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The Nexus Between Nurse Burnout, Missed Care And Patient Outcomes

Shweta Singh
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Abstract

Background & Significance: Nurse burnout is a healthcare crisis affecting nearly half of U.S. hospital nurses and has been tied to negative patient outcomes such as preventable adverse events – the third leading cause of death in the U.S. Despite the pervasiveness of burnout, much remains to be understood about exactly how, and to what extent, hospital nurse burnout impacts the delivery of care and patient outcomes. This study advances our understanding of the complex phenomenon of burnout by examining its impact on specific nurse-reported preventable adverse events, and positing that missed care is a pathway by which hospital nurse burnout undermines quality of care and patient safety.

Methods: This cross-sectional, secondary data analysis of three linked datasets from 2005-2008 assessed a sample of 23,784 registered nurses working in 587 hospitals across four states. Employing a series of multilevel multivariable robust logistic regressions, a mediation analysis was conducted to examine the associations between hospital-level nurse burnout, hospital-level missed care, and five nurse-reported frequent adverse events (medication errors, pressure ulcers, falls with injury, hospital-associated urinary tract infections and central line bloodstream infections), after controlling for patient severity, nurse and hospital characteristics.

Results: Hospital nurse burnout was found to be significantly associated with all five nurse-reported adverse events and missed care partially mediated this relationship in four out of the five outcomes. The odds of nurses reporting frequent adverse events increase by 12-20% with every 10% increase in the proportion of burned out nurses, after accounting for patient severity, nurse and hospital characteristics. Missed care was found to explain 15-33% of the relationship between hospital nurse burnout and hospital nurse-reported adverse events.

Conclusion & Implications: This study provides new evidence that hospitals with higher proportions of burned out nurses have higher odds of nurse-reported preventable adverse events—partially due to missed care. To the author's knowledge, this is the first large-scale study in the U.S. to document these associations and empirically demonstrate that missed care partially explains how nurse burnout leads to preventable harm to patients. Given the current policy climate increasingly demanding safe, high quality, value-based patient care, this study suggests that organizational-level interventions aimed at reducing nurse burnout may be a critical strategy to mitigate costly, occasionally life-threatening adverse events.

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THE NEXUS BETWEEN

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THE NEXUS BETWEEN NURSE BURNOUT, MISSED CARE AND PATIENT OUTCOMES

DEDICATION

To my dearest little sister, Arya Singh (1991 – 2013):

My life's greatest achievement
has always been and will forever remain
being your Didi.

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I stand upon the shoulders of giants. This has been a profoundly difficult journey for me – one that has tested me emotionally, physically, and spiritually. When life beset me with the unimaginable loss of my sister, I had to take time to care for my family and myself. But I never *once* thought of abandoning my dream of becoming a nurse scholar to advance the science, profession, and cause of nursing. And I never quit because of those who never quit on me – because of the unwavering commitment, patience, and encouragement of those who never stopped believing in me. I am forever indebted to this extraordinary league of human beings who I am blessed to call my mentors, my colleagues, my friends, and my family.

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To my Rhoads 6 oncology crew: you prove – over and over again, every single day – that nurses are the backbone of our healthcare system. My six years as an RN at

the bedside with you ceaselessly inspire what I value. The profoundly human experience we shared together will always be my guide wherever I may go.

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ABSTRACT

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Shweta Singh

Matthew D. McHugh

Background & Significance: Nurse burnout is a healthcare crisis affecting nearly half of U.S. hospital nurses and has been tied to negative patient outcomes such as preventable adverse events – the third leading cause of death in the U.S. Despite the pervasiveness of burnout, much remains to be understood about exactly how, and to what extent, hospital nurse burnout impacts the delivery of care and patient outcomes. This study advances our understanding of the complex phenomenon of burnout by examining its impact on specific nurse-reported preventable adverse events, and positing that missed care is a pathway by which hospital nurse burnout undermines quality of care and patient safety.

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Results: Hospital nurse burnout was found to be significantly associated with all five nurse-reported adverse events and missed care partially mediated this relationship in four out of the five outcomes. The odds of nurses reporting frequent adverse events increase by 12-20% with every 10% increase in the proportion of burned out nurses, after accounting for patient severity, nurse and hospital characteristics. Missed care was found to explain 15-33% of the relationship between hospital nurse burnout and hospital nurse-reported adverse events.

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CHAPTER 1: INTRODUCTION AND SPECIFIC AIMS

"If burnout only affected individuals in isolation, it would be far less…devastating in its impact than it is. Burnout in human services agencies is like an infection in hospitals: it gets around. It spreads…to clients."
- Edelwich & Brodsky, 1980

In recent years, healthcare provider burnout has rightfully been described as a health care crisis and an epidemic that must be treated as a national priority (Jha, Ilif, & Chaoui, 2019; Shin, Gandhi, & Herzig, 2016). Alarmingly, over 40% of hospital nurses—who form the front line of healthcare delivery to millions of patients around the clock—suffer from burnout (Aiken, Clarke, Sloane, Lake, & Cheney, 2008). A 2019 national survey found that nearly 75% of Americans are concerned about healthcare provider burnout, and nearly 80% fear that provider burnout diminishes the quality of their care and threatens their safety (The Harris Poll & American Society of Hospital Pharmacists, 2019). And they are not wrong.

Hospital nurse burnout has been found to be linked to negative patient outcomes such as decreased patient satisfaction (Leiter, Harvie, & Frizzell, 1998; McHugh, Kutney-Lee, Cimiotti, Sloane, & Aiken, 2011; Vahey, Aiken, Sloane, Clarke, & Vargas, 2004) reports of poor quality of care (Laschinger, Shamian, & Thomson, 2001; Parker & Kulik, 1995; Poghosyan, Clarke, Finlayson, & Aiken, 2010; Van Bogaert, Clarke, Roelant, Meulemans, & Van de Heyning, 2010), safety and overall adverse events (Leiter & Laschinger, 2006; Liu et al., 2018).

Over 440,000 people die annually from preventable adverse events, making it the third leading cause of death in the United States (Advisory Board Company, 2013; James, 2013; Makary & Daniel, 2016). This staggering number of preventable deaths is

made even worse by the fact that adverse events are known to be underestimated (Classen et al., 2011; U.S. Department of Health and Human Services, 2012). In addition to the grave cost in human lives, these errors cost hospitals over $30 billion dollars annually (Institute of Medicine [IOM], 2000). Globally, one out of every ten hospitalizations results in preventable adverse events (Jha et al., 2013). Nationally, it has been estimated that one out of every three hospital admissions results in patient harm from a preventable adverse event (Classen et al., 2011). The pervasiveness of hospital nurse burnout and preventable adverse events—and their dire consequences—demand a deeper investigation into how, and to what extent, hospital nurse burnout leads to preventable patient adverse events.

Background

"How well we are cared for by nurses affects our health, and sometimes can be a matter of life or death"
- Institute of Medicine, 2004, pg. 2

Central to understanding and improving hospital patient outcomes is a thorough assessment of the preceding structures and processes of care delivery by nurses, the primary providers of direct care to hospital patients 24 hours a day (IOM, 2004). Given the pivotal role nurses play in the provision of care, it is necessary to examine factors that influence their performance. Burnout, an occupationally-based, multidimensional phenomenon, has been found to negatively impact job performance (Maslach, Jackson, & Leiter, 1996).

The majority of research on nurse burnout has predominantly focused on two areas: predictors and job consequences. Studies have found that interpersonal relationships and organizational characteristics of work environments, such as poor

staffing and quality of management, are determinants of nurse (RN) burnout (Aiken, Clarke, Sloane, Sochalski, & Silber, 2002; Vahey et al., 2004; Van Bogaert et al., 2010). Other studies have linked burnout to negative job outcomes, including decreased job satisfaction, absenteeism, intent-to-leave and turnover (Aiken et al., 2001; Maslach, Schaufeli, & Leiter, 2001; McHugh et al., 2011). However, the relationship between provider burnout, job performance and patient outcomes remains relatively understudied (Halbesleben, Rathert, & Williams, 2013). Nurse burnout has been found to be associated with: decreased patient satisfaction (Leiter et al., 1998; McHugh et al., 2011; Vahey et al., 2004), increased urinary tract and surgical site infections (Cimiotti, Aiken, Sloane, & Wu, 2012), altered medication administration practices (Halbesleben et al., 2013), poor overall quality of patient care (Poghosyan et al., 2010; Van Bogaert et al., 2010), safety and overall adverse events (Laschinger & Leiter, 2006; Liu et al., 2018). The findings of these studies warrant further inquiry into the mechanisms by which nurse burnout leads to poor patient outcomes.

One possible pathway emerges from evidence that patient outcomes are adversely affected when nurses are unable to provide necessary care (Papastavrou, Andreou, & Efstathiou, 2014). In health services research, the provision of care is also referred to as the process of care, or care provided and received (Donabedian, 1988). One process of care measure that has been proposed in the literature, missed care – defined as necessary patient care left undone – is considered to be an error of omission in patient safety literature (Kalisch, Landstrom, & Hinshaw, 2009). In a systematic review of 17 quantitative studies, missed nursing care was found to be associated with decreased patient safety and quality of care (Papastavrou et al., 2014). Studies have also linked

missed care to medication errors, pressure ulcers, falls, nosocomial infections (Kalisch, Xie, & Dabney, 2014; Lucero, Lake, & Aiken, 2010; Schubert et al., 2008), patient satisfaction (Lake, Germack, & Viscardi, 2016; Schubert et al., 2008), readmissions (Brooks Carthon, Lasater, Sloane, & Kutney-Lee, 2015; Brooks Carthon, Lasater, Rearden, Holland, & Sloane, 2016), increased inpatient mortality (Ball et al., 2018; Schubert, Clarke, Aiken, & de Geest, 2012), and nurse perceptions of quality of care and patient safety (Ball, Murrells, Rafferty, Morrow, & Griffiths, 2014).

The next logical inquiry is whether, and to what extent, missed care serves as a pathway between nurse burnout and patient outcomes. Though not explicitly studied to date, a number of studies suggest that a link may indeed be present. One study assessing nurse burnout in nursing homes found a significant association with missed care (White, Aiken, & McHugh, 2019). Research has shown that burnout is associated with poor job performance, decreased productivity and effectiveness at work (Dewa, Loong, Bonato, Thanh, & Jacobs, 2014; Maslach et al., 2001; Parker & Kulik, 1995), as well as prolonged stress-related health outcomes, including insomnia (Vela-Bueno et al., 2008) and substance abuse (Maslach et al., 2001). The provision of required nursing care such as surveillance, communication, and education may be negatively impacted by burned out nurses who have fewer physical, cognitive and emotional resources (Halbesleben & Rathert, 2008). Lower productivity and efficiency may lead to greater amounts of missed care. Furthermore, nurses must constantly make cognitively complex decisions about patient care involving attention, thought, knowledge, and judgment (IOM, 2004), all of which may be affected by burnout. As burnout leads to withdrawal and distancing from

work, burned out nurses may make suboptimal decisions, taking shortcuts and doing the bare minimum as opposed to adhering to best practices (Maslach, 2003).

Given this context and body of literature, the purpose of this study is to expand our understanding of how – and to what extent – hospital nurse burnout impacts the delivery of care and patient outcomes, specifically nurse-reported frequent adverse events. This study hypothesizes that hospitals with higher proportions of burned out nurses are more likely to have higher proportions of missed care, which may partially explain the link between hospital nurse burnout and nurse-reported frequent adverse events.

Study Overview, Specific Aims, and Hypotheses

This study is a secondary data analysis of three linked datasets. Measures of nurse burnout, nurse-reported adverse events, and additional nursing factors were derived from the University of Pennsylvania's Multi-State Nursing Care and Patient Safety Survey, conducted from 2005-2008 (Aiken et al., 2011). Information on the structural characteristics of study hospitals was obtained from the American Hospital Association's Annual Survey. Information on patient illness severity was obtained from the Centers for Medicare & Medicaid Services' Provider Specific File data. To achieve the study's purpose, two specific aims were addressed:

Specific Aim 1: To examine the relationship between hospital nurse burnout and patient outcomes, specifically nurse-reported adverse events.

Hypothesis 1: Hospitals with higher proportions of burned out nurses will have increased odds of nurses reporting frequent adverse events, including

medication errors, pressure ulcers, falls with injury, hospital-associated urinary tract infections and hospital-associated central line infections.

Specific Aim 2: To determine whether missed care partially mediates the relationship between hospital nurse burnout and patient outcomes, specifically nurse-reported adverse events.

Hypothesis 2: Hospitals with higher proportions of burned out nurses will have higher proportions of missed care. Missed care will partially explain the relationship between hospital nurse burnout and increased odds of nurses reporting frequent adverse events, including medication errors, pressure ulcers, falls with injury, hospital-associated urinary tract infections and hospital-associated central line infections.

Study Significance and Policy Implications

To the author's knowledge, this is the first large-scale study in the U.S. to assess the impact of hospital-level nurse burnout on nurse-reported medication errors, falls, pressure ulcers and central line infections while accounting for potential patient, nurse and hospital confounders. Moreover, this study uniquely advances the existing body of research linking nurse burnout to patient outcomes by being among the first to empirically examine missed care as a possible pathway between nurse burnout and preventable adverse events. Additionally, with a highly representative sample of 23,784 nurses from 587 hospitals in four geographically diverse states that comprise a quarter of the U.S. population, this study's findings are widely generalizable.

Notably, four out of the five outcomes individually assessed in this study are indictors of patient safety targeted by federal and state regulations, reimbursement

schemes, and public reporting mandates. Specifically, key changes in policy stemming from the Deficit Reduction Act (DRA) of 2005 and the Affordable Care Act (ACA) of 2010 spurred regulations to incentivize hospitals to improve performance on these outcomes. The Hospital-Acquired Conditions Reduction Program (HAC) of the ACA is one such regulation pursuant to which the Centers for Medicare & Medicaid Services (CMS) reduces hospital payments for hospitals with total HAC scores in the worst performing quartile (CMS, 2019). Since its inception, for poor performance on program metrics, the HAC program has withheld over $350 million from hospitals every year (CMS, 2019b). Therefore, hospital administrators have increased motivation to understand modifiable factors such as nurse burnout that influence their organizational performance on these regulated measures.

Additionally, this study is important in light of the U.S. Department of Health and Human Services' Partnership for Patients Initiative. This national public-private partnership is pursuing the goal of reducing hospital-acquired conditions, including the five study outcomes, by 20% in five years (CMS, 2019a). This widespread collaborative includes over 80% of acute care hospitals in the U.S. (Clarkwest et al., 2014). This study's findings are especially pertinent to this program by providing empirical evidence of a unique strategy that may contribute to the central aim of this initiative.

Further highlighting the significance and timeliness of this study's findings is its alignment with national efforts aimed at reducing provider burnout. The Action Collaborative on Clinician Well-Being and Resilience, led by the National Academy of Medicine, maintains key goals that were addressed by this study: raising the visibility of

clinician burnout and emphasizing evidenced-based solutions to improve patient safety by reducing clinician burnout (National Academy of Medicine, 2019).

Furthermore, this study's results may help inform healthcare stakeholders in the international community as well. It is known that nurse burnout and missed care are both highly prevalent in hospitals around the globe (Aiken et al., 2011; Ausserhofer et al., 2014; Poghosyan et al., 2010; Schubert et al., 2012). With over 40 million adverse events resulting in the loss of over 20 million disability-adjusted life years annually, patient harm as a result of unsafe care in hospitals has become a major policy emphasis globally (Jha et al., 2013).

Finally, by linking nurse burnout, missed care, and preventable adverse events, this study arguably provides empirical support to the notion that reducing burnout may be foundational to achieving the Triple Aim—a blue print to optimizing health system performance by the simultaneous pursuit of improving the health of populations, enhancing the patient experience of care, and reducing per-capita costs of healthcare (Whittington, Nolan, Lewis, & Torres, 2015). Healthcare leaders have called for the reduction of provider burnout to be added as a fourth pillar to a new Quadruple Aim—an approach this study conceptually and empirically supports (Bodenheimer & Sinsky, 2014; Sikka, Morath, & Leape, 2015).

By assessing a mechanism by which nurse burnout impacts patient outcomes, this study substantially advances existing literature and will be of interest to hospital administrators, payers, federal and state agencies, policymakers, patient advocacy organizations, researchers, providers and patients alike. By highlighting negative patient outcomes of a globally pervasive phenomenon, this study seeks to inform leaders in

healthcare, spur political advocacy, and empirically bolster the rationale for allocating resources towards reducing hospital nurse burnout—which may be a unique and necessary strategy for mitigating preventable harm to patients, reducing costs, and improving patient outcomes.

CHAPTER 2: BACKGROUND AND REVIEW OF LITERATURE

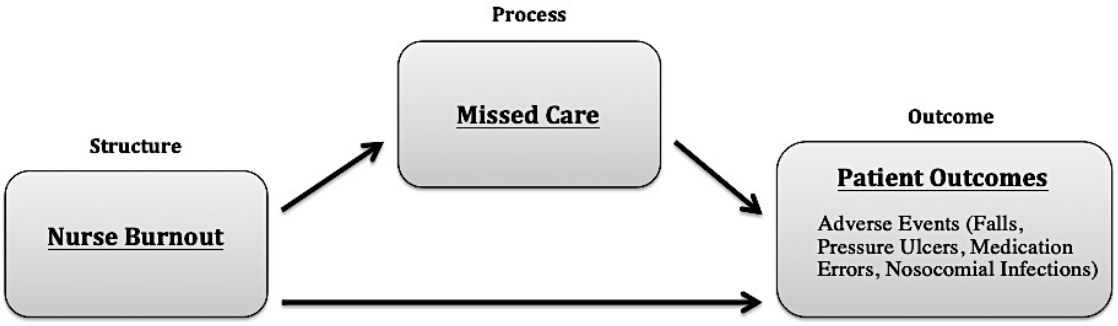
Introduction

This study assesses the relationship between nurse burnout and nurse-reported patient adverse events, and explores missed care as a potential mechanism by which burnout impacts these outcomes. This chapter reviews the existing body of evidence regarding the theoretical conceptualization, definition, and measurement of nurse burnout. The chapter also provides a review of literature linking nurse burnout to patient outcomes and processes of care. Based on the evidence reviewed and existing theoretical frameworks, this chapter posits that further investigation into the link between hospital nurse burnout, missed care and patient outcomes is necessary. The chapter concludes with a summary of the gaps in the current literature as well as the contributions of this study.

Conceptual Framework

The conceptual model that guides this study is shown below in **Figure 1**. The relationships between the core study variables – nurse burnout, missed care, and patient outcomes – are depicted. The model in Figure 1 was influenced by Donabedian's time-honored quality of care framework of structure, process, and outcome (Donabedian, 1988), and by the Conservation of Resources theory (COR) (Hobfoll, 1989).

Figure 1. Conceptual Model of the Relationships Between Nurse Burnout, Missed Care and Patient Outcomes



Donabedian (1988) defines structure as all of the attributes of the settings in which care is provided. Structure includes organizational components, material resources, and human resources, such as employees and their characteristics (Donabedian, 1988). The practice environment, defined as the organizational work characteristics that facilitate or constrain nursing practice (Lake, 2002) includes nurse and hospital organizational characteristics, and is considered a structure within this model. Process includes the giving and receiving of care, whereas outcomes are changes in status attributable to antecedent care and structures (Donabedian, 1988). In other words, outcomes are the effects of care provided within an organizational context (Donabedian, 1988). Donabedian (1988) linked these three categories in a linear fashion by positing that poor structures lead to poor processes, which ultimately result in poor outcomes. As shown in Figure 1, of the key variables in the study, nurse burnout is the structural component, missed care is the process measure, and the outcome is nurse-reported patient adverse events. Multi-site nursing studies have substantiated the relationship between structures and outcomes by linking poor practice environments to poor provider and patient outcomes including burnout, increased odds of mortality, medication errors, failure to rescue, and poorer overall quality of care (Aiken et al., 2002; Aiken et al., 2008;

Aiken et al., 2011; Friese, Lake, Aiken, Silber, & Sochalski, 2008; Laschinger & Leiter, 2006). However, the process link between structures and outcomes has been relatively understudied.

This study conceptualizes nurse burnout as being a structural characteristic of the practice environment. This model is supported by many studies that show that variation in organizational characteristics, such as the practice environment and staffing, and nursing characteristics, such as education, are associated with variation in patient outcomes (Aiken et al., 2011; Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2001; Vahey et al., 2004; You et al., 2013). As such, this study adjusts for organizational variables, including the practice environment and staffing, as detailed in Chapter 3, while exploring the independent role of nurse burnout on missed care and patient outcomes. Informed by Donabedian's framework, it is hypothesized that nurse burnout, as a characteristic of the hospital environment, results in poor patient outcomes partially through missed care.

Though the majority of existing studies linking burnout to outcomes lack conceptual frameworks, a popular guiding theory in organizational behavior is the Conservation of Resources theory (COR) (Halbesleben & Rathert, 2008). COR theory posits that providers whose psychological and/or physical resources are depleted over a span of time experience emotional exhaustion and burnout (Halbesleben & Rathert, 2008; Halbesleben et al., 2013). This exhaustion negatively impacts job performance (Cropanzano, Rupp, & Byrne, 2003; Halbesleben & Buckley, 2004; Wright & Bonett, 1997). Among other things, it causes providers to employ shortcuts and unsafe work-arounds in their delivery of care, and ultimately, results in a resource loss cycle

(Halbesleben et al., 2013; Lee & Ashforth, 1996). Therefore, burned out employees may perform more poorly than non-burned out employees (Halbesleben & Buckley, 2004; Naidoo et al., 2012). COR also posits that both burned out and non-burned individuals and groups act differently in the presence and absence of stress and burnout (Halbesleben & Buckley, 2004; Hobfoll, 1989). The loss of resources as well as the perception of this loss negatively impacts individuals and groups (Maslach & Leiter 2016). A critical tenet of COR theory is that this resource loss cycle occurs at both the individual and organizational levels (Hobfoll, Halbesleben, Neveu, & Westman, 2018)

Overall, the Donabedian framework contributed to the inclusion of the core structure-process-outcome components in this study's conceptual framework. COR theory contributed the rationale for including missed care as a mediator because it explains how burnout leads to overall poor job performance and unsafe care (Halbesleben & Buckley, 2004).

In the model guiding this study, Figure 1, nurse burnout is conceptualized as a complex, job-related phenomenon (Maslach et al., 2001) that is a characteristic of hospitals. Missed care is defined as necessary care left undone by nurses (Sochalski, 2004). The patient outcomes component of the model includes preventable adverse events as reported by nurses. While there are various definitions for adverse events (AHRQ Patient Safety Network, 2019; IOM, 2000; Jha et al., 2013), for the purposes of this study, adverse events are broadly defined as preventable harm experienced by patients as a result of care provided or omitted. Nurse-reported frequent adverse events included in the study are: patients receiving wrong medication or dose, pressure ulcers

developing after admission, falls with injury after admission, and healthcare-associated infections including urinary tract infections and central-line bloodstream infections.

This framework centrally posits that missed care may be one pathway that explains how nurse burnout results in poor patient outcomes. By including another relationship arrow directly between nurse burnout and patient outcomes, the proposed model allows for the possibility of additional direct and indirect pathways between the complex phenomenon nurse burnout and patient outcomes. Overall, the conceptual model is strengthened by existing evidence and the theoretical links it maintains with the established frameworks described above.

Burnout: Development and Definitions

Prior to its existence in the academic community, the concept of "burn out" was a societal term that was colloquially used to describe people who were overworked or, in other contexts, abusing drugs (Bradley, 1969; Schaufeli & Buunk, 2003). In recent times, burnout appears as a diagnosis in the International Statistical Classification of Diseases and Related Health Problems (ICD-11). It is described as an *occupational* phenomenon that "should not be applied to describe experiences in other areas of life" (World Health Organization, 2019). While burnout is now being explored across all occupations, the initial concern about burnout arose specifically in the context of caregiving occupations, such as health and human service occupations (Maslach & Leiter, 2016). The historical development of the concept of burnout helps to elucidate why the majority of burnout research has been done in human service occupations, the core of which is the relationship between provider and client (Maslach et al., 2001). The term first appeared in the academic literature in 1969 when a case was made that correctional officers needed

scheduled time off to be able to return to work with "renewed vigor" and offset the growing "staff burn out phenomenon" (Bradley, 1969, p. 366). In 1974, Freudenberger, a psychiatrist who worked in a free clinic, published a paper explicating the physical, emotional and behavioral signs of "burn-out," highlighting that people working in jobs addressing the recognized needs of others were at highest risk. He described that burnout varies by individual, in degree and symptomatology (Freudenberger, 1974). Around this same time, Maslach, a social and health psychology researcher, was interviewing human service workers to understand how emotional coping strategies influenced job behavior (Maslach et al., 2001).

Maslach's work informed the definition of burnout around which there is broad academic consensus: a multidimensional syndrome of emotional exhaustion (EE), depersonalization (D), and reduced personal accomplishment (PA) (Maslach, Jackson, & Leiter, 1986; Schaufeli & Buunk, 2003). Emotional exhaustion, widely accepted as the main component of burnout, is the depletion of emotional resources caused by interpersonal demands (Schaufeli & Buunk, 2003). Depersonalization refers to the development of cognitive distance, negative attitudes, and impersonal responses towards the recipients of care (Maslach et al., 1986). Reduced personal accomplishment is a negative self-evaluation of one's work with clients (Maslach et al., 1986). Like Freudenberger, Maslach highlights the variation that exists in the experience and consequences of burnout. She suggests that different patterns of burnout occur as people experience varying combinations of its three dimensions (Maslach, 2003).

Other definitions of burnout exist in the literature. Per Hobfoll and Freedy (1993), repeated investment in work without sufficient resources or rewards results in

burnout. Burnout has also been defined as a state of mental, physical and emotional exhaustion (Pines & Aronson, 1988). In a more simplistic definition, Cherniss posited that burnout "refers to a process in which the professionals' attitudes and behavior change in negative ways in response to job strain" (cited in Schaufeli & Buunk, 2003, p. 387). In defining burnout on a continuum using established psychological concepts such as stress and strain, one must differentiate burnout from other commonly equated concepts. Burnout is often distinguished from stress temporally in that burnout is a long-term process and results from chronic and prolonged exposure to job stress (Schaufeli, Maslach, & Marek, 1993). Burnout is conceptually distinct from temporary exhaustion or fatigue that is relieved after rest (Melamed, Shirom, Toker, Berliner, & Shapira, 2006). The complexity of burnout is apparent in the various definitions of the term. However, common elements among the definitions help to differentiate burnout from related concepts and highlight the distinctive identity of burnout: a complex, job-related phenomenon that develops over a period of time.

Combining the theoretical underpinnings and definition of burnout as described above, this study conceptualizes and examines nurse burnout as a structural characteristic of hospital environments. While burnout occurs to individuals, it is fundamentally a job-related phenomenon that exists as a feature of the practice environment both within and outside of individuals who are burned out.

At the individual level, burned out nurses have reduced physical, cognitive, and emotional resources, which impacts their ability to interact with colleagues as well as patients (Halbesleben & Rathert, 2008). This resource deficit fundamentally impacts burned out nurses' ability to provide safe, high-quality care, as they focus on conserving

limited resources through short-cuts or omissions of necessary care entirely (Halbesleben & Rathert, 2008). Burned out individuals are known to make more mistakes (Bakker, Westman, & Hetty van Emmerik, 2009). If higher proportions of caregivers are burned out, errors are less likely to be intercepted and more likely to go undetected by colleagues, which may increase the likelihood of patient harm (Welp, Meier, & Manser, 2015).

In addition to operating at the individual level, similar to what research on many organizational behavior constructs has shown, burnout also reflects something larger about groups within contexts (Leiter, Bakker, & Maslach, 2014a). Studies have shown that there is a shared, collective experience of burnout (Bakker, Le Blanc, & Schaufeli, 2005; González-Morales, Peiró, Rodríguez, & Bliese, 2012). Burnout can spread via many pathways: consciously, unconsciously, directly and indirectly (Bakker, Demerouti, & Schaufeli, 2003; Halbesleben & Leon, 2014).

One way that burnout manifests itself as a collective, hospital-level characteristic is that similar work environment demands and resource deficits can lead to similar experiences of burnout (Bakker et al., 2003). This explains how nurses within the same hospital but working on different units, who may never come in direct contact, could have the same shared experience of burnout. Studies have also shown burnout to be contagious, as provider burnout in practice environments may increase the prevalence of burnout among other colleagues (Bakker et al., 2005; Shanafelt et al., 2010). Seeing burnout in others accentuates negative components of the practice environment, which explains how perceived burnout in other nurses can impact an individual's own ratings and experience of burnout (González-Morales et al., 2012). Perceived stress can have the

same acute impact on an individual's job performance as actual stress (Passalacqua & Segrin, 2012).

Within hospitals, burnout may have an especially pronounced impact at the organizational, collective level, given that patients are cared for by more than one nurse; hospital care is provided by a team. As care providers are interdependent, they are impacted by burned out colleagues on their teams. One study assessing job performance-shaping factors leading to errors found that there are external, internal and team performance-shaping factors (Sasou & Reason, 1999). Burnout can lead to ineffective communication (Passalacqua & Segrin, 2012; Travado et al., 2005), collaboration, and coordination (Bakker et al., 2009). Communication issues negatively impact many aspects of care, including the inability to prevent and detect both individual and shared errors (IOM, 2004). Burnout can also result in increased demands on non-burned out individuals to compensate for their burned-out counterparts (Bakker et al., 2009). This workload compensation may compel nurses to adopt unsafe practices such as shortcuts or missing necessary care. In sum, by spreading between nurses and undermining safety culture and its attendant norms, burnout can negatively impact the quality of care provided by teams including both burned out and non-burned out nurses.

The Measurement of Burnout

The complex nature of burnout is highly relevant when considering measurement of the phenomenon. Among the numerous tools that measure burnout are: the Maslach Burnout Inventory (MBI), Measure Burnout (MB), Oldenburg Burnout Inventory (OBI), and the Copenhagen Burnout Inventory (CBI) (Demerouti & Bakker, 2008; Poghosyan, Aiken, & Sloane, 2009). However, there is not adequate evidence on the validity of the

MB, OBI and CBI (Halbesleben & Buckley, 2004). Having established sound psychometric properties of high reliability and validity, and being the only tool that measures the three aforementioned dimensions of burnout, the MBI is the gold standard for measuring provider burnout (Dyrbye et al., 2017; Halbesleben & Buckley, 2004; Maslach & Jackson, 1981). Another advantage of the MBI is that it has been validated by the majority of empirical studies on burnout, both nationally and internationally (Dyrbye et al., 2017; Maslach et al., 1996; Poghosyan et al., 2009). Widespread use of the tool has facilitated consistency in the measurement of burnout and easier comparison across studies (Halbesleben & Buckley, 2004). For these reasons, this study measures nurse burnout using the MBI.

The original MBI, also known as "MBI: Human Services Survey," takes approximately 10-15 minutes to complete and consists of 22-items divided into 3 subscales, each measuring a different dimension of burnout as conceptualized by Maslach and Jackson (Maslach & Jackson, 1981). The EE subscale includes 9 items, the D subscale has 5 items, and the PA subscale includes 8 items (Maslach et al., 1996). Each item uses a 7-point Likert scale to assess the frequency of feelings, ranging from never to every day (Maslach et al., 1996). In Maslach's conceptualization, burnout is defined as a continuous measure, ranging from low to high degrees of experienced feelings of burnout (Maslach et al., 1996). Each of the subscales is scored separately, and respondents are placed into one of three categories depending on their scores: high, average, or low degree of burnout. Based on normative distributions from a prior study conducted on 1,104 physicians and nurses, the numerical cut-off point for high burnout for medical professionals, doctors and nurses, has been established as: an EE score of ≥27, a DP score

of ≥10, and a PA score of ≤33 (Maslach & Jackson, 1981). According to the MBI manual, individual subscale scores must be considered independently and not as a combined score (Maslach et al., 1996; Maslach, Jackson, & Leiter, 2016).

Disagreement exists in the measurement of burnout using the three subscales of the MBI. Studies examining the factorial validity of the MBI among nurses have found the initial three-factor structure to have some cross-loading among certain items from the various subscales (Beckstead, 2002; Poghosyan et al., 2009). The EE subscale is widely considered to be the core, essential component of not only nurse burnout, but burnout generally (Evans & Fischer, 1993). Furthermore, vast literature supports the use of the EE subscale, and it has consistently been found to have the strongest predictive validity (Halbesleben et al., 2013; Kalliath, O'Driscoll, Gillespie, & Bluedorn, 2000; Lee & Ashforth, 1996; Vahey et al., 2004). It has been argued that the EE subscale is the only intrinsic component of burnout (Evans & Fischer, 1993). The PA subscale is the only subscale that is reverse scored, such that a lower score reflects higher burnout (Maslach et al., 1996). There is a large body of evidence suggesting that the PA subscale has the weakest associations with the other two subscales (Kalliath & Morris, 2002; Lee & Ashforth, 1996). Authors have posited that the PA subscale may have these weak associations because it measures other psychological constructs, such as satisfaction, that independently develop in parallel with burnout but are not constitutive of it (Kalliath & Morris, 2002). Furthermore, studies have shown that the D subscale is a direct and often exclusive function of the EE subscale (Garden, 1987; Maslach et al., 1996), thus supporting the common practice of measuring burnout using only the EE subscale (Cimiotti et al., 2012; Cropanzano et al., 2003; Halbesleben et al., 2013; Maslach et al.,

1996; McHugh et al., 2011). The EE subscale has also been empirically shown to have the most impact and is most consistently related to health outcomes (Ahola & Hakanen, 2014). Among the three subscales of the MBI, the EE subscale has been shown to be the most strongly related to nurse-reports of quality and safety (Van Bogaert et al., 2010). Furthermore, EE appears to be the most responsive to the organizational environment and social interactions therein, and has even been shown to mediate the relationship between work environments and depersonalization (Maslach et al., 1996). This evidence provides support that the most effective interventions for addressing burnout should target the emotional exhaustion component. Taking the above literature into account, this study measured nurse burnout using the EE subscale.

Nurse Burnout and Patient Outcomes

To the author's knowledge, there are currently ten studies that link hospital nurse burnout to negative patient outcomes, and all found statistically significant associations between nurse burnout and poor patient outcomes. These negative outcomes include reports of poor quality of patient care (Laschinger et al., 2001; Parker & Kulik, 1995; Poghosyan et al., 2010; Van Bogaert et al., 2010) and safety (Liu et al., 2018), overall adverse events (Laschinger & Leiter, 2006; Liu et al., 2018), decreased patient satisfaction (Leiter et al., 1998; McHugh et al., 2011; Vahey et al., 2004), and increased hospital-associated urinary tract and surgical site infections (Cimiotti et al., 2012). One study included 53,846 nurses from six countries and found that, independent of other nurse characteristics and the quality of nurse work environments, higher levels of nurse burnout were associated with lower nurse-reported quality of patient care (Poghosyan et

al., 2010). The authors posited that burnout may impact job performance and reduce the likelihood of proficient care (Poghosyan et al., 2010).

Three of the ten studies linked nurse burnout to patient satisfaction (Leiter et al., 1998; McHugh et al., 2011; Vahey et al., 2004). All three studies found statistically significant inverse relationships between nurse burnout and patient satisfaction (Leiter et al., 1998; McHugh et al., 2011; Vahey et al., 2004). Only one of the three studies, McHugh et al. (2011), used the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey to measure the patient experience of care. The HCAHPS survey measures patients' experiences with aspects of care as compared to general feelings of satisfaction. The study found that as the percentage of burned out nurses increased, the percentage of patients who would give the hospital a high rating and would definitely recommend the hospital decreased (McHugh et al., 2011).

Only one of the adverse events assessed in the study, hospital-associated urinary tract infections, has been previously assessed independently in relation to nurse burnout. In a study including over 7,000 nurses, Cimiotti et al. (2012) found that hospitals with higher proportions of nurse burnout had significantly more urinary tract and surgical site infections. Every 10% increase in burned out nurses in a hospital was associated with an increase of 1-2 infections per 1,000 patients (Cimiotti et al., 2012). The study showed that the number of hospital-acquired infections was reduced in hospitals where burnout was reduced, with the most pronounced effect occurring when burnout was reduced by 30% (Cimiotti et al., 2012). The authors theorized that burnout-induced cognitive detachment may result in impaired infection control practices, such as hand hygiene, ultimately leading to increased infections (Cimiotti et al., 2012). Although not solely

assessing hospital nurse burnout, another study using an objective patient outcome, standardized mortality ratios, found that EE among ICU providers was associated with patient mortality as well as clinician-rated patient safety (Welp et al., 2015)

Studies have assessed burnout as a mediator between hospital organizational characteristics—such as the work environment and staffing—and job and patient outcomes. Hospital nurse burnout was found to be a full mediator between staffing and hospital-associated urinary tract infections and surgical site infections (Cimiotti et al., 2012). Burnout was also found to fully mediate the relationship between work environment stressors and social support and the outcome of nurse job performance (Parker & Kulik, 1995). Furthermore, nurse burnout was found to be a partial mediator between the work environment and the outcomes of overall adverse events (Liu et al., 2018) and nurse-reported quality of care (Laschinger et al., 2001; Laschinger & Leiter, 2006; Van Bogaert, Meulemans, Clarke, Vermeyen, & P, 2009). Taken together, these studies provide evidence of the significant impact that hospital nurse burnout has on job performance and patient outcomes, and warrants further inquiry into the process of care by which it may have this impact.

Nurse Burnout and Process of Care

The findings of the above studies warrant further inquiry into the pathways and processes by which nurse burnout leads to poor patient outcomes. One such pathway, proposed in this study, is rooted in evidence linking nurse burnout and the process of care. Process of care, or care provided and received, encompasses the entire manner in which care is delivered, and is considered a core component of the quality of care (Donabedian, 1988).

Studies have shown that burned out nurses are more likely perform poorly on the job, as evidenced by poorer self-rated and supervisor-rated job performance (Parker & Kulik, 1995) and increased prevalence of short-cuts with medication administration (Halbesleben et al., 2013). Although not assessing nurses, another study showed that burned out internal medicine residents were more likely to report engaging in sub-optimal patient care practices (Shanafelt, Bradley, Wipf, & Back, 2002).

Numerous processes have been hypothesized to explain the relationship between burnout and poor job performance (Campbell & Cornett, 2002; Maslach, 2003). One hypothesis is that cognitive fatigue associated with burnout leads to decreased attention capacity (Campbell & Cornett, 2002). In a study testing cognitive performance among burned out and non-burned out individuals, burned out individuals displayed impaired general cognitive processing in the form of slower reaction times (Oosterholt, Maes, Van der Linden, Verbraak, & Kompier, 2014). Compared to controls, burned out subjects have also exhibited delayed recall (Jonsdottir et al., 2013). Burned out providers exhibit decreased motivation and withdraw physically and psychologically from the job (Maslach, 2003). Furthermore, burned out individuals have been found to exhibit a myriad of health problems including sleep disturbances, fatigue, vital exhaustion, substance abuse (Maslach et al., 2001) and cardiovascular disease (Melamed et al., 2006). It is hypothesized that these health problems and other manifestations of burnout, such as helplessness and emotional and cognitive withdrawal, lead to lapses in professional judgment, decreased productivity and sub-optimal care practices (Dewa et al., 2014; Maslach et al., 2001; Schaufeli & Buunk, 2003).

The evidenced link between burnout, impaired judgment and decision-making may compromise vital nursing responsibilities and the delivery of patient care. The nursing process of care, including assessment, diagnosis, planning, intervention and evaluation fundamentally demands knowledge, thought and judgment (Potter, Perry, Stockert, & Hall, 2016). In order to provide safe care, nurses must constantly remain cognitively sharp and attentive to ever-changing patient needs (Bittner & Gravlin, 2009; Institute of Medicine (IOM), 2004; Potter et al., 2005; Potter et al., 2016). In addition to knowledge and attention, decisions regarding the provision of nursing care are influenced by goal conflicts (Ebright, Patterson, Chalko, & Render, 2003). Goal conflicts refer to the risk tradeoff nurses must constantly make when deciding on possible courses of action (Ebright et al., 2003). Due to a lack of physical, cognitive and emotional resources, burned out nurses have disparate motivational processes and prioritize care differently than non-burned out nurses (Halbesleben & Rathert, 2008). Burned out nurses focus on conserving limited resources and energy by avoiding thorough patient care, potentially doing the bare minimum and even missing necessary care entirely (Halbesleben & Rathert, 2008).

Missed Care

One process of care measure that is increasingly being used to evaluate the quality of nursing performance is missed care, or necessary care left undone (Lucero, Lake, & Aiken, 2009; Sochalski, 2004). The term "missed care" first appeared in the literature in 2006 (Kalisch, 2006), and has also been called unfinished care (Sochalski, 2004), omitted care (Ausserhofer et al., 2014), rationed care (Papastavrou et al., 2014; Schubert et al., 2008), unmet nursing care (Brooks Carthon et al., 2016), and tasks left undone.

Alarmingly, one study of over 2,000 registered nurses in England found that 86% of nurses report that they are routinely unable to complete required patient care (Ball et al., 2014). Examples of nursing tasks that are recognized areas of missed care include surveillance, medication administration, patient mobilization, hygiene, skin care, communication, feeding, teaching, discharge planning, emotional support, and documentation (Papastavrou et al., 2014).

Missed care has also been linked to poor patient outcomes (Papastavrou et al., 2014) including adverse events such as medication errors, pressure ulcers, falls, and nosocomial infections (Ausserhofer et al., 2013; Kalisch et al., 2014; Lucero et al., 2010; Schubert et al., 2008), as well as lower nurse-reported patient safety ratings (Ball et al., 2014). A study done on eight Swiss acute care hospitals found that a 0.5 unit increase in rationing was associated with over a 10% increase in the odds of nurse-reported adverse events, and a 37% decrease in the odds of patients reporting satisfaction with their care (Schubert et al., 2008). One study of over 8,670 nurses in Pennsylvania found that unfinished care explained over 40% of the variation in quality of care ratings of hospitals (Sochalski, 2004). Another study found that patients were 51% more likely to die in hospitals with the highest nurse-reported care rationing levels than patients in other hospitals (Schubert et al., 2012). Other studies have also linked missed care to mortality (Ball et al., 2018), as well as patient satisfaction (Lake et al., 2016; Schubert et al., 2008) and readmissions (Brooks Carthon et al., 2015; Brooks Carthon et al., 2016).

Missed care has been explored in the context of decision-making and prioritization of nursing care (Schubert et al., 2008). Nurses make decisions about the provision or omission of care for each patient and may prioritize components of care

differently based on other demands and their own internal values (Kalisch et al., 2009). In a concept analysis, it was found that antecedents to missed nursing care include factors that affect the nurse's internal process, prioritization and decision-making (Kalisch et al., 2009), which, as explicated by the research presented above, are negatively impacted by burnout. Poor perceived team interactions (Jones, Hamilton, & Murry, 2015), poor teamwork (Kalisch & Lee, 2010), impaired communication, and insufficient time have also been cited as contributing to missed care (Kalisch et al., 2009), all of which are impacted by burnout (Passalacqua & Segrin, 2012; Travado et al., 2005). Additionally, research has shown that burnout is associated with decreased productivity and effectiveness at work (Dewa et al., 2014; Maslach et al., 2001). One way that lower productivity and efficiency may lead to more missed care is that burned out nurses may have less time to complete necessary tasks as compared to their non-burned out colleagues. In sum, as burned out providers are less cognitively vigilant and less likely to put forth the required energy towards optimal care, important nursing tasks such as surveillance, communication, delegation, and patient education may be missed. As COR theory posits, burned out nurses may conserve resources by doing less (Hobfoll et al., 2018). This posited relationship between nurse burnout and missed care has been confirmed by one study assessing nursing home nurse burnout, which found a statistically significant association between burnout and missed care (White et al., 2019).

Furthermore, similar to burnout, this study conceptualizes that missed care operates at both the individual and organizational level, reflecting the norms and overall safety culture in a hospital. In fact, studies have shown that organizational factors have a stronger influence on missed care than individual nurse characteristics (Jones et al.,

2015). As explicated above, a higher proportion of burned out nurses may impact the overall safety culture and norms, resulting in a higher proportion of nurses who miss necessary care, whether or not they are burned out themselves, ultimately threatening patient safety.

Gaps in Literature and Study Contributions

The existing literature linking burnout to patient outcomes is limited in several ways and this study aims to address these key limitations below. First, most of the existing studies lack a theoretical framework to guide the development, analysis and findings of their research. Given the dynamic nature of burnout, and the equally complex relationships it has to processes of care and patient outcomes, guiding conceptual models are crucial to advancing the understanding of the phenomenon. As such, this study posits—and indeed is driven by—a conceptual framework that includes a potential mechanism by which burnout impacts patient outcomes.

Additionally, one must be cautious in interpreting and comparing findings across studies because of the lack of a universally utilized measurement of burnout. While every study assessing nurse burnout and patient outcomes used the MBI to measure the phenomenon, a limitation arises in the varied use of the three subscales of the MBI. The studies also varied in their classification of burnout; while some studies reported using the established healthcare provider cut-off scores to delineate high burnout (Aiken et al., 2002; Aiken et al., 2011; Cimiotti et al., 2012; McHugh et al., 2011), others measured burnout on a continuum (Poghosyan et al., 2010). Utilizing a defined cut-off helps to clearly differentiate if and how nursing care provision varies between nurses who report being highly burned out and those that do not. This study utilizes the EE subscale for

measurement as it is widely considered to constitute the core component of burnout (Evans & Fischer, 1993) and has been shown to have the strongest predictive validity (Kalliath et al., 2000; Lee & Ashforth, 1996; Vahey et al., 2004). Furthermore, nurse burnout was measured as a dichotomous variable, with any nurse respondent scoring ≥27 considered burned out. This high burnout EE cut-off was established by the creators of the MBI based on normative distributions from a study of 1,104 physicians and nurses (Maslach & Jackson, 1981) and is not only consistent with previous studies (Aiken et al., 2008; Cimiotti et al., 2012; Halbesleben et al., 2013; McHugh et al., 2011), but was also validated in this study sample.

Another limitation among the majority of existing studies is that burnout has been routinely defined and measured as solely an individual phenomenon (Leiter et al., 2014a). This study moves beyond that framework by acknowledging the multilevel nature of burnout, and specifically conceptualizes and examines burnout at the organizational level.

An additional limitation is that the outcomes studied in relation to nurse burnout are limited in number. Quality measures and outcomes such as 30-day mortality, readmissions, and individual adverse events including falls, pressure ulcers, medication errors, and central line infections remain understudied. Although there are currently only a small number of studies linking nurse burnout to patient outcomes, the studies all found statistically significant results linking burnout to poor patient outcomes. As such, further investigation is warranted into the associations between burnout and patient outcomes. This study addresses this limitation as both aims seek to expand the literature linking hospital nurse burnout to nurse-reported patient outcomes. Aim 1 assesses adverse events that have yet to be individually linked to hospital nurse burnout in the U.S.,

including pressure ulcers, falls, and hospital-associated central line infections. By assessing a broader set of outcomes and consequences that are especially relevant to current financial incentives and government regulations, this study helps build the evidence to support efforts to reduce nurse burnout.

Another major limitation in previous literature is that potential causal mechanisms between nurse burnout and patient outcomes have yet to be assessed (Poghosyan et al., 2010). As such, Aim 2 goes beyond assessing the patient consequences of burnout to addressing a potential mechanism by which they occur. This problem is uniquely addressed by exploring a process of care measure, missed care, as a possible explanatory link in the relationship between nurse burnout and adverse events. By assessing the relationship between burnout and missed care, the study sheds light upon a pathway by which burnout negatively and tangibly impacts the provision of care. By positing that missed care may be a link between burnout and poor patient outcomes, this study delves deeper into understanding a potential causal pathway, thus advancing the science of nurse burnout and its consequences.

This study not only expands the extant literature by addressing the issues of theoretical frameworks, measurement, pathways and outcomes, but also strengthens the generalizability of findings. The majority of existing studies linking nurse burnout and patient outcomes have been conducted from a single hospital, health system, or state (Cimiotti et al., 2012; Halbesleben et al., 2013; Leiter et al., 1998; Parker & Kulik, 1995). This threatens the external validity and generalizability of the studies. Unlike these studies, the current study sample is highly representative, and includes thousands of nurse reports from hundreds of hospitals in four large states, California, Florida, New Jersey

and Pennsylvania, that comprised 25% of the U.S. population at the time of the survey (U.S. Census Bureau, 2011).

Overall, this study provides more insight into a phenomenon that drains resources, erodes the quality of nursing care and compromises patient safety. By assessing the relationship and pathway between nurse burnout and patient outcomes, this study expands our understanding of burnout and, in doing so, may support future efforts to mitigate burnout as a way to improve quality of care and patient safety.

CHAPTER 3: METHODOLOGY

Overview

The following chapter explains the methodology of the study. The study design, data sources, sample, variables, instruments and measurement, as well as data analysis procedures are presented. The chapter concludes with ethical considerations and the steps taken to protect data integrity.

The study assessed the relationship between nurse burnout, missed care and patient outcomes. The design was a secondary analysis of linked cross-sectional data obtained from three data sources: the 2005-2008 Multi-State Nursing Care and Patient Safety Survey, the 2006-2007 American Hospital Association's Annual Survey of Hospitals, and the 2006-2007 Centers for Medicare and Medicaid Services (CMS) Provider Specific File.

Data Sources

Multi-State Nursing Care and Patient Safety Survey

The Multi-State Nursing Care and Patient Safety Study is the parent study upon which the secondary data analysis is based. This survey of nurses was conducted from 2005 - 2008 by the Center for Health Outcomes and Policy Research at the University of Pennsylvania, supported by the National Institute of Nursing Research (RO1NR04513) and led by Principal Investigator, Dr. Linda Aiken (Aiken et al., 2011). The primary goal of the survey was to obtain a broad range of information on nurses and organizational features of their work environments to conduct health services research, inform public

policy, and improve patient care and safety. The survey included questions related to nurse demographics, nursing education, staffing levels, work hours, missed nursing care and the quality of the work environment. The survey also included items related to nurse job outcomes, including satisfaction, burnout, and intent to leave, as well as patient outcomes, including nurse reports of adverse events, quality of care and patient safety (Aiken et al., 2011).

Over 272,783 nurses were randomly sampled from state nurse licensure lists from four states (Aiken et al., 2011). Fifty percent of all nurses licensed in New Jersey (52,545 nurses), 25% of nurses in Florida (52,545 nurses) and 40% of all nurses in Pennsylvania (64,321 nurses) and California (106,532 nurses) directly received the survey by mail at their home address (Aiken et al., 2011; McHugh et al., 2011). Survey data were collected in New Jersey, Pennsylvania, and California between September 2005 and August 2006, and in Florida from November 2007 through April 2008 (Aiken et al., 2011). A modified Dillman approach was utilized, which included follow-up postcard reminders and an additional mailing of the survey to non-respondents (Dillman, 1978; Dillman, Smyth, & Christian, 2014). To ensure confidentiality, the survey included a perforated area for nurses to remove their identifiable personal information prior to returning the survey. The survey asked nurses to provide the name of their employer. In this way, the names of hospitals were obtained without compromising the privacy of respondents. The survey specifically stated that the employing institutions would never be identified by name in subsequent research. The hospital names were necessary to be able to aggregate the nurse responses to the hospital level, link to existing data, and ultimately assess organizational burnout, performance and outcomes.

The initial survey response rate was 39%, and to assess non-response bias that could negatively impact validity, a second random sample of 1300 non-respondents was conducted with phone calls and monetary incentives (Aiken et al., 2011; McHugh et al., 2011). This sample of non-respondents yielded a 91% response rate and it was found that there were no statistically significant differences among the reports of respondents and non-respondents on the relevant variables in this study (Smith, 2009). This double-sampling approach to address nonresponse bias in surveys of front-line nurses used as informants of organizational quality and safety has been shown to yield representative, unbiased samples (Lasater et al., 2019). Furthermore, by surveying nurses directly in their homes as opposed to collecting primary data in hospitals, hospital response bias, a threat to validity, is reduced (Aiken et al., 2011; Kutney-Lee, Lake, & Aiken, 2009). In all, about 100,000 nurse-respondents provided information on nine out of every ten hospitals in all four states (Aiken et al., 2011).

Literature supports the approach of surveying nurses to obtain accurate, valid and reliable information on hospital organizations and outcomes (Aiken, Sochalski, & Lake, 1997; Lasater et al., 2019; McHugh & Stimpfel, 2012), and many studies have used nurse-reported information as an outcome measure (Aiken et al., 2001; Kutney-Lee et al., 2009; Lucero et al., 2010; Schubert et al., 2008). When compared to other process and outcomes data sources, such as administrative and patient-reported data, nurse-reported data have been found to be a valid and reliable measure of patient care quality and safety outcomes (Cina-Tschumi, Schubert, Kressig, De Geest, & Schwendimann, 2009; Gerolamo, 2008; McHugh & Stimpfel, 2012; Smeds-Alenius, Tishelman, Lindqvist, Runesdotter, & McHugh, 2016).

American Hospital Association's Annual Survey of Hospitals

The American Hospital Association (AHA) Annual Survey of Hospitals is a national survey of all hospitals in the United States and has been conducted by the AHA since 1946 (American Hospital Association, 2014). The survey contains hundreds of items of information, including organizational structure, expenses and geographic indicators on over 6,300 hospitals (AHA, 2014). The AHA Annual Survey data from 2006-2007 was used to acquire hospital identification numbers, bed size, teaching status, technological capacity, and ownership—that were used as control variables in the analysis. The AHA Annual Survey data from 2006 was linked to the nurse survey data from New Jersey, Pennsylvania, and California, whereas AHA data from 2007 was linked to the nurse survey data from Florida (Aiken et al., 2011).

The Centers for Medicare and Medicaid Services Provider Specific File

Similarly, the CMS Provider Specific File data from 2006-2007 was the source for the variable used to control for patient severity, case mix index (CMI). CMI is a hospital-level value indicating the average clinical complexity and resource needs of all patients who received care in a hospital (CMS, 2016; U.S. Department of Health and Human Services [DHHS], 2018a). A higher CMI indicates a more complex patient population. The value is calculated by summing the Medicare Severity-Diagnosis Related Group (MS-DRG) weight of each discharge and dividing by the total number of discharges (DHHS, 2018a). Patients are assigned to one MS-DRG based on multiple factors including the principal and secondary diagnoses, age, sex, procedures performed, comorbidities, complications and discharge status. Although designed by CMS, the MS-DRG weights apply to all patient discharges across all payers (DHHS, 2018a).

Sample

Nurses

The nurse sample, obtained from the Multi-State Nursing Care and Patient Safety Survey, included registered nurses who provided direct patient care as staff nurses in adult, non-federal, acute care hospitals. The rationale for selecting inpatient nurses in acute care settings is that they are the primary providers of care to patients, optimally positioned on the frontlines, 24/7. Furthermore, nurses that reported being assigned 20 or more patients were excluded as these nurses are most likely not staff nurses providing direct bedside care (McHugh et al., 2011). The final study sample included 23,784 registered nurses.

Hospitals

Hospitals included in the study are adult, non-federal, acute care hospitals from the four states included in the Multi-State Nursing Care and Patient Safety Survey: New Jersey, Pennsylvania, Florida and California. The rationale for excluding federal hospitals, including the Veterans Health Administration (VHA) hospitals, is that these hospitals have uniquely differing patient populations and characteristics, administrative protocols, survey sampling, and reporting measures (U.S. Veterans Health Administration, 2012).

Hospitals with less than 10 nurse respondents from the nurse survey were excluded. Aggregating responses of multiple informants, and specifically 10 informants, has been found to be a reliable measure of organizational performance (Marsden et al., 2006). Furthermore, previous studies using the same nurse survey data have found this number to be sufficient for providing reliable information on hospital organizations and

patient outcomes (Aiken et al., 2011; Stimpfel, Sloane, & Aiken, 2012). The final study sample included 587 hospitals. Study hospitals had an average of 68 nurse survey respondents, ranging from 10 to 245 nurses per hospital.

Study Variables and Measurement

The following section describes the study variables, and how they were operationally defined and measured. The primary independent variable was nurse burnout. The study outcomes were nurse-reported, hospital-associated frequent adverse events, including medication errors, pressure ulcers, falls, urinary tract and central line infections. Missed care was examined to assess whether it acts as a partial mediator in the relationship between nurse burnout and patient outcomes. The covariates of the study are also described in detail below. The section ends with a detailed table of study variables that includes the data source, level of analysis, type of variable, as well as how the variable is defined, categorized and measured in the study. Nurse burnout and missed care were analyzed at the hospital level; adverse events were analyzed at the nurse level. The study's conceptualization of burnout as a collective, organizational feature supports the hospital level measurement of burnout. This collective experience of burnout measured at the organizational-level is empirically supported (Halbesleben & Leon, 2014). Additionally, the fact that hospital care is provided to patients by multiple nurses over time, and often across units, further supports hospital-level analyses of the independent variables that are thought to impact patient outcomes (Kutney-Lee et al., 2009).

Key Study Variables

Nurse burnout.

The primary explanatory variable in the study, nurse burnout, was measured using the Emotional Exhaustion (EE) subscale of the Maslach Burnout Inventory- Human Services Survey (MBI-HSS) tool (Maslach et al., 1986) that is embedded within the Multi-State Nurse Survey. The MBI is a reliable and valid instrument and is considered the gold standard for measuring provider burnout (Halbesleben & Buckley, 2004). Rationale for the measurement of nurse burnout using the EE subscale is explicated in Chapter 2 and is also consistent with previous studies (Cimiotti et al., 2012; Halbesleben et al., 2013; Maslach et al., 1996; McHugh et al., 2011). Furthermore, internal consistency was assessed across the EE subscale questions and was found to be reliable with a Cronbach's alpha of 0.92.

The EE subscale consists of nine items that use a 7-point Likert scale to assess the frequency of negative feelings comprising burnout, ranging from never to every day (Maslach et al., 1996). EE subscale items include declarative statements to gauge, for example, how often respondents feel they are working too hard on the job and feel burned out at work. Each of the nine items of the EE subscale are given a numerical value from zero to six depending on the frequency the respondent selected, with zero being never and six being every day. The number-value assigned to each of the nine EE subscale items are summed to create a subscale score. The range of theoretical scores on the EE subscale is zero to 54. Based on normative distributions from a prior study conducted on 1,104 physicians and nurses, the numerical cut-off point for high emotional exhaustion for medical professionals has been established as a score of ≥27 (Maslach & Jackson,

1981). This cut-off number was calculated from the upper third of the normative distribution of the study (Maslach & Jackson, 1981).

In this study, nurse burnout, defined as high emotional exhaustion, was initially measured from the nurse survey as a dichotomous variable, with any nurse respondent scoring ≥27 considered burned out. This method of using the numerical cut-off for high emotional exhaustion to distinguish burned out nurses is consistent with previous studies (Aiken et al., 2008; Cimiotti et al., 2012; Halbesleben et al., 2013; McHugh et al., 2011). Furthermore, similar to the previously established cut-off, the distribution of MBI scores was examined and 27 was found to be the cut-off for the upper third of this study's sample. At the nurse level, burnout was measured as a dichotomous variable, being coded "1" for nurses who scored ≥27 on the EE subscale. As the study conceptualizes nurse burnout as a hospital-level phenomenon, nurse survey data was aggregated to the hospital level, where nurse burnout was defined as a continuous variable measuring the proportion of burned out nurses in a hospital. Aggregation of individual burnout scores to obtain a group-level mean burnout has been validated in other studies (Bakker, Emmerik, & Euwema, 2006; Moliner, Martínez-Tur, Peiró, Ramos, & Cropanzano, 2005). Furthermore, the studies linking nurse burnout to patient outcomes have aggregated nurse-level burnout to unit-level (Vahey et al., 2004; Van Bogaert et al., 2010) and hospital-level measures of burnout (Cimiotti et al., 2012; McHugh et al., 2011).

Missed care.

Data on the mediator assessed in the study, missed care, was obtained from the Multi-State Nursing Care and Patient Safety Survey. In the survey, missed care was

assessed using a question that asks nurses to report which of 12 listed nursing activities were necessary but left undone due to a lack of time on their most recent shift. The 12 tasks include: patient surveillance; skin care; teaching/counseling patients and families; administering medications on time; adequately documenting nursing care; coordinating patient care; pain management; oral hygiene; treatments and procedures; preparing patients and families for discharge; developing or updating care plans; and comforting/talking with patients. These tasks were specifically included in the missed care question by nurse researchers and survey methodologists to capture essential nursing care activities (Lake et al., 2017). The question specifies that the tasks be necessary for patient care; as such, it was hypothesized that necessary care that is missed would impact patient outcomes. This measure of missed care has been used widely and its predictive validity has been established in studies assessing the impact of nursing factors on patient outcomes (Ball et al., 2014; Brooks Carthon et al., 2015; Lake et al., 2016). Furthermore, internal consistency of the measure was assessed and was found to be acceptable with a Cronbach's alpha of 0.82.

Similar to nurse burnout, missed care was analyzed at the hospital level. This measurement fits within the theoretical framework that there is an organizational-level of burnout and missed care impacting outcomes. Additionally, the aggregation of nurse reports to assess the hospital-level impact of missed necessary care on patient outcomes has been validated empirically (Brooks Carthon et al., 2015; Lake et al., 2016). In the nurse survey data, missed care was first dichotomized, being coded "1" for nurses who reported leaving at least one or more necessary tasks undone, and "0" for nurses who reported leaving no necessary care undone. For analytic purposes, the missed care

variable was aggregated to the hospital level and defined as the proportion of nurses leaving at least one necessary task left undone. Research has shown that, at the hospital level, on average, even an increase in 1 unmet nursing care task is significantly associated with a 7 to 9 point increase in the proportion of nurse-reported frequent medication errors, falls and nosocomial infections (Lucero et al., 2010).

Outcomes

Nurse-reported adverse events.

On the Multi-State Nursing Care and Patient Safety Survey, nurses reported the frequency of the five adverse outcomes of this study using a 7-point Likert scale, ranging from never to every day (specifically: never, a few times a year or less, once a month or less, a few times a month, once a week, a few times a week, and every day). The five adverse events included as outcomes of interest in the study were: patient received wrong medication or dose; pressure ulcers developed after admission; patient falls with injury after admission; hospital-associated urinary tract infections; and hospital-associated central-line bloodstream infections.

In the study, all of the nurse-reported adverse events were measured and analyzed at the nurse-level as dichotomized variables. Nurses reporting that the adverse events occurred a few times a year or less were defined as infrequent (coded as "0"), while nurses reporting the events occurring more than a few times a year up through every day were defined as frequent (coded as "1"). This dichotomized measurement of nurse-reported adverse events is consistent with previous studies (Kelly, Kutney-Lee, Lake, & Aiken, 2013; Kutney-Lee et al., 2009; Lucero et al., 2010; Olds & Clarke, 2010). This dichotomization helped with ease of interpretation and presentation of study findings, as

well as providing results that are comparable across multiple studies. In sensitivity analyses, these outcomes were assessed at the hospital level. Aggregated to the hospital level, nurse-reported adverse events were the average percentage of nurses who reported the adverse event occurring frequently across hospitals.

Covariates

In order to assess the impact of the hypothesized predictor (nurse burnout) and mediator (missed care) on patient adverse events, the effects of other measured variables known to impact adverse events were statistically accounted for. Research has linked nursing and hospital structural characteristics, as well as organizational features, such as nurse practice environments and staffing, to adverse events (Brennan et al., 1991; Kelly et al., 2013; Kutney-Lee et al., 2009; Lucero et al., 2010; Smith, Plover, McChesney, & Lake, 2019; Thomas, Orav, & Brennan, 2000). As such, these variables were included as controls in the study models. The following section will describe the measurement of the covariates included in the models. A summary of all the model variables is provided in **Table 1**.

Nurse staffing.

Nurse staffing, calculated as the average patient to registered nurse ratio, was assessed at the hospital level and accounted for in the study models. Studies have demonstrated that nurse staffing impacts adverse events including hospital associated urinary tract and central line infections, pressure ulcers (Stone et al., 2007), and falls (Krauss et al., 2005; Unruh, 2003).

In the Multi-State Nurse Survey, nurses were separately asked to report how many patients and registered nurses providing direct patient care were on their unit

during their most recent shift. The hospital level staffing measure was calculated as a continuous measure of the average number of patients per direct care RN. The validity of this aggregated measure of staffing has been demonstrated in previous studies (Aiken et al., 2002; Aiken, Clarke, Cheung, Sloane, & Silber, 2003; Aiken et al., 2008; Kutney-Lee et al., 2009; Lucero et al., 2009). This measure of staffing has also been used to assess nurse staffing in relation to nurse-reported adverse events (Kelly et al., 2013; Kutney-Lee et al., 2009; Lucero et al., 2010). Furthermore, a hospital-level nurse staffing measure may better account for the fact that patients often receive care over multiple days in more than one unit within hospitals (Aiken et al., 2002).

Nurse practice environment.

The term nurse practice environment refers to the organizational work characteristics that facilitate or constrain nursing practice (Lake, 2002). The nurse practice environment variable was measured at the hospital-level using the Practice Environment Scale of the Nursing Work Index (PES-NWI) tool (Lake, 2002) included in the Multi-State Nursing Care and Patient Safety Survey. The PES-NWI is a valid and reliable instrument endorsed by the National Quality Forum and is widely considered the gold standard for assessing the nurse work environment (Lake, 2002; Lake et al., 2019; National Quality Forum, 2015; Warshawsky & Havens, 2011).

The instrument includes 31 items comprising five subscales of the nurse practice environment (developed from exploratory factor analysis): staffing resource and adequacy; nurse participation in hospital affairs; nursing foundations for quality of care; nurse manager ability, leadership and support of nurses; and collegial nurse-physician relations (Lake, 2002). Items are scored based on a 4-point Likert scale: strongly agree;

somewhat agree; somewhat disagree; strongly disagree. Higher scores indicate stronger agreement that the organizational features described in the items are present in the work environment. Previously established internal consistency coefficients for the subscales ranged from Cronbach's alphas of 0.71 to 0.84 (Lake, 2002). The PES-NWI has been validated through use in a number of studies assessing the relationship between the nurse work environment and nurse and patient outcomes (Aiken et al., 2008; Lake et al., 2019; Lee & Scott, 2018; Parke, Tuckett, Eley, & Hegney, 2010; Warshawsky & Havens, 2011). Furthermore, the nurse practice environment has been specifically linked to patient adverse events included in this study (Fasolino & Snyder, 2012; Kelly et al., 2013; Kutney-Lee et al., 2009; Lucero et al., 2010; Smith et al., 2019).

A hospital-level composite measure of the PES-NWI was created by averaging the subscale scores of all nurses in each hospital, and taking the mean of the combined subscale scores. The predictive validity of this hospital level composite measure of the practice environment has been demonstrated in previous studies (Kelly et al., 2013; Kelly, Kutney-Lee, McHugh, Sloane, & Aiken, 2014). The correlations between the five PES-NWI subscales and the abovementioned staffing measure were assessed. The Staffing Resource and Adequacy subscale was found to be moderately correlated with the study staffing measure ($r= -0.47$). As such, the subscale was excluded from the study PES-NWI composite measure. Reliability was assessed for the composite measure with 4 subscales used in this study sample, and was found to be internally consistent with a Cronbach's alpha of 0.85. This hospital-level PES-NWI composite score was controlled for in the study models, described in detail below.

Nurse characteristics: age, sex, education, unit type, years of RN experience.

Nurse characteristics including sex, education, unit type and years of RN experience were included in the study models. All nurse characteristics were obtained from the Multi-State Nursing Survey and were defined, measured and controlled for at the nurse level in the study models.

Nurse age has been associated with nurse perceptions and experiences on the job (Erickson & Grove, 2008; Kim J., An, Kim, & Yoon, 2007), so it was considered a potential covariate that could impact nurse-reported outcomes. However, upon calculating Pearson's correlation coefficients, age was found to be highly collinear with years of RN experience (0.74, $p<0.001$) and thus was not included in final models. Years of RN work experience and nursing unit type have been shown to be significantly associated with nurse perceptions of patient safety and reports of adverse events, including medication errors (Kim et al., 2007) and patient falls (Blegen, Vaughn, & Goode, 2001). The likelihood of preventable adverse events has been shown to vary in intensive care units (ICUs) compared to non-ICU settings (Kelly et al., 2013; Latif, Rawat, Pustavoitau, Pronovost, & Pham, 2013). Nurse unit type was controlled for this reason, in addition to the fact that nurse staffing varies between ICU and non-ICU settings (Aiken et al., 2008). Nurse sex was controlled for as it may impact job experiences and nurse reports of outcomes, and more specifically, has been shown to be associated with patient falls (Kang, Kim, & Lee, 2014). Studies have shown a significant association between nurse education and patient outcomes (Aiken et al., 2003). More specifically, hospitals with higher proportions of baccalaureate-prepared nurses have

lower rates of patient mortality (Estabrooks, Midodzi, Cummings, Ricker, & Giovannetti, 2005; Kutney-Lee, Sloane, & Aiken, 2013) and failure-to-rescue (Aiken et al., 2011).

Nurse age, reported in the nurse survey, was used descriptively and measured as a continuous variable. Nurse sex was reported by nurses as either male or female. Sex was measured as a dichotomous variable with a value of "1" assigned to female and a value of "0" assigned to male.

In the nurse survey, nurses were asked for the highest degree they hold in nursing. For descriptive purposes, nurse education was reported in Table 3 as a categorical variable with five categories: diploma, associate degree, baccalaureate degree, master's degree, and doctoral degree. For analytic purposes, nurse education was measured as a dichotomous variable with a value of "0" assigned to nurses without a baccalaureate degree, and "1" assigned to nurses with a baccalaureate degree or higher. This definition has been validated by literature showing the association between baccalaureate-prepared nurses and patient outcomes (Aiken et al., 2011; Kutney-Lee et al., 2013).

Nursing unit type was categorized into three groups: "0" assigned to nurses reporting working in medical-surgical units; "1" assigned to intensive care units; and "2" assigned to other units. Research has shown that nurse reports of frequent nosocomial infections and patient falls vary across ICU and medical-surgical units (Lucero et al., 2010).

Regarding years of nurse work experience, nurses reported the number of years they provided direct patient care as an RN. This variable was measured as a continuous variable and controlled for in the study models.

The above measures of nurse covariates have been validated by use in previous studies that account for the impact of nurse characteristics on organizational outcomes (Brooks Carthon et al., 2019; Kelly, McHugh, & Aiken, 2012).

Hospital characteristics: bed size, teaching status, technology status, ownership.

Due to potential confounding influences on patient adverse events, study models accounted for hospital structural characteristics obtained from the American Hospital Association Annual Survey such as bed size, teaching status, technology status, and ownership. Hospital structural characteristics have often been utilized as a proxy for quality of care, provider, and patient characteristics not available in survey data and have been shown to be associated with patient outcomes (Manheim, Feinglass, Shortell, & Hughes, 1992). The odds of preventable adverse events have been shown to be associated with hospital teaching status and ownership (Thomas et al., 2000). Hospital teaching status has been shown to be associated with nosocomial infections (Lucero et al., 2010). Hospital technology has been shown to impact patient outcomes, such as adverse occurrences (Silber, Rosenbaum, & Ross, 1995) and mortality (Bastos et al., 1996; Manheim et al., 1992; Shortell et al., 1994).

Hospital bed size was classified into three categories: small (≤100 beds); medium (101-250 beds); and large (≥ 251 beds).

Teaching status of the hospitals was defined by the ratio of medical residents to beds. Hospitals were categorized into one of three groups: non-teaching (no medical residents); minor teaching (≤ 1:4 ratio of medical residents to beds); and major teaching (≥ 1:4 ratio of medical residents to beds).

Hospital technology status was measured as a dichotomous variable: a value of "1" was assigned to institutions that provide open heart and/or organ transplant surgery, while a value of "0" was assigned to hospitals not providing such services.

Hospital ownership was categorized into three groups: non-profit, profit, and government (non-federal).

The validity of the above measures of hospital covariates have been established in previous studies that accounted for the impact of organizational characteristics and structures on patient outcomes (Kelly et al., 2013; Stimpfel, Sloane, McHugh, & Aiken, 2016).

Patient illness severity measure: hospital case mix index.

Hospital patient case mix index (CMI) is a hospital-level value used as an indicator of the clinical complexity and resource needs of all patients who received care in a hospital (U.S. Department of Health and Human Services, 2018a). A higher CMI indicates that the hospital served a more complex patient population. Larger hospitals with high teaching and technology capabilities tend to have higher CMIs (Mendez, Harrington, Christenson, & Spellberg, 2014). Models should be risk adjusted for differences in patients across hospitals to avoid spurious associations (Iezzoni, 2013). The CMI variable accounts for multiple patient factors including the principal and secondary diagnoses, age, sex, procedures performed, comorbidities, complications and discharge status (DHHS, 2018a). As studies show that patient illness severity increases the risk of experiencing adverse events, hospital case mix index was controlled for in the study models (Bohlouli, Tonelli, Jackson, Hemmelgam, & Klarenbach, 2016; Daley, 2013; Lucero et al., 2010).

Table 1. Study Variables				
Variables	**Source**	**Level**	**Type**	**Measurement**
Predictor				
Nurse burnout	Nurse survey	Hospital	Continuous	% of burned out nurses
Mediator				
Missed care	Nurse survey	Hospital	Continuous	% of nurses that left at least 1 necessary task left undone
Outcomes: Adverse Events				
Medication error	Nurse survey	Nurse	Dichotomous	0 = Infrequent ; 1 = Frequent
		Hospital	Continuous	% of nurse-reported frequent adverse event
Pressure ulcers after admission	Nurse survey	Nurse	Dichotomous	0 = Infrequent ; 1 = Frequent
		Hospital	Continuous	% of nurse-reported frequent adverse event
Falls with injury after admission	Nurse survey	Nurse	Dichotomous	0 = Infrequent ; 1 = Frequent
		Hospital	Continuous	% of nurse-reported frequent adverse event
Hospital-associated urinary tract infections	Nurse survey	Nurse	Dichotomous	0 = Infrequent ; 1 = Frequent
		Hospital	Continuous	% of nurse-reported frequent adverse event
Hospital-associated central line infections	Nurse survey	Nurse	Dichotomous	0 = Infrequent ; 1 = Frequent
		Hospital	Continuous	% of nurse-reported frequent adverse event
Covariates				
Hospital-level Characteristics				
Staffing	Nurse survey	Hospital	Continuous	Average #Patients/RN ratio
Nurse practice environment	Nurse survey	Hospital	Continuous	Composite score: Mean of PES-NWI subscale means (not including Staffing and Resource Adequacy subscale)
Bed size	AHA survey	Hospital	Categorical	0 = Small, ≤100 1 = Medium, 101 - 250 2 = Large, >250
Teaching status	AHA survey	Hospital	Categorical	0 = None 1 = Minor, resident to bed ratio ≤1:4 2 = Major, resident to bed ratio >1:4
Technology status	AHA survey	Hospital	Dichotomous	0 = Low Technology 1 = High Technology, open heart and/or organ transplant
Ownership	AHA survey	Hospital	Categorical	0 = Government ; 1 = Non-profit ; 2 = Profit
Case Mix Index	CMS PSF	Hospital	Continuous	Value of patient clinical complexity
Nurse Characteristics				
Age	Nurse survey	Nurse	Continuous	Age
Sex	Nurse survey	Nurse	Dichotomous	0 = Male ; 1 = Female
Nurse education	Nurse survey	Nurse	Dichotomous	0 = Less than BSN ; 1 = BSN or higher
Nursing unit type	Nurse survey	Nurse	Categorical	0 = Medical-Surgical Unit 1 = Intensive Care Unit 2 = Other
Years RN experience	Nurse survey	Nurse	Continuous	Years practicing as a direct patient care RN

Note. PES-NWI: Practice Environment Scale of the Nursing Work Index. AHA: American Hospital Association. CMS PSF: Centers for Medicare and Medicaid Services Provider Specific File. BSN: Bachelors of Science in Nursing. RN: Registered Nurse.

Data Analysis

The following section will outline the secondary data analysis procedures, including the construction of the final analytic dataset, followed by the analysis plan that was used to address the specific aims of the study. All of the data analyses were conducted using the program STATA IC 13, and for all tests, statistical significance was set at the alpha level of $p<0.05$.

Prior to linking the data, the nurse survey data was assessed and cleaned independently. The sample was limited to direct care RNs working in adult, non-federal inpatient settings; the other observations were dropped. New, derived variables were created as necessary and defined as explicated above. For hospital-level measures, nurse responses were calculated as means and aggregated to the hospital level. The final analytic sample of the study was obtained by linking the three data sources: the Multi-State Nursing Care and Patient Safety Survey, the American Hospital Association Annual Survey, and the Centers for Medicare and Medicaid Services Provider Specific File. The three data sets were merged using a unique hospital identification number.

Variables were assessed for percentages and patterns of missing data and errors, such as invalid responses. Data analysis is less likely to be biased when the amount of missing data from a variable is less than 10% (Bennett, 2001). Among the primary variables of interest, hospital nurse burnout and missed care had no missing data. Among the five outcome variables, missing data ranged from 2.5% - 9.1%. Upon analysis, there was no statistically significant variation of the missing data across hospitals. As such, there was no evidence of a pattern among the missing data that would introduce a systematic bias and threaten the validity and generalizability of results (Kane &

Radosevich, 2010). Therefore, missing data was handled by listwise deletion of observations—the most frequently used method for handling missing data (Kang, 2013). Furthermore, sensitivity analyses were conducted on the final analytic models to assess the potential impact of missing data among covariates on the study findings. The only covariates with greater than 5% of missing data, nurse unit type and CMI, were selected for sensitivity analyses. The analytic models were run without nurse unit type and separately without CMI; both results were consistent with the study's overall findings.

Prior to using inferential statistics to address the study aims, descriptive analyses were conducted on all study variables. Means, standard deviations and ranges were examined for continuous variables, whereas frequency and percentages were obtained for categorical variables. Variables were assessed for significant violations in their distributions. The distribution of the primary predictor variable, burnout, and mediating variable, missed care, are presented in Chapter 4, in addition to the frequency of the five study outcomes, nurse-reported frequent adverse events. Additionally, to further explore relationships among key variables, the mediating and outcome variables were explored across tertiles of the independent variable, nurse burnout.

Covariates were selected for inclusion in the final models based on consistent empirical findings showing significant associations with the study outcomes: adverse events. Prior to multivariable modeling, bivariate analyses were conducted on the variables to assess the strength, direction and significance of the relationships between one another, as well as to assess for multicollinearity. Correlations were assessed using Pearson correlations, point-biserial correlations, and variance inflation factors.

Analysis of Specific Aims

Aim 1 examined the relationship between nurse burnout and nurse-reported frequent adverse events, and Aim 2 assessed whether missed care was a partial mediator in this relationship. It was hypothesized that higher percentages of nurse burnout are associated with higher odds of nurse-reported frequent adverse events (hypothesis 1), and that missed care partially explains this relationship (hypothesis 2). Both aims were statistically assessed using the Baron and Kenny method of mediation analysis (Baron & Kenny, 1986).

As explicated in Chapter 2, it was hypothesized that there are multiple pathways between the complex phenomenon of burnout and poor patient outcomes, and missed care may be one of them. With mediation analyses, it is recommended to determine a priori whether the mediator is hypothesized to be a complete or partial mediator (Gelfand, Mensinger, & Tenhave, 2009). Guided by literature and the study's conceptual framework, missed care was evaluated as a partial mediator, or a variable that accounts for some of the relationship between nurse burnout and patient adverse events.

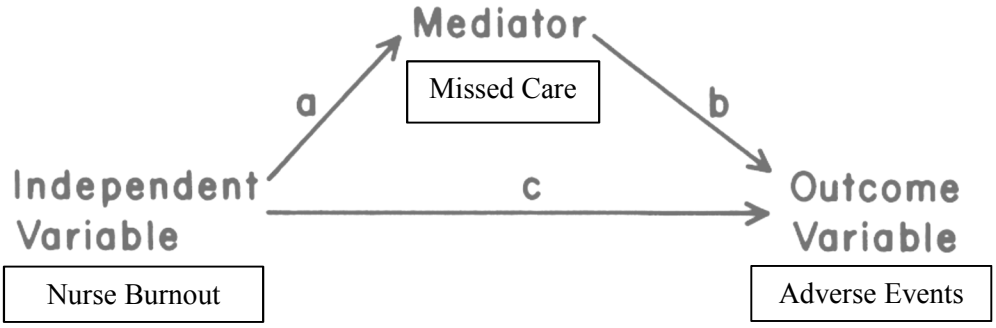
As a partial mediator, missed care may partially explain how or why nurse burnout is related to poor patient outcomes. Missed care is a partial mediator if the following conditions are met (Baron & Kenny, 1986; Bennett, 2000):

A. Variations in levels of the independent variable (nurse burnout) are significantly associated with variations in the partial mediator (missed care). (See Path A in the **Figure 2** below)

B. In the presence of the independent variable (burnout), variations in the partial mediator (missed care) are significantly associated with variations in the dependent variables (adverse events). (See Path B in the Figure 2 below)

C. When Paths A and B are controlled for, the previous significant, direct association between the independent variable (nurse burnout) and the outcome variables (nurse-reported adverse events) will be significantly decreased rather than eliminated altogether. In other words, the addition of missed care in the multivariable model for patient outcomes should attenuate the estimated coefficient for the burnout variable. (Path C in Figure 2 below).

Figure 2. Mediation Model adapted from Baron & Kenny (1986)



To assess the evidence of partial mediation, a series of multilevel multivariable robust logistic regression analyses were conducted as follows (Baron & Kenny, 1986):

1) First, the presumed partial mediator, missed care, was regressed on the independent variable, nurse burnout.
2) Second, the dependent variables, adverse events, were independently regressed on the independent variable, nurse burnout.

3) Third, the dependent variables, adverse events, were independently regressed on both the independent variable, nurse burnout, and the partial mediator, missed care.

In summary, in order for missed care to be a partial mediator between nurse burnout and adverse events, the first equation must show that nurse burnout is significantly associated with missed care at the alpha $p<0.05$ level. The second equation must show that nurse burnout is significantly associated with the adverse events. If the prior two relationships are non-significant, it can be concluded that mediation is not likely. If both are significant, the analysis continues to the third equation, adjusting for both missed care and burnout, and must show that missed care is significantly associated with the adverse events, and that the association between nurse burnout and adverse events is decreased in comparison to the results from the second equation (Bennett, 2000).

The study outcomes, nurse-reported frequent adverse events, were dichotomous with a binomial distribution. As such, robust logistic regression was selected to address the study aims. Multilevel multivariable robust logistic regression analyses require large sample sizes for accuracy and precision. Generally, the recommended minimum for an adequate sample size is 10 observations multiplied by the number of independent variables in the model, divided by the proportion of positive cases (Peduzzi, Concato, Kemper, Holford, & Feinstein, 1996). The final study models had 13 independent variables, so the minimum recommended sample size for the five outcomes would be 492 – 1,181 nurses. The size of this study's sample well exceeded this recommended minimum.

Multilevel logistic regression also requires the observations to be independent. In the dataset, there are multiple observations within in each hospital. As nurses are nested within hospitals, there is potential for a clustering effect that can impact the validity of regression results. As such, Huber-White sandwich estimators were used to apply robust standard errors that account for the clustering of nurses within hospitals (Huber, 1967; White, 1996; Williams, 2000).

For all regressions, the five adverse outcomes were assessed independently. Regarding the multilevel nature of the models, the variables were assessed as follows: the primary explanatory variable (nurse burnout) and mediating variable (missed care) at the hospital level; the adverse event outcomes at the nurse level; nurse characteristic covariates (sex, BSN education, unit type and years experience) at the nurse level; and hospital covariates (bed size, teaching status, technology status, ownership, patient case mix index, nurse staffing and practice environment) at the hospital level. For ease of interpretation, the nurse burnout variable was multiplied by 10 such that odds ratios indicated the effect of a 10% increase in nurse burnout at the hospital level on the odds of nurse-reported frequent adverse events, after controlling for the listed covariates. The same was done for the missed care variable.

Validity of logistic regression models is generally assessed to determine whether the results can be extended to the broader population from which the sample was derived (Park, 2013). The validity of the logistic regression models for the five outcomes was assessed with the Hosmer-Lemeshow goodness of fit test, which compares observed and expected frequencies over multiple groups and produces a goodness of fit chi-square statistic (Hosmer & Lemeshow, 1980; Park, 2013). A p-value of >0.05 indicates there is

no evidence that observed event rates in a sample do not match expected event rates. With chi-square statistics ranging from 2.68 to 13.86, and p-values ranging from 0.09 to 0.95, there was no evidence indicating poor fit among the models for all five of the study's outcomes.

Sensitivity Analyses

Two sensitivity analyses were conducted to corroborate study findings: one analyzed both aims entirely at the hospital level, and the other utilized an additional method of mediation analysis to assess the relationship between nurse burnout, missed care and patient adverse events.

Emphasis is increasingly placed on hospital-level reports of patient-safety, including publically reported hospital-level adverse events. As such, the first sensitivity analysis replicated the aforementioned mediation analysis but exclusively at the hospital level, such that all included variables were analyzed at the hospital level.

At the hospital level, the outcomes were measured independently as continuous variables indicating the percentage of nurses reporting frequent adverse events. As such, multivariable linear regression was used in the Baron and Kenny mediation analysis. The hospital-level distribution of the outcomes was assessed for normality using histograms, skewness and kurtosis. Substantial departure from normality is indicated by an absolute skew value >2.1, and kurtosis >7.1 (Kim, 2013; West, Finch, & Curran, 1995). Among the five nurse-reported adverse events, skewness ranged from 0.4 – 1.1, and kurtosis ranged from 2.9 – 5.5. Each of the five adverse events was skewed slightly to the right, however no serious deviation from normality was detected. For ease of interpretation, variables were scaled such that linear regression estimates reflected a change in the

percentage points of the reported adverse events associated with a 10% increase in the proportion of burned out nurses, after controlling for hospital bed size, teaching status, technology status, ownership, case mix index, nurse staffing and practice environment.

The second sensitivity analysis was conducted at the hospital level using the Sobel method of mediation analysis (Sobel, 1982; Sobel, 1986). The Sobel test assesses mediation by calculating the statistical significance of the indirect effect, which is the difference between the estimates of the impact of burnout on the outcomes obtained in the regressions with and without the mediator (missed care) present (Allen, 2017). The Sobel test uses the traditional mediation series of regressions as described above. As such, it utilizes the output from the regressions provided in the hospital-level sensitivity analysis described above. As with the above sensitivity analysis, the Sobel mediation linear regressions have the same controls and each outcome is assessed independently.

The Sobel test equation is as follows: z-value = $a*b/\text{SQRT}(b^2*s_a^2 + a^2*s_b^2)$, where "a" is the unstandardized regression coefficient for the association between the independent variable (burnout) and mediator (missed care); "b" is the unstandardized coefficient for the association between the mediator (missed care) and the dependent variable (adverse event), when the independent variable is also a predictor of the dependent variable; "s_a" is the standard error of "a"; and "s_b" is the standard error of "b." The null hypothesis that there is no indirect effect (indirect effect = 0) is rejected at the $p<0.05$ level for a two-tailed test. For a variable to be considered a partial mediator, the Sobel test requires that the reduction in variance explained by the independent variable in the presence of the mediator be statistically significant. Finally, the Sobel test provides the percentage of the relationship between the independent variable (nurse burnout) and

the dependent variable (adverse event) that is mediated by missed care. This is done by dividing the indirect effect by the total effect, which is the coefficient obtained when the outcome (adverse event) is regressed on the independent variable (burnout) (Preacher & Leonardelli, 2019)

Data Integrity and Human Subjects

All of the data for the study are stored and backed up electronically on a secure, firewall-protected server managed by the Office of Information Technology Services of the University of Pennsylvania School of Nursing. All data were analyzed on password-protected computers located within a locked office in the University of Pennsylvania School of Nursing. The computer and server are equipped with antiviral software. No data was printed or transferred outside of the University.

As explicated in the data sources section above, data from the Multi-State Nursing Care and Patient Safety Survey, the American Hospital Association Annual Survey, and the Centers for Medicare and Medicaid Services Provider Specific File do not contain any respondent names and existed in a de-identified state prior to the start of the secondary data analysis. The names of the hospitals assessed in the study were not reported. This secondary analysis of de-identified data poses no risk to patients or nurses. Institutional Review Board approval was obtained prior to study commencement (IRB protocol #825193, Appendix A).

CHAPTER 4: RESULTS

Overview

The purpose of this study was to explore how, and to what extent, hospital nurse burnout impacts care delivery and patient outcomes. Using descriptive and inferential statistics, this was explored by first assessing the relationship between hospital nurse burnout and five nurse-reported patient adverse events, followed by examining the role of missed care as one potential pathway between burnout and adverse events. It was hypothesized that hospitals with higher proportions of burned out nurses would be associated with increased odds of nurse-reported adverse events, and that missed care would partially mediate this relationship. The following chapter provides results from descriptive, correlational, and multiple linear and logistic regression analyses that were conducted to test these hypotheses.

The study sample included 23,784 registered nurses working in direct patient care roles in 587 hospitals across four states: California, Florida, New Jersey and Pennsylvania. Using descriptive statistics, this chapter first presents the characteristics of the hospitals and nurses in the sample. Continuous variables are presented with means, standard deviations and ranges; categorical variables are reported as frequencies and percentages. The frequency distribution of the predictor variable, nurse burnout, and the mediator, missed care, are provided. Next, the frequency of each of the five outcomes is provided. Additionally, percentages of missed care and nurse-reported adverse events are also explored by tertiles of hospital nurse burnout. Then, correlations between burnout, missed care and the aforementioned covariates are presented to identify any multicollinearity issues.

Next, the findings from unadjusted models assessing the bivariate relationships between burnout and nurse-reported adverse events, as well as between burnout and missed care, are described. The mediation analysis using the Baron and Kenny approach is then presented (Baron & Kenny, 1986). Multiple logistic regression analyses that address both Aim 1 and Aim 2 of the study are described. Finally, results from sensitivity analyses are presented. These include assessing mediation entirely at the hospital level, as well as using the Sobel test as another analytic method to confirm mediation results.

Characteristics of the Study Sample

Hospitals

A summary of hospital characteristics is shown in **Table 2**. The table includes structural and organizational characteristics of the 587 hospitals in the sample. Study hospitals had an average of 68 nurse survey respondents, ranging from 10 to 245 nurses per hospital.

The largest percentage of hospitals was located in California (39%), followed by Florida (25%), Pennsylvania (23%), and New Jersey (12%). Core-based statistical area provides further information on hospital location with respect to population density in geographical areas (DHHS, 2018b). The majority of hospitals were located in metropolitan and division areas where greater than 50,000 people reside. Nine percent of hospitals were located in areas with less than 50,000 people, and 2% of hospitals were in rural areas (population <10,000 people). The majority of hospitals had greater than 100 beds; of those, 44% had greater than 250 beds. Twelve percent of hospitals had 100 beds or less.

With regard to teaching status, the majority of the hospitals, 52%, had no postgraduate medical trainees. Of the hospitals with trainees, 40% had a 1:4 ratio or less of medical trainees to beds. The majority (56%) of hospitals were classified as low technology, meaning that they did not have the ability to conduct open heart and/or organ transplantation surgery, whereas 44% were high technology hospitals. Regarding ownership, 73% of hospitals were non-profit, 17% were for-profit, and 10% were government-owned hospitals.

Hospital case mix index is a standard indicator that reflects the clinical complexity and resource needs of all patients in a hospital (DHHS, 2018a). A higher CMI indicates that the hospital served a more complex patient population. Among the 587 hospitals, the average hospital case mix index was 1.13, with a standard deviation (SD) of 0.41. Ten percent of study hospitals had a CMI of 1.39 or higher.

The average nurse staffing level of hospitals, calculated as the average patient to nurse ratio, was 4.93, with a SD of 1.29. The average nurse work environment score, measured by the Practice Environment Scale of the Nursing Work Index (PES-NWI), was 2.73, with a SD of 0.22, and ranged from 2.07 to 3.38.

Table 2. Characteristics of Study Hospitals (N = 587 Hospitals)		
	N	**%**
State, n (%)		
California	231	39%
Florida	149	25%
New Jersey	72	12%
Pennsylvania	135	23%
Core-based Statistical Area, n (%)		
Division (>2.5 million)	237	40%
Metropolitan (50,000-2.5 million)	291	50%
Micro (10,000-50,000)	50	9%
Rural (<10,000)	9	2%
Bed Size, n (%)		
≤100 beds	69	12%
101-250 beds	260	44%
>250 beds	258	44%
Teaching Status, n (%)		
Non-teaching (No postgraduate trainees)	305	52%
Minor (Resident to bed ratio ≤ 1:4)	237	40%
Major (Resident to bed ratio > 1:4)	45	8%
Technology Status, n (%)		
High (Open heart and/or organ transplant)	256	44%
Low (No open heart and/or organ transplant)	331	56%
Ownership, n (%)		
Government	54	10%
Non-profit	412	73%
Profit	98	17%
	Mean	**SD**
Case Mix Index, mean (SD)	1.13	0.41
Staffing, mean (SD)	4.93	1.29
PES-NWI, mean (SD)	2.74	0.22

Note. Total counts may not equal hospital sample size of 587 due to missing values in the AHA and CMS data. Percentages may not sum to 100% due to rounding. Case Mix Index is a hospital value indicating patient clinical complexity and resource needs. Staffing is defined as the ratio of patients to direct care RNs. PES-NWI: Practice Environment Scale of the Nursing Work Index, excludes the Staffing and Resource Adequacy subscale. SD: standard deviation.

Nurses

Characteristics of nurses in the study sample are provided in **Table 3**. The sample includes 23,784 registered nurses providing direct patient care for patients in 587 hospitals across four states. The majority of nurses, 93%, were female. The average age of nurses in the study was 44.2 years (SD: 10.6 years), and the average years of RN work experience providing direct patient care was 16.0 years (SD: 10.9). With respect to highest level of nursing education, over 43% of nurses reported having a baccalaureate degree or higher, 39% held an associates degree, and 18% received education from a diploma program. Regarding nursing unit type, approximately 19% of nurses reported working in an intensive care unit on their last shift, 19% worked in medical-surgical units, and 62% worked in other hospital units such as emergency rooms, operating rooms, and labor and delivery.

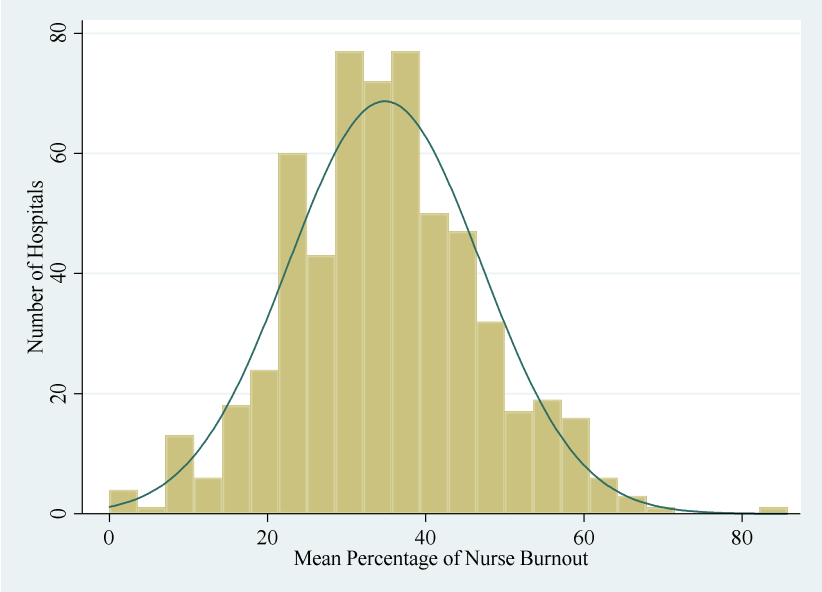
Table 3. Characteristics of Nurses (N = 23,784 Nurses)	
Age (years), mean (SD)	44.21 (10.64)
Sex, n (%)	
Female	22,027 (93.05%)
Male	1,645 (6.95%)
Nurse Education, n (%)	
Diploma	3,989 (17.59%)
Associates	8,854 (39.05%)
Bachelors	9,124 (40.24%)
Masters	694 (3.06%)
Doctorate	9 (0.04%)
Nursing Unit Type, n (%)	
Medical-Surgical	3,773 (18.68%)
Intensive Care	3,883 (19.22%)
Other	12,542 (62.10%)
Years of RN Experience, mean (SD)	16.03 (10.88)

Note. Total counts may be less than sample size of 23,784 nurses due to missing values. Percentages may not add to 100% due to rounding. Nurse Education is the highest degree held in nursing. SD: standard deviation.

Descriptive and Correlational Analysis of Study Variables of Interest

The following section provides descriptive statistics on the main predictor variable of interest, nurse burnout. Nurse burnout was defined as the hospital-level percentage of nurses scoring ≥27 on the emotional exhaustion subscale of the Maslach Burnout Inventory-Human Services Survey (Maslach et al., 1986). A visual representation of the frequency and distribution of hospital-level nurse burnout across study hospitals is shown in a histogram in **Figure 3**. Nurse burnout was normally distributed, with a slight right skewness of 0.16. The average percent of burned out nurses at the hospital level was 34.8%, with a SD of 12.2%. Hospital burnout ranged from 0% to 85.7%. The median percentage of hospital burnout was 34.3%. The interquartile range of burnout across study hospitals was 26.8% to 42.3%. In other words, 25% of hospitals had less than 26.8% of burned out nurses, and 25% of hospitals had greater than 42.3% burned out nurses.

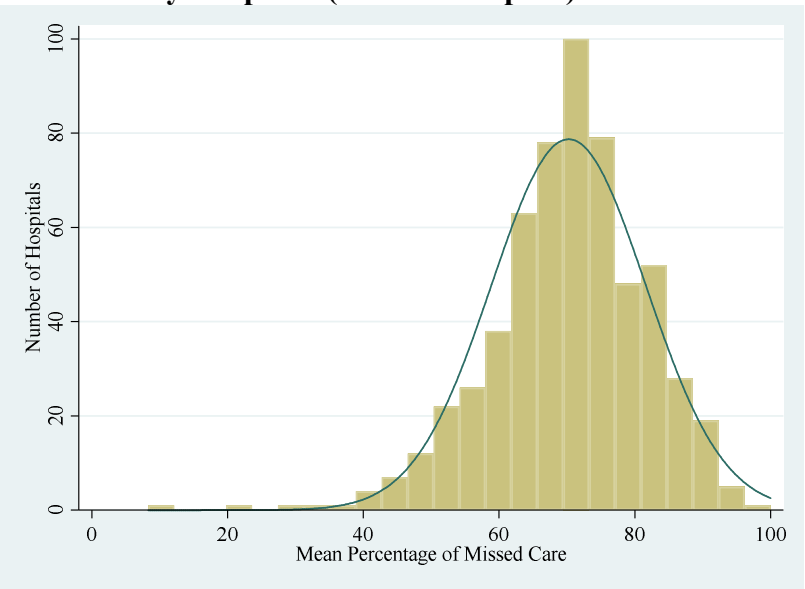
Figure 3. Frequency and Distribution of Nurse Burnout Across Study Hospitals (N = 587 Hospitals)



Note. Nurse Burnout is defined as scoring ≥27 on the Emotional Exhaustion subscale of the Maslach Burnout Inventory (Maslach 1986).

Figure 4 provides the frequency and distribution of the mediating variable missed care across study hospitals. Missed care was defined as the hospital-level percentage of nurses reporting leaving at least one necessary patient care task left undone. Missed care was relatively normally distributed, with a moderate left skewness of -0.71 (Kim, 2013). Across hospitals, an average of 70.2% of nurses reported missing necessary care, with a standard deviation of 11.4%. The median hospital-level missed care was 70.8%. The hospital-level range of missed care was 8% to 100%. The interquartile range of missed care across hospitals was 63.7% to 77.4%.

Figure 4. Frequency and Distribution of Missed Care Across Study Hospitals (N = 587 Hospital)



Note. Missed care is defined as nurses reporting leaving at least one necessary patient care task left undone.

After descriptively assessing nurse burnout and missed care, both variables were assessed in relation to each other. **Table 4** provides the percentage of missed nursing care across tertiles of nurse burnout at the hospital level. Hospital-level nurse burnout was categorized by tertiles: low (33.2% of the data), moderate (33.1% of the data), and high (33.7% of the data) percentages of burned out nurses. Of the 587 hospitals, 195

were in the low percentage of burnout category (0-30% burned out), 194 were in the moderate category (>30%-39.2% burned out), and 198 hospitals were in the high category (>39.2%-85.7% burned out). The mean percentage of missed care across all hospitals was 70.2% (SD 11.4%). The average missed care percentages across burnout categories, from low to high, were 64%, 71%, and 76%, respectively. As such, Table 4 shows a hospital-level trend of increasing mean percentages of missed care with increasing percentages of nurse burnout. One-way analysis of variance showed that missed care varied significantly across the tertiles of hospital nurse burnout at the $p<0.001$ level. Specifically, hospitals with higher average percentages of burned out nurses had higher average percentages of missed care.

Table 4. Missed Care Percentage by Tertiles of Hospital-Level Nurse Burnout (N = 587 Hospitals)

		Hospital-Level Nurse Burnout Tertiles			
Variable	**Overall**	**Low Percentage Burnout** N = 195 (0-30%)	**Moderate Percentage Burnout** N = 194 (>30%-39.2%)	**High Percentage Burnout** N = 198 (>39.2%-85.7%)	**P-Value**
Missed Care, mean (SD)	70.2% (11.4%)	63.5% (12.2%)	70.7% (9.3%)	76.4% (8.3%)	<0.001

Note. P-value calculated using a one-way analysis of variance test as missed care is a continuous variable.
SD: standard deviation

Next, **Table 5** presents the frequency and percentage of the study outcomes, which are five nurse-reported adverse events: patient received wrong medication or dose, pressure ulcers developed after admission, falls with injury after admission, and healthcare-associated urinary tract and central line infections. Nurse-reported adverse events were coded as frequent vs. infrequent. Frequent adverse events were defined as nurses reporting the event occurring at least once a month or more. Table 5 includes information on the outcomes at the nurse and hospital levels, because while nurse-level outcomes were used in the primary analysis of the study, hospital-level outcomes were assessed in subsequent sensitivity analyses.

At the nurse-level, the percentages of nurses who reported frequent patient adverse events ranged from 11.1% to 26.4%. Among the five outcomes, frequent hospital-acquired urinary tract infections were reported the most (26.4%). This was followed by frequent hospital-acquired central line infections (20.8%), pressure ulcers after admission (15.2%), falls with injury after admission (13%), and patient received wrong medication or dose, which was reported least frequently (11.1%).

Across hospitals, the average percentages of nurses reporting frequent patient adverse events were similar to the overall individual nurse-level reports, ranging from 11.6% to 25.8%. The ranking of adverse events from most frequently to least frequently reported was the same at both the nurse and hospital levels (urinary tract infections, central line infections, pressure ulcers, falls with injury, and medication errors, in that order). The slight variations in the nurse and hospital level means are likely due to the fact that hospitals varied in the number of nurse respondents.

Table 5. Adverse Events: Frequency & Percentage at Nurse and Hospital Levels					
Adverse Event	**Nurses Reporting Frequent Adverse Event N = 23,784**		**Average Hospital % of Nurses Reporting Frequent Adverse Event N = 587**		
	# RNs	**% RNs**	**Avg. %**	**SD**	**Median**
Medication Errors	2,571	11.1%	11.6%	8.0%	10.1%
Pressure Ulcers	3,404	15.2%	15.0%	9.0%	13.5%
Falls with Injury	2,926	13.0%	13.7%	9.1%	12.1%
Urinary Tract Infections	5,744	26.4%	25.8%	11.7%	25.7%
Central Line Infections	4,490	20.8%	18.1%	11.1%	17.1%

Note. Total counts may be less than sample size due to missing values. Adverse Event defined as frequent when nurses reported the event occurring greater than a few times a year. SD: standard deviation.

Table 6 presents the frequencies of nurse-level adverse events across tertiles of hospital-level burnout. Logistic regressions confirmed that all five nurse-reported adverse events were significantly associated with hospital-level burnout ($p<0.001$). The frequencies of all five nurse-reported adverse events varied across tertiles of burnout. Variation in percentages of nurse-reported frequent adverse events was seen across hospitals with differing percentages of burnout. Specifically, across all five outcomes, higher percentages of frequent adverse events were reported in hospitals with higher percentages of nurse burnout. For example, in the full sample, more than one out of every four nurses reported frequent hospital-associated urinary tract infections (UTIs). In hospitals with the lowest percentages of burnout, 21.8% of nurses reported UTIs, whereas in hospitals with the highest percentages of burnout, 29.6% of nurses reported frequent UTIs. This trend was seen across all of the nurse-reported patient outcomes.

Table 6. Frequent Adverse Event Percentage by Tertiles of Hospital-Level Nurse Burnout (N = 23,784 Nurses)

		Hospital-Level Nurse Burnout			
Adverse Event	**All**	**Low Percentage Burnout** N = 195 (0-30%)	**Moderate Percentage Burnout** N = 194 (>30-39.2%)	**High Percentage Burnout** N = 198 (>39.2-85.7%)	**P-value**
Medication Errors, n (%)	2,571 (11.1%)	601 (8.9%)	1,005 (11.1%)	965 (13.2%)	<0.001
Pressure Ulcers, n (%)	3,404 (15.2%)	747 (11.5%)	1,310 (14.9%)	1,347 (19.0%)	<0.001
Falls with Injury, n (%)	2,926 (13.0%)	635 (9.7%)	1,065 (12.0%)	1,226 (17.1%)	<0.001
Urinary Tract Infections, n (%)	5,744 (26.4%)	1,377 (21.8%)	2,328 (27.3%)	2,039 (29.6%)	<0.001
Central Line Infections, n (%)	4,490 (20.8%)	1,018 (16.2%)	1,885 (22.2%)	1,587 (23.2%)	<0.001

Note. P-values calculated using logistic regressions. SD: standard deviation

After assessing the study population, key predictor, mediating and outcome variables, as well as the trends between them, correlations between independent variables and covariates were assessed for potential multicollinearity. Multicollinearity diagnostics were conducted using Pearson and point-biserial correlations, as well as variance inflation factors (VIFs). Correlation strength ranges from -1 to 1. Correlations ranging from -0.3 to 0.3 were considered weak; 0.3 to 0.6 and -0.6 to -0.3 were considered moderate; and 0.6 to 1.0 and -1.0 to -0.6 were considered strong (Akoglu, 2018). Both the Pearson and point-biserial correlation analyses yielded consistent correlation estimates. As such, only Pearson coefficients are reported below.

Table 7 shows a correlation matrix of nursing characteristics. The majority of relationships were statistically significant as shown, but the strongest correlation was between nurse age and years of RN experience (0.74, $p<0.001$). This statistical evidence of collinearity combined with previous literature linking years of RN experience and patient adverse events are why nurse age was not controlled for in the final models (Blegen et al., 2001).

Table 7. Correlation Matrix of Nursing Characteristics (N = 23,784 Nurses)							
Variables	**1**	**2**	**3**	**4a**	**4b**	**4c**	**5**
1. Age	1						
2. Sex	-0.0123	1					
3. BSN Education	-0.1964 ***	-0.0045	1				
4. Unit Type							
a. Medical-Surgical	-0.0261 ***	-0.0138 *	-0.0435 ***	1			
b. ICU	-0.0393 ***	0.0659 ***	0.0766 ***	-0.2338 ***	1		
c. Other	0.0529 ***	-0.0425 ***	-0.0272 ***	-0.6134 ***	-0.6244 ***	1	
5. Years Experience	0.7393 ***	-0.1000 ***	-0.0377 ***	-0.1024 ***	0.0005	0.0817 ***	1

Note. p<0.05*; p<0.01**; p<0.001***; BSN education represents nurses holding a baccalaureate degree or higher. ICU: intensive care unit. Years experience is the number of years of RN work experience. Total nurses may be less than 23,784 due to missing values.

Table 8 contains Pearson correlation coefficients assessing the correlations between the study nurse staffing measure, defined as the ratio of patients to direct care RNs, and the PES-NWI (composite and subscales) scores. Of all the subscales, the PES-NWI Staffing and Resource Adequacy subscale was most highly correlated to the study staffing variable (-0.47, $p<0.001$). This is considered a moderately strong negative correlation. This statistical evidence – combined with the theoretical and clinical significance that both measures are metrics of nurse staffing – supports the rationale for excluding the Staffing and Resource Adequacy subscale in the overall PES-NWI score used in the subsequent study analyses. As expected, the PES-NWI subscales were all moderately to strongly correlated with each other and the PES-NWI composite measure, ranging from 0.52 to 0.91.

Table 8. Pearson Correlations of Nurse Staffing and PES-NWI Subscales (N = 587 Hospitals)							
Variables	**1**	**2**	**2a**	**2b**	**2c**	**2d**	**2e**
1. Staffing	1						
2. PES - NWI	-0.4131	1					
a. Staffing and Resource Adequacy	-0.4658	0.8655	1				
b. Nurse Manager Ability, Leadership, and Support	-0.2967	0.8734	0.6945	1			
c. Foundations for Quality of Care	-0.3299	0.9143	0.7065	0.7651	1		
d. Nurse Participation in Hospital Affairs	-0.3090	0.8885	0.6593	0.7294	0.8759	1	
e. Nurse-Physician Relationships	-0.3560	0.7333	0.5895	0.5218	0.5859	0.5244	1

Note. All correlations significant at the $p < 0.001$ level. Staffing defined as the ratio of patients to direct care RNs; PES-NWI: Practice Environment Scale of the Nursing Work Index.

Table 9 provides a correlation matrix of hospital characteristics and hospital-level nursing variables: burnout, missed care, staffing and practice environment. The majority of variables were weakly correlated. The correlation between burnout and missed care was significant, moderate and positive (0.50), which suggests that as burnout increases, missed care increases. The nursing practice environment, without the Staffing and Resource Adequacy subscale, was moderately negatively correlated with burnout (-0.55), missed care (-0.45), and staffing (-0.37). The remaining variables were weakly correlated with burnout and missed care, the key variables of interest. There were a few categories that were highly correlated with other categories of the same variable. Major teaching and technology were moderately correlated (0.49). This moderate correlation is not concerning for the interpretation of the mediation analysis models because multicollinearity is a problem that specifically impacts the estimates of only the collinear variables (Allison, 2012). The aforementioned variables are being used as controls and are not collinear with the variables of interest.

Table 9. Correlation Matrix of Organization of Nursing and Hospital Characteristics (N=587 Hospitals)															
Variables	**1**	**2**	**3**	**4**	**5a**	**5b**	**5c**	**6a**	**6b**	**6c**	**7**	**8**	**9a**	**9b**	**9c**
1. RN Burnout	1														
2. Missed Care	0.5046 ***	1													
3. Staffing	0.3228 ***	0.2584 ***	1												
4. Practice Environment	-0.5529 ***	-0.4484 ***	-0.3685 ***	1											
5. Bed Size															
a. ≤ 100 beds	-0.1406 ***	-0.0974 *	0.0939 *	0.0362	1										
b. 101 – 250 beds	0.0785	0.0206	0.0547	-0.1188 **	-0.3243 ***	1									
c. > 250 beds	0.0225	0.0437	-0.1124 **	0.0925 *	-0.3232 ***	-0.7869 ***	1								
6. Teaching Status															
a. Non-teaching	-0.0348	-0.0333	0.0220	0.0591	0.2662 ***	0.0029	-0.1721 ***	1							
b. Minor teaching	0.0352	0.0306	0.0114	-0.0939 *	-0.2345 ***	0.0691	0.0859 *	-0.8528 ***	1						
c. Major teaching	0.0187	0.0083	-0.0563	0.0567	-0.0654	-0.1271 **	0.1706 ***	-0.2997 ***	-0.2363 ***	1					
7. Technology Status	0.0229	0.0557	-0.1463 ***	0.0871 *	-0.2897 ***	-0.2989 ***	0.4872 ***	-0.1463 ***	0.0414	0.1982 ***	1				
8. Case Mix Index	0.0381	0.0401	-0.0881 *	-0.0184	-0.1422 ***	-0.1027 *	0.1874 ***	-0.0703	0.0223	0.0845 *	0.1347 **	1			
9. Ownership															
a. Government	-0.0511	0.0092	-0.1431 ***	0.0497	-0.0412	-0.0525	0.0803	-0.0183	-0.0765	0.1773 ***	0.0341	-0.0490	1		
b. Non-profit	-0.0691	-0.0750	0.0999 *	0.1209 **	0.0058	-0.0834 *	0.0847 *	0.0448	-0.0482	0.0142	-0.0185	0.1785 ***	-0.4681 ***	1	
c. Profit	0.1129 **	0.0793	0.0281	-0.2033 ***	0.0210	0.1082 **	-0.1203 **	-0.0816 *	0.1453 ***	-0.1118 **	0.0570	-0.1661 ***	-0.1410 ***	-0.6652 ***	1

Note. p<0.05*; p<0.01**; p<0.001***; Staffing defined as the ratio of patients to direct care RNs. PES-NWI: Practice Environment Scale of the Nursing Work Index, excludes the Staffing and Resource Adequacy subscale. Total hospitals may be less than 587 due to missing values.

VIFs, as shown in **Table 10**, were calculated for the covariates included in the subsequent multivariable models to assess for multicollinearity. Conservatively, VIFs greater than 2.50 can be considered concerning for multicollinearity contributing to increased variance of estimated coefficients (Allison, 2012). If present, this could result in less precise estimates and impact reliability of the overall model (Allison, 2012). Each adverse event was assessed independently. The VIFs obtained were consistent across all outcomes; as such, the five VIF tables were consolidated into Table 10. The highest VIF obtained was 1.72, therefore there were no VIFs that were concerning for multicollinearity.

Table 10. Variance Inflation Factors for Organization of Nursing and Hospital Characteristics (N = 541 Hospitals)	
Variable	**VIFs for all Adverse Events**
Burnout	1.71
Missed Care	1.48
Staffing	1.27
PES-NWI	1.72
Bed Size	1.48
Minor Teaching Status	1.13
Major Teaching Status	1.21
High Technology	1.38
Ownership: Government	1.09
Ownership: For Profit	1.17
CMI	1.09
Mean VIF	**1.34**

Note. All Adverse Events refer to medication errors, pressure ulcers, falls with injury, urinary tract infections, and central line infections. VIF: variance inflation factor; VIFs >2.5 are concerning for multicollinearity. PES-NWI: Practice Environment Scale of the Nursing Work Index, excludes the Staffing and Resource Adequacy subscale. Staffing defined as the ratio of patients to direct care RNs. CMI: Case Mix Index is a hospital value indicating patient clinical complexity and resource needs.

Overall, the correlation tables show that multicollinearity was not an issue among the variables to warrant exclusion from study models. As such, with the exception of nurse age, all of the nursing and hospital variables assessed above were retained as controls in the subsequent mediation models because of their theoretical links, clinical significance and empirically supported associations with the outcomes of interest.

Analysis of Specific Aims

This section provides results of the analyses that addressed the two specific aims of the study:

Specific Aim 1: To examine the relationship between nurse burnout and patient outcomes, specifically nurse-reported adverse events.

Hypothesis 1: Hospitals with higher proportions of burned out nurses will have increased odds of nurses reporting frequent adverse events, including medication errors, pressure ulcers, falls, hospital-acquired urinary tract infections, and hospital-acquired central line infections.

Specific Aim 2: To determine whether missed care partially mediates the relationship between nurse burnout and patient outcomes, specifically nurse-reported adverse events.

Hypothesis 2: Hospitals with higher proportions of burned out nurses will have higher proportions of missed care. Missed care will partially explain the relationship between burned out nurses and poor patient outcomes, including medication errors, pressure ulcers, falls, hospital-acquired urinary tract infections, and hospital-acquired central line infections.

As explicated in Chapter 3, the Baron and Kenny method was used to test partial mediation. Finding partial mediation requires that the independent, mediating, and outcome variables are assigned a priori, and assumes that there are two pathways impacting the outcome variables: the direct effect of the independent variable, and the indirect effect of the independent variable through the mediator (Baron & Kenny, 1986). According to the Baron and Kenny method, in order to conclude that missed care

partially mediates the relationship between nurse burnout and patient outcomes, the following conditions must be met: variations in burnout must be significantly associated with variations in adverse events as well as missed care; after controlling for burnout, variations in missed care must be associated with variations in adverse events; and finally, the initial significant relationship between burnout and adverse events must be significantly attenuated in the presence of missed care. The results of specific aim 1, the relationship between burnout and adverse events, are an included step in the mediation analysis for specific aim 2.

Table 11 presents the results of multilevel logistic regression analyses showing the unadjusted bivariate relationship between hospital-level nurse burnout and nurse-level adverse events. All five outcomes were assessed independently and all models accounted for clustering of nurses within hospitals. The odds ratios describe the effect of a 10% increase in hospital-level nurse burnout on the odds of nurse-reported frequent adverse events. As hypothesized, the results show that a 10% increase in nurse burnout was significantly associated with increased odds of all five patient outcomes, with the change in odds ranging from 17% to 33% ($p<0.001$). The largest effects were seen with frequent patient falls and pressure ulcers. A 10% increase in hospital-level nurse burnout was significantly associated with a 33% increase in the odds of a nurse reporting frequent patient falls with injury after admission (CI: 1.27–1.40, $p<0.001$). Similarly, a 10% increase in nurse burnout was associated with a 27% greater likelihood of nurses reporting frequent pressure ulcers developing after admission (CI: 1.22–1.32, $p<0.001$).

Table 11. Odds Ratios Estimating the Unadjusted Effect of Hospital-Level Nurse Burnout on Frequent Adverse Events

Adverse Event Outcomes	OR	95% CI	P-Value
Medication Errors	1.19	1.13 - 1.26	<0.001
Pressure Ulcers	1.27	1.22 – 1.32	<0.001
Falls with Injury	1.33	1.27 – 1.40	<0.001
Urinary Tract Infections	1.19	1.14 – 1.24	<0.001
Central Line Infections	1.17	1.11 – 1.24	<0.001

Note. The sample size ranged from 21,611 to 23,179 nurses across the five outcomes due to missing values. Each adverse event was assessed independently. All models account for the clustering of nurses within hospitals. OR: Odds Ratios, ORs indicate the change in the odds of the adverse event associated with every 10% increase in the proportion of burned out nurses in hospitals; CI: confidence interval.

Table 12 shows the results of hospital-level linear regression analyses assessing the unadjusted and adjusted relationship between nurse burnout and missed nursing care. The adjusted model controls for hospital-level variables including bed size, teaching status, technology status, ownership, and case mix index, as well as nurse staffing and the nurse practice environment. Both the bivariate and adjusted relationship between nurse burnout and missed care were found to be statistically significant at the $p<0.001$ level and in the direction hypothesized. Every 10% increase in the proportion of burned out nurses in a hospital was associated with a 4.71 percentage point increase in the percent of nurses who reported missing necessary care (CI: 4.05–5.36, $p<0.001$). This effect size was equivalent to slightly less than half of the SD of missed care (SD 11.4%).

In the adjusted model, the relationship between hospital-level nurse burnout and missed care remained significant ($p<0.001$). After adjusting for hospital nurse staffing, nurse practice environment, bed size, teaching, technology, ownership, and case mix index, every 10% increase in the hospital proportion of burned out nurses was significantly associated with a 3.10 percentage point increase in the percent of reported missed care (CI: 2.27–3.94, $p<0.001$), or slightly less than a third of the SD of missed care. This significant relationship between the independent variable, nurse burnout, and mediating variable, missed care, satisfy a key criterion in the Baron and Kenny mediation test. It was a necessary finding to enable continued analysis in the determination of missed care as a mediator between nurse burnout and each of the five outcomes.

Table 12. Regression Coefficients Estimating the Effect of Nurse Burnout on Missed Care (N = 587 Hospitals)

	Unadjusted			Adjusted		
Variable	**Coefficient**	**SE**	**95% CI**	**Coefficient**	**SE**	**95% CI**
Missed Care	4.71***	0.33	4.05 – 5.36	3.10***	0.42	2.27 – 3.94

Note. p<0.001***; Adjusted model includes hospital characteristics (bed size, teaching status, technology status, ownership, and case mix index) as well as staffing and the Practice Environment Scale score (without the Staffing and Resource Adequacy subscale). N=541 for the adjusted model due to missing values. Regression coefficients refer to the change in the percentage points of reported missed care with each 10% increase in the proportion of burned out nurses in hospitals. SE: standard error. CI: confidence interval.

Table 13 builds upon Tables 11 and 12 by showing the results of adjusted multilevel multivariable robust logistic regressions that assessed the mediation effect of missed care on the relationship between nurse burnout and patient outcomes. For ease of interpretation, burnout and missed care were multiplied by 10 such that the odds ratios indicate changes in the odds of the nurse-reported frequent adverse events associated with every 10% increase in the proportion of burned out nurses (and missed care, added in Model 2). Each of the five outcomes was assessed independently. All models used robust standard errors to account for the clustering of nurses within hospitals, and were fully adjusted with all of the controls (staffing, practice environment, case mix index, bed size, teaching, technology, and ownership, as well as nurse-level variables, sex, education, unit type and years experience).

The Model 1 column in Table 13 addresses Aim 1 of the study, and satisfies another key Baron & Kenny mediation criterion by showing evidence that the independent variable, nurse burnout, is significantly associated with all five adverse events, as hypothesized. Odds ratios are presented to indicate the size of the effect of a 10% increase in burnout on the outcomes, after controlling for all of the listed covariates. Even after controlling for all of the aforementioned hospital and nursing characteristics, a 10% increase in nurse burnout remained significantly associated with an increased odds of all frequent adverse events ($p<0.001$), with increases ranging from 12% to 20%. The largest impact of burnout was seen with frequent patient falls with injury (20% increased odds), followed by hospital-associated central line infections and pressure ulcers (19% increased odds), medication errors (16% increased odds), and hospital-associated urinary tract infections (12% increased odds).

A 10% increase in hospital-level nurse burnout was statistically significantly associated with a 20% increased odds of nurses reporting frequent patient falls with injuries ($p<0.001$). It is important to note that the effect of nurse burnout remained significant across all outcomes even after controlling for hospital and nursing characteristics including nurse staffing, practice environment, sex, education, unit type, and years experience, as well as hospital bed size, teaching and technology status, ownership, and patient case mix index.

The Model 2 columns present the results from five adjusted, independent, multi-level multivariable logistic regressions with the only difference being the addition of missed care in the Model 2 equations. Model 2 completes Aim 2 of the study, and successfully satisfies the Baron & Kenny test of mediation, by providing evidence that missed care partially mediates the relationship between hospital-level nurse burnout and four of the five nurse-reported frequent patient adverse events (pressure ulcers, falls with injury, hospital-associated urinary tract infections and central line infections).

For example, after adjusting for hospital and nurse characteristics, a 10% increase in burnout is associated with a 19% increase in the odds of nurse-reported frequent central line infections ($p<0.001$). After controlling for burnout, a 10% increase in hospital-level missed care is associated with a 9% increase in central line infections ($p=0.025$). When missed care is accounted for, every 10% increase in burnout is significantly associated with only a 15% increase in the odds of central line infections, instead of 19%. Similar patterns were observed among pressure ulcers, falls with injury, and hospital-associated urinary tract infections, with the exception of medication errors. Of note, burnout remained significantly associated with medication errors in the presence

of missed care ($p<0.001$), but missed care was not found to be a significant partial mediator of that relationship ($p=0.437$).

For all of the adverse events, aside from medication errors, the addition of missed care in the model significantly reduced the odds of the patient outcomes by between 2% and 4%. This demonstrates that missed care accounts for some, but not all, of the previously established relationship between burnout and adverse events. In other words, missed care serves as a significant partial mediator between nurse burnout and frequent patient adverse events.

Succinctly, Table 12 shows that variations in nurse burnout are significantly associated with variations in missed care. Table 13, Model 1 shows that variations in nurse burnout are significantly associated with variations in frequent patient adverse events. Table 13, Model 2 shows that after accounting for burnout, variations in missed care are significantly associated with variations in adverse events, and crucially, that the relationship between burnout and four of the five studied adverse events is attenuated in the presence of missed care.

Table 13. Logistic Regression Models Assessing the Mediation Effect of Missed Care on the Relationship Between Nurse Burnout and Patient Outcomes

	Model 1			Model 2		
	OR	**95% CI**	**P-Value**	**OR**	**95% CI**	**P-Value**
Medication Errors						
Burnout	1.16	1.08 – 1.24	<0.001	1.15	1.07 – 1.23	<0.001
Missed Care				1.03	0.96 – 1.11	0.437
Pressure Ulcers						
Burnout	1.19	1.12 – 1.26	<0.001	1.16	1.10 – 1.23	<0.001
Missed Care				1.08	1.01 – 1.16	0.023
Falls with Injury						
Burnout	1.20	1.13 – 1.28	<0.001	1.16	1.09 – 1.24	<0.001
Missed Care				1.11	1.02 – 1.20	0.010
Urinary Tract Infections						
Burnout	1.12	1.06 – 1.19	<0.001	1.10	1.03 – 1.17	0.004
Missed Care				1.08	1.02 – 1.15	0.014
Central Line Infections						
Burnout	1.19	1.10 – 1.28	<0.001	1.15	1.07 – 1.24	<0.001
Missed Care				1.09	1.01 – 1.18	0.025

Note. Each adverse event was analyzed independently. The sample size ranged from 17,217 to 18,372 nurses across the five outcomes due to missing values. All models account for clustering of nurses within hospitals and are fully adjusted for hospital characteristics (bed size, teaching status, technology status, ownership, and patient case mix index), staffing, the Practice Environment score (without Staffing and Resource Adequacy subscale), and nursing characteristics (sex, BSN education, unit type, and years experience). Burnout was multiplied by 10 such that odds ratios indicate changes in the odds of the frequent adverse event associated with every 10% increase in the proportion of burned out nurses. Model 1 shows the outcome, frequent adverse event, regressed on the independent variable, burnout, controlling for all of the above listed covariates. After controlling for all covariates, Model 2 shows the outcome, frequent adverse event, regressed on both the independent variable, burnout, and the mediating variable, missed care, which is also multiplied by 10. OR: odds ratio. CI: confidence interval.

Sensitivity Analysis

As emphasis is placed on hospital-level patient safety, including public reporting of hospital-level measures of adverse events (CMS, 2019b), sensitivity analyses were conducted at the hospital-level to confirm the previous findings at the nurse-level. The two sensitivity analyses below used the same analytic sample and were both conducted entirely at the hospital level. Each of the five adverse events was analyzed independently, and all models controlled for the hospital-level characteristics of nurse staffing, practice environment, bed size, teaching status, technology status, ownership and case mix index.

Table 14 presents hospital-level adjusted multivariable linear regression estimates of the impact of nurse burnout on frequent adverse events, with and without missed care. Variables were scaled for ease of interpretation such that estimates indicate changes in the percentage of the reported adverse event associated with every 10% increase in the hospital-level proportion of burned out nurses. The same was done with missed care in Model 2. Each adverse event was assessed independently, and all models were fully adjusted for hospital-level nurse staffing, practice environment, bed size, teaching status, technology status, ownership and case mix index. Similar to the findings in Table 13, with the exception of medication errors, all hospital-level models showed that nurse burnout was significantly associated with adverse events, and that missed care partially mediated this relationship.

As shown in Model 1, the largest impact of burnout was seen with frequent pressure ulcers (2.12%, $p<0.001$), followed by falls with injury (2.03%, $p<0.001$), hospital-associated central line infections (1.98%, $p<0.001$), and urinary tract infections

(1.94%, p<0.001). As shown in Model 2, for all adverse events, aside from medication errors, the addition of missed care in the model mitigated the change in percent of reported adverse events attributed to burnout by between 0.29 and 0.64 percent.

For example, in Model 1, pressure ulcers had a coefficient of 2.12 (p<0.001); that is, for every 10% increase in the proportion of burned out nurses, the hospital-level percent of nurse-reported frequent pressure ulcers increases by 2.12% (about a quarter of a SD for the outcome), after controlling for the above hospital-level characteristics. The pressure ulcer estimate decreases to 1.7% in the presence of missed care in Model 2 (<0.001), meaning that hospital-level missed care partially explains the association between hospital-level burnout and hospital-level adverse events.

Regarding medication errors, and again mirroring the nurse-level results in Table 13, burnout was still significantly associated with medication errors in the presence of missed care (p=0.016); however missed care did not significantly mediate that relationship (p=0.085).

In conclusion, the hospital-level sensitivity analysis in Table 14 supports the findings from the multi-level mediation analysis with nurse-level outcomes in Table 13. Together, both tables provide corroborating evidence that nurse burnout is significantly associated with reports of frequent adverse events and that missed care partially explains that association.

Table 14. Linear Regression Models Assessing the Mediation Effect of Missed Care on the Relationship Between Nurse Burnout and Patient Outcomes (N = 541 Hospitals)

	Model 1			Model 2		
	Estimate	**SE**	**P-Value**	**Estimate**	**SE**	**P-Value**
Medication Errors						
Burnout	1.03	0.33	0.002	0.84	0.35	0.016
Missed Care				0.59	0.34	0.085
Pressure Ulcers						
Burnout	2.12	0.36	<0.001	1.67	0.37	<0.001
Missed Care				1.45	0.36	<0.001
Falls with Injury						
Burnout	2.03	0.35	<0.001	1.68	0.37	<0.001
Missed Care				1.13	0.36	<0.001
Urinary Tract Infections						
Burnout	1.94	0.48	<0.001	1.30	0.49	0.008
Missed Care				2.06	0.48	<0.001
Central Line Infections						
Burnout	1.98	0.43	<0.001	1.69	0.45	<0.001
Missed Care				0.94	0.44	0.035

Note. Each adverse event analyzed independently. All models are adjusted for hospital characteristics (bed size, teaching status, technology status, ownership, and patient case mix index), staffing, the Practice Environment score (without Staffing and Resource Adequacy subscale). Burnout was multiplied by 10 such that the estimates indicate changes in the percentage of the reported adverse event associated with every 10% increase in the proportion of burned out nurses. Model 1 shows the outcome, frequent adverse event, regressed on the independent variable, burnout, controlling for all of the above listed covariates; Model 2 shows the outcome, frequent adverse event, regressed on both the independent variable, burnout, and the mediating variable, missed care, which is also multiplied by 10 for ease of interpretability. OR: odds ratio. CI: confidence interval.

Table 15 displays results from an additional sensitivity analysis completed at the hospital level. This analysis was done with another statistical test of mediation, the Sobel test, to support the study findings from the Baron & Kenny method showing that missed care is a partial mediator between nurse burnout and patient outcomes (Sobel, 1982). The Sobel test calculates the statistical significance of the indirect effect, which is the direct effect subtracted from the total effect (Allen, 2017). In this study, the direct effect is the coefficient obtained when the outcome (frequent adverse event) is regressed on the independent variable (burnout) and the mediator (missed care). The total effect is the coefficient obtained when the outcome, the adverse event, is regressed on the independent variable, burnout. After running the above regressions as shown in Table 14, the Sobel test calculates the indirect effect and then tests it for statistical significance. The null hypothesis that there is no indirect effect (indirect effect = 0) is rejected at the $p<0.05$ level for a two-tailed test (Preacher & Leonardelli, 2019). For a variable to be considered a partial mediator, the Sobel test requires that the reduction in variance explained by the independent variable in the presence of the mediator be statistically significant. Finally, the Sobel test provides the proportion of the total effect that is mediated by dividing the indirect effect by the total effect.

Each adverse event in Table 15 was assessed independently, and every model included the hospital-level covariates: nurse staffing, practice environment, bed size, technology status, teaching status, ownership and case mix index. Table 15 shows that the reduction in the variance of adverse events explained by a 10% increase in burnout – in the presence of missed care – ranges from 0.18% to 0.64%. With the exception of medication errors (0.18, p-value=0.094), the Sobel coefficients are statistically significant

for all hospital-level nurse-reported frequent adverse events. This means that there is a statistically significant indirect effect of burnout on adverse events through the mediator, missed care. Furthermore, the percentage of the total effect of burnout on adverse events that is mediated by missed care ranges from 15% to 33%.

For example, there was a 0.64% reduction in the effect of a 10% increase in nurse burnout associated with UTIs in the presence of missed care. This reduction was statistically significant ($p<0.001$), signifying that missed care is a mediator. Furthermore, missed care explains 33% of the relationship between nurse burnout and frequent UTIs; 21% of the relationship with frequent pressure ulcers; 17% of the relationship with frequent falls with injury; and 15% of the relationship with central line infections. With respect to medication errors, the Sobel test results aligned with the previous Baron & Kenny test findings (Tables 13 and 14) that missed care was not a mediator in the relationship between nurse burnout and medication errors ($p=0.094$). In sum, the Sobel test sensitivity findings support the study's earlier results and provide additional information regarding the extent to which hospital-level nurse burnout impacts nurse-reported frequent adverse events through missed care.

Table 15. Sobel Test Assessing the Mediation Effect of Missed Care on the Relationship Between Nurse Burnout and Patient Outcomes (N = 541 Hospitals)

Frequent Adverse Events	Sobel Coefficient of Indirect Effect	SE	P-Value	Percentage of Total Effect Mediated
Medication Errors	0.18	0.11	0.094	--
Pressure Ulcers	0.45	0.13	<0.001	21.2%
Falls with Injury	0.35	0.12	0.003	17.4%
Urinary Tract Infections	0.64	0.17	<0.001	33.0%
Central Line Infections	0.29	0.14	0.042	14.7%

Note. Each adverse event was analyzed independently. All models are adjusted for hospital characteristics (bed size, teaching status, technology status, ownership, and patient case mix index), staffing, the Practice Environment score (without Staffing and Resource Adequacy subscale). SE: standard error.

Summary of Findings

- Study findings are from a large sample of 23,784 registered nurses working in direct patient care roles in 587 hospitals across four states (California, Florida, New Jersey and Pennsylvania). The hospitals were predominantly non-profit, medium to large hospitals located in densely populated areas. Roughly half of the sample hospitals were teaching hospitals with high technology.
- Across hospitals, on average, 35% of nurses were burned out, and 70% of nurses reported missing necessary patient care. Between 11% and 26% of nurses reported frequent hospital-associated patient adverse events including medication errors, pressure ulcers, falls with injury, urinary tract infections and central line infections.
- Significantly higher percentages of missed care occur in hospitals with higher percentages of burned out nurses.
- Significantly higher percentages of frequent patient adverse events occur in hospitals with higher percentages of burned out nurses.
- Every 10% increase in the proportion of burned out nurses in hospitals is significantly associated with a 3.1% increase in missed necessary patient care, after controlling for the practice environment, staffing, patient severity, and hospital characteristics.
- Every 10% increase in the proportion of burned out nurses is significantly associated with 12-20% increased odds in frequent patient adverse events, controlling for patient severity, as well as nurse and hospital characteristics.

- Missed care explains one pathway by which nurse burnout contributes to poor patient outcomes even after controlling for patient severity, as well as nurse and hospital characteristics.
- Missed care explains 15%-33% of the relationship between hospital nurse burnout and nurse-reported frequent patient adverse events.

CHAPTER 5: DISCUSSION

Introduction

The purpose of this study was to empirically explore how—and to what extent—hospital nurse burnout impacts nurse-reported patient adverse events. It was hypothesized that hospitals with higher percentages of burned out nurses would have higher odds of nurse-reported adverse events, and that missed care would partially explain this relationship. A series of adjusted multilevel multivariable robust logistic regressions were used pursuant to the Baron and Kenny mediation method and confirmed both of these hypotheses. These findings were further corroborated by sensitivity analyses conducted at the hospital level using both the Baron and Kenny as well as Sobel tests of mediation.

This study uniquely advances the existing body of literature on nurse burnout. To the author's knowledge, it is the first large scale study in the U.S. to assess the impact of hospital-level nurse burnout on a set of nurse-reported adverse events, including medication errors, falls, pressure ulcers and central line infections—while simultaneously accounting for a diverse set of patient, nursing, and hospital characteristics. Of note, this study uniquely examined missed care as a pathway between nurse burnout and patient outcomes. Importantly, it is among the first studies to empirically demonstrate that missed necessary care may partially explain the relationship between nurse burnout and increased odds of nurse-reported frequent patient adverse events.

The following chapter begins with a discussion of principal findings, limitations, and recommendations for future research. It concludes with implications of interest to

healthcare stakeholders including patients, patient advocacy groups, providers, payers, state and federal policymakers, researchers, and hospital administrators.

Findings

Hospital Nurse Burnout is Significantly Associated with Frequent Adverse Events

This study's findings were derived from a highly representative sample of 23,784 nurses from 587 hospitals in four geographically diverse states comprising a quarter of the U.S. population. Across hospitals, on average, almost 2 out of every 5 nurses were burned out. Using adjusted multilevel multivariable robust logistic regressions controlling for patient, nurse and hospital characteristics, this study found that every 10% increase in the hospital-level proportion of burned out nurses was significantly associated ($p<0.001$) with 12-20% increased odds in nurse-reported frequent adverse events including medication errors (16%), pressure ulcers after admission (19%), falls with injury (20%), hospital-associated urinary tract infections (12%) and hospital-associated central line infections (19%). These findings align with—and build upon—existing literature linking hospital nurse burnout with an overall measure of patient adverse events and patient safety (Liu et al., 2018), and hospital-associated urinary tract and surgical site infections (Cimiotti et al., 2012).

This study found that the percentage of burned out nurses in sample hospitals ranged widely from 0% to 86%, and that this variation in nurse burnout was found to be significantly associated with wide variations in the odds of frequently reported adverse events. For example, this study found that the odds of frequent central line infections (OR 1.19, $p<0.001$) increases by 19% with every 10% increase in the proportion of burned out nurses. Therefore, the odds of frequently reported central line infections are

42% greater (1.19 x 1.19=1.42) in hospitals with 40% burned out nurses as compared to hospitals with 20% burned out nurses. These findings are concerning for all healthcare stakeholders as they highlight how dramatically patient safety outcomes vary by proportions of hospital-level nurse burnout.

Previous studies have demonstrated that organizational features such as the practice environment and nurse staffing impact patient adverse events (Kelly et al., 2013; Kutney-Lee et al., 2009; Lucero et al., 2010). This study illuminates that even after accounting for these organizational features (in addition to nursing characteristics—sex, BSN education, unit type, years experience; and hospitals characteristics—bed size, teaching and technology status, ownership and patient case mix index), nurse burnout had an independent and significant effect on the odds of all five frequent adverse events. The comprehensive inclusion of variables known to impact adverse events, and the remaining effect size and significance of burnout, helps develop a more granular understanding of the variables impacting patient adverse events. These findings suggest that, when warranted, nurse burnout should be accounted for in future models examining the causes of adverse events.

Finally, while studies have assessed burnout at the individual-level (Liu et al., 2018; Parker & Kulik, 1995; Poghosyan et al., 2010), this study employed multilevel modeling with nurse burnout measured at the hospital-level—an approach that has not been thoroughly explored in existing burnout literature. This was informed by this study's model conceptualizing burnout as a complex phenomenon operating both at the individual and organizational levels (Halbesleben & Leon, 2014; Van Bogaert et al., 2010). The multilevel results demonstrate that the organizational proportion of burned

out nurses is significantly associated with nurse-reported frequent patient adverse events.

This empirical finding critically sheds light on how a collective culture of burnout compounded with individual burnout can impact patient care. Hospital patients are cared for by more than one nurse and often on more than one unit. Hospital care is fundamentally provided by teams of providers, and a higher proportion of burned out nurses likely impacts overall care norms and safety culture (Welp et al., 2015). This can occur, for example, through poor communication, inadequate coordination, and workload compensation (Bakker et al., 2009), which is the increased demand on non-burned out individuals to compensate for their burned-out counterparts. In other words, even when nurses are not burned out individually, when working in an environment saturated with a high proportion of burned out nurses, they may be compelled to adopt unsafe practices, such as short-cuts or missing necessary care, potentially causing preventable adverse events.

Missed Care Partially Explains the Relationship Between Burnout and Adverse Events

Having established the impact of hospital nurse burnout on frequent patient adverse events, the second aim of the study sought to empirically explore the processes that explain how. Thus, this aim addressed what leaders in the field of burnout research consider the next critical step in the advancement of existing knowledge on burnout: understanding the mechanisms through which burnout impacts poor outcomes (Halbesleben & Leon, 2014; Leiter et al., 2014a). Missed care, a process of care measure defined as necessary care left undone, has been associated with patient adverse events such as medication errors, falls, pressure ulcers and nosocomial infections (Kalisch et al.,

2014; Lucero et al., 2010; Schubert et al., 2008). As explicated in Chapter 2, this study hypothesized that missed care serves as a partial mediator between nurse burnout and frequent adverse events.

This hypothesis was empirically confirmed, first by demonstrating that variations in burnout were significantly associated with variations in missed care, and then by showing that missed care attenuated the relationship between nurse burnout and frequent adverse events. At the hospital level, every 10% increase in the proportion of burned out nurses was significantly associated with a 3.1% increase in the proportion of nurses reporting missed care, even after controlling for the practice environment, staffing, patient case mix index and hospital characteristics ($p<0.001$). This significant finding that higher proportions of burnout are associated with higher proportions of missed necessary care at the hospital-level, supports the theory that hospital nurse burnout is negatively associated with quality of care norms.

Using adjusted multilevel multivariable robust logistic regressions controlling for practice environment, staffing, patient case mix index, as well as hospital and nurse characteristics, the study found that missed care partially mediated the relationship between hospital nurse burnout and four out of five of the study outcomes: pressure ulcers, falls with injury, and hospital-associated urinary tract infections and central line infections.

As the hypothesis of *partial* mediation was confirmed, this suggests that hospital nurse burnout impacts nurse-reported frequent adverse events in more than one way, outside its indirect effect through missed care. For example, a central line infection could result from missed care, an error of omission, such as a required dressing change being

left undone allowing for subsequent growth of bacteria or exposure of the site. It could also result from an error of commission, such as a dressing change completed in haste that deviates from evidence-based protocols like adequate hand hygiene and maintenance of the sterile field. This empirical finding—shining a light on one pathway, missed care, and simultaneously shining a light on the existence of other pathways—is an additional unique contribution to the understanding of burnout's complexities and consequences. It further suggests that mitigating adverse events may not only necessitate the reduction of the commission of errors, but also the reduction of omitted care, which as this study suggests, could both be attenuated through the reduction of nurse burnout.

An interesting finding was that missed care did not mediate the relationship between nurse burnout and medication errors. Of all five of the study adverse events obtained from the Multi-State Nursing Care and Patient Safety Survey, medication errors was the only outcome that was specifically worded as an error of commission, as opposed to an error of omission: "patient *received* wrong medication or dose." Therefore, given that missed care centrally involves errors of omission, it is logical that it does not explain the relationship between burnout and an error of commission, medication errors. That being said, burnout was still significantly associated with medication errors in the presence of missed care (OR 1.15, $p<0.001$). This finding again demonstrates that there are other mechanisms explaining the relationship between nurse burnout and nurse-reported frequent adverse events.

This study also found that missed care operates as a partial mediator when nurse-reported frequent adverse events were analyzed at the hospital-level. Furthermore, the study employed an additional test of mediation, the Sobel method, and confirmed the

previous findings of partial mediation by assessing the significance of the attenuation of burnout's impact on adverse events with and without missed care present. An additional noteworthy finding was that missed care explains between 15% - 33% of the relationship between nurse burnout and frequent adverse events: pressure ulcers (21%), falls (17%), hospital-associated urinary tract infections (33%), and central line infections (15%). This finding further bolsters the study's hypothesis that missed care is a key mechanism driving the relationship between nurse burnout and frequent patient adverse events, but does not fully explain it.

Limitations

In order to most comprehensively inform future research that may build upon the findings herein, it is important to note study limitations. The cross-sectional design of the study precludes conclusions on causality. However, this study provides empirically established, statistically significant associations between hospital nurse burnout, missed care and nurse-reported patient outcomes, without which causal relationships cannot be ascertained. As such, this study importantly provides a conceptual blueprint linking complex variables and empirical evidence to inform the inquiry, design, and analysis of future studies attempting to establish causality.

Another limitation of the study is the analysis of secondary data obtained from a nurse survey that was not specifically designed for this study. The study's process of care measure, missed care, was limited to the 12 patient care tasks included in the survey question. Other nursing tasks that may be associated with preventable adverse events, such as hand hygiene, maintenance of isolation precautions, and changes of intravenous catheters, were not specifically listed in the survey question. However, it should be noted

that the survey question contained items such as patient surveillance and skin care that encapsulate numerous other specific nursing tasks that are directly relevant to the adverse events assessed in this study.

Another consideration with these secondary data is the time frame of data collection. Though the initial study was conducted from 2005 to 2008, there have not been indications of major changes in the trends of key study variables that would impact the applicability of study findings on the relationships between nurse burnout, missed care, and nurse-reported frequent adverse events, which continue to be pressing issues. In fact, as explicated above and expounded upon below, the increasing attention of media, government, academic and healthcare institutions to the provider burnout crisis, and specifically its relation to patient safety, arguably signals a kairos moment for evidence-based research, such as this study, to further our understanding of the complex phenomenon and inform potential solutions.

The use of nurse-reported data on patient adverse events could be considered a limitation of the study. The five patient outcome measures assessed in the study were obtained from retrospective nurse reports of the frequency of these adverse events occurring to their patients. As the primary providers of direct patient care in hospitals, nurses have the most intimate knowledge of patient adverse events. As such, nurses may be better able to discern adverse events throughout their interactions with patients and provision of care as compared to an outside observer (Welp et al., 2015). Of all hospital employees, errors are most often prevented and reported by nurses (Leape et al., 1995; DHHS, 2012). It is possible that nurses may have over-reported, under-reported, or simply failed to recall adverse events. However, given that the confidential nurse survey

was mailed to nurses' residences and was not affiliated with their employers, there was no potential for punitive consequences that may have impacted their responses. Furthermore, studies have shown that surveying nurses is a valid and reliable approach to obtaining accurate information on hospital organizations and outcomes (Aiken et al., 1997; Lasater et al., 2019; McHugh & Stimpfel, 2012). Compared to other process and outcomes data sources, such as administrative and patient-reported data, nurse-reported data have been found to be an accurate measure of patient care quality and safety outcomes (Cina-Tschumi et al., 2009; Gerolamo, 2008; McHugh & Stimpfel, 2012; Smeds-Alenius et al., 2016). Furthermore, nurse reports and recall of adverse events, specifically, have been validated in studies comparing prospective and retrospective data (Aiken, Sloane, & Klocinski, 1997; Gerolamo, 2008).

Potential same-source bias was reduced in multiple ways. One way was through the proximal and methodological separation of study measure questions in the Multi-State Nursing Care and Patient Safety Survey (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). In the 10 page nurse survey, the measures of nurse burnout, missed care and adverse events were not located on the same pages, nor did any of the three measures immediately precede or follow one another. Additionally, each question used different response formats; two of them used Likert scales. Furthermore, the Maslach Burnout Inventory-Human Services Survey (1986) had negative and positive statements interspersed unlike the other two measures. Another method of reducing same-source bias was assessing survey data using aggregated measures in a multi-level analysis. The independent variables, nurse burnout and missed care, were aggregated to the hospital level, whereas the dependent variable, nurse-reported adverse events, was assessed at the

individual level. Averaging over the measurement error in individual nurse responses through aggregation reduces same-source bias, thereby increasing the validity of findings (Chum et al., 2019; Roux, 2007).

Overall, the study's core strengths far outweigh its limitations. Given the size of the sample—tens of thousands of nurses spread across multiple units in hundreds of hospitals located in multiple, geographically diverse states—the study findings are derived from the largest, most diverse, most generalizable sample yet to be examined in assessing the relationships between hospital nurse burnout, missed care and nurse-reported patient adverse events. Furthermore, the ability to account for nurse and hospital characteristics that are known to impact patient adverse events strengthens the validity of the study's findings. The conceptualization and measurement of nurse burnout as a feature of hospital organizational culture makes the findings particularly useful for hospital-level interventions known to have the most impact on burnout. Finally, combined with the strengths above, this study importantly advances the science of nurse burnout by empirically demonstrating how, and to what extent, it may impact preventable adverse events through missed care.

Recommendations for Future Research

"Every scientific 'fulfillment' raises new 'questions'; it asks to be 'surpassed' ... Whoever wishes to serve science has to resign himself to this fact ... they will be surpassed scientifically—let that be repeated—for it is our common fate and, more, our common goal. We cannot work without hoping that others will advance further than we have. In principle, this progress goes on ad infinitum."
- Max Weber

The following section contains recommendations that can be used to guide a program of research to advance the existing literature on hospital nurse burnout. This section first provides recommendations about conceptual framework, design and

measurement for future studies, and then highlights additional lines of research on mechanisms, outcomes and interventions.

As studies have shown nurse burnout to be a complex phenomenon, it is particularly vital for burnout to be studied systematically, and specifically guided by conceptual frameworks. Any conceptual framework should consider the existing body of literature, including this study, which suggests it is possible that burnout has direct, indirect and reciprocal relationships of varying strengths over time in its impact on patient outcomes (Leiter, Bakker, & Maslach, 2014b). For example, it has been shown that burned out providers who deliver poor quality care continue to be negatively affected by their actions (Waterman et al., 2007). The complexity of these potentially reciprocal relationships warrant moving beyond mutually exclusive, "either-or" approaches about the ways in which nurse burnout relates to patient outcomes (Leiter et al., 2014a). Considering studies have shown hospital nurse burnout to have both individual and group level effects, future studies should consider multilevel, multivariable models that are consistent with conceptual frameworks. With regard to design, when possible, researchers should employ longitudinal studies to develop causal inferences from the chronological unfolding of events between nurse burnout and patient outcomes.

Though nurse burnout is a complex phenomenon, its measurement has been established with the Maslash Burnout Inventory-Health Services Survey (HBI-HSS) (Maslach et al., 2016). As much remains to be understood about the patient care consequences of nurse burnout, it is important for the measurement of burnout in future studies to be comparable for the purpose of building a coherent, integrated body of work. As such, when possible, future studies should use the MBI-HSS, as it has been proven to

be psychometrically sound and is arguably the gold standard of nurse burnout measurement (Dyrbye et al., 2017; Halbesleben & Buckley, 2004; Maslach et al., 2016; Poghosyan et al., 2009).

Future studies should expand the quality and safety outcomes linked to nurse burnout by assessing outcomes such as patient engagement, mortality, failure to rescue, and readmissions. Regarding outcome measurement, it is advisable to consider sources like administrative data—such as claims data, discharge abstracts, and hospital chart reviews—as well as manager, colleague, and patient reports to supplement self-reports (Parker & Kulik, 1995; Poghosyan et al., 2010). Missed care is often communicated between nurses during shift change reports. This could be another source of data to gauge omitted necessary care and its relationship with nurse burnout. Future studies should also assess the cost consequences of nurse burnout, which has implications for incentivizing healthcare stakeholders to take action. Economic models that estimate the costs of hospital nurse burnout should not only consider the costs associated with nurse and hospital outcomes such as absenteeism and turnover, but also patient outcomes such as preventable adverse events that this study has shown to be empirically associated with hospital nurse burnout.

Future studies should also expand our understanding of the mechanisms by which nurse burnout results in these outcomes. Previous studies have assessed nurse burnout itself as a mediator between organizational characteristics—the practice environment and staffing—and quality and safety outcomes (Cimiotti et al., 2012; Laschinger et al., 2001; Laschinger & Leiter, 2006; Liu et al., 2018; Parker & Kulik, 1995; Van Bogaert et al., 2009). Building upon these findings, this study zoomed in further to assess the pathway

between burnout and safety outcomes, after controlling for the practice environment and staffing. A significant gap in burnout literature was addressed by conducting a mediation analysis to uncover one possible explanation of how nurse burnout impacts nurse-reported adverse events. This study found that missed care explains 15-33% of the variation in the study outcomes associated with burnout. This finding that missed care *partially* explains the relationship between hospital nurse burnout and nurse-reported adverse events highlights the need for future studies to focus their lens on other mechanisms that may explain the relationship between nurse burnout and patient outcomes.

The ultimate goal of nurse burnout research is to inform interventions to prevent and alleviate nurse burnout. Given finite resources and a still nascent body of literature, organizational leaders and researchers would both benefit through collaborative partnerships in developing, implementing, and evaluating hospital nurse burnout interventions (Leiter & Maslach, 2014). Such efforts should assess components of the practice environment that most impact burnout, such as nurse engagement and management, and then assess targeted hospital-level interventions to modify those components. The development and design of future nurse burnout studies should always take into account the critical aim of informing strategies to mitigate burnout, which this study has shown could advance our collective effort to promote care quality and safety.

Implications

The findings of this study have significant implications for healthcare stakeholders, including hospital administrators, payers, state and federal agencies, policy makers, patient advocacy groups, researchers, providers, and most importantly, patients.

The following section situates the study in the current healthcare context, then provides policy implications of the findings herein, and ends with implications for hospital-level interventions.

Contextualizing the Study: Nurse Burnout in the Current Healthcare Climate

Despite headlines sounding the alarms that provider burnout is a public health crisis and an epidemic (Jha et al., 2019; Shin et al., 2016), faced with finite resources, hospital administrators rank nursing issues like nurse burnout below items such as reimbursement from government payers and clinical quality as priorities (PricewaterhouseCoopers' Health Research Institute, 2007). The flaw with this hierarchy is its failure to account for the fact that nursing issues like nurse burnout impact all of the line items ranked as higher priorities (Jones, 2008). This prioritization perhaps stems from an incomplete understanding of the consequences of nurse burnout on the structures, processes and outcomes of healthcare in hospitals.

As this study empirically demonstrates, hospital nurse burnout is significantly associated with costly and life-threatening preventable adverse events. These adverse events are widely used by policy makers and the public as indicators of clinical quality and patient safety, and consequently are tied to government reimbursements and public reporting mandates. The study findings suggest that nurse burnout should be reprioritized as a problem whose solution may simultaneously help mitigate preventable adverse events that undermine the quality of care and patient safety outcomes in hospitals around the world.

Policy Implications

Two major tools used by policy makers to improve hospital patient safety and

outcomes are financial incentives and public transparency. Four out of the five adverse events assessed in this study—falls with injury after admission, pressure ulcers after admission, hospital-associated urinary tract infections and hospital-associated central line infections—feature in ongoing efforts of federal and state policy makers utilizing these tools.

Currently, through the Hospital-Acquired Condition Reduction Program (HAC) and the Value-Based Purchasing Program (VBP) administered by the Centers for Medicare & Medicaid Services (CMS), the federal government adjusts hospital reimbursements to incentivize improvements in quality of care and patient safety (CMS, 2019b). The occurrence of four of the study's adverse events assessed is factored into the government's reimbursements to hospitals. The HAC program alone has withheld over $350 million from hospitals each year (CMS, 2019b). Therefore, hospital administrators seeking to avoid penalties and maximize reimbursements are incentivized to understand the factors impacting their adverse events, including nurse burnout and missed care.

Additionally, CMS administers the Partnership for Patients Initiative with the primary goal of reducing hospital-acquired conditions, including the five study outcomes, by 20% (CMS, 2019a). This widespread national public-private partnership includes federal agencies, health improvement organizations, patient advocacy organizations and 80% of U.S. hospitals (Clarkwest et al., 2014). This study is of unique import as the findings suggest that the strategy of nurse burnout reduction could help address the central aim of this national pursuit.

Further highlighting the timeliness of this study is its alignment with other concerted efforts aimed at reducing healthcare provider burnout. The National Academy

of Medicine's Action Collaborative on Clinician Well-Being and Resilience seeks to achieve goals centrally addressed by this study: raising the visibility of clinician burnout and, most importantly, exploring and emphasizing evidenced-based solutions to improve patient safety by reducing clinician burnout (National Academy of Medicine, 2019).

Furthermore, to reduce information asymmetry and increase accountability, CMS publically reports annual data on hospital performance, quality, and safety—again including hospital-specific data on four out of the five study outcomes (CMS, 2019b). Additionally, over 50% of states currently mandate public reports of hospital quality and safety, including data on adverse events (National Quality Forum, 2010). Healthcare providers are weary about allowing their own loved ones to be cared for in institutions rampant with provider burnout; the public deserves access to this information as well. Given the empirically documented associations between burnout, missed care and adverse events, the study findings suggest that policy makers should consider mandating the public reporting of hospital nurse burnout. Hospitals seeking to preserve their reputation among current and potential patients, attract and retain healthcare providers, as well as maintain a competitive advantage against other hospitals—all key revenue sources—must have a thorough understanding of nursing factors such as nurse burnout and missed care that contribute to the adverse events subject to mandatory public reporting.

Implications for Hospital-Level Interventions

When faced with unwelcome comparative performance data, hospital administrators occasionally tend to attribute these outcomes to features that are known to be unmodifiable, for example, patient illness severity and volume (Iezzoni, 2013). This

approach may not be conducive to yielding meaningful solutions to reduce preventable adverse events. This study highlights an alternative target for interventions: the modifiable feature of nurse burnout. By including comprehensive hospital, nurse and patient severity controls in the analytic models, this study helps further isolate the independent effect of this modifiable feature, burnout, on adverse events, and thus prevents attribution to some unmodifiable factors which studies have shown to influence adverse events. When developing strategies to address nurse burnout, hospital administrators must take into account its fundamental characteristics, which this study has discussed in detail.

Burnout is an occupationally based phenomenon, a consequence of poor work environments (Leiter & Laschinger, 2006; Maslach, Leiter, & Jackson, 2012; Van Bogaert et al., 2009). As such, individual-level interventions such as mindfulness and resilience training alone are not sufficient and cannot effectively address burnout (Ahola, Toppinen-Tanner, & Seppänen, 2017; The Joint Commission, 2019). At present, the most commonly implemented burnout interventions are at the individual level (Bagnall, Jones, Akter, & Woodall, 2016). Focusing solely on individual-level interventions can imply that individual nurses are at fault for being burned out (Costa & Moss, 2018), and reflects the assumption that the individual nurse is expected to overcome ever-present workplace stressors as opposed to those stressors being eliminated (Leiter & Maslach, 2014). As the Institute of Medicine concluded in its seminal report 20 years ago, combating system-level errors requires system-level solutions, including a culture of safety (IOM, 2000).

This study's conceptualization and analysis of burnout at the hospital-level—as a

component of the practice environment, a part of the very organizational structure of hospitals—is particularly useful for hospitals considering appropriate organizational-level interventions. It has been shown that organizational-level analyses in burnout studies are the most informative for burnout interventions, in part because many organizational-level features are modifiable unlike, for example, individual personality types (Maslach et al., 2012).

Before implementing specific burnout interventions, hospital administrators must first assess the baseline extent of nurse burnout across their institution. They can use information from large studies such as this to obtain benchmarks for comparison. They must then invest resources in developing and implementing targeted, hospital-level interventions within a specific time frame, and re-evaluate the extent of burnout over time to assess the impact of those interventions (The Joint Commission, 2019). Administrators should consider assessing incremental improvements in burnout scores when gauging progress, as burnout fundamentally exists on a continuum. By measuring burnout at the organizational level, hospitals can compare changes in burnout levels with changes in existing measures already being evaluated at the organizational level —such as performance, cost, quality and safety outcomes. Given the study's conceptualization of burnout as a response to chronic organizational stressors over time, it is unlikely that short-term, one-time interventions will meaningfully mitigate burnout (Leiter & Maslach, 2014). Furthermore, as this study has posited that burnout manifests itself as a facet of organizational culture, interventions must have a longer timeline such that new norms can take root to replace existing behaviors shaped by a culture of burnout. The passage of time creates opportunities for reciprocal practice and reinforcement of new norms

between team members, critical to sustaining and improving the overall culture of safety (Leiter & Maslach, 2014). Although addressing burnout at the collective cultural level requires time, evidence suggests that in comparison to individual level interventions, organizational level burnout interventions have longer lasting effects (Bagnall et al., 2016).

The fundamental nature of burnout necessitates organizational-level interventions to modifiable components of the practice environment. Modifiable features of the nurse practice environment shown to be associated with hospital nurse burnout (Leiter & Laschinger, 2006) include all five subscales of the PES-NWI, the gold standard of assessing the state of nurse practice environments (Lake et al., 2019): nurse manager ability, leadership and support of nurses; staffing and resource adequacy; nursing foundations for quality of care; nurse participation in hospital affairs; and collegial nurse-physician relations. Improvements to staffing and nurse practice environments, as measured by the PES-NWI, are shown to be associated with declines in nurse burnout over time (Aiken et al., 2018; Kutney-Lee, Ann, Wu, Sloane, & Aiken, 2013). One study found that a single standard deviation improvement in the practice environment was associated with a 22% lower odds of burnout even after accounting for wage (McHugh & Ma, 2014).

Organizational changes to address these modifiable features include promoting open communication, improving manager and collegial support, propagating a culture of learning, as well as empowering participation and engagement in organizational decision making (Bagnall et al., 2016). Studies have found that specifically improving nurse leadership (Leiter & Laschinger, 2006; Van Bogaert et al., 2009) and nurse engagement

are possible strategies to reduce hospital nurse burnout (Kutney-Lee et al., 2016) and improve patient safety (Brooks Carthon et al., 2019). One tried and tested approach recommended by the IOM to improve the nurse practice environment is working to obtain Magnet hospital recognition (Aiken et al., 2018). This accreditation is achieved by following a blueprint to integrate and promote organizational facets such as nursing leadership, empowerment, and best practices. By transforming their culture to fundamentally improve the environments in which nurses deliver care, Magnet hospitals have been shown to have significant reductions in nurse burnout (Kelly et al., 2012; Kutney-Lee et al., 2015).

In sum, this study suggests that hospital administrators should consider organizational level interventions—targeting these modifiable components of the practice environment—which have been shown to prevent and alleviate both organizational and individual-level burnout (Le Blanc, Hox, Schaufeli, Taris, & Peeters, 2007). This strategy could be a value-added approach that synergistically addresses pervasive organizational problems, such as missed care and adverse events, impacting the quality of care and patient safety.

Conclusion

This study centrally sought to bridge the gap between what is intuitively known about the negative consequences of hospital nurse burnout and what the science empirically demonstrates about its impact. While burnout is increasingly recognized as a pervasive threat to quality of care and patient safety, this study provides a magnifying glass assessing how and to what extent.

To the author's knowledge, this is the largest study in the U.S. to document significant associations between hospital nurse burnout and preventable patient adverse events (medication errors, falls with injury, pressure ulcers, hospital-associated urinary tract infections, and hospital-associated central line infections). This is one of the first studies to empirically demonstrate that missed necessary care partially explains how hospital nurse burnout may lead to preventable patient adverse events. These findings were significant even after accounting for the effects of hospital, nurse, and patient characteristics shown to impact adverse events. Given the current policy climate emphasizing safe, high-quality, value-based patient care, this study's findings suggest that investing in organizational-level interventions to reduce hospital nurse burnout can serve as a means to mitigate the pervasive care consequences that flow from it. This study's findings may be invaluable to healthcare stakeholders who all share the common goal of expediting evidence-based improvements in patient safety and outcomes.

This study makes a key contribution to evidence on the pernicious consequences of failing to care for nurses who care for the rest of us. In doing so, this study's empirical findings help bolster the compelling case that nurse burnout is not simply a nurse problem – it is fundamentally a healthcare problem that profoundly affects us all.

Appendix A: Institutional Review Board Exemption

University of Pennsylvania
Office of Regulatory Affairs
3624 Market St., Suite 301 S
Philadelphia, PA 19104-6006
Ph: 215-573-2540/ Fax: 215-573-9438
INSTITUTIONAL REVIEW BOARD
(Federalwide Assurance # 00004028)

31-May-2016

Ann M Kutney Lee
Attn: Shweta Singh
shwetas@nursing.upenn.edu
akutney@nursing.upenn.edu

PRINCIPAL INVESTIGATOR	: Ann M Kutney Lee
TITLE	: The Nexus Between Nurse Burnout, Missed Care and Patient Outcomes
SPONSORING AGENCY	: No Sponsor Number
PROTOCOL #	: 825193
REVIEW BOARD	: IRB #8

Dear Dr. Kutney Lee:

The above-referenced research proposal was reviewed by the Institutional Review Board (IRB) on 5/27/2016. It has been determined that the proposal meets eligibility criteria for IRB review exemption authorized by 45 CFR 46.101, category 4.

This does not necessarily constitute authorization to initiate the conduct of a human subject research study. You are responsible for assuring other relevant committee approvals.

Consistent with the federal regulations, ongoing oversight of this proposal is not required. No continuing reviews will be required for this proposal. The proposal can proceed as approved by the IRB. This decision will not affect any funding of your proposal.

Please Note: The IRB must be kept apprised of any and all changes in the research that may have an impact on the IRB review mechanism needed for a specific proposal. You are required to notify the IRB if any changes are proposed in the study that might alter its IRB exempt status or HIPAA compliance status. New procedures that may have an impact on the risk-to-benefit ratio cannot be initiated until Committee approval has been given.

If your study is funded by an external agency, please retain this letter as documentation of the IRB's determination regarding your proposal.

Please Note: You are responsible for assuring and maintaining other relevant committee approvals.

If you have any questions about the information in this letter, please contact the IRB administrative staff. Contact information is available at our website: http://www.upenn.edu/IRB/directory.

Thank you for your cooperation.

Sincerely,

Christina Kolenut

Digitally signed by Christina Kolenut
Reason: I attest to the accuracy and integrity of this document
Date: 2016.05.31 17:00:49 -04'00'

IRB Administrator

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