean=16.6, range 8.3-18.6; 2nd quartile mean=19.8, range 18.6-20.8; 3rd quartile mean=21.9, range 20.8-23.2; 4th quartile mean=25.7, range 23.2-31.9.

Patient Characteristics

Table 4.2 provides characteristics of the patient sample. The final analytic sample included 1,939,878 surgical patients. Over half (51.3%) of the sample was comprised of orthopedic surgery patients, over a third (36.7%) were general surgery patients, and less than a quarter (13.1%) were vascular surgery patients. On average, patients in our sample were 62 years of age and over 50% were female. The comorbidities shown in Table 4.2 include those derived from Elixhauser's comorbidity index. Of note, over half (56.7%) of the sample had hypertension, greater than 15% had obesity, 20% had diabetes, and 10% of patients had depression.

Focusing on the outcomes of interest in our study, less than 1% (0.8%) of patients in our sample died in the hospital within 30 days of admission. Almost 10% (8.3%) of patients were readmitted within 30 days of discharge. Of the 15% of patients that experienced adverse events, 4% of them died (i.e. failure to rescue). The average length of stay for our sample was 4.3 days.

Table 4.2 Characteristics of Patient Sample

	All Surgical Patients (n=1,939,878) No. (%)
Demographics	
Age (years), mean (SD)	62.0 (16.6)
Men	887,507 (45.8)
Transfer status	45,138 (2.3)
Surgical Group	
General Surgery	691,867 (36.7)
Orthopedic Surgery	993,636 (51.2)
Vascular Surgery	254,375 (13.1)
Comorbidities	
Congestive heart failure	83,853 (4.3)
Valvular disease	72,481 (3.7)
Pulmonary circulation disease	17,892 (0.9)
Peripheral vascular disease	127,437 (6.6)
Paralysis	30,630 (1.6)
Other neurological disorders	102,772 (5.3)
Chronic pulmonary disease	301,960 (15.6)
Diabetes without chronic complications	307,979 (15.9)
Diabetes with chronic complications	130,965 (6.8)
Hypothyroidism	247,901 (12.8)
Renal Failure	179,447 (9.3)
Liver Disease	69,653 (3.6)
Peptic Ulcer Disease with bleeding	8,784 (0.5)
AIDs	3,174 (0.2)
Lymphoma	9,211 (0.5)
Metastatic cancer	45,292 (2.3)
Solid tumor without metastasis	25,703 (1.3)
Rheumatoid arthritis/collagen vas	59,997 (3.1)
Coagulopathy	68,125 (3.5)
Obesity	326,084 (16.8)
Weight loss	61,047 (3.2)
Fluid and electrolyte disorders	293,505 (15.1)
Chronic blood loss anemia	19,499 (1.0)
Deficiency anemias	260,988 (13.5)
Alcohol abuse	59,426 (3.1)
Drug abuse	45,302 (2.3)
Psychoses	57,581 (3.0)
Depression	202,213 (10.4)
Hypertension	1,099,302 (56.7)
Outcomes	
30-day in-hospital mortality	15,000 (0.8)
Failure to rescue	12,858 (4.2)
Adverse events	308,112 (15.9)
Length of stay (days), mean (SD)	4.3 (5.3)
30-day readmissions	161,842 (8.3)

Abbreviations: SD = standard deviation, n = number

Note. Transfer status denotes transferred vs. not transferred.

Aim 1 Results

Table 4.3 presents the analysis for Aim 1. For binary outcomes, we used a series of logistic regression models and present odds ratios (OR). For the length of stay analysis, we use a zero truncated negative binomial (ZTNB) regression to present the incidence rate ratio (IRR). For all outcomes, the first model considered the unadjusted relationship between hospital-level nurse burnout and the respective patient outcome. The second model stepped in hospital and patient characteristics.

Specific Aim #1: To determine the relationship between nurse burnout and patient outcomes (30-day mortality, failure to rescue, adverse events, length of stay, and readmissions).

Hypothesis 1: There will be an association between hospitals with a higher average nurse burnout score and poor patient outcomes, including higher rates of 30-day mortality, failure to rescue, adverse events, readmissions, and longer length of stay.

Table 4.1 showed the extensive variation in nurse burnout across U.S. hospitals. Aim 1 explored whether the variation in patient outcomes could be explained by the variation in nurse burnout. The first column in Table 4.3 presents regression models estimating the unadjusted relationship between hospital-level nurse burnout and outcomes. The second column shows models with controls for patient and hospital characteristics. Starting with the unadjusted model, nurse burnout was significantly related to 30-day in-hospital mortality (OR=1.06, p=.003). This means for a 1 standard deviation increase in the average nurse burnout score, the odds of patient mortality increased by 6%. The trend for mortality remained consistent after controlling for patient and hospital characteristics (OR=1.05, p=.023). As we standardized our measure of burnout, a 1 standard deviation increase coincides with an increase in the hospital's

average nurse burnout score from the 50th percentile to the 84th percentile. At the 50th percentile, the average nurse burnout score was 20.8 and at the 84th percentile (84.1 on a normal curve) the average nurse burnout score was 24.5. These results can be further interpreted by considering a 2 standard deviation change in the average nurse burnout score, which corresponds with a move from the 50th (50th percentile score=20.8) to the 98th percentile (i.e. 97.7 on a normal curve; 97.7th percentile score=29.1). To illustrate such a change in patient mortality, the unrounded odds ratio can be exponentiated to the 2nd power ($1.062081^2 = 1.12801605$). Therefore, a 2 standard deviation change for a hospital from the 50th to the 98th percentile is associated with a 13% increase in the odds of patient mortality.

We also found a significant relationship between the hospital average nurse burnout score and failure to rescue in the fully adjusted models. Specifically, a 1 standard deviation increase in the hospital-level nurse burnout score was associated with a 5% increase in the odds of a patient dying after experiencing an adverse event (OR=1.05, p=.086). While the unadjusted model was not statistically significant, the second model, adjusting for patient and hospital characteristics reached statistical significance (OR 1.05, p=.038). A 2 standard deviation change, or a hospital's change from the 50th percentile to the 98th percentile, was associated with a 9% increase in the odds of failure to rescue ($1.046299^2 = 1.0947416$). We did not find a statistically significant association between burnout and adverse events in the unadjusted models (OR=1.00, p=.974) or in the models that adjusted for patient and hospital characteristics (OR=0.99, p=.537).

For our analysis of length of stay, we found similar trends to mortality and failure to rescue. A 1 standard deviation increase in the average burnout score, or a change from the 50th percentile to the 84th percentile, was associated with a 2% increase in

hospital length of stay (IRR=1.02, p=.038). This finding was consistent after accounting for patient and hospital characteristics (IRR=1.01, p=.035). The unadjusted model can be further interpreted via a 2 standard deviation change, or a change from the 50th percentile to the 98th percentile being associated with a 5% increase in hospital length of stay ($1.022825^2 = 1.04617098$).

We did not find a statistically significant association between burnout and readmissions in the unadjusted models (readmissions OR=1.02, p=.146) or in the models that adjusted for patient and hospital characteristics (readmissions OR=1.01, p=.314).

Table 4.3 Effects of burnout on patient outcomes

Patient Outcomes	Unadjusted		Adjusted for Patient & Hospital Characteristics	
	OR (95% CI)	P[a]	OR (95% CI)	P[a]
30-day in-hospital mortality	1.06 (1.02, 1.11)	.003	1.05 (1.01, 1.10)	.023
Failure to Rescue	1.05 (0.99, 1.10)	.086	1.05 (1.00, 1.09)	.038
Adverse Events	1.00 (0.96, 1.04)	.974	0.99 (0.94, 1.03)	.537
30-day length of stay (IRR)	1.02 (1.00,1.04)	.038	1.01 (1.00, 1.03)	.035
30-day readmissions	1.02 (0.99, 1.04)	.146	1.01 (0.99, 1.03)	.314

Abbreviations: CI = confidence interval, OR= odds ratio, IRR= Incidence Rate Ratio.

Note: Burnout represents the average burnout score of nurses in a hospital. The odds ratio reflects a 1 standard deviation change in the average score of burnout. Hospital characteristics include bed size, teaching status, technology status, and state. Patient characteristics include age, sex, transfer status, comorbidities, and surgical procedure.

Aim 2 Results

Specific Aim #2: To evaluate whether the effect of nurse burnout on patient outcomes (30-day mortality, failure to rescue, and length of stay) was attenuated by the quality of the nurse work environment and nurse staffing.

Hypothesis 2: The relationship between nurse burnout and patient outcomes will be attenuated by the quality of the nurse work environment and nurse staffing.

For the analysis of Aim 2, a third set of models was brought into Table 4.4 for the findings that had a statistically significant relationship in Aim 1 (i.e. mortality, failure to rescue, and length of stay). The third and final model stepped in the nursing resource characteristics including nurse staffing and the nurse work environment. Nurse education is also present in the final model as a covariate. We hypothesized that improvements to the nurse work environment and nurse staffing could be used to address nurse burnout and improve patient outcomes. In general, we found this to be true for the nurse work environment. Specifically, for mortality, we found that a change in the nurse work environment from poor to good was associated with a reduction in the odds of 30-day in-hospital mortality by 18% (OR=0.82, p=.001). In this final mortality model, the effect of nurse burnout on the odds of death was no longer significant (OR=1.00, p=.859). This finding suggests that improving the nurse work environment has benefits beyond just eliminating nurse burnout's impact on mortality. It suggests that improvements to the nurse work environment could be used improve nurse well-being and prevent avoidable sources of death among patients.

For failure to rescue, a change in the nurse work environment from poor to good was associated with a 18% drop in the odds of death after experiencing an adverse event (OR=0.82, p=.003). This finding mirrors the trend for mortality as the inclusion of

the nurse work environment in the final model removed the independent effect that nurse burnout had on failure to rescue. Such a conclusion is supported through our statistical modeling, which shows that when both nurse burnout and the nurse work environment are in the model, the nurse work environment remains significant, but nurse burnout no longer is. From this, we can conclude that the nurse work environment explains much of the variability in patient outcomes that was explained by nurse burnout as well as additional variability that was not explained by nurse burnout. This suggests that investments in the nurse work environment are potentially associated with greater reductions in preventable causes of patient death, beyond what eliminating nurse burnout could accomplish alone. If a researcher were to do this study, but not account for the work environment, they could potentially come to the conclusion that burnout alone is the problem to be addressed and take actions that might not ultimately improve outcomes (i.e. implement individual level interventions to build coping skills). Our study's examination of Aim 2 highlights an important point: If hospitals were to focus on reducing burnout through individual interventions like mindfulness practices, they would merely be addressing the symptoms of a much greater problem and the issues with burnout and patient care would likely persist. By addressing the work environment directly, hospital administrators can get to the cause of nurse burnout and affect change for nurses and save patient lives on a much greater scale.

For the length of stay analysis, we found that the addition of the nurse work environment and staffing attenuated the effect of nurse burnout. Although neither the nurse work environment or staffing were significant, their presence in the model attenuated any effect that nurse burnout had on length of stay, suggesting that improvements in the work environment and staffing could potentially reduce length of stay.

Table 4.4 Effects of burnout and nursing resources on patient outcomes

Patient Outcomes	Model 1		Model 2		Model 3	
	OR (95% CI)	P[a]	OR (95% CI)	P[a]	OR (95% CI)	P[a]
30-day in-hospital mortality						
Nurse Burnout	1.06 (1.02, 1.11)	.003	1.05 (1.01, 1.10)	.023	1.00 (0.95, 1.05)	.859
Nurse Education	--		--		0.95 (0.93, 0.98)	.001
Nurse Staffing	--		--		1.00 (0.96, 1.06)	.847
Nurse Work Environment	--		--		0.82 (0.72, 0.92)	.001
Failure to Rescue						
Nurse Burnout	1.05 (0.99, 1.10)	.086	1.05 (1.00, 1.09)	.038	1.00 (0.95, 1.05)	.910
Nurse Education	--		--		0.98 (0.95, 1.01)	.153
Nurse Staffing	--		--		1.00 (0.95, 1.05)	.965
Nurse Work Environment	--		--		0.82 (0.72, 0.94)	.003
30-day length of stay (IRR)						
Nurse Burnout	1.02 (1.00,1.04)	.038	1.01 (1.00, 1.03)	.035	1.00 (0.98, 1.02)	.945
Nurse Education	--		--		1.00 (0.99, 1.01)	.488
Nurse Staffing	--		--		1.02 (1.00, 1.04)	.084
Nurse Work Environment	--		--		0.96 (0.91, 1.01)	.081

Models: 1, Unadjusted; 2, Adjusted for Patient and Hospital Characteristics; 3, Model 2 + Education, Staffing, and Work Environment**.**

Abbreviations: CI = confidence interval, OR= odds ratio, IRR= incidence rate ratio.

Note: Burnout represents the average burnout score of nurses in a hospital. The odds ratio reflects a 1 standard deviation change in the average score of burnout. Hospital characteristics include bed size, teaching status, technology status, and state. Patient characteristics include age, sex, transfer status, comorbidities, and surgical procedure. Nurse education represents a 10% increase in the percentage of nurses with a baccalaureate degree in a hospital.

Staffing represents an additional patient per nurse and includes controls for the proportion of medical-surgical and ICU nurses in hospitals. Work environment is categorized as poor, mixed, and good. The odds ratio reflects the change in work environment from poor to good. Work environment was created from PES-NWI and excludes the staffing and resource adequacy subscale.

CHAPTER 5: DISCUSSION

Introduction

Clinician burnout has been described as an epidemic sweeping through our healthcare system (Perlo et al., 2017). Previous research has found that burnout reduces productivity and work quality (Maslach, 1997; Maslach et al., 2001). An alternative explanation is that the diminished productivity and quality associated with burnout is due to individuals working within poor work environments. This shows that the responsibility is on the organizations and those who lead them to create environments in which nurses can provide high-quality care. For nurses, quality translates into patient lives, making it critical to understand how the effect of nurse burnout on patient care can be alleviated. For nurses to operate at their highest level, they must be empowered by the system to do their best work, which is centered around caring for the patient rather than trouble shooting issues related to their work environment. “To Err is Human” and “Crossing the Quality Chasm” identified the role of the system in shaping the quality and safety of patient care (Donaldson et al., 2000; NAM, 2001). However, “Taking Action Against Clinician Burnout: A Systems Approach to Professional Well-Being” goes a step further by asserting that part of providing high-quality care, is “caring for the clinician” and links the well-being of the healthcare provider with the health of the patient (NAM, 2019). While the National Academy of Medicine report identifies nurse burnout as a danger to patients, it also situates burnout within a larger sociological framework, suggesting that nurse burnout and poor patient outcomes are a result of the same cause, a poor work environment. However, the assertion is underscored as much of the

cited research between nurse burnout and patients has not been examined with objective patient outcomes.

Our study built on prior work by considering the relationship between nurse burnout and a robust set of objective patient outcomes including 30-day mortality, failure to rescue, adverse events, length of stay, and readmissions (Aim 1). We went beyond reports of staffing and included a measure of the nurse work environment, a conglomeration of hospital features identified as the primary cause of nurse burnout (Lake et al., 2019). By considering the nurse work environment and staffing in our analysis, we were able to determine how investments in these nursing resources could be used to mitigate nurse burnout's effect on patient care.

Collectively, our results suggest that there is a relationship between nurse burnout and patient outcomes, including mortality, failure to rescue, and length of stay. However, what underlies both nurse burnout and poor patient outcomes are poor work environments. Aim 1 alone might suggest that burnout is about the individual, but contextualized with Aim 2, our findings reinforce the assertion that nurse burnout and patient safety cannot be addressed without system-wide efforts to improve the work environment.

Discussion of Principal Findings

The overarching goal of this study was to evaluate the relationship between nurse burnout and objective patient outcomes including 30-day mortality, failure to rescue, adverse events, length of stay, and readmissions (Aim 1). We hypothesized that patients in hospitals with higher levels of nurse burnout would have higher odds of negative patient outcomes. In summary, we found a relationship between nurse burnout

and the odds of mortality, failure to rescue, and length of stay, but not between nurse burnout and readmissions or between nurse burnout and adverse events. In Aim 2 we sought to determine if the nurse work environment and nurse staffing attenuated the relationship between nurse burnout and patient outcomes. In general, we found this to be true for the nurse work environment, but not for nurse staffing.

A 1 standard deviation increase in the average nurse burnout score was associated with a 5% increase in the odds of mortality (OR 1.05, p=.023), even after adjusting for patient and hospital characteristics. In Aim 2, we found that a change in the nurse work environment from poor to good was associated with a decrease in the odds of mortality by 18% (OR 0.82, p=.001). As hypothesized, the effect of nurse burnout was completely attenuated. The strength of the association between the nurse work environment and the odds of mortality suggests that further reductions in patient mortality are achievable by efforts to improve the work environment, which evidence suggests is also key to reducing nurse burnout. Having a supportive work environment with the appropriate autonomy, positive working relationships, and administrative support could go a long way in eliminating feelings of burnout and promoting nurse well-being, while also addressing concerns for patient safety.

Similar to our mortality findings, we see a consistent trend for failure to rescue, with a 1 standard deviation increase in average nurse burnout score being associated with a 5% increase in the odds failure to rescue (OR 1.05, p=.038). An improvement in the nurse work environment presented a protective effect, with a progression from poor to good work environments being associated with a 18% drop in the odds of failure to rescue (OR 0.82, p=.003).

We found that nurse burnout's relationship to length of stay was also significant with a 1 standard deviation increase in the average nurse burnout score being

associated with 1% increase in length of stay (OR 1.01, p=.035). Although they did not reach statistical significance, the addition of the nurse work environment and staffing attenuated the effect of nurse burnout on length of stay. This suggests that improvements in both nursing resources could have similarly advantageous effects in minimizing nurse burnout and shortening length of stay. Previous work has been inconclusive regarding nurse burnout's relationship with length of stay. One study found that higher nurse burnout was associated with improvements in length of stay (Schaufeli et al., 1995) and another study found no relationship between nurse burnout and length of stay (Welp et al., 2015). We did not find an association between nurse burnout and the odds of readmissions or adverse events.

Despite not finding a relationship between nurse burnout and all the objective patient outcomes, we found a strong relationship between nurse burnout, mortality, failure to rescue, and length of stay. We echo the conclusion of Welp and colleagues: (1) The worst patient outcomes (i.e. mortality and failure to rescue) are unable to be masked by variables previously linked to patient risk of death (e.g. patient and hospital characteristics); and (2) When nurses are burned out, there are objectively life-threatening consequences for patients (Welp et al., 2015).

We found that unfavorable patient outcomes are more likely to occur in hospitals where nurses have higher scores in burnout. However, the factor that accounts for both high nurse burnout and poor patient outcomes is the quality of the nurse work environment. This is in part due to what we show descriptively in Table 4.1 ─ there are not high numbers of burned out nurses in good work environments (e.g. only 1% of hospitals with good work environments had nurses in the highest quartile of burnout). If hospitals focused on the outcome for Aim 1, they might choose to concentrate on nurse burnout and emphasize individual-level interventions to address it. Our Aim 2 findings

illustrate why that should not be the only approach. Instead, our results suggest that hospitals should focus on improving the nurse work environment to solve the problem underlying nurse burnout and poor patient outcomes. We show that there is a natural synergy between nurse well-being and patient care. Hospital administrators could use the same intervention (i.e. improving the nurse work environment) to address patient outcomes and support a healthy workforce.

We did not find an effect for nurse staffing on patient outcomes, but further research is required to determine the moderating effect that other nursing resources may have on nurse staffing's relationship with nurse burnout and patient outcomes. For example, prior research has found that nurse staffing is associated with decreases in failure to rescue and mortality, but only in the presence of good nurse work environments (Aiken et al., 2012). This interaction suggests that the effect of nurse staffing is complex and possible interactions between nurse burnout, nurse staffing, nurse education, and the nurse work environment should be explored in future research.

Limitations

There were some limitations to this study. **(1)** We used cross-sectional data, limiting our ability to discuss causal inference. However, an analysis of panel data using cross-sectional data from 2006 and 2016 found that the associations observed cross-sectionally were similar to the longitudinal panel results (Sloane, Smith, McHugh, & Aiken, 2018). While it is possible that our findings for burnout would be similar, future work should consider the association between burnout and patient outcomes over time.

(2) Previous studies have suggested that 30-day mortality is preferable to in-hospital mortality as it captures deaths that occur in the hospital and deaths that occur after discharge in the community, reducing the concern for bias associated with in-

hospital mortality as it reflects hospital discharge patterns (e.g. hospitals that transfer patients sooner or favor shorter length of stay will have better in-hospital mortality rates) (Baker et al., 2002; Chassin, Park, Lohr, Keesey, & Brook, 1989; Drye et al., 2012; Jencks, Williams, & Kay, 1988). Quality guidelines recommended by the Centers of Medicare & Medicaid recommend using outcomes with a standardized period of time (such as 30 days from admission) to avoid bias in results (CMS, 2019). However, due to missing data concerns, we used 30-day in-hospital mortality in the primary analysis. We completed a sensitivity analysis (see Appendix B) using 30-day mortality for 3 of the 4 states (i.e. FL, NJ, PA) that had 30-day mortality data available. We found the results to be consistent with the main analysis, but it leaves out the largest state (CA). As a result of missing data this sensitivity analysis is missing nearly one million patients.

In addition to the mortality sensitivity analysis, we also replicated the main analysis using the dichotomized version of the burnout variable (see Appendix A). As discussed in Chapter 3 and in Appendix A, our study took a different approach than much of the burnout-outcomes research, which relies on a dichotomized version of burnout (Aiken et al., 2002; Cimiotti et al., 2012; Maslach et al., 1986; McHugh et al., 2011; Tawfik et al., 2019). Instead, our study retained the continuous form of burnout as dichotomization has noted limitations related to information loss and reduced sensitivity (Altman, 2006; Pedhazur, 1982). The differences observed in statistical significance between Table 4.3 and Appendix A suggest that some of the nuances in nurse burnout and its relationship to patient outcomes are missed by relying on a dichotomized version of burnout. Our findings highlight the importance of considering burnout on a continuous scale, reflective of its complexity as phenomenon occurring on a continuum. For example, our findings suggest that nurses that do not reach the threshold to be considered burned out still have important implications for patient outcomes, which might

not have been shown if burnout was dichotomized to be consistent with much of prior research.

Our final sensitivity analysis in Appendix C shows the results for our quality assurance checks. We assessed the impact of multicollinearity among the nursing resource variables as correlated predictor variables can cause unreliable regression coefficients (Allison, 2012). We show our testing, results, and discussion detailing why the risk for multicollinearity among the nursing resource variables was low. In summary, the three sensitivity analyses provide reassuring evidence supporting the findings and conclusions presented in the main analysis.

Implications

In 2017, the National Academy of Medicine created the Action Collaborative for Clinician Well-Being and Resilience with a focus on “caring for the caregiver” (Brigham et al., 2018). Additionally, healthcare professionals have noted that the well-being of clinicians must be addressed to improve the health and well-being of patients (Bodenheimer & Sinsky, 2014). Our work describes the extent and consequences of nurse burnout as well as a realistic solution for organizations looking to effect change.

In Aim 1, we found that patients have a higher risk for mortality and failure to rescue as well as a longer length of stay when cared for in hospitals where nurses are more burned out. However, our analysis in Aim 2 shows that nurse burnout and poor patient outcomes are symptoms of the same organizational failings, a poor work environment. This highlights the connection between clinician well-being and patient care, an interdependent relationship that could be supported by improvements to the nurse work environment. These findings support the National Academy of Medicine

recommendation that health systems should create supportive work environments to foster clinician well-being (NAM, 2019).

Organizations have a moral and ethical responsibility to provide clinicians with a safe workplace that optimizes their well-being and the delivery of safe, efficient care. Health systems must strike a balance between cutting costs and providing clinicians with the necessary resources and support to do their work. Our findings show that some hospitals have few burned out nurses and good patient outcomes, in part because they have good work environments. Encouraging individual self-care is one approach, but our results echo the concerns of Mechanic, that the stressors associated with the workplace "are not amenable to individual solutions, but depend on highly organized cooperative efforts that transcend those of any individual man no matter how well developed his personal resources" (Mechanic, 1974, p. 34). The nurse work environment is a modifiable feature of hospitals and directly addresses the main cause of nurse burnout.

In their call to expand the Triple Aim into the Quadruple Aim, Bodenheimer and Sinsky outline practical examples for how practices can improve the work life of primary care physicians (Bodenheimer & Sinsky, 2014). Similarly, our results can be adapted to provide such recommendations for bedside nurses. We found that improvements to the nurse work environment, a modifiable feature of hospitals, could be used to simultaneously lower nurse burnout and improve patient outcomes. The Magnet accreditation system is a blueprint for hospital administrators looking to do both. Magnet hospitals are known for excellence in nursing care and the Magnet accreditation program is the only evidence-based program that shows that systematic changes to enhance nurse work environments are associated with reductions in nurse burnout and improved patient outcomes (Lake et al., 2019; Wei et al., 2018).

Directions for Future Research

We completed a cross-sectional analysis examining the relationship between nurse burnout and objective patient outcomes, but future research should consider the consequences of nurse burnout on objective patient outcomes over time to support a causal link. Our study also used hospitalized surgical patients as there is a well-established risk adjustment for this group. In the future, other patient populations and settings should also be considered.

Despite prior research showing a link between staffing and the development of burnout as well as between staffing and poor patient outcomes (Aiken et al., 2002; Aiken et al., 2013; Chen et al., 2013; Cimiotti et al., 2012; Seago et al., 2006), we did not find that staffing attenuated the association between nurse burnout and mortality or between nurse burnout and failure to rescue. However, we did find that the presence of staffing in the model independently diminished the effect of nurse burnout on length of stay even though it was not statistically significant in the final model shown in Table 4.4. The full modeling was not shown in Table 4.4 for parsimony, but nurse staffing and the nurse work environment were stepped in independently of each other, and then together. When this was done, staffing's presence in the model attenuated the effect of burnout even though the odds ratios themselves were not significant. Similar effects were found for the nurse work environment and length of stay. Future research should consider potential interactions between nurse staffing and other nursing resource variables to determine nurse staffing's relationship with burnout and patient outcomes.

We did not find a relationship between nurse burnout and readmissions or adverse events. The healthcare team includes physicians, social workers, pharmacists, physical therapists, respiratory therapists, etc., but our analysis captures the rate of

burnout among nurses. Future research should consider team composition and the role of burnout in compromising patient outcomes. For example, being cared for by a team of burned out clinicians could magnify the chances for errors to be missed, exposing the patient to potential harm and increasing the probability of poor outcomes (Welp et al., 2015, p. 9). Regardless, for mortality and failure to rescue (the most severe outcomes), nurse burnout alone has clear effects.

Improvements to the nurse work environment have been shown to be associated with better outcomes for nurses in previous research and this is echoed by our work (Lake et al., 2019). Future studies should consider if such improvements to the nurse work environment are also associated with better outcomes for other clinicians.

In recent years, the paradigm has shifted from focusing on burnout alone to supporting highly engaged employees that "go beyond the formal structure of their positions to take initiative" (Leiter & Bakker, 2010). Those who feel engaged are dedicated and highly committed to their work (Leiter & Bakker, 2010). Burnout and engagement exist on a spectrum (Maslach & Leiter, 2008), wherein engagement exists as the opposite, or the positive antithesis to burnout (Maslach et al., 2001, p. 417). One such study found that higher levels of nurse engagement were associated with improved quality, safety, and patient satisfaction scores (Kutney-Lee et al., 2016). Hospital administrators can cultivate nurse engagement by investing in the environment, particularly by empowering nurses in participate in organizational decision making (Kutney-Lee et al., 2016). Our results show that improvements in the nurse work environment are associated with reductions in nurse burnout and poor patient outcomes. Based on this finding, future work should examine the effects of nurse engagement on patient outcomes.

While COVID-19 has imposed tremendous strains on our health system, it has unveiled the reality of what so many clinicians are already familiar with – do more with less. This mantra is a result of the system-wide failures to provide clinicians with the support and resources they need to not only do their work well, but in a sustainable way that supports their personal well-being while caring for others. In the era of managed care and value-based purchasing, hospitals have refocused on cutting costs and reducing system inefficiencies at the expense of clinicians. Such changes have severely impacted the day-to-day demands of front-line healthcare providers, like nurses, considerably. These efforts at efficiency have made inferior work environments the norm rather than the exception, with many nurses reporting high levels of burnout before the pandemic even began. In our study, we found that less than 20% of hospitals had good work environments, leaving around 80% of hospitals with serious improvements to make. We hypothesize that the COVID-19 pandemic further strained hospitals that were already poorly resourced and understaffed for nurses, increasing the likelihood of clinicians developing burnout. Preliminary research assessing COVID-19's impact on nurses showed that almost 75% of nurses surveyed reported symptoms of burnout and over two-thirds of nurses were considering leaving their job as a result of the pandemic (Volmer, 2020). It is true than COVID-19 placed unique strains on nurses, but it exacerbated the worst features of poor work environments: lack of resources and staff, mismanagement and ineffective leadership, strained working relationships, and low autonomy to change one's work situation. We contend that the nurses that were at the highest risk for burnout were those already in substandard work environments, which made up the majority of our sample. Future work could explore the strains the COVID-19 pandemic placed on hospitals and nurses and how this relationship affected patient outcomes.

Summary

Despite recommendations made over two decades ago to improve work environments (IOM, 2001), the quality of the nurse work environment and nurse burnout vary significantly across hospitals. This study describes the pervasiveness of nurse burnout, its association with objective patient outcomes, and how investments in nursing resources could be used to potentially reduce burnout and improve patient outcomes. We show that the well-being of patients is associated with the well-being of the nurses caring for them. We found that in hospitals with higher average nurse burnout scores, patients are at greater risk for mortality, failure to rescue, and longer length of stay. This implies that above the risks of surgery, patient health status on admission, and other hospital resources, the outcome for patients depends on which hospital they are admitted to, the quality of the work environment, and the well-being of the clinicians caring for them. We also found that when nurses care for patients in good work environments characterized by supportive leadership, adequate resources, and good working relationships with colleagues, nurses are less likely to experience burnout and patients' risk for poor outcomes is minimized. In order for the United States to achieve the Triple Aim of high quality, safe, and high value patient care, nurses and other clinicians must have the adequate resources and support to do their jobs (Bodenheimer & Sinsky, 2014). Improving the nurse work environment is one way for hospital administrators to achieve this.

APPENDIX A: DICHOTOMIZED BURNOUT VARIABLE

Table A1. Effects of burnout on patient outcomes (using 10% changes in burnout)

Patient Outcomes	Unadjusted		Adjusted for Patient & Hospital Characteristics	
	OR (95% CI)	P[a]	OR (95% CI)	P[a]
30-day in-hospital mortality	1.05 (1.02, 1.09)	.004	1.03 (1.00, 1.07)	.077
Failure to rescue	1.04 (0.99, 1.09)	.085	1.03 (0.99, 1.07)	.133
Adverse events	1.00 (0.97, 1.03)	.956	0.99 (0.95, 1.03)	.521
30-day length of stay (IRR)	1.02 (1.00,1.04)	.081	1.01 (1.00, 1.02)	.084
30-day readmissions	1.01 (0.99, 1.03)	.268	1.00 (0.99, 1.02)	.635

Abbreviations: CI = confidence interval, OR= odds ratio, IRR= Incidence Rate Ratio.
Note: A 1-unit increase in burnout represents a 10% increase in nurses reporting burnout in a hospital.
Hospital characteristics include bed size, teaching status, technology status, and state.
Patient characteristics include age, sex, transfer status, comorbidities, and surgical procedure.

Table A2. Effects of burnout and nursing resources on patient outcomes (using 10% changes in burnout)

Patient Outcomes	Model 1		Model 2		Model 3	
	OR (95% CI)	P[a]	OR (95% CI)	P[a]	OR (95% CI)	P[a]
30-day in-hospital mortality						
Nurse Burnout	1.05 (1.02, 1.09)	.004	1.03 (1.00, 1.07)	.077	0.99 (0.96, 1.03)	.742
Nurse Education	--		--		0.96 (0.93, 0.98)	.001
Nurse Staffing	--		--		1.01 (0.96, 1.05)	.835
Nurse Work Environment	--		--		0.81 (0.73, 0.92)	.001
Failure to rescue						
Nurse Burnout	1.04 (0.99, 1.09)	.085	1.03 (0.99, 1.07)	.133	0.99 (0.96, 1.03)	.708
Nurse Education	--		--		0.98 (0.95, 1.01)	.154
Nurse Staffing	--		--		1.00 (0.95, 1.05)	.943
Nurse Work Environment	--		--		0.82 (0.72, 0.92)	.001
30-day length of stay (IRR)						
Nurse Burnout	1.02 (1.00,1.04)	.081	1.01 (1.00, 1.02)	.084	1.00 (0.99, 1.01)	.949
Nurse Education	--		--		1.00 (0.99, 1.01)	.488
Nurse Staffing	--		--		1.02 (1.00, 1.04)	.082
Nurse Work Environment	--		--		0.96 (0.91, 1.00)	.055

Models: 1, Unadjusted; 2, Adjusted for Patient and Hospital Characteristics; 3, Model 2 + Education, Staffing, and Work Environment**. Abbreviations:** CI = confidence interval, OR= odds ratio, IRR= Incidence Rate Ratio. **Note:** A 1-unit increase in burnout represents a 10% increase in nurses reporting burnout in a hospital. Hospital characteristics include bed size, teaching status, technology status, and state. Patient characteristics include age, sex, transfer status, comorbidities, and surgical procedure. Work environment is categorized as poor, mixed, and good. The odds ratio reflects the change in work environment from poor to good. Work environment was created from PES-NWI, excluded the staffing and resource adequacy subscale. Staffing represents an additional patient per nurse and included controls for the proportion of medical-surgical and ICU nurses in hospitals.

Appendix A Discussion:

We checked the consistency of our results by testing a dichotomized version of the nurse burnout variable. In main analysis, our version of the burnout is in its continuous form, but in this sensitivity analysis we use a dichotomized version where burned out nurses were identified with an emotional exhaustion score ≥ 27, which is consistent with how burnout has been conceptualized and measured in prior research (Aiken et al., 2002; Cimiotti et al., 2012; Maslach et al., 1986; McHugh et al., 2011; Tawfik et al., 2019). Individual scores were aggregated to the hospital-level to determine the proportion of burned out nurses in each hospital. For statistical modeling, we scaled our hospital-level burnout variable so that the effect on patient outcomes corresponds with an increase of 10% in proportion of burned out nurses, which is consistent with prior research (Brooks-Carthon et al., 2020; Cimiotti et al., 2012).

The first column in Table A1 presents regression models estimating the unadjusted relationship between nurse burnout and outcomes. The second column shows models with controls for patient and hospital characteristics stepped in. Starting with the unadjusted model, nurse burnout was significantly related to 30-day in-hospital mortality (OR=1.05, p=.004). This can be interpreted to mean that for each 10% increase in the proportion of burned out nurses, the odds of patient mortality increased by 5%. The trend for mortality remained consistent after stepping in patient and hospital characteristics, although it did not retain statistical significance (OR=1.03, p=.077).

For failure to rescue, we found that the unadjusted model was close to significance (OR=1.04, p=.085). Even though we did not find statistical significance after adjusting for patient and hospital characteristics (OR=1.03, p=.133), the odds ratio remained stable and showed consistent trends with mortality. We did not find an

association between burnout and adverse events in the unadjusted models (adverse events OR=1.00, p=.956) or in the model that adjusted for patient and hospital characteristics (adverse events OR=0.99, p=.521).

In our analysis of length of stay, we found that the relationship between nurse burnout and 30-day length of stay was not significant for both the unadjusted model (OR=1.02, p=.081) and the model that adjusted for patient and hospital characteristics (OR=1.01, p=.084). However, the odds ratios for length of stay mirrored the trends observed in mortality and failure to rescue.

We did not find an association between burnout and readmissions in the unadjusted model (readmissions OR=1.01, p=.268) or in the model that adjusted for patient and hospital characteristics (readmissions OR=1.00, p=.635).

Although these findings in our sensitivity analysis did not reach statistical significance as consistently as the results depicted in the main analysis, it provides an interesting discussion point for how burnout is conceptualized as a study variable. In the main analysis we use a continuous version, which is somewhat divergent from previous research that has primarily relied on the dichotomized version (Aiken et al., 2002; Cimiotti et al., 2012; McHugh et al., 2011; Tawfik et al., 2019). Variable dichotomization "leads to a loss of information, and consequently to a less sensitive analysis" (Pedhazur, 1982, p. 453). So the difference in significance that we observe between the continuous form of burnout and the dichotomized form of burnout show what is lost. Specifically, we show how values under the threshold of 27 are still associated with adverse patient outcomes even though much of previous research categorized scores close to 27, yet still below it, as not burned out. If we had dichotomized burnout, as much of previous burnout-outcomes research has done, we might have missed what we show to be statistically significant in the main analysis.

APPENDIX B: 30-DAY MORTALITY SENSITIVITY ANALYSIS

Table B1. Effects of burnout and nursing resources on 30-day mortality

	Model 1 OR (95% CI)	P[a]	Model 2 OR (95% CI)	P[a]	Model 3 OR (95% CI)	P[a]
30-day mortality						
Nurse Burnout	1.07 (1.03, 1.12)	.001	1.08 (1.04, 1.12)	<.001	1.05 (1.00, 1.10)	.060
Nurse Education	--		--		0.97 (0.94, 1.00)	.025
Nurse Staffing	--		--		0.97 (0.93, 1.02)	.206
Nurse Work Environment	--		--		0.87 (0.77, 0.99)	.036

Models: 1, Unadjusted; 2, Adjusted for Patient and Hospital Characteristics; 3, Model 2 + Education, Staffing, and Work Environment**.**

Abbreviations: CI = confidence interval, OR= odds ratio, IRR= Incidence Rate Ratio.

Note: Burnout represents the average burnout score of nurses in a hospital. The odds ratio reflects a 1 standard deviation change in the average score of burnout. Hospital characteristics include bed size, teaching status, technology status, and state. Patient characteristics include age, sex, transfer status, comorbidities, and surgical procedure. Nurse education represents a 10% increase in the percentage of nurses with a baccalaureate degree in a hospital.

Staffing represents an additional patient per nurse and includes controls for the proportion of medical-surgical and ICU nurses in hospitals. Work environment is categorized as poor, mixed, and good. The odds ratio reflects the change in work environment from poor to good. Work environment was created from PES-NWI and excludes the staffing and resource adequacy subscale.

Appendix B Discussion:

As referenced in the limitations section of Chapter 5, 30-day in-hospital mortality has drawbacks as an outcome measure. To address these concerns, we completed an analysis of 30-day mortality for the states that had data available. For our analysis of 30-day mortality, 836,382 patients (43.12%) were missing at the time of analysis as CA (missing the last quarter of 2014 as well as all of 2015 and 2016) and NJ (missing 2016 data only) did not have some mortality data available at the time of analysis. We used the standardized average nurse burnout score that was presented in the main analysis. In the unadjusted column, we found that a 1 standard deviation in the average nurse burnout score, from the 50^{th} to the 84^{th} percentile, was associated with 7% increase in the odds of mortality (OR=1.07, p=.001). This finding was consistent after adjusting for patient and hospital characteristics (OR=1.08, p<.001). In model 3, the nursing resource characteristics were stepped in, and the nurse work environment attenuated the effect that nurse burnout had on patient outcomes. We show that a change in the work environment from poor to good is associated with a 13% drop in the odds of 30-day mortality (OR=0.87, p=.036). These mortality findings are consistent with the findings shown in the main analysis, providing further evidence to support the findings of this study.

APPENDIX C: MULTICOLLINEARITY

Table C1. Pearson correlation matrix for nursing variables

	Nurse burnout	Nurse work environment	Nurse staffing	Proportion of medical-surgical nurses	Proportion of ICU nurses	Proportion of Nurses with a baccalaureate degree
Nurse burnout	1.0000					
Nurse work environment	-0.4074	1.0000				
Nurse staffing	0.1731	-0.1316	1.0000			
Proportion of medical-surgical nurses	0.1120	-0.0276	0.1405	1.0000		
Proportion of ICU nurses	-0.0646	0.0402	-0.3885	0.2692	1.0000	
Proportion of Nurses with a baccalaureate degree	-0.0848	0.2607	-0.2542	-0.0250	0.1029	1.0000

Note. Nurse burnout represents a 10% increase in the percentage of nurses with burnout in a hospital. Nurse work environment was created from PES-NWI and excludes the staffing and resource adequacy subscale. Nurse Staffing represents an additional patient per nurse. The proportion of medical-surgical nurses and ICU nurses in hospitals were included as controls for staffing. Nurse education represents a 10% increase in the proportion of nurses with a baccalaureate degree.

Table C2. Spearman correlation matrix for nursing variables

	Proportion of burned out nurses	Nurse work environment	Nurse staffing	Proportion of medical-surgical nurses	Proportion of ICU nurses	Proportion of Nurses with a baccalaureate degree
Proportion of burned out nurses	1.0000					
Nurse work environment	-0.4039	1.0000				
Nurse staffing	0.1813	-0.1366	1.0000			
Proportion of medical-surgical nurses	0.1081	-0.0265	0.1308	1.0000		
Proportion of ICU nurses	-0.0808	0.0446	-0.3791	-0.2504	1.0000	
Proportion of Nurses with a baccalaureate degree	-0.0743	0.2527	-0.2564	-0.0419	0.1313	1.0000

Note. Nurse burnout represents a 10% increase in the percentage of nurses with burnout in a hospital. Nurse work environment was created from PES-NWI and excludes the staffing and resource adequacy subscale. Nurse Staffing represents an additional patient per nurse. The proportion of medical-surgical nurses and ICU nurses in hospitals were included as controls for staffing. Nurse education represents a 10% increase in the proportion of nurses with a baccalaureate degree.

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Table C3. Variance Inflation Factors for Nursing Resource Characteristics

(N = 523 Hospitals)

Variable	VIFs for 30-day in-hospital mortality
Nurse Burnout	1.39
Nurse Education	1.19
Nurse work environment	--
Mixed	1.72
Good	2.24
Nurse staffing	1.30
Proportion of ICU nurses	1.08
Proportion of medical-surgical nurses	1.25

Abbreviations: VIF= Variance Inflation Factor

Note. Nurse burnout represents a 10% increase in the percentage of nurses with burnout in a hospital. Nurse education represents a 10% increase in the percentage of nurses with a baccalaureate degree in a hospital. Work environment is categorized as poor, mixed, and good. Work environment was created from PES-NWI and excluded the staffing and resource adequacy subscale. Staffing represents an additional patient per nurse and includes controls for the proportion of medical-surgical nurses and ICU nurses in hospitals.

Table C4. Variance Inflation Factors for Nursing Resource Characteristics

(N = 523 Hospitals)

Variable	VIFs for 30-day mortality
Nurse Burnout	1.40
Nurse Education	1.21
Nurse work environment	--
Mixed	1.76
Good	2.29
Nurse staffing	1.28
Proportion of ICU nurses	1.10
Proportion of medical-surgical nurses	1.25

Abbreviations: VIF= Variance Inflation Factor

Note. Nurse burnout represents a 10% increase in the percentage of nurses with burnout in a hospital. Nurse education represents a 10% increase in the percentage of nurses with a baccalaureate degree in a hospital. Work environment is categorized as poor, mixed, and good. Work environment was created from PES-NWI and excluded the staffing and resource adequacy subscale. Staffing represents an additional patient per nurse and includes controls for the proportion of medical-surgical nurses and ICU nurses in hospitals.

Appendix C Discussion:

To assess multi-collinearity between nurse burnout and the nursing resources (i.e. nurse work environment, nurse staffing, and nurse education), we used Pearson correlations, Spearman correlations, and variance inflation factors. Pearson correlations are used for data that are normally distributed. Spearman correlations are rank ordered and a nonparametric equivalent to Pearson correlations, meaning that they do not make distribution assumptions and are not as susceptible to outliers. We found that the nurse work environment was negatively correlated with nurse burnout (Pearson r= -0.4074; Spearman r= -0.4039), indicating that as the work environment improves, nurse burnout decreases. We also found that the proportion of ICU nurses and nurse staffing were negatively correlated (Pearson r= -0.3885; Spearman r= -0.3791), indicating that as the proportion of ICU nurses increased, nurse staffing improved (i.e. less patients per nurse). This supports our decision to include the proportion of ICU and medical-surgical nurses as controls for nurse staffing (e.g. higher proportions of ICU nurses would make nurse staffing levels appear better than they are). From this we also concluded that there was no concerning evidence of multicollinearity among the nursing resource variables.

We also computed variance inflation factors (VIFs), which are presented in Appendix D in Tables D3 and D4. Table D3 presents VIFs for 30-day in-hospital mortality and Table D4 presents VIFs for 30-day mortality. A variance inflation factor >2.5 is concerning and would suggest that the variance of a regression coefficient is inflated due to collinearity (Allison, 2012). However, none of our variables exceed the 2.5 threshold, providing further evidence that the risk of multicollinearity in our models among the nursing resource variables is low.

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