2022

Heart Rate Variability and Stress in the Intensive Care Unit Nursing Workplace

Paula Miller Levi
University Of Alabama At Birmingham

HEART RATE VARIABILITY AND STRESS IN THE INTENSIVE CARE UNIT NURSING WORKPLACE

by

PAULA MILLER LEVI

JACQUELINE MOSS, COMMITTEE CHAIR
KAREN HEATON
PENG LI
W. CHANCE NICHOLSON
PENNI WATTS
PARIYA WHEELER

A DISSERTATION

Submitted to the graduate faculty of The University of Alabama at Birmingham,
in partial fulfillment of the requirements for the degree of
Doctor of Philosophy

BIRMINGHAM, ALABAMA

2022

HEART RATE VARIABILITY AND STRESS
IN THE INTENSIVE CARE UNIT NURSING WORKPLACE

PAULA MILLER LEVI

NURSING

ABSTRACT

Intensive care unit (ICU) nurses work in a demanding environment, facing repeated encounters with trauma and ethical issues when caring for patients. Psychological stressors can include death of patients, violent acts by patients or their families, caring for suffering patients, and moral distress from performing futile care. These factors place ICU nurses at increased risk of developing post-traumatic stress disorder (PTSD). Suffering from chronic PTSD symptoms can negatively impact nurses' psychological and physical health. There are also consequences for patients and hospitals, including increased risk for substandard care, decreased government reimbursements from poor patient satisfaction scores, and retention issues.

Few studies have reported types of workplace events that lead to occupational stress and PTSD in ICU nurses. Moreover, few studies have examined PTSD and stress in ICU nurses using the objective measure of heart rate variability (HRV). Therefore, the purpose of this dissertation was to investigate the association between PTSD and psychological stress in ICU nurses and events experienced in the workplace. Three manuscripts were produced: (a) a concept analysis review paper examining the phenomenon of PTSD in ICU nurses, (b) a qualitative study exploring the lived experiences of ICU nurses who cared for COVID-19 patients during the height of the

pandemic, and (c) an observational, correlational study examining the association between PTSD (and psychological stress) and HRV.

This research advances health science knowledge through in-depth, novel findings on PTSD and psychological stress in ICU nurses from workplace experiences. Manuscript One described the concept of PTSD as it applied specifically to ICU nurses. Manuscript Two developed an intricate understanding of stress and trauma ICU nurses experienced caring for COVID-19 patients and its impact on their professional and personal lives. Manuscript Three revealed ICU nurses had reduced HRV due to events at work and new nurses had greater reductions in HRV than experienced nurses. Additionally, over half of the ICU nurses had low resilience and increased peritraumatic dissociative experiences, both of which signal risk for development of PTSD. More prospective research is needed with large cohorts, including ICU nurses with and without depression, and a longitudinal design to confirm these findings.

Keywords: heart rate variability, intensive care unit nurses, post-traumatic stress disorder, occupational stress

DEDICATION

To

Kristen and Chelsea

ACKNOWLEDGMENTS

I would like to thank the Deep South Center for Occupational Health and Safety for the funding I received toward my education and my research (Grant # T42OH008436).

I also thank the ICU nurses who participated in the studies.

TABLE OF CONTENTS

Page

LIST OF TABLES

Table *Page*

POST-TRAUMATIC STRESS DISORDER IN INTENSIVE CARE UNIT NURSES: A CONCEPT ANALYSIS

INTENSIVE CARE NURSES' LIVED EXPERIENCES CARING FOR COVID-19 PATIENTS

HEART RATE VARIABILITY AND STRESS IN THE INTENSIVE CARE UNIT NURSING WORKPLACE

LIST OF FIGURES

Figure *Page*

INTRODUCTION

POST-TRAUMATIC STRESS DISORDER IN INTENSIVE CARE UNIT NURSES: A CONCEPT ANALYSIS

HEART RATE VARIABILITY AND STRESS IN THE INTENSIVE CARE UNIT NURSING WORKPLACE

LIST OF ABBREVIATIONS

ANS autonomic nervous system

APA American Psychiatric Association

BTQ Brief Trauma Questionnaire

CD-RISC-10 Connor-Davidson Resilience Scale-10 item

ED-A Emotional Distress-Anxiety

ED-D Emotional Distress-Depression

HF high-frequency

HRV heart rate variability

IES-R Impact of Event Scale-Revised

ICU intensive care unit

PCL-5 Posttraumatic Stress Disorder Checklist-5

PDEQ Peritraumatic Dissociative Experiences Questionnaire

PDS Posttraumatic Diagnostic Scale

PNS parasympathetic nervous system

PPE personal protective equipment

PSS Perceived Stress Scale

PROMIS Patient-Reported Outcomes Measurement Information System

PTSD post-traumatic stress disorder

PTSS-10 Post-Traumatic Symptom Scale-10

SD Sleep Disturbance

SSI Stressful Situations Instrument

SNS sympathetic nervous system

TSQ Trauma Screening Questionnaire

CHAPTER 1

INTRODUCTION

This dissertation was accomplished through three manuscripts that link knowledge and culminate in better understanding of post-traumatic stress disorder (PTSD) in intensive care unit (ICU) nurses. These three manuscripts are comprised of a concept analysis, qualitative study, and manuscript relaying the results of the dissertation research. The concept analysis manuscript illustrated the concept of PTSD and how it applies uniquely to ICU nurses. This manuscript provided the rationale needed to guide the dissertation research. The second manuscript reported on qualitative study findings, revealing a complex and comprehensive understanding of the phenomenon of PTSD in ICU nurses. The third manuscript presented the findings of the dissertation research on heart rate variability and stress in the ICU nursing workplace. The final chapter provided implications for practice and research from conclusions of the three manuscripts.

The objective of this first chapter is to introduce the research problem, background, and significance for this dissertation. Additionally, this chapter will describe the concepts of relevance, present an overview of the three manuscripts, and provide specific aims and research questions for manuscripts two and three. Definitions for key terms are also provided.

Problem Statement

Intensive care unit (ICU) nurses are in a challenging field, with considerable responsibility and constant exposure to psychological stress and trauma. These factors place them at a high risk for developing PTSD (Colville et al., 2017; Mealer et al., 2009; Rodríguez-Rey et al., 2019). Despite the World Health Organization's (2006) "Working Together for Health" report attributing the global shortage of healthcare employees largely due to stressful work conditions, few interventions to prevent or mitigate PTSD in ICU nurses are available (Karanikola & Mpouzika, 2018; Salmon & Morehead, 2019). This dissertation research will examine ICU nurses' heart rate variability (HRV) response (stress-reactivity and -recovery) to events encountered at work and whether there is an association between reduced HRV and negative physiological and psychological outcomes in ICU nurses.

Background and Significance of the Problem

Health care organizations in the United States (U.S.) are facing a critical shortage of ICU nurses (Nursing Solutions, Incorporated, 2020). One explanation for this shortage is the stressful work environment of the ICU. Nurses who work in ICUs are constantly exposed to psychological stressors, which include, among others, death of patients, violent acts by patients or their families, caring for patients who are suffering, and futile care (Karanikola & Mpouzika, 2018; Levi & Moss, 2022; Salmon & Morehead, 2019). These factors place ICU nurses at increased risk of developing PTSD (Brooks et al., 2018; Greenberg et al., 2021; Guttormson et al., 2022; Heesakkers et al., 2021; Jones et

al., 2020; Levi et al., 2021; Salmon & Morehead, 2019; Schuster & Dwyer, 2020; Tang et al., 2016; Van Steenkiste et al., 2022).

Post-Traumatic Stress Disorder

The American Psychiatric Association (APA) first incorporated the disorder of "post-traumatic stress" to the *Diagnostic and Statistical Manual of Mental Disorders* (3rd ed.; *DSM-III*) in 1980, after many returning Vietnam War veterans who experienced trauma required care (Crocq & Crocq, 2000). After the 2000 *DSM-IV* revision, PTSD criteria included both direct and indirect traumatic events, including witnessing of trauma to others (Pai et al., 2017). Since then, PTSD has been documented as occurring in nurses, notably in ICU nurses, who constantly witness death and dying of patients (Mealer et al., 2009; Pai et al., 2017). The 2013 *DSM-5* revision included, among other updates, the reclassification of PTSD from an anxiety-related disorder to a trauma- and stressor-related disorder (APA, 2013). This diagnostic category is distinctive in that it requires that the individual must be subjected to a traumatic event as a precondition for diagnosis of PTSD. The definition of trauma was refined to "actual or threatened death, serious injury, or sexual violence." Also, the condition of "repeated or extreme exposure to aversive details of a traumatic event" was added, reinforcing the eligibility of workers, such as ICU nurses, who encounter the consequences of traumatic experiences as part of their duties at work (APA, 2013; Pai et al., 2017). The *DSM-5* specified four symptom clusters that must be met for PTSD diagnosis: (a) unwanted intrusive memories of the trauma, (b) avoidance of similar situations or reminders, (c) negative alterations in cognitions and mood, and (d) marked alterations in arousal and reactivity (APA, 2013).

Post-Traumatic Stress Disorder in Intensive Care Unit Nurses

Previous research has determined that some ICU nurses suffer from PTSD due to their experiences in the workplace. Mealer and colleagues (2009) were among the first to report that approximately 20% of ICU nurses met the conditions for PTSD diagnosis. This is of concern, as this approaches the 23% rate of PTSD for returning military veterans (Fulton et al., 2015). Frequent exposure to stressful and/or traumatic events at work increases both the chance of developing PTSD and of worsening symptoms (Milligan-Saville et al., 2018; Salmon & Morehead, 2019; Schuster & Dwyer, 2020).

When ICU nurses suffer the burdensome symptoms of PTSD, both their psychological and physical well-being are adversely impacted (Karanikola & Mpouzika, 2018; Ong et al., 2016). Furthermore, these symptoms often affect ICU nurses' personal and professional lives (de Boer et al., 2014; Mealer et al., 2012). "Hyperarousal" and "negative alterations in mood" symptoms can often lead to problems maintaining interpersonal relationships with coworkers, superiors (e.g., nurse managers, hospital administration), and family members. For example, ICU nurses with PTSD may suffer "alterations in mood" symptoms of detachment, "hyperarousal" symptoms of angry outbursts, and "intrusion" symptoms of flashbacks of the traumatic event (de Boer et al., 2014; Mealer et al., 2012). Ultimately, nurses may leave their job or profession for a less stressful position and attempt to avoid these symptoms (Rodney et al., 2022; Tolksdorf et al., 2022).

Detrimental physical health conditions may develop with chronic PTSD, including, but not limited to, diabetes, hypertension, cardiovascular disease, and impaired memory (Brudey et al., 2015; Dedert et al., 2010; Hoerster et al., 2019). There is also

significant risk for development of anxiety, depression, substance abuse, sleep disturbances, and alcohol abuse (Al Maqbali et al., 2021; Bensley et al., 2018; Mealer et al., 2012; Ong et al., 2016; Pappa et al., 2020). In severe cases, ICU nurses with symptoms of PTSD may even have suicidal thoughts (Ariapooran et al., 2022; Hong et al., 2021; Shen et al., 2020). Unfortunately, there is a shortage of data which restricts our understanding of nurse suicide ideation and suicide. A study by Patrician et al. (2020) using 2015 data from the Centers for Disease Control and Prevention's National Violent Death Reporting System determined suicide rates for employed female and male nurses ages 16 to 64 years were greater than those of women and men in the comparable total population.

Consequences for Patient Care

When ICU nurses suffer from PTSD, their symptoms can negatively affect patient care. "Re-experiencing" symptoms, such as nightmares, can cause poor sleep quality for the ICU nurse, which can lead to physical exhaustion and impaired cognition on the job (Ong et al., 2016; Shen et al., 2020). Diminished cognitive ability from poor sleep has been associated with medication errors (Park & Kim, 2013). Negative mood can translate to lack of empathy towards patients (Mealer et al., 2012; Salmon & Morehead, 2019). In addition, hyperarousal symptoms can result in the ICU nurse displaying irritable behavior toward their patient or having angry outbursts (de Boer et al., 2014).

Consequences for Healthcare Organizations

There are also consequences for the healthcare organization when ICU nurses suffer from PTSD (Czaja et al., 2012; Salmon & Morehead, 2019). Consequences can include decreased job satisfaction, absenteeism, and dismal patient satisfaction ratings due to substandard care (Karanikola & Mpouzika, 2018; Salmon & Morehead, 2019). These factors lead to increased costs, retention problems, and diminished reimbursement for healthcare organizations (Centers for Medicare & Medicaid Services, 2021). An oft-cited rationale ICU nurses with symptoms of PTSD report for exiting their job is the need for a less stressful position (De los Santos & Labrague, 2020; Rodney et al., 2022; Zeiher et al., 2022). Currently, the annual turnover rate for ICU nurses is greater than 18% (Nursing Solutions, Incorporated, 2020). This rate is higher than for the general working population or other types of nurses. High turnover rates not only increase healthcare costs, but also adversely impact staff morale and quality of patient care (Chegini et al., 2019; Lavoie-Tremblay et al., 2022; Moss et al., 2016).

The Global Pandemic Coronavirus-19

This dissertation research commenced pre-coronavirus disease (COVID-19), beginning September 2019, lasting through the U.S. COVID-19 death rate peak in 2020-2021, and finishing in the fall of 2022 when there were far fewer hospitalizations and deaths (Worldometer, 2022). When the pandemic began, reports surfaced of nurses around the globe experiencing psychological stress and trauma, particularly ICU nurses caring for the most critically ill COVID-19 patients (Schecter et al., 2020). Hospitals

scrambled to prepare for the pandemic, but there were many problems (Uppal et al., 2020). A scarcity of personal protective equipment (PPE) soon developed, including gloves, gowns, face masks, goggles, face shields, respirators, and air-purifying respirators (Livingston et al., 2020). For example, the spread of the virus across China, where nearly half of the world's face masks are produced, halted China's face mask production and shipping (Ranney et al., 2020). Additionally, the Strategic National Stockpile, prompted by the September 11, 2001, terrorist attacks for future public health emergencies, failed to replenish PPE (Livingston et al., 2020). These failures left ICU nurses without the proper PPE to protect themselves while caring for COVID-19 patients (Handfield et al., 2020; Ranney et al., 2020). There were also global shortages of ventilators, due to the number of critically ill COVID-19 patients requiring mechanical ventilation (Bhatraju et al., 2020; Richardson et al., 2020). Many ICU nurses were concerned not only for their own safety, but also for the safety of their families (Crowe et al., 2021; Levi & Moss, 2022). Additionally, the ventilator shortage caused heart-wrenching decisions to be made about who would live and who would die (Fjølner et al., 2022; Liddell et al., 2020). Infectious disease epidemics and pandemics have long been recognized as having profound psychological effects on frontline healthcare workers (Cabarkapa et al., 2020; Lehmann et al., 2015; McAlonan et al., 2007). The lack of knowledge of the virus, lack of ventilators for patients, lack of PPE to protect themselves, and high death rate of COVID-19 patients were among the many psychological stressors ICU nurses faced at work (Crowe et al., 2021; Guttormson et al., 2022; Levi & Moss, 2022; Shechter et al., 2020; Tan et al., 2020).

Resilience

Most individuals who experience trauma do not develop PTSD (National Institute of Mental Health, 2022). Protective factors, such as resilience, can play a key part in reducing risk (Hart et al., 2014; Yu et al., 2019). Resilience, or the ability to cope effectively despite adverse events, has been linked to several intrinsic factors, including a strong social support network, optimism, and high self-esteem (American Psychological Association, 2022a). Coping strategies (e.g., problem negotiation, mindfulness meditation) used to minimize stressors can also play an integral part in resilience (Babore et al., 2020; Finstad et al., 2021; Green & Kinchen, 2021).

Heart Rate Variability as a Measure of Stress and PTSD

Heart rate variability (HRV) is the fluctuation in time intervals between heartbeats and reflects functioning of an individual's autonomic nervous system (ANS) and ability to respond to stress (Ge et al., 2020; Kim et al., 2018). The variation in heartbeats is controlled by the ANS, which is generally described as having two major branches comprised of the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). When an individual encounters a stressful event in the environment (e.g., workplace stress), the SNS starts the fight-or-flight response and heart rate increases. In a healthy individual, the PNS takes over when the stress event is over and heart rate slows down (Cleveland Clinic, 2022). This represents HRV in response to stress. A higher HRV suggests healthy self-regulation and adaptability to stress. Reduced (or low) HRV can signify inadequate ability to adapt to stress and can be a predictor of health problems

(e.g., cardiovascular disease, PTSD, chronic stress) (Colzato et al., 2018; Ge et al., 2020; Kim et al., 2018; Ulmer et al., 2018). The use of HRV as a valid and objective biomarker to identify stress has been expanding in the health sciences literature, particularly in the domain of PTSD (Ge et al., 2020; Gillie & Thayer, 2014; Hourani et al., 2020; Kim et al., 2018; Michopoulos et al., 2015; Schneider & Schwerdtfeger, 2020; Ulmer et al., 2018).

Study Purpose

The purpose of this dissertation was to investigate the association between PTSD and psychological stress in ICU nurses and events experienced in the workplace. This was achieved through the production of three manuscripts that include a concept analysis review paper (Manuscript One), findings of preliminary pilot research to support the dissertation research (Manuscript Two), and the major findings of the dissertation research (Manuscript Three).

Overview of the Three Manuscripts

Manuscript 1 - Post-Traumatic Stress Disorder in Intensive Care Unit Nurses: A Concept Analysis

The purpose of Manuscript One was to illustrate the concept of PTSD in ICU nurses. A concept analysis is useful when a concept has transformed over time due to new knowledge or when there is uncertainty regarding its definition (Walker & Avant, 2011). Walker and Avant's eight-step method (2011) was chosen for its rigorous analysis. Performing a systematic search of the literature generated knowledge about what is known and not known and allowed for the refinement of the concept as it applied

specifically to ICU nurses. The resultant analysis culminated in better comprehension of the concept of PTSD and its impact on ICU nurses' personal and professional lives, patient care, and healthcare organizations for which they work. The findings from this analysis informed the need for this dissertation study and the development of research questions.

Manuscript 2 - Intensive Care Unit Nurses' Lived Experiences Caring for COVID-19 Patients

The purpose of the study in Manuscript Two was to examine how work-related experiences caring for COVID-19 patients impacted ICU nurses' lives. COVID-19 is a novel virus with many unknown aspects. In 2020, a number of published studies had investigated the quantitative prevalence rates of psychological stress and trauma from caring for COVID-19 patients; however, little of the peer-reviewed information had been derived from qualitative studies. An in-depth review of the literature revealed that some ICU nurses suffered symptoms of sleep disruptions, headaches, anxiety, depression, and in extreme cases, suicidal contemplations while caring for COVID-19 patients (Shen et al., 2020; Tan et al., 2020; Yifan et al., 2020). However, a gap existed in the literature on how work-related experiences caring for COVID-19 patients has impacted ICU nurses' lives.

A phenomenological methodology was chosen as the most appropriate method to investigate the lived experiences of ICU nurses caring for COVID-19 patients. This method allowed for heightened understanding of how caring for COVID-19 patients impacted the nurses' personal and professional lives (Creswell & Poth, 2018; Moustakas,

1994). Ten one-on-one, semi-structured, one-hour interviews provided valuable insight into the ICU nurses' perceptions of caring for COVID-19 patients. For the quantitative portion of the research, symptoms of PTSD were assessed utilizing the Posttraumatic Stress Disorder Checklist (PCL-5), job satisfaction was measured with a 5-point Likert scale, and intention to leave their job was determined with a "yes or no" question. The specific aims and research questions included:

Aim 1

Investigate the lived experiences of ICU nurses caring for COVID-19 patients admitted to the ICU to heighten the understanding of what this means in the nurses' personal and professional lives.

Research Question 1a: What are the experiences of ICU nurses caring for COVID-19 patients?

Research Question 1b: What are the experiences of ICU nurses when communicating with family and friends of COVID-19 patients?

Research Question 1c: What are the experiences of ICU nurses with their own family and friends while caring for COVID-19 patients?

Aim 2

Assess for PTSD using the PCL-5.

Research Question: Are ICU nurses suffering from symptoms of PTSD while caring for COVID-19 patients?

Aim 3

Assess job satisfaction with a 5-point Likert scale.

Research Question: How satisfied are ICU nurses with their job?

Aim 4

Assess intent to leave job with a "yes or no" question.

Research Question: Have ICU nurses caring for COVID-19 patients thought about leaving their job in the past 6 months?

Manuscript 3 - Heart Rate Variability and Stress in the Intensive Care Unit Nursing Workplace

The dissertation research utilized HRV as an objective biomarker to evaluate psychological stress. This was achieved by measuring ICU nurses' HRV via their physiological response and recovery to events experienced in the workplace. This research captured moment-to-moment experiences of the ICU nurses in their work environment, linking workplace events with HRV activity. This type of design assisted in justification for differences in individual stress experiences in a given shift. The association between HRV and PTSD (including perceived stress and peritraumatic dissociative experiences) was investigated. The association of resilience, sleep disturbance, anxiety, and depression was also explored. Findings of this research will inform interventions to mitigate or prevent PTSD in ICU nurses using the measure of HRV. Specific aims and research questions included:

Aim 1

Explore the association between HRV and events ICU nurses experience in the workplace.

> Research Question 1a: Is there an association between HRV and nurse demographic characteristics to events experienced by ICU nurses in the workplace?
>
> Research Question 1b: What are the events ICU nurses experience at work associated with HRV?

Aim 2

Investigate the association between HRV to events ICU nurses experience in the workplace and traumatic stress responses.

> Research Question 2a: Is there an association between HRV to events ICU nurses experience in the workplace and PTSD as measured by the PCL-5?
>
> Research Question 2b: Is there an association between HRV to events ICU nurses experience in the workplace and peritraumatic stress as measured by the Peritraumatic Dissociative Experiences Questionnaire (PDEQ)?
>
> Research Question 2c: Is there an association between HRV to events ICU nurses experience in the workplace and perceived stress as measured by the Perceived Stress Scale (PSS)?

Aim 3

Investigate the association between HRV/PCL-5 score ≥ 33 and nurse demographic characteristics.

Research Question: Is there an association between HRV/PCL-5 score ≥ 33 and nurse demographic characteristics?

Aim 4

Investigate the association between HRV/PCL-5 score ≥ 33 and sleep disturbance.

Research Question: Is there an association between HRV/PCL-5 score ≥ 33 and sleep disturbance as measured by the Patient-Reported Outcomes Measurement Information System (PROMIS) Sleep Disturbance Scale – Short Form?

Aim 5

Investigate the association between HRV/PCL-5 score ≥ 33 and anxiety.

Research Question: Is there an association between HRV/PCL-5 score ≥ 33 and anxiety as measured by the Patient-Reported Outcomes Measurement Information System (PROMIS) Emotional Distress-Anxiety Scale – Short Form?

Aim 6

Investigate the association between HRV/PCL-5 score ≥33 and depression.

Research Question: Is there an association between HRV/PCL-5 score ≥ 33 and depression as measured by the Patient-Reported Outcomes Measurement

Information System (PROMIS) Emotional Distress-Depression Scale – Short Form?

Aim 7

Investigate the association between HRV/PCL-5 score ≥ 33 and resilience.

Research Question: Is there an association between HRV/PCL-5 score ≥ 33 and resilience as measured by the CD-RISC-10 Scale?

The purpose of this chapter is to introduce a three-paper dissertation entitled *Heart Rate Variability and Stress in the Intensive Care Unit Nursing Workplace*. Topics addressed in this chapter include: (a) the background and significance of the problem, (b) research problem statement, (c) the aims and research questions, (d) the guiding conceptual framework for the study, (e) a brief description of study design and methods, and (f) definitions for terminology that will be used throughout the chapters of this dissertation.

Theoretical Framework

Thayer and Lane's (2000) Neurovisceral Integration Model (NVIM) was first presented to organize research on stress and adaptive responses, focusing on a biomarker for emotion regulation. The model provides a framework for the integrative relationship between autonomic function and mental health centered on a network of reciprocal cardio-neural pathways known as the central autonomic network (CAN), and how these

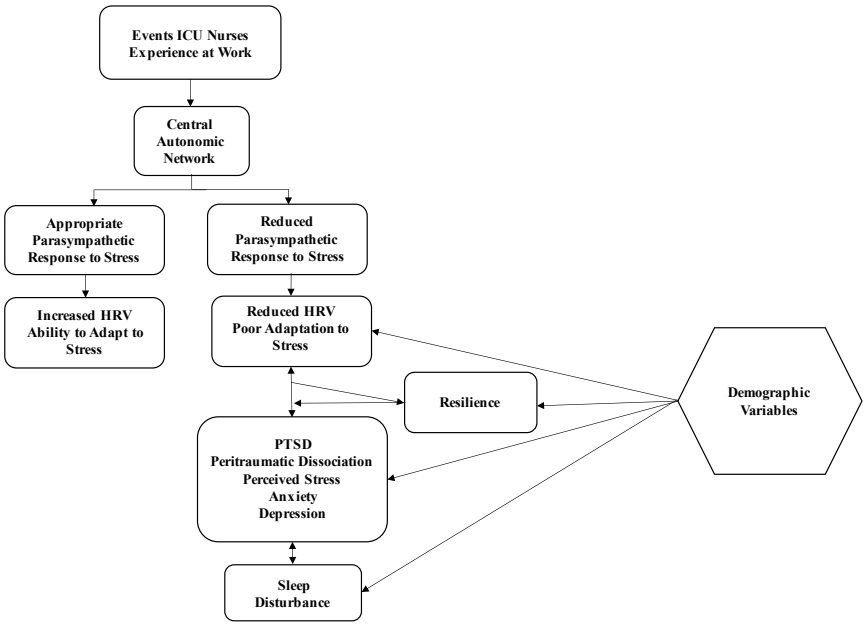
various brain regions work together (Smith et al., 2017; Thayer & Lane, 2009). The CAN controls the activity of preganglionic sympathetic and parasympathetic neurons and is involved in responding to changing environments, maintaining homeostasis, and behavioral responses necessary for adaptability (Thayer & Lane, 2009). The preganglionic sympathetic and parasympathetic neurons in the CAN innervate the sinoatrial node of the heart by way of the stellate ganglia and the vagus nerve and are the proximal factor determining HRV (Smith et al., 2017). The model describes how such a system can become unbalanced (e.g., via extreme stress), rendering it unresponsive to the normal range of signals (Thayer & Lane, 2009).

Conceptual Model

When individuals cope with chronic stress or psychological trauma, the body has limited resources (Thayer & Lane, 2009). Chronic psychological stress (e.g., PTSD, perceived stress, peritraumatic distress) can lead to alterations in physiological function, long-term damage in the body (e.g., heart disease, diabetes, impaired cognitive function, stroke), and functional deterioration in daily life (McEwen, 2005; Thayer & Lane, 2007). HRV measurements reflect this process, with HRV becoming more reduced as symptoms of psychological stress or PTSD become chronic (Ge et al., 2020; Kim et al. 2018; Schneider & Schwerdtfeger, 2020). Other negative physiological and psychological outcomes may result, including anxiety, depression, and sleep disturbance (Lewis et al., 2020; Pappa et al., 2020). Resilience factors may thwart the development of psychological stress and PTSD (Hart et al., 2014; Mealer et al., 2017).

Figure 1

Conceptual Model of the Dissertation Research



Note. The conceptual model was used to guide the generation of research questions for quantitative analyses of this dissertation.

Summary

The overarching aim of this dissertation was to provide a better understanding of PTSD in ICU nurses through the generation of three manuscripts in order to inform interventions to mitigate or prevent development of PTSD. The concept analysis (first manuscript) illustrated the concept of PTSD and how it pertains uniquely to ICU nurses. This manuscript provided the rationale needed to guide the dissertation research. The second manuscript reported on qualitative study findings, revealing a complex and comprehensive understanding of the phenomenon of PTSD in ICU nurses. The third manuscript presented the findings of the dissertation research. The first chapter has

presented the problem, significance, background, and purpose of these studies, and provided an overview of the three manuscripts included in this dissertation. Chapter 5 of this dissertation combined the findings from the three manuscripts and provided a comprehensive understanding of PTSD in ICU nurses. Recommendations for future research have been provided.

Definitions of Key Terms

Anxiety

A nervous disorder characterized by a state of excessive uneasiness and apprehension. Individuals who suffer from anxiety often experience physical symptoms such as sweating, trembling, dizziness, or panic attacks (APA, 2022b).

Central autonomic network

Anatomically, the central autonomic network (CAN) is composed of the anterior cingulate, insular, orbitofrontal, and ventromedial prefrontal cortices; the central nucleus of the amygdala; the paraventricular and related nuclei of the hypothalamus; the periaquaductal gray matter; the parabrachial nucleus; the nucleus of the solitary tract; the nucleus ambiguus; the ventrolateral medulla; the ventromedial medulla; and the medullary tegmental field (Thayer et al., 2009). The reciprocal cardio-neural pathways of the CAN react to signals from the environment, allowing for physiological and behavioral changes to permit adaptation to homeostasis (Lamotte et al., 2021).

Depression

Depression is a negative affective state, ranging from unhappiness to extreme feelings of sadness, pessimism, and despondency, that interferes with daily life (APA Dictionary of Psychology, 2022). For a diagnosis of depression, the DSM-5 states the individual must be experiencing five or more symptoms during the same 2-week period and at least one of the symptoms must be (a) depressed mood or (b) loss of interest or pleasure in activities. Qualifying symptoms include: depressed mood; marked diminished interest in activities; significant weight loss when not dieting or weight gain; a slowing down of physical movement; fatigue; feelings of worthlessness; diminished ability to think or concentrate; recurrent thoughts of death, suicide attempt, or specific plan for committing suicide.

Heart rate variability

Heart rate variability is defined as the time intervals between consecutive heartbeats (Shaffer & Ginsberg, 2017).

Perceived stress

Perceived stress is defined as the thoughts or opinions that an individual has about how stressful situations are in their life during the current time period or over a given time (Phillips, 2013).

Peritraumatic dissociative experiences

Peritraumatic dissociative experiences are defined as individual reactions that arise when the trauma occurs, including depersonalization, derealization, dissociative amnesia, out-of-body experiences, emotional detachment, and altered time awareness (Thompson-Hollands et al., 2017).

Post-traumatic stress disorder

Post-traumatic stress disorder (PTSD) is used in this dissertation as it is defined in the *DSM-5* (2013). The *DSM-5* defines PTSD as a trauma- and stressor-related disorder involving a direct or indirect exposure to a traumatic event or repetitive episodes (Criterion A). For diagnostic purposes, symptoms fall into four specified symptom clusters that stem from the traumatic event(s): unwanted disturbing recollections of the trauma (Criterion B), avoidance of similar situations or reminders (Criterion C), negative alterations in cognitions and mood (Criterion D), and marked alterations in arousal and reactivity (Criterion E). Symptoms and stress responses must last longer than 1 month (Criterion F); cause significant distress and/or impairment (Criterion G); and not be due to medication, substance use, or other illness (Criterion H).

Resilience

There is a lack of a universally accepted definition of resilience (Aburn et al., 2016); however, the APA defines resilience as the process of adapting well in the face of adversity, trauma, tragedy, threats, or significant sources of stress (APA, 2022a).

Sleep disturbance

Sleep disturbance is defined as persistent disturbance of typical sleep patterns, including the amount, quality, and timing of sleep (APA Dictionary of Psychology, 2022).

POST-TRAUMATIC STRESS DISORDER IN INTENSIVE CARE UNIT NURSES: A CONCEPT ANALYSIS

by

PAULA LEVI, PATRICIA A. PATRICIAN, DAVID E. VANCE,
AOYJAI P. MONTGOMERY, JACQUELINE MOSS

Workplace Health & Safety, *69*(5):224-234. https://doi.org/10.1177/216507992097

MANUSCRIPT 1

POST-TRAUMATIC STRESS DISORDER IN INTENSIVE CARE UNIT NURSES: A CONCEPT ANALYSIS

ABSTRACT

Background: Intensive care unit (ICU) nurses are at increased risk of post-traumatic stress disorder (PTSD) due to their stressful work environment. Using Walker and Avant's conceptual analysis method, we sought to review the literature to better understand PTSD as it pertained to ICU nurses and its impact on their lives, patient care, and health care organizations.

Methods: For the review, we searched the Cumulative Index of Nursing and Allied Health Literature (CINAHL), PubMed, and PsycINFO. Keyword searches included the terms "post-traumatic stress disorder" AND "psychological stress" AND "intensive care unit nurses." Abstract and full text reviews were conducted. Ten articles met our inclusion criteria of being published in the past 10 years (2010–2020), peer reviewed, written in English, and referred specifically to PTSD and psychological stress in ICU nurses.

Findings: Antecedents for PTSD in ICU nurses are their stressful work environment, where exposure to traumatic events is experienced, and a lack of support from their manager, coworkers, and organization. Defining attributes included reexperiencing, avoidance, negative alterations in cognition and mood, and hyperarousal. Consequences identified included burnout, job dissatisfaction, and intention to leave their job. The conceptual definition of PTSD in ICU nurses was illustrated by the attributes,

antecedents, consequences, model case, empirical referents, and by the negative impact on the nurse, patients, and health care organization.

Conclusion/ Application to Practice: Hospital administrators, nurse managers, and occupational health nurses should ensure policies and interventions are in place to recognize and reduce the risk of PTSD among ICU nurses.

Keywords: intensive care unit nurses, post-traumatic stress disorder, PTSD

Introduction

Post-traumatic stress disorder (PTSD) is a psychiatric disorder affecting nearly five million adults in the United States and costing more than $42 billion dollars annually (Kilpatrick et al., 2013). Due to the nature of the job, namely caring for complex, high acuity of patients, intensive care unit (ICU) nurses may be affected by numerous stressors and traumas in the workplace. These include: 1) performing cardiopulmonary resuscitation; 2) frequently witnessing death and serious injuries of patients; 3) caring for patients who are suffering; and 4) performing futile care (Karanikola & Mpouzika, 2018; Mealer et al., 2007). Consequently, ICU nurses are at high risk for developing PTSD (Colville et al., 2017; Mealer et al., 2009; Rodriguez et al., 2019). Mealer et al. (2009) determined that approximately 33% of ICU nurses have symptoms of PTSD, and nearly 23% of ICU nurses meet the American Psychiatric Association diagnostic criteria for PTSD, a much higher percentage than that of general nurses (18%) and the general population (8% to 10%).

Background

Widespread attention was brought to the concept of psychological trauma after thousands of young soldiers experienced horrors during combat in World War I (Lasiuk & Hegadoren, 2006). The term “shellshock” was created to describe their condition with symptoms such as uncontrolled crying, feelings of numbness, inability to speak, and memory problems (Myers, 1915). During the 1960s and 1970s, physicians and researchers caring for individuals who survived the Holocaust (Nathan et al, 1963), rape

victims (Burgess & Holmstrom, 1974), and abused children (Kempe, & Kempe, 1978) accumulated more understanding of this unique type of psychological trauma and made significant scientific contributions (Lasiuk & Hegadoren, 2006). In 1980, with this new knowledge, and the extraordinary number of Vietnam veterans affected with chronic psychological distress, the American Psychiatric Association (APA) first included "post-traumatic stress" disorder in the *Diagnostic and Statistical Manual of Mental Disorders-III* (Crocq, & Crocq, 2000). In 1994, the *DSM-IV* revised the definition of PTSD to include both direct and indirect traumatic events. Since then, PTSD has been recognized in healthcare professions, especially in nursing, that are continuously subjected to witnessing death and dying (Pai, Suris, & North, 2017).

Currently, PTSD is described in the *DSM-5* (2013) as involving a direct or indirect exposure to a single traumatic event or repetitive episodes that result in symptoms and stress responses which last greater than one month (American Psychiatric Association [APA], 2013). The *DSM-5* revision changed PTSD from an anxiety-related disorder to a trauma- and stressor-related disorder and categorized symptoms that result from the traumatic event(s) into four clusters. The symptom clusters are re-experiencing the trauma, avoidance, negative alterations in cognition and mood, and marked alterations in arousal and reactivity (APA, 2013).

When ICU nurses suffer from the debilitating symptoms of PTSD, both their psychological and physical health is directly impacted (Karanikola & Mpouzika, 2018; Ong et al., 2016). Patient care and the healthcare organization are also negatively influenced (Czaja et al., 2012; Salmon & Morehead, 2019). Patient care may be affected when ICU nurses with PTSD suffer from diminished concentration and cognitive ability,

leading to medication errors or even sentinel events, events that result in a patient's death or serious physical or psychological harm (Park & Kim, 2013). Additionally, nurses may exhibit a lack of empathy towards their patients, sometimes termed compassion fatigue (Salmon & Morehead, 2019). Many ICU nurses with PTSD experience symptoms of burnout caused by excessive stress in the demanding work environment (Colville et al., 2019; Mealer et al., 2009; Rodríguez-Rey et al., 2019). Burnout arises from the inability to cope with work-related stress over an extended period of time and is characterized by emotional exhaustion, depersonalization (cynical or indifferent attitude towards one's job), and decreased sense of personal accomplishment (Maslach et al., 1986; Vahedian-Azimi et al., 2019).

Adverse effects of ICU nurses with PTSD also impact hospital-wide outcomes due to decreased quality of patient care from experiencing encumbering symptoms of PTSD, and retention issues, both of which can lead to significant monetary costs (Salmon & Morehead, 2019). The United States healthcare system is currently experiencing a critical shortage of ICU nurses (Chan et al. 2019). The turnover rate for ICU nurses is presently over 18% (Nursing Solutions, Incorporated, 2020). Replacing one ICU nurse costs approximately $70,000 (Society of Critical Care Medicine, n.d.). Using this figure, a hospital with 40 ICU beds and 100 ICU nurses with an annual turnover rate of 18% would lose nearly $1,260,000 per year (Moss et al., 2016).

The need for healthcare professionals and hospital stakeholders to better understand PTSD as it pertains to ICU nurses is critical to maintain the health of their employees, improve patient care, and optimize organizational outcomes. Gaps in the literature include the antecedent, and the overall impact of PTSD among ICU nurses.

Although there is ample research on PTSD now as opposed to decades ago and in many populations, how this uniquely applies to ICU nurses and how they experience PTSD is not well articulated in the current literature. Thus, the purpose of this concept analysis is to clarify the concept of PTSD as it applies to ICU nurses, using the Walker and Avant method (Walker & Avant, 2011). Implications for research and practice are provided.

Method

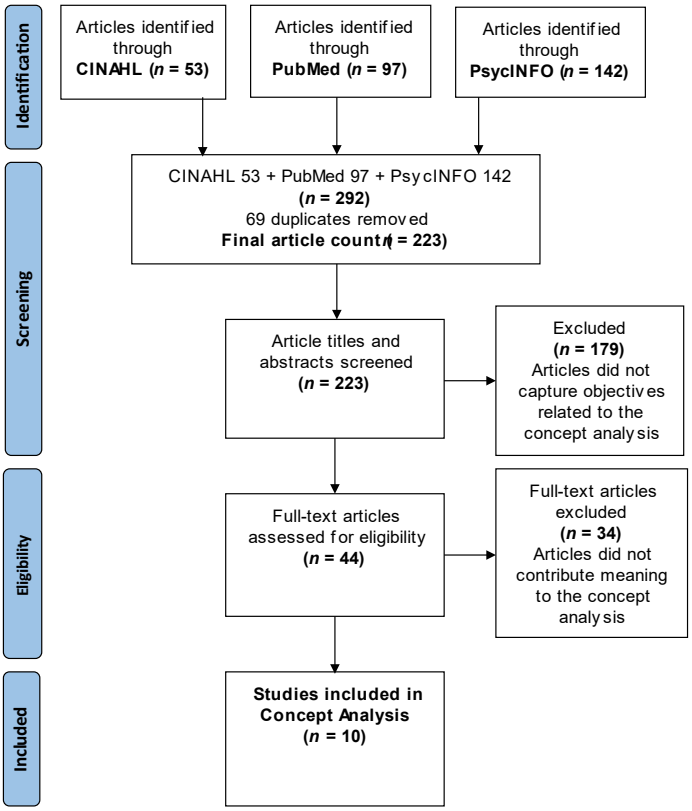
Walker and Avant's conceptual analysis method (2011) was chosen for its structured and rigorous process. A concept analysis is beneficial when a concept has changed over time with new knowledge about the concept or when there is confusion concerning its definition. By using Walker and Avant's eight-step framework, the concept is broken down into its components and differentiated from similar concepts. The iterative process helps refine the concept by identifying all uses of the concept, and defining its key attributes, antecedents, and consequences. Implementation of this process is instrumental in explicating a model case, borderline case, and contrary case to better illustrate the concept. The final step is determining the empirical referents, which assists in measuring the concept (Walker & Avant, 2011). The steps in the Walker and Avant conceptual analysis method allow for better understanding of the concept across healthcare disciplines.

A review of the literature included peer-reviewed research articles published in the literature over the past ten years, from 2010 to 2020. As seen in Figure 1, the databases searched include: Cumulative Index of Nursing and Allied Health Literature

(CINAHL), PubMed, and PsycINFO. The keywords used in the database searches included the terms “post-traumatic stress disorder” AND “psychological stress” AND “intensive care unit nurses.” The search resulted in 53 articles found in CINAHL, 97 articles in PubMed, and 142 articles in PsycINFO. The combined results of the database searches resulted in 292 articles. A total of 69 duplicates were removed. The resulting literature was examined by evaluating titles and abstracts for relevance. The inclusion criteria for this concept analysis included articles in peer-reviewed journals that performed or discussed studies which evaluated PTSD and psychological stress in ICU nurses and were written in the English language. Articles were excluded if PTSD or psychological stress was not evaluated in ICU nurses, or if they were not peer-reviewed articles available through the electronic databases or were not written in English. This preliminary title and abstract review excluded 179 articles that were not articles on PTSD and psychological stress in ICU nurses, resulting in 44 articles that were eligible for full-text review. The 44 research articles were read in full, and references within the articles were also reviewed. After a thorough review, 34 articles were excluded since they either were correlational studies which only stated prevalence rates and did not describe symptoms of psychological stress or PTSD in ICU nurses, or the prime focus was on other topics, such as resilience, emotional exhaustion, or which type of ICU had the highest prevalence of PTSD. Thus, a total of ten articles were included in this concept analysis.

Figure 1

PRISMA Diagram of Identification of Articles that Contributed to the Concept Analysis of Post-Traumatic Stress Disorder in Intensive Care Unit Nurses



Note. PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Results

The results were identified after an immersion in the literature, which included a compilation of all the uses of the concept. The results were organized by the steps in the Walker and Avant conceptual analysis method. Choosing a concept and determining the purpose of the concept analysis, the first two steps of the Walker and Avant conceptual analysis method, are stated earlier in this article.

In Table 1, the content of each of the ten articles was examined to determine what attributes, related symptoms, and consequences are specific to PTSD in ICU nurses. PTSD attributes were identified by carefully analyzing each of the ten articles and the information was subsequently recorded. At the conclusion of this process, the defining attributes were discovered, as these are the characteristics that appear repeatedly in a concept (Walker & Avant, 2011). Related symptoms were found in a similar manner and are comprised of both physical and psychological symptoms. Consequences were also discovered and often occur as a result of PTSD. Based on this, Figure 2 provides a visual summary of the antecedents, defining attributes, and consequences for the ICU nurse, the patient, and the healthcare organization.

Table 1

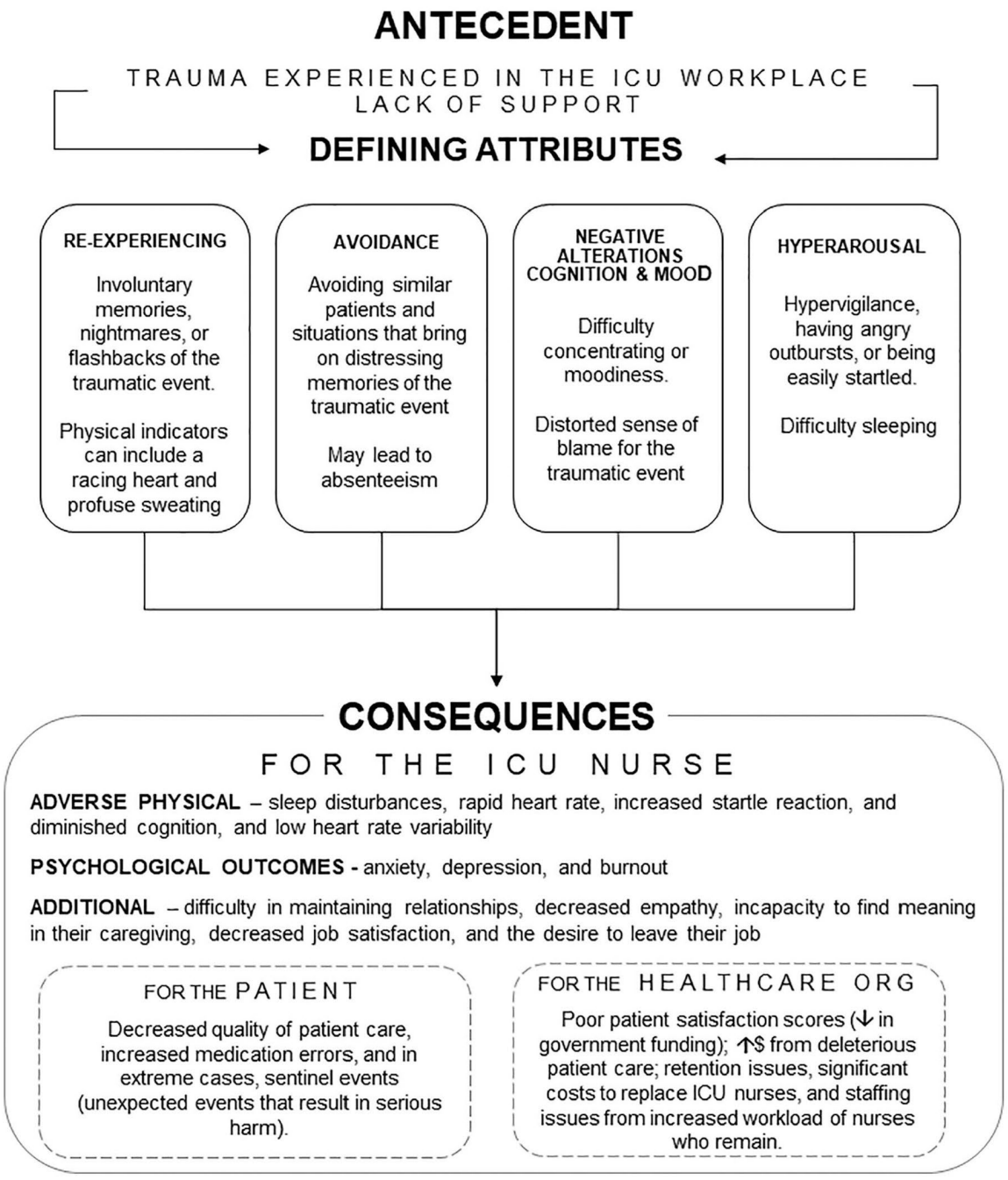
PTSD Attributes, Symptoms, and Consequences Described by Selected Articles as They Pertain to ICU Nurses Article

Study/Article	Ong et al.	Mealer et al.	Colville et al.	Vahedian-Azimi et al.	Rodríguez-Rey et al.	Salmon & Morehead	Karanikola & Mpouzika	de Boer et al.	Abu-El-Noor et al.	Shen et al.
Measure / **Symptoms**	PTSS-10	PDS	TSQ	SSI (stress)	TSQ	none	none	TSQ	IES-R	Survey of Stress Symptoms
PTSD Attributes										
Re-experiencing	X	X	X	X	X	X		X	X	
Avoidance		X		X		X		X	X	
Cognition/Mood		X		X	X	X		X		X
Arousal	X	X	X	X	X	X		X	X	X
Related Symptoms										
Crying								X	X	X
Racing Heart						X		X	X	
Sweating						X			X	
Muscle tension	X			X		X				
Sleeping difficulty	X	X		X		X	X		X	X
Problems with Relationships		X			X		X			
Thoughts of Suicide							X			X
Consequences										
Shame/Guilt/ Despair	X	X		X				X		
Anxiety	X		X	X		X		X		X
Depression	X		X	X		X	X			X
Burnout			X	X	X	X	X			
Job Dissatisfaction		X		X	X	X	X			
Intent to Leave		X		X		X	X			

Notes. IES-R = Impact of Event Scale-Revised; PDS = Posttraumatic Diagnostic Scale; PTSS-10 = Post-Traumatic Symptom Scale-10; SSI = Stressful Situations Instrument; TSQ = Trauma Screening Questionnaire.

Figure 2

Antecedents, Defining Attributes, and Consequences for ICU Nurses with PTSD



Identification of All Uses of the Concept

The APA Online Dictionary of Psychology (2020) defines PTSD as "a disorder that may result when an individual lives through or witnesses an event in which he or she believes that there is a threat to life or physical integrity and safety." The disorder may also occur from repeated exposure to traumatic events. The online Free Medical Dictionary (n.d.) defines PTSD as a "trauma- and stressor-related disorder" in *DSM-5*, arising from a traumatic event involving actual or threatened death, serious injury, or sexual violence to self or others.

Defining Attributes

The defining attributes are the most important aspect of the concept analysis since they offer the broadest insight into the concept (Walker & Avant, 2011). The prevailing defining attributes in the articles describing ICU nurses suffering with PTSD were determined after a thorough review. They are re-experiencing the traumatic event, avoidance, negative alterations in cognition and mood, and hyperarousal.

Re-experiencing

Eight of the ten articles reviewed determined re-experiencing symptoms. Re-experiencing occurs as involuntary memories, nightmares, or flashbacks of the traumatic event (Colville et al., 2017; Ong et al., 2016). These re-experiencing events are typical immediately following a traumatic event; however, when they last longer than a few

months, it can be a predictor of PTSD (APA, 2013). Re-experiencing can be triggered by tactile sensations, smells, noises, or unwanted thoughts (APA, 2013). Mealer et al. (2012) reported that one nurse could no longer eat salmon because the look and texture reminded her of her traumatic experience caring for her patient with an open wound: "*…you could see down to the bottom of her spine and you could see like all the connective tissue."* Physical indicators may also be described when re-experiencing the traumatic event, such as muscle tension, a racing heart, and profuse sweating (Abu-El-Noor et al., 2018; de Boer et al., 2014; Salmon & Morehead, 2019).

Avoidance

Five of the ten articles reviewed determined avoidance symptoms. Avoidance is exhibited by avoiding thoughts or feelings of the traumatic event (Salmon & Morehead, 2019). Additional signs involve avoiding people and situations that bring on distressing memories of the traumatic event. In ICU nurses, avoidance is often demonstrated through avoidance of similar patients from the experienced trauma and absenteeism (de Boer et al., 2014; Salmon & Morehead, 2019). In de Boer et al.'s (2014) study, one ICU nurse stated, "*certain patients were avoided… I sometimes feel the need to choose 'risk-free' patients*." Substance abuse and excessive alcohol use is another mechanism of avoidance documented in ICU nurses with PTSD (Mealer et al., 2012; Karanikola & Mpouzika, 2018); and, in dire cases of PTSD, there may even be suicidal behavior (Karanikola & Mpouzika, 2018; Shen et al., 2020).

Negative Alterations in Cognition and Mood

Six of the ten articles determined symptoms of negative alterations in cognition and mood. Impaired cognitive ability and mood may be exhibited as trouble concentrating or moodiness (de Boer et al., 2014; Salmon & Morehead, 2019). A distorted sense of blame for the triggering event may occur (Mealer et al., 2012; Vahedian-Azimi et al., 2019). Lastly, there may be a marked lack of interest in activities previously enjoyed (Vahedian-Azimi et al., 2019), as well as feelings of detachment and estrangement from friends and coworkers (Mealer et al., 2012). After ICU nurses have experienced trauma in the workplace and are suffering from PTSD, they feel changed from the person they were before and have feelings of detachment and estrangement. They may feel they no longer "really know anyone," or trust anyone, and have no one with whom they can share their grief (Mealer et al., 2012).

Hyperarousal

Nine of the ten articles determined symptoms of hyperarousal. Hyperarousal is a physiological response to stress, similar to the "fight or flight" response (APA, 2013). Hyperarousal symptoms in ICU nurses with PTSD can include irritability, hypervigilance, angry outbursts, or being easily startled (de Boer et al., 2014; Shen et al., 2020). Difficulty sleeping (Ong et al., 2016; Shen et al., 2020) and problems maintaining interpersonal relationships may also develop (Karanikola & Mpouzika, 2018; Mealer et al., 2012).

Antecedents and Consequences

Antecedents are events or incidents that must occur prior to the occurrence of the concept (Walker & Avant, 2011). The antecedent for PTSD in ICU nurses is their stressful work environment where exposure to traumatic events is experienced through direct patient care, such as performing cardiopulmonary resuscitation, witnessing patients die, or seeing patients who are hemorrhaging (Karanikola & Mpouzika, 2018; Salmon et al., 2019). Indirect exposures, such as repeated exposure to traumatic events in the ICU workplace, also qualify as an antecedent (APA, 2013). According to the Society of Critical Care Medicine (n.d.), approximately 20% of patients admitted to the ICU die. An additional antecedent for ICU nurses is lack of support from their manager, coworkers, and organization (de Boer et al., 2014; Mealer et al., 2012). A lack of support is felt by ICU nurses when: 1) they reach out to their nurse manager for help but are criticized or reprimanded for their lack of knowledge (Mealer et al., 2012); 2) they feel they don't "really know" their coworkers, or are not being heard (de Boer et al., 2014); or, 3) they do not feel appreciated by their organization (Salmon & Morehead, 2019). The lack of support, or perceived lack of support, leads to feelings of aloneness, and can result in increased stress and psychological trauma (Spiegel, 1944).

Consequences are events that ensue as a result of the occurrence of the concept (Walker & Avant, 2011). The development of PTSD in ICU nurses can result in psychological consequences, such as feelings of shame and despair, and constantly wondering what could have been done differently for their patient (de Boer et al., 2014; Mealer et al., 2012). Long-lasting physical consequences can arise from the development of PTSD. According to Edmondson et al.'s (2013) meta-analytic review, PTSD is

associated with increased risk for decreased heart rate variability, coronary heart disease, and cardiac mortality. Heart rate variability (HRV) is the change of time intervals in consecutive heart beats; too little variation can indicate chronic stress and pathology (Thayer et al., 2009).

When ICU nurses suffer from symptoms of PTSD, there are also consequences for the patient (Salmon & Morehead, 2019; Vahedian-Azimi et al., 2019). Patient care is affected by each of the four defining attribute symptoms that ICU nurses with PTSD experience. For example, re-experiencing symptoms leads to poor sleep quality for the ICU nurse which can result in physical exhaustion (Shen et al., 2020) and impaired cognition (Salmon & Morehead, 2019; Vahedian-Azimi et al., 2019). Avoidance symptoms can result in avoidance of similar patients (de Boer et al., 2014), or lack of quality care if they do receive a patient similar to that from the traumatic event. Negative alterations in cognition and mood can mean a lack of empathy towards their patients (Salmon & Morehead, 2019), or diminished concentration and cognitive ability, leading to medication errors (Park & Kim, 2013). Hyperarousal symptoms can result in the ICU nurse displaying irritable behavior toward their patient, or perhaps having angry outbursts (Rodríguez-Rey et al., 2019).

Other consequences include anxiety, depression, burnout, decreased job satisfaction, and the desire to leave their job. These are also consequences for the healthcare organization, as they are also affected. The majority of the articles used in this concept analysis reported on the prevalence of anxiety and depression in ICU nurses with PTSD. Yet not discussed, stress disorders, such as PTSD, anxiety, and depression are familial and heritable (Smoller, 2016) and can often overlap (Brady et al., 2000). The

overlap of these disorders can lead to diagnostic confusion and, more importantly, the underdiagnosis of PTSD (Brady et al., 2000). Current research suggests that ICU nurses with PTSD are at higher risk in developing burnout syndrome (Colville et al.,2019; Moss et al., 2016; Rodríguez-Rey et al., 2019). With burnout syndrome, the ICU nurses suffer from emotional exhaustion, depersonalization, and feelings of failure (Maslach et al., 1986; Rodríguez-Rey et al., 2019). Both PTSD and burnout syndrome in ICU nurses are associated with job dissatisfaction and intent to leave their job, which can impact patient care and the financial bottom line of the hospital (Moss et al., 2016; Salmon & Morehead, 2019).

Cases

To illustrate how this concept manifests in ICU nurses, a model case, a borderline case, and a contrary case have been constructed. A model case is "a pure case of the concept, a paradigmatic example, or a pure exemplar" (Walker & Avant, 2011, p. 163). A borderline case has most, but not all, of the defining attributes, and a contrary case exemplifies what the concept clearly is not.

Model Case

Pamela is a 32-year-old ICU nurse who works in an intensive care unit of a large hospital. Over the past few weeks, she has been caring for a 71-year-old patient with COVID-19. Pamela's patient only required supplemental oxygen in the form of a nasal cannula when first admitted, but now the patient is extremely anxious and gasping for air.

The hospital has been inundated with COVID-19 patients, and supplies have dwindled. Pamela increases the patient's oxygen, administers the ordered anti-anxiety medication, and puts in a stat call to the respiratory therapy team and the patient's critical care doctor. Then Pamela looks around the unit and wonders if any of the other patients on ventilators might have recovered enough to be weaned. The alarms go off in Pamela's patient's room, and she realizes that her patient is experiencing a cardiopulmonary arrest. A code blue is called, and despite her efforts, along with other nurses on the unit and the code team, the patient dies. Pamela becomes consumed with thinking about what else she could have done to help her patient. She awakens from nightmares of the traumatic event, often finding that her heart is racing and that she is in a cold sweat. At work, she now avoids patients that remind her of this patient and becomes anxious when she gets new patient assignments. She is also having trouble concentrating and startles easily when she hears alarms. Her friends call her to get together for a walk, but she no longer takes pleasure in activities that she once enjoyed. This case includes all the defining attributes of PTSD: re-experiencing, avoidance, negative alterations in cognition and mood, and arousal.

Borderline Case

Kayla is a 32-year-old ICU nurse working in a surgical ICU at a local hospital. She receives a 30-year-old female patient, post motor vehicle accident from the Operating Room. The patient is intubated and receiving a massive transfusion of packed red blood cells, but the patient continues to hemorrhage from the abdominal surgical site. Blood is saturating the patient's gown and sheets. Despite the massive transfusion of

blood, the patient experiences a cardiopulmonary arrest and expires. In the next few months, Kayla cannot stop thinking of the patient hemorrhaging and has been having nightmares about the event. At work, Kayla becomes anxious when she is assigned patients after abdominal surgeries because they remind Kayla of losing this patient. Fortunately, she has been able to care for patients after other types of surgeries with ease. She is also able to enjoy her life outside of work. Kayla has symptoms of re-experiencing and avoidance but does not demonstrate symptoms in all the symptom clusters, and therefore demonstrates a borderline case.

Contrary Case

Krista is a 29-year-old ICU nurse at a trauma center who receives an 18-year-old male after he accidently shot himself in the face when falling out of a deer-hunting stand. Krista is horrified by the young man's wounds but continues to work with competence to stabilize the patient. The patient experiences a cardiopulmonary arrest and expires, despite her appropriate interventions, along with other nurses on the unit and the code team. Krista is visibly shaken by the loss of her patient and cries with other staff members who attempted to save the young man. She talks to the nurse manager and team leader immediately after the event and feels better after seeking their support. After work, she meets a friend to go workout. Although Krista was subjected to a traumatic event, she experiences none of the attributes of PTSD.

Empirical Referents

The final step in a concept analysis is determining empirical referents. Empirical referents are actual phenomena that demonstrate the existence of the concept (Walker & Avant, 2011), and therefore are concrete representations of the concept of interest. The disorder of PTSD has been defined and classified by the *DSM-5*, giving rise to symptom clusters, which then formed the basis for screening tools for PTSD, such as the Posttraumatic Stress Disorder Checklist (PCL-5) which is used extensively in research as a measure of PTSD symptoms (National Center for PTSD, n.d.). The PCL-5 was revised to reflect *DSM-5* changes to the PTSD criteria. The PCL-5 is a self-report measure that can screen individuals by assessing the presence and severity of PTSD symptoms. The items are rated on a 5-point Likert-type scale (0 = "not at all" to 4 = "extremely"). The scale contains 20 items divided into four subscales of symptom clusters specified in the *DSM-5*: re-experiencing (five items), avoidance (two items), negative alterations in cognitions and mood (seven items), and hyperarousal (six items). Individuals must have at least one symptom of intrusion, one symptom in avoidance, two symptoms in negative alterations in cognition and mood, and two symptoms of hyperarousal to be indicative of PTSD. The PCL-5 has been shown to have strong internal consistency ($\alpha = 0.94$) and test-retest reliability ($r = 0.82$) and is a psychometrically sound self-report measure of the *DSM-5* (Blevins et al., 2015).

Discussion

There is little found in the literature as to how PTSD applies to ICU nurses and how they experience PTSD in the workplace. The concept of PTSD as it pertains to ICU nurses is unique and should be recognized by healthcare professionals and hospital stakeholders to benefit the health of the nurse, patient, and organizational outcomes. Antecedents for ICU nurses consist of a stressful work environment, where they may experience cumulative traumatic episodes, and a lack of support from co-workers, their manager, or the organization. It has been recognized for decades that a change is necessary to reduce stress in the ICU (Karanikola & Mpouzika, 2018).

The prevailing defining attributes found in the literature are *re-experiencing*, *avoidance*, *negative alterations in cognitions and mood*, and *hyperarousal.* When ICU nurses suffer from these PTSD symptoms as a result of trauma in the workplace, the psychological burden is especially difficult because they must spend the majority of their day in the environment where the trauma occurred (Salmon & Morehead, 2019). Furthermore, their job requires them to work in a fast-paced environment and to sometimes make quick and critical decisions based on the slightest imbalance in their patients' condition, while titrating intravenous medications, for example (Rodriguez et al., 2017). When suffering from PTSD symptoms, such as impaired cognition, a high-stress workload adds to further stress for the ICU nurse with PTSD if they have no tools or intervention to manage their symptoms.

Consequences identified were found to affect the nurse, patients, and the healthcare organization. Consequences for the ICU nurse involve feelings of shame, despair, and constantly wondering what could have been done differently for their patient

(Mealer et al., 2012; Ong et al., 2016). Other consequences include anxiety, depression, and burnout (Colville et al., 2017; Shen et al., 2020; Vahedian-Azimi et al., 2019). Patients suffer the repercussions of PTSD symptoms of the ICU nurses, which may range from a bad mood (e.g., negative alterations in mood), or angry outburst (e.g., hyperarousal), or perhaps a medication error (e.g., negative alteration in cognition).

The healthcare organization is negatively impacted by substandard job performance, poor patient satisfaction scores (leading to a decrease in government funding), and increased costs from deleterious patient care (Moss et al., 2016; Salmon & Morehead, 2019). Stress can result in cognition impairment and the reduction of stress is needed to improve nurses' cognitive impairment (Park & Kim, 2013). Finally, the healthcare organization is affected by absenteeism and retention issues (Moss et al., 2016; Salmon & Morehead, 2019). Nurses may leave their job, seeking to escape the effects of their trauma. Significant costs are incurred to replace ICU nurses who choose to leave their job and staffing issues arise from increased workload for nurses who remain (Moss et al., 2016; Salmon & Morehead, 2019).

Implications for Occupational Health Nursing

The findings of this concept analysis contribute to important implications for occupational health nursing practice. Despite the prevalence of PTSD in ICU nurses, policies addressing screening and interventions are notably lacking in our healthcare system. Symptoms of PTSD lasting longer than one month should be addressed as soon as possible to prevent manifestation of persistent symptoms and the development of

anxiety, depression, and burnout syndrome (Greene et al., 2016; Mealer et al., 2009). By understanding the concept of PTSD as it relates to ICU nurses, prompt identification and diagnosis can occur, and timely treatment can be initiated.

Initial assessment of mental health at point of hire for ICU nurses and ongoing assessment checks can assist in early identification and prevention of PTSD. Heart rate variability can be a valuable, noninvasive measure in detection of psychological stress and assessment of the autonomic nervous system (Messina et al., 2012). If low heart rate variability is discerned at point of hire, nurse managers could suggest mindfulness-based cognitive training (MBCT) to mitigate psychological stress. Additionally, the nurse will be better equipped to determine if she or he is suitable for the position and working in such a stressful environment.

While PTSD has been recognized as a critical problem in ICU nurses, there are few evidence-based interventions available in practice. The use of real-time, heart rate variability assessment via a wearable device (e.g., a chest belt that transmits data to a wristwatch with iOS software technology), when used in conjunction with resiliency training program, such as MBCT, can offer a much-needed intervention for ICU nurses (McCraty & Atkinson, 2012). The employment of MBCT would likely improve psychological health and result in ICU nurses having the ability to continue working in the stressful environment of the ICU and not leave their position or their profession (Salmon & Morehead, 2019). Large-scale randomized clinical trials are needed to establish the effectiveness of interventions, such as HRV assessment in conjunction with MBCT, on physical and psychological outcomes so that ICU nurses can manage the stress and trauma they must face in their work environment (Salmon & Morehead, 2019).

Lastly, a healthy work environment in the ICU must be achieved to reduce the risk for development of PTSD (Karanikola & Mpouzika, 2018; Salmon & Morehead, 2019). Managers can establish a healthy work environment and support for ICU nurses by recognizing commendable efforts on a job well done to make the nurse feel valued as an employee and allowing collaboration, ensuring their voice is heard (Happell et al., 2013). The National Institute for Occupational Safety and Health (2011) introduced the *Total Worker Health* Program in 2011, recognizing that workplace interventions are needed to improve the overall health and well-being of the worker. Hospital administrators, nurse managers, and occupational health nurses must work together to implement policies and interventions to reduce the risk of PTSD for their ICU nurse employees.

Limitations

This concept analysis only utilized peer-reviewed articles in the English language from online research databases, leaving the potential for missed references. A paucity exists of peer-reviewed articles regarding PTSD with a strict sample of ICU nurses. A few articles include some physicians, or other ICU personnel, in study samples concerning PTSD prevalence in the realm of intensive care.

Conclusions

This concept analysis provides a better understanding of overall attributes, antecedents, and consequences of PTSD among ICU nurses. The model, borderline, and

contrary cases also illustrate the examples of ICU nurses who are experiencing PTSD and who are not. Furthermore, PTSD measurement that can be used in research studies as well as in the workplace (either by nurse managers or co-workers) to identify ICU nurses who are likely to have PTSD was provided. Conceptual clarity of PTSD in ICU nurses provides a foundation for healthcare professionals and hospital stakeholders to address the gap for better communication of the concept and much-needed policies and interventions to aid ICU nurses with PTSD in the burden they carry.

References

* Indicates the 10 articles identified in the PRISMA.

*Abu-El-Noor, N. I., Aljeesh, Y. I., Radwan, A.-K. S., Abu-El-Noor, M. K., Qddura, I. A.-I., Khadoura, K. J., & Alnawajha, S. K. (2018). Post-traumatic stress disorder among health care providers two years following the Israeli attacks against Gaza Strip in August 2014: Another call for policy intervention. *Archives of Psychiatric Nursing*, *32*(2), 188-193. http://dx.doi.org/10.1016/j.apnu.2017.10.014

American Psychiatric Association (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., Text Revision). American Psychiatric Publishing.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5)*. American Psychiatric Publishing.

American Psychological Association Dictionary of Psychology. (n.d.). *Posttraumatic stress disorder*. https://dictionary.apa.org/posttraumatic-stress-disorder

Blevins, C. A., Weathers, F. W., Davis, M. T., Witte, T. K., & Domino, J. L. (2015). The posttraumatic stress disorder checklist for DSM-5 (PCL-5): Development and initial psychometric evaluation. *Journal of Traumatic Stress*, *28*(6), 489-498. https://doi:10.1002/jts.22059

Brady, K. T., Killeen, T. K., Brewerton, T., & Lucerini, S. (2000). Comorbidity of psychiatric disorders and posttraumatic stress disorder. *Journal of Clinical Psychiatry*, *61* (Suppl 7), 22-32. https://pubmed-ncbi-nlm-nih-gov.ezproxy3.lhl.uab.edu/10795606/

Burgess, A. W., & Holmstrom, L. L. (1974). Rape trauma syndrome. *The American Journal of Psychiatry*, *131*(9), 981-986. https://doi-org.ezproxy3.lhl.uab.edu/10.1176/ajp.131.9.981

Chan, Z. C., Tam, W. S., Lung, M. K., Wong, W. Y., & Chau, C. W. (2013). A systematic literature review of nurse shortage and the intention to leave. *Journal of Nursing Managagement, 21*(4), 605-613. https://doi:10.1111/j.1365-2834.2012.01437.x

*Colville, G. A., Smith, J. G., Brierley, J., Citron, K., Nguru, N. M., Shaunak, P. D., Tam, O., & Perkins-Porras, L. (2017). Coping with staff burnout and work-related posttraumatic stress in intensive care. *Pediatric Critical Care Medicine*, *18*(7), e267-e273. https://doi:10.1097/pcc.0000000000001179

Crocq, M. A., & Crocq, L. (2000). From shell shock and war neurosis to posttraumatic stress disorder: A history of psychotraumatology. *Dialogues in Clinical Neuroscience, 2*(1), 47-55. https://pubmed-ncbi-nlm-nih-gov.ezproxy3.lhl.uab.edu/22033462/

Czaja, A. S., Moss, M., & Mealer, M. (2012). Symptoms of posttraumatic stress disorder among pediatric acute care nurses. *Journal of Pediatric Nursing*, *27*(4), 357-365. https://doi:10.1016/j.pedn.2011.04.024

*de Boer, J., van Rikxoort, S., Bakker, A. B., & Smit, B. J. (2014). Critical incidents among intensive care unit nurses and their need for support: Explorative interviews. *Nursing in Critical Care*, *19*(4), 166-174. https://doi:10.1111/nicc.12020

Edmondson, D., Kronish, I. M., Shaffer, J. A., Falzon, L., & Burg, M. M. (2013). Posttraumatic stress disorder and risk for coronary heart disease: A meta-analytic review. *American Heart Journal, 166*(5), 806-814. https://doi:10.1016/j.ahj.2013.07.031

Greene, T., Neria, Y., & Gross, R. (2016). Prevalence, detection and correlates of PTSD in the primary care setting: A systematic review. *Journal of Clinical Psychology in Medical Settings*, *23*(2), 160-180. https://doi:10.1007/s10880-016-9449-8

Happell, B., Dwyer, T., Reid, S. K., Burke, K. J., Caperchione, C. M., & Gaskin, C. J. (2013). Nurses and stress: Recognizing causes and seeking solutions. *Journal of Nursing Management*, *21*(4), 638-647. https://doiorg.ezproxy3.lhl.uab.edu/10.1111/jonm.12037

*Karanikola, M. N. K., & Mpouzika, M. D. A. (2018). Time to create a healthy work environment in ICU: A review of current evidence and commentary. *CONNECT: The World of Critical Care Nursing*, *12*(2), 44-47. https://doi:10.1891/1748-6254.12.2.4

Kemp, A. H., & Quintana, D. S. (2013). The relationship between mental and physical health: Insights from the study of heart rate variability. *International Journal of Psychophysiology*, *89*(3), 288-296. https://doi.org/10.1016/j.ijpsycho.2013.06.018

Kempe, R. S., & Kempe, C. H. (1978). *Child abuse*. Fontana Open Books.

Kilpatrick, D. G., Resnick, H. S., Milanak, M. E., Miller, M. W., Keyes, K. M., & Friedman, M. J. (2013). National estimates of exposure to traumatic events and PTSD prevalence using DSM-IV and DSM-5 criteria. *Journal of Traumatic Stress*, *26*(5), 537-547. https://doi:10.1002/jts.21848

Lasiuk, G.C., & Hegadoren, K. M. (2006). Posttraumatic stress disorder part I: Historical development of the concept. *Perspectives in Psychiatric Care*, *42(*1), 13-20.

Maslach, C., Jackson, S. E., Leiter, M. P., Schaufeli, W. B., & Schwab, R. L. (1986). *Maslach burnout inventory* (Vol. 21). Consulting Psychologists Press.

McCraty, R., & Atkinson, M. (2012). Resilience training program reduces physiological and psychological stress in police officers. *Global Advances in Health and Medicine*, *1*(5), 44-66. https://doi:10.7453/gahmj.2012.1.5.013

Mealer, M., Burnham, E. L., Goode, C. J., Rothbaum, B., & Moss, M. (2009). The prevalence and impact of post traumatic stress disorder and burnout syndrome in nurses. *Depression and Anxiety*, *26*(12), 1118-1126. https://doi:10.1002/da.20631

Mealer, M., Jones, J., & Meek, P. (2017). Factors affecting resilience and development of posttraumatic stress disorder in critical care nurses. *American Journal of Critical Care*, *26*(3), 184-192. https://doi:10.4037/ajcc2017798

*Mealer, M., Jones, J., & Moss, M. (2012). A qualitative study of resilience and posttraumatic stress disorder in United States ICU nurses. *Intensive Care Medicine*, *38*(9), 1445-1451. https://doi:10.1007/s00134-012-2600-6

Mealer, M. L., Shelton, A., Berg, B., Rothbaum, B., & Moss, M. (2007). Increased prevalence of post-traumatic stress disorder symptoms in critical care nurses. *American Journal of Respiratory and Critical Care Medicine*, *175*(7), 693-697. https://doi:10.1164/rccm.200606-735OC

Messina, G., Vicidomini, C., Viggiano, A., Tafuri, D., Cozza, V., Cibelli, G., Devastato, A., De Luca, B., & Monda, M. (2012). Enhanced parasympathetic activity of sportive women is paradoxically associated to enhanced resting energy

expenditure. *Autonomic Neuroscience*, *169*(2), 102-106. https://doi.org/10.1016/j.autneu.2012.05.003

Moss, M., Good, V. S., Gozal, D., Kleinpell, R., & Sessler, C. N. (2016). An official critical care societies collaborative statement-burnout syndrome in critical care health-care professionals: A call for action. *Chest*, *150*(1), 17-26. https://doi:10.1016/j.chest.2016.02.649

Myers, C. S. (1915). A contribution to the study of shell shock: Being an account of three cases of loss of memory, vision, smell, and taste, admitted into the duchess of Westminster's war hospital, Le Touquet. *The Lancet, 185*, 316-320. http://dx.doi.org/10.1016/S0140-6736(00)52916-X

National Center for PTSD. (2022). *PTSD checklist for DSM-5 (PCL-5).* U.S. Department of Veterans Affairs. https://www.ptsd.va.gov/professional/assessment/documents/using-pcl5.pdf 2020

National Institute for Occupational Safety and Health. (2011). *Total worker health.* https://www.cdc.gov/niosh/twh/totalhealth.html

Nursing Solutions, Incorporated. (2020). *Retention & RN Staffing Report.* https://www.nsinursingsolutions.com/Documents/Library/NSI_National_Health_Care_Retention_Report.pdf

*Ong, Y. Z., Siddiqui, S., John, S., Chen, Z., & Chang, S. (2016). The prevalence of post-traumatic stress disorder in intensive care unit staff and the common coping strategies used. *Annals of the Academy of Medicine, Singapore*, *45*(5), 215-218. https://annals.edu.sg/pdf/45VolNo5May2016/V45N5p215.pdf

Pai, A., Suris, A. M., & North, C. S. (2017). Posttraumatic stress disorder in the DSM-5: Controversy, change, and conceptual considerations. *Behavioral Science* (Basel), *7*(1). https://doi:10.3390/bs7010007

Park, Y. M., & Kim, S. Y. (2013). Impacts of job stress and cognitive failure on patient safety incidents among hospital nurses. *Safety and Health at Work*, *4*(4), 210-215. https://doi:10.1016/j.shaw.2013.10.003

Rodriguez, A. C., Lee, D. A., & Makic, M. B. F. (2017). Situational awareness in critical care: An aviation approach to reduce error. *Journal of PeriAnesthesia Nursing*, *32(*6), 650–652. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.jopan.2017.08.001

*Rodríguez-Rey, R., Palacios, A., Alonso-Tapia, J., Pérez, E., Álvarez, E., Coca, A., Mencia, S., Marcos, A., Mayordomo-Colunga, J., Fernandez, F., Gomez, F., Cruz, J., Ramos, V., & Olmedilla, M. (2019). Are pediatric critical personnel satisfied with their lives? Prediction of satisfaction with life from burnout, posttraumatic stress, and posttraumatic growth, and comparison with noncritical pediatric staff. *Pediatric Critical Care Medicine, 20*(3), e160-e169. https://doi.org/10.1097/PCC.0000000000001861

*Salmon, G., & Morehead, A. (2019). Posttraumatic stress syndrome and implications ford practice in critical care nurses. *Critical Care Nursing Clinics of North America, 31*(4), 517-526.

*Shen, X., Zou, X., Zhong, X., Yan, J., & Li, L. (2020). Psychological stress of ICU nurses in the time of COVID-19. *Critical Care, 24*(1), 200. https://doi:10.1186/s13054-020-02926-2

Smoller J. W. (2016). The genetics of stress-related disorders: PTSD, depression, and anxiety disorders. *Neuropsychopharmacology: Official Publication of the American College of Neuropsychopharmacology*, *41*(1), 297–319. https://doi-org.ezproxy3.lhl.uab.edu/10.1038/npp.2015.266

Society of Critical Care Medicine. (n.d.). *Critical Care Statistics*. https://www.sccm.org/Communications/Critical-Care-Statistics

Spiegel, H. X. (1944). Preventive psychiatry with combat troops. *American Journal of Psychiatry*, *101*(3), 310-315. https://ajp.psychiatryonline.org/doi/abs/10.1176/ajp.101.3.310?journalCode=ajp

Thayer, J. F., Hansen, A. L., Saus-Rose, E., & Johnsen, B. H. (2009). Heart rate variability, prefrontal neural function, and cognitive performance: The neurovisceral integration perspective on self-regulation, adaptation, and health. *Annals of Behavioral Medicine*, *37*(2), 141-153. https://link.springer.com/content/pdf/10.1007/s12160-009-9101-z.pdf

*Vahedian-Azimi, A., Hajiesmaeili, M., Kangasniemi, M., Fornés-Vives, J., Hunsucker, R. L., Rahimibashar, F., Pourhoseingholi, M. A., Farrokhvar, L., & Miller, A. C. (2019). Effects of stress on critical care nurses: A national cross-sectional study. *Journal of Intensive Care Medicine*, *34*(4), 311-322. https://doi:10.1177/0885066617696853

Walker, L., & Avant. K. (2011). *Strategies for theory construction in nursing*. New Jersey: Pearson/Prentice Hall.

INTENSIVE CARE UNIT NURSES' LIVED EXPERIENCES CARING FOR COVID-19 PATIENTS

by

PAULA LEVI AND JACQUELINE MOSS

Workplace Health & Safety, *70*(8):358-367. https//:doi.org/10.1177/21650799211064262

Format adapted for dissertation

MANUSCRIPT 2

INTENSIVE CARE UNIT NURSES' LIVED EXPERIENCES CARING FOR COVID-19 PATIENTS

ABSTRACT

Background: Intensive care unit (ICU) nurses are enduring unprecedented burden caring for COVID-19 patients. Few studies have reported types of work-related events that lead to occupational stress and post-traumatic stress disorder (PTSD).

Methods: ICU nurses were recruited at an academic health science center to explore their experiences caring for COVID-19 patients. Participants were interviewed for 1 hour using open-ended questions. Symptoms of PTSD were assessed using the PTSD Checklist-5, job satisfaction with a Likert-type scale, and intention to leave their job with a "yes or no" question. Semi-structured interviews were transcribed and analyzed using NVivo software; quantitative data were analyzed using frequencies and means with R 4.0.5.

Findings: The ICU nurse sample was comprised of nine females and one male, all Caucasian, with a mean age of 26.6 years. Analysis of interview transcripts revealed six recurring themes: Change in Practice, Emotion, Patient's Family, Isolation, Job Satisfaction, and Public Reaction. Quantitative findings revealed 7 of 10 met diagnostic criteria for PTSD. Most participants (7/10) were "somewhat satisfied" with their job. Five of 10 considered leaving their job in the last 6 months.

Conclusions/Implications for Practice: Understanding the impact stressful pandemic-related patient care has on ICU nurses provides evidence that new policies are needed. Furthermore, qualitative findings provide insight into the best design and deployment of

interventions to reduce stress and prevent development of PTSD. More research is needed to understand long-term effects of PTSD and to evaluate strategies to prevent PTSD during stressful emergency surges in intensive care.

Keywords: COVID-19; PTSD; intensive care unit nurses; post-traumatic stress disorder; workplace distress.

Background

Intensive care unit (ICU) nurses are frontline workers, caring for the most critically ill patients. Due to their extreme level of responsibility and cumulative exposure to psychological stress and trauma, they are at high risk for developing post-traumatic stress disorder (PTSD; Levi et al., 2021; Salmon & Morehead, 2019). Schuster and Dwyer's (2020) integrative review of 24 pre-COVID studies reported that 8.5% to 20.8% of registered nurses met the criteria for PTSD. The American Psychiatric Association (2013) *Diagnostic and Statistical Manual of Mental Disorders* (5th ed., *DSM-5*) ascertains that PTSD can develop after individuals experience a traumatic event (or cumulative episodes) causing considerable distress or impairment lasting longer than 1 month. The *DSM*-5 (American Psychiatric Association, 2013) identifies four symptom clusters of PTSD: (a) intrusive and recurring memories of the traumatic event(s), (b) avoidance of similar situations or reminders of the traumatic event(s), (c) negative changes in cognition and mood, and (d) hyperarousal and exaggerated startle response.

During the COVID-19 pandemic the literature has shown that some ICU nurses have suffered physical (e.g., sleep disturbances, headaches) and psychological symptoms (e.g., anxiety, depression, and in severe cases, suicidal contemplations) while caring for COVID-19 patients (Shen et al., 2020; Tan et al., 2020; Yifan et al., 2020). However, a gap exists in the literature on the types of work-related events that ICU nurses caring for COVID-19 patients' experience that result in psychological distress and the impact this has on their health. This study aimed to investigate the lived experiences of ICU nurses caring for COVID-19 patients to understand and describe the stressful experiences and

determine whether these experiences impacted their mental health and attitudes toward their careers.

Methods

A phenomenological methodology was selected as the most appropriate to investigate the lived experiences of ICU nurses caring for COVID-19 patients. A phenomenological approach can capture an in-depth analysis through textural (the ICU nurses' perceptions) and structural descriptions (how they experienced the phenomenon) to "convey the overall essence of their lived experiences" (Creswell & Poth, 2018). Through the sharing of stories, a complex and detailed understanding of the phenomenon can be revealed (Creswell & Poth, 2018). Colaizzi's (1978) procedural framework (Table 1) was used for the qualitative analysis. Questionnaires were administered by the principal investigator (PI) to obtain demographic information and to assess for PTSD, job satisfaction, and intention to leave their job.

Table 1

Colaizzi's Data Analysis Framework Procedure

Step Number	Data Analysis Step
Step One	Reading transcripts to acquire a sense of each transcript
Step Two	Extracting significant statements from transcripts
Step Three	Formulation of meanings
Step Four	Organizing formulated meanings into themes
Step Five	Exhaustively describing the investigated phenomenon
Step Six	Identification of the fundamental structure of the phenomenon
Step Seven	Validating the process by returning findings to participants

Sample and Setting

A convenience sample of 10 ICU nurses caring for COVID-19 patients was recruited at an academic health science center in the southeastern United States within the period of August 10, 2020 to September 13, 2020. Recruitment techniques to incorporate a diverse sample of participants included visits to the unit to explain the study purpose and relay that all perspectives are valuable and needed. Snowballing, a recruitment method in which participants are asked to assist in identifying other potential participants (Sadler et al., 2010), was also employed. Inclusion requirements included that participants were currently caring for COVID-19 patients admitted to the ICU, at least 21 years old, and employed at the academic health science center for at least 6 months as an ICU nurse. Participants of all genders, races, and ethnicities were sought. Exclusion

criteria consisted of ICU nurses who were unable or unwilling to meet for an audiotaped telephone interview for 60 minutes.

Ethical Considerations

Ethics approval for this research was obtained from a university institutional review board. Verbal informed consent was given by all participants prior to interviews. Participants were informed that they had the right to withdraw from the study at any time. Confidentiality was assured and participants' names were replaced by unique identifiers.

Data Collection

Due to COVID-19 social distancing guidelines, semi-structured interviews were conducted via audiotaped telephone calls to minimize risk of COVID-19 transmission. The principal investigator (PI) conducted the semi-structured telephone interviews in a private room with a closed door. To reduce burden of study participation, participants were able to choose the time and date to be interviewed. Most participants shared their experiences from the privacy of their homes, enhancing confidentiality. Sociodemographic information included age (in years), gender (male/female), ethnicity (Caucasian, African American, Latinx or Hispanic, Asian, Native American, Other), marital status (single, married or domestic partnership, widowed, divorced, separated), level of education (categories bachelor's degree, licensed practical nurse, associate degree, master's degree), years employed as an ICU nurse, and years at current position.

Following the tradition of phenomenology, open-ended questions were designed to explore the ICU nurses' experiences, perceptions, thoughts, and feelings (Creswell & Poth, 2018). The questions asked about the ICU nurses' experiences of caring for COVID-19 patients, experiences with the patients' family members and friends, and experiences with their own families (Table 2). To gain thick, rich descriptions and reveal the underlying meaning behind their experiences, participants were encouraged to talk freely. Most importantly, and guided by the philosophy of phenomenology, the PI did not lead the participant or influence their response (Creswell & Clark, 2017). This was achieved by allowing the participant to steer the conversation, as opposed to directing and controlling the conversation, and bracketing prior knowledge and beliefs about the phenomenon.

Table 2

Interview Guide

Interview Questions
What have you experienced in terms of caring for COVID-19 patients?
What were your experiences communicating with the family and friends of COVID-19 patients?
What were your experiences with your family and friends while caring for these COVID-19 patients?
Probes
Could you expand on that?
Can you give me an example?
How did that make you feel?

Participant interviews lasted approximately 1 hour (ranging from 47 to 70 minutes). A journal was used to reflect on thoughts that arose during the interviews. When redundancy of data ("saturation") from the group of participants was reached, recruitment concluded. The data were de-identified to protect confidentiality and identity of participants. Electronic data were stored on a password-protected computer, encrypted in OneDrive on the academic health science center's server network, with only the unique identifier assigned to each participant. Other data included observations (e.g., crying, voices cracking with emotion, laughing) on the audio recordings and reflection notes.

Data Analysis

Interviews were transcribed verbatim within 24 hours of each audiotaped interview. Colaizzi's (1978) seven-step method of qualitative data analysis was chosen to enhance credibility and trustworthiness in data collection and analysis. QSR International's NVivo 12 (Victoria, Australia) qualitative data analysis software was used to analyze interview transcriptions. To promote trustworthiness, the PI and second author attempted to bracket any prior knowledge and beliefs about the phenomenon, acknowledging their ICU nursing experience.

Following Colaizzi's (1978) steps, transcripts were repeatedly reviewed to allow the PI to become familiar with the core meaning. In the second step, significant statements were extracted from each transcript. The third step involved generating statements into codes and formulating meanings from codes. In the fourth step, formulated meanings of similar codes were organized into themes. Step 5 involved the integration of the coded statements into an exhaustive description of the phenomenon to gain conceptual understanding. Data analysis was performed concurrently with data collection to recognize when data saturation had been accomplished. Step 6 entailed identifying the fundamental structure of the phenomenon of the lived experience of ICU nurses caring for COVID-19 patients. Finally, in Step 7, findings were validated with participants to enhance rigor.

When code categories were firmly established, the PI (PML) and second author (JM) independently carried out analyses on the same data to establish reliability of coding (kappa coefficient = 0.89). Additional strategies to establish credibility and trustworthiness included generating thick, rich description, clarifying researcher biases

from the onset, prolonged engagement in data collection, and member-checking to ensure participants' meanings and perspectives were represented rather than the PI's (Lincoln & Guba, 1985). Reliability of coding was accomplished through the use of two coders to analyze transcript data. Finally, to ensure trustworthiness and dependability of the research, an ongoing audit trail was maintained by the PI to track the process of research, how decisions were made, and the procedure of conducting intercoder agreement checks (Lincoln & Guba, 1985).

Results

The ICU nurse sample was comprised of nine females and one male, all Caucasian, with a mean age of 26.6 years. Seven of the nurses were single and three were married. Mean years as an ICU nurse and mean years at job was 1.95 years (Table 3). The analysis of the interview transcripts revealed six recurring themes: Change in Practice, Emotion, Patient's Family, Isolation, Job Satisfaction, and Public Reaction. The theme Change in Practice included four subthemes: Overburden, Knowledge, Quality of Care, and Futility.

Table 3

ICU Nurse Demographics (n=10).

ICU NURSE DEMOGRAPHICS	
Mean Age	**26.6**
Female *n* (%)	**9 (90)**
Caucasian *n* (%)	**10 (100)**
Degree n (%)	
Associate Degree	**3 (30)**
Bachelor's Degree	**6 (60)**
Master's Degree	**1 (10)**
Mean Years as ICU Nurse	**1.95**
Mean Years at Job	**1.95**
Married *n* (%)	**3 (30)**
Single *n* (%)	**7 (70)**

Table 4

Additional Experiences of Study Nurses

Theme and Subthemes	Study Nurses' Lived Experiences
Change in Practice Subthemes: *Knowledge*	Nobody really knew what we needed to do to protect ourselves. When we can see it's getting close, we do allow family to come up, but…it's all very situational and it changes all the time.
Overburden	The pace is a lot faster than it was. It's hard, because you keep feeling like you're falling behind. That's been really hard, just trying to do everything for your patients. It's been a lot of added responsibility. The physical workload has also increased a lot which creates another level of stress, as well.
Quality of Care	If one of your patients is really sick or has an acute process going on, it's really easy to feel like you're neglecting your other patient. You used to be able to run in and just … but now we have to get all of this gear on and that made me feel conflicted inside of myself.
Futility	I've had a couple of patients, where … I really feel like I'm doing more harm than good. They just look miserable, and the family just can't let go. What makes me feel the worst is knowing that we put her through that for nothing, essentially, because she did pass away.
Emotion	It was one of the most horrific days. You have … moments when you just walk away, and you spend (time) in the bathroom to get yourself to stop crying. We tell all the (new) nurses coming in, if you have a breakdown, if you can't handle it, if you start to panic in the room, that is okay. I have seen too many people die. It's hard (crying). I am too young to be experiencing something like this in my life.
Patient's Family	Whenever patients are transitioning to end-of-life, actively dying … dealing with their family members is really tough. It's been really hard because they're not there to see how bad their loved one is. Having to explain that over the phone is very difficult.
Isolation	I try to talk about it, and I just want them to understand so bad, and try to help me along this process. But I don't get that, like I want. There's not one person on this unit who has not had a panic in these suits, feeling isolated … feeling like they don't know what they're doing, freaking out.
Public Reaction	They didn't know they were on speakerphone, but it really hurt me. And it made me feel so offended and really down on myself. No one really wants to talk about how young people are dying alone.
Job Satisfaction	It helps that I have so many friends that work with me. It's been really hard for us to feel supported.

Change in Practice

Overburden

Study nurses described a distinct change in practice since the pandemic began. They explained they were overburdened at work with an increase in the level of acuity of patients, daily workload, and number of patient deaths. One nurse stated, “I basically spent 10 hours in that patients’ room from the time they got there, until the time that they died.” Another nurse recalled, “I had two patients by myself and both just crashed at the same time . . . it just became a very stressful situation to get the help that I needed.” The ICU nurses must take time to put on PPE before entering the room and remember all needed supplies. A nurse explained, “You used to be able to run in and just help your patient, but now we have to get all of this gear on.” One nurse talked of the difference in the number of patient deaths, “One week my (assigned) patient died every single day.” The nurses also shared that many patients were dying alone because family members were not allowed on the unit due to risk of COVID-19 transmission. The family is called to come to the ICU only when the end of life is near. But the exact time a patient will die is hard to predict, so often, patients die alone. One nurse said, “I see people die all the time, but it’s just not like this . . . all alone.”

Knowledge

In the beginning of the COVID-19 pandemic, the ICU nurses had a critical need for knowledge about the novel coronavirus. One nurse recalled caring for her first patient infected with COVID-19:

> We didn't know if PPE was going to be effective. We thought it's really going to affect only those who are older or are immunocompromised, and very quickly our patient population was not representing that. With all of the obstacles, like PPE and not understanding the disease, (it) made taking care of these patients so much scarier.

The ICU nurses also discussed the lack of knowledge regarding ever-changing hospital policies concerning COVID-19, especially for proper PPE and visitation. One nurse stated, “Not knowing, like, what to do . . . not having concrete policies, but things just changing all the time. What sort of masks we have to wear . . . that just changes all the time.”

Quality of Care

Study nurses spoke of how they were unable to give patients their usual quality care due to following hospital guidelines to minimize the risk of COVID-19 transmission (e.g., clustering care to reduce nursing encounters), time for donning PPE, and increased workload caring for these patients. One nurse stated, “I couldn’t (get in the room fast enough), and it caused my patient harm.” Another nurse reported,

> It makes me feel guilty because I’m on the outside (following hospital guidelines to minimize the risk of COVID-19 transmission). I should be doing everything to help them, but I feel like I can’t . . . I feel grief really.

And another nurse, “It makes you feel like a bad nurse . . . we do everything we can, but still we can’t do the little things like we used to do.”

Futility

The study nurses described experiencing futility; that they tried so hard to save their patients yet kept witnessing so many patients die. One nurse said, "Every day you come in and you see the same type of patients over and over again. You see people die over and over again. It's just like repetitive." Another type of futility addressed was futile care, or medical treatment not likely to produce any meaningful benefit to the patient (Kyriakopoulos et al., 2017). One nurse stated, "I feel like these patients are lying here suffering, and we're coding them, and we're just intervening so much, when they are ultimately going to pass away." Another nurse recounted,

> I remember being teary giving report, just thinking about all the things that we had been doing to this woman that seemed so unnecessary … to where in any other circumstance the family would just … let go peacefully, instead of spinal taps and neurological tests and everything.

Emotion

Study nurses were experiencing many negative emotions in their daily lives from caring for COVID-19 patients, including grief, worry, sadness, fear, and anger. They talked of an emotional "toll" from caring for these patients. One nurse described an episode of trying to save a COVID-19 patient's life and reported frequently re-experiencing the event, "after the code, it literally looked like a war zone . . . and that is what haunts me every day in my dreams." The nurses voiced their fear of bringing the virus home to family members, some of whom were newborns, elderly, or immunocompromised. One nurse stated, "I want to work, I don't want to let my co-workers down, but I mean, I have to protect my family." The nurses felt grief from the

overwhelming amount of patient deaths and difficulty experiencing grief with the patient's family. One nurse expressed how, for her, even the simple task of putting an isolation gown on a family member and taking it off carried so much emotional weight,

> . . . the intimacy of having to dress a family member up in the isolation garb and then take it off at the most distressed point in their life, and give them dignity, but also a goodbye with their loved one.

The nurses talked of their frustration battling COVID-19. One nurse said, "I just cried for two hours because I was just so frustrated, worn out, and tired." Another nurse discussed the overall work environment, saying "We have always had really great teamwork, and we still do. It's just, you could tell that there are underlying emotions: anger, frustration, and just numbness." One nurse explained, "I definitely have felt like angry, like angry at my co-workers, angry at doctors, like just angry at people. I find myself just snapping at people and like, honestly, yelling sometimes, which is not like me." Another nurse spoke of uncharacteristic anger and frustration that she recognized as a symptom of her experiences at work:

> I didn't realize . . . that lashing out is a symptom. I was just so full of anger and I looked it (PTSD) up myself and I saw the signs and symptoms. And I was like, "this is new to me." You know, there's tons of "you could get help," but I also feel like it's my job.

Patient's Family

The pandemic brought new policies, including restrictions on visitation. The ICU nurses were sympathetic that family members were not allowed on the unit due to

minimizing viral transmission. With this new restriction, the nurses were burdened with added responsibilities. Nurses now had a primary role in discussing patient status and care and often sought to help families connect using tablets and cell phones. When family were able to come to the unit (usually because the patient's condition had declined considerably), they were often in shock after seeing their loved one for the first time since admission. One nurse acknowledged, "It's been really sad to see people come in from being fine at their house, you know, yesterday and then the next time their family sees them we are withdrawing care (or) we're there coding (the patient)." One nurse talked about an experience with family:

> When she came in and saw him for the first time … she went through every range of guilt … trying to shake the patient awake … telling me to turn everything off and yelling at me and yelling at the doctors because she was just so taken aback by all the drips and machinery all over her husband (crying). It was very scary … and also, the stress because I didn't know how to handle that type of situation.

The nurses also spoke of the difficulty of witnessing patients die alone. The nurses used tablets or phones for families to see and talk to patients. During these times, families were having their most personal conversations. One nurse described a final call from family to say goodbye:

> I think, um, honestly … (sniffling, voice cracking) the worst experiences are the most stressful experiences with families. There was this one woman (and) her children on the telehealth, taking turns (talking), and she ended up passing that night, and (crying hard now) they said, "Mom,

> you've got to get better (voice cracking), you just can't leave us now." And that's just not the way to say goodbye to people.

Isolation

In the beginning of the pandemic, most of the ICU nurses self-imposed isolation due to fear of spreading the virus. One nurse explained,

> "When we first started, I wouldn't go around my parents … or grandparents for the fear that I was going to be the cause to get them sick. It was really hard … I went, like, two months without seeing them."

Family and friends were also fearful of contracting the virus due to their caring for COVID-19 patients. One nurse recalled seeing family for the first time after self-isolating from them, "They didn't want to see us, and the first time I saw them I didn't know if I could hug them. It's really hard. You feel ostracized." Another nurse stated, "our hospital (in the beginning) . . . treated us like we were dirty. They told us we weren't allowed to work on other units. (Some) doctors who had consults would refuse to come on our unit." At times, study nurses also felt isolated from each other while busily caring for COVID-19 patients:

> There's been situations where … things that I just couldn't really handle by myself … felt very unsafe for me and the patient, and just kind of lost for what to do… my patient is desatting (desaturation of oxygen level) and I look out the window and there's no other nurses around. And I just feel panicky, like what do I do? Even though I've been a nurse for (some) years, I still just feel really scared. I feel like a new nurse all over again.

Public Reaction

Study nurses discussed how angered they were that they were putting their health and their families' health at risk caring for COVID-19 patients, and yet some people ignored social distancing guidelines. One nurse said, "I think the hardest part, is for me, seeing how the rest of the world, especially in the beginning, didn't take it seriously, and didn't social distance, and still don't now." The nurses spoke of being shunned by family and friends. One nurse recalled, "At the beginning, I had several family and friends who didn't want to see me. I understand . . . they're coming from a place of safety, but it did hurt me." Study nurses also spoke of personal injury from others due to caring for COVID-19 patients, "Sometimes my friends say, 'can we please just stop talking about COVID' and it kind of hurts my feelings."

Job Satisfaction

Study nurses had differing feelings about job satisfaction. One nurse said, "I have a very strong work ethic. I want to work. I love my job." Other nurses reported on aspects of their job they were not happy about. One nurse stated,

> One of the most stressful things … is that we weren't really asked to care for COVID-19 patients. It was like here is this disease … we don't have enough PPE … but just get in there and do it."

Another nurse recounted how she felt when the hospital reduced salaries due to pandemic-related financial consequences:

> You know, toward the beginning … (they) cut our pay. We just felt like that was such a big slap in the face, and that definitely contributed, I think, to a lot of our stress. Now we're getting COVID pay. We just talk about all

the time how we wish administration and higher ups would come down to the unit for a day and see what we deal with.

Quantitative Results

The quantitative portion of this research assessed for PTSD using the PTSD Checklist-5. The 20-item scale measures PTSD using the four DSM-5 cluster symptoms: re-experiencing of traumatic event(s), avoidance of reminders or similar situations, negative alterations in cognition and mood, and hyperarousal symptoms. Blevins et al.'s (2015) initial psychometric evaluation determined the PCL-5 was a psychometrically sound measure and exhibited strong reliability and validity. Cronbach's alpha coefficient of internal consistency was .94 and retest reliability was .82. Of the 10 ICU nurses, 7 (70%) met the diagnostic criteria for PTSD using a PCL-5 cut-point score of ≥31. Job satisfaction findings determined that 1 of the 10 (10%) ICU nurses was very satisfied with their job; 7 (70%) were somewhat satisfied, 1 (10%) was neither satisfied nor dissatisfied, and 1 was somewhat dissatisfied. Five of the 10 (50%) participants had considered leaving job in the last 6 months.

Discussion

Infectious disease outbreaks affect frontline health care workers disproportionately, from threatening their lives, to changing and stressful work demands, and coping with high death rates, all of which can further heighten their fear, anxiety, and stress (Mohammed et al., 2015). Through the sharing of the study nurses' stories, an intricate and detailed description of their experiences underscored the psychological

stress and trauma these nurses lived through (and continue to endure) caring for COVID-19 patients. Our study nurses experienced many changes in practice, including overburden at work; lack of knowledge, or ever-changing knowledge of the COVID-19 virus and hospital policies; not being able to give patients their standard quality of care; and futility. Study nurses experienced overburden at work due to increased workload, heightened acuity of patients, and added work responsibilities. There was also ever-changing knowledge of the virus and associated hospital policies. Study nurses could no longer give patients their standard quality of care because of COVID-19 transmission precautions, time for donning PPE, and increased workload caring for these patients. For nearly two decades, the nursing profession has been ranked as one of the most trusted professions (Gallup Incorporated, 2020). Study nurses experienced feelings of guilt and inadequacy from not being able to maintain quality of care for their patients. Study nurses perceived their efforts as futile due to the unprecedented number of patient deaths or when they felt patients would no longer benefit from aggressive care. Jameton (1984) created the term "moral distress" to illustrate when nurses are constrained to do things that they believe are morally wrong. End-of-life care that is perceived to be overly aggressive is an especially common source of moral distress (Dodek et al., 2019; Henrich et al., 2016). These changes in practice, echoed in prior research (Crowe et al., 2021; Galehdar et al., 2021; Lapum et al., 2021; Schroeder et al., 2020; Silverman et al., 2021), caused study nurses significant stress.

Study nurses suffered a wide range of emotions while caring for COVID-19 patients, including worry, fear, grief, anger, and frustration. These emotions are in accordance with other study findings which illustrated nurses' fear of COVID-19

transmission to themselves and/or their family (Galehdar et al., 2021), moral distress from not being able to give their best care (Galehdar et al., 2021; Jia et al., 2021), and difficulty in hearing the heart-wrenching last words of grief-stricken family members (LoGiudice & Bartos, 2021). Also distressing for our sample of nurses, and other nurses caring for COVID-19 patients during the pandemic, was witnessing patients dying alone (Crowe et al., 2021; LoGiudice & Bartos, 2021; Robinson & Stinson, 2021).

After many months of self-imposed isolation from family and friends without contracting the virus, study nurses felt safer and began to see family again, practicing social distancing. However, similar to other studies (Crowe et al., 2021; Kackin et al., 2020), some family and friends were fearful of reuniting with them, resulting in study nurses feeling ostracized. In contrast to our findings, however, the ICU nurses in Kackin et al.'s (2021) study preferred to isolate from others when they felt shunned. One reason cited was the risk of being stigmatized by society. Another type of isolation some study nurses experienced was isolation from coworkers due to increased workload and coworkers being busy in patients' isolation rooms. This caused them psychological distress when alone with their patient whose condition was deteriorating. Renowned psychiatrist Herbert Spiegel (1944) found that a lack of support, or even a perceived lack of support, can cause a sense of aloneness which can result in psychological trauma during distressing situations.

Study nurses experienced both stress and anger when individuals disregarded the importance of social distancing, while they were being pushed to the brink at work and placed themselves and their family at risk. The significant stress study nurses experienced caring for COVID-19 patients adversely impacted most study nurses' job satisfaction. An

unsettling survey by the American Nurses Association (2020), with responses from more than 32,000 nurses caring for patients during the COVID-19 pandemic, found 87% were very or somewhat afraid to go to work. It is well-documented that psychological stress experienced in the workplace contributes to a high turnover and results in some nurses leaving the nursing profession altogether (Lim et al., 2010; Morley et al., 2020; Vahedian-Azimi et al., 2019).

Findings from the quantitative data analysis also provided insight into the psychological stress study nurses experienced caring for COVID-19 patients, as 7 of 10 study nurses met diagnostic criteria for PTSD. While our quantitative findings of PTSD are not generalizable due to the small sample, Greenberg et al.'s (2021) study found an alarming 49% of ICU nurse participants who cared for COVID-19 patients with probable PTSD (in a sample of 344 ICU nurses). Furthermore, nearly 20% of these nurses reported thoughts of self-harm or suicide.

Mealer et al.'s (2012) study investigated traumatic event(s) nurses with probable PTSD (21% of 744 nurses) experienced, citing failure to save a patient (50%), performing futile care (36%), and witnessing patients die (29%) as the top events that caused the trauma. Similarly, our study found events that inflicted psychological stress or trauma included witnessing many patients die, compounded by the fact that many died alone; performing futile care; being isolated from coworkers when their patient's condition was declining; and frequently hearing their patients' family members' heart-wrenching last words to their loved one. The nurses in our study (mean age = 26.6 years; mean years of ICU experience = 1.95 years), and in ICUs in general, are younger than the overall nursing population (Data USA, 2019; National Council of State Boards of

Nursing, 2017). d'Ettorre et al.'s (2021) systematic review of health care workers caring for patients during the COVID-19 pandemic also found a high rate of post-traumatic stress in young health care workers with low work experience. More research is needed to examine the difference in how nurses experience traumatic work, occupational, or work-life events at different levels of experience and/or age.

Limitations

Although the researchers sought to recruit a diverse group of nurses, there was a lack of racial and sexual diversity among participants. It is possible that the difficult experiences reported by these ICU nurses, who all identified as White, may differ from other ethnicities. For instance, research suggests that Blacks experience higher levels of violent victimization and a higher lifetime prevalence of PTSD when compared with Whites; Asians may experience substantially lower levels of violent victimization and are at lower risk for the development of PTSD (Brooks Holliday et al., 2020; Roberts et al., 2011). In addition, women are approximately twice as likely to suffer from PTSD as men (National Center for PTSD, n.d.). Of note, in the study state, 81% of nurses are White, 15% Black, and 4% consist of other races (Alabama Board of Nursing, 2016). Furthermore, only 10% of nurses are male. Further limitations include that this study was limited to a particular ICU unit and findings may not be generalizable to other COVID units. Quantitative findings are not generalizable due to the small sample size.

Implications for Practice

The findings of this research contribute to important implications for occupational health nursing practice. Hospital administrators, nurse managers, and occupational health nurses need to develop and implement policies and evidence-based interventions to mitigate or prevent development of PTSD for their ICU nurse employees. Offering ICU nursing staff ongoing psychological support, as needed (e.g., incident debriefing, counseling, or support through an employee assistance program) and as opt-out rather than opt-in may increase participation. Mental health screenings should be made accessible and affordable. Identification of symptoms of PTSD must be confidential and seeking treatment should not threaten nurses' licensure or employment.

Early identification of psychological stress and PTSD can assist in prevention of long-term health consequences, including cardiovascular disease, diabetes, and hypertension (Dyball et al., 2019). A McKinsey Global Institute (2021) study found 62% of 400 frontline nurses who cared for COVID-19 patients believed that active monitoring of nurse distress would be effective in supporting the well-being of nurses. Heart rate variability (HRV) is an objective, noninvasive, and low-cost tool that can measure psychological stress and autonomic nervous system function (Ge et al., 2020; Kim et al., 2018). Past research has found a significant association between PTSD and reduced, or low, HRV (Ge et al., 2020; Schneider & Schwerdtfeger, 2020). If low HRV indicating psychological stress is observed, nurse managers and occupational health nurses can recommend a program where skills in self-regulation techniques are learned (e.g., focused breathing techniques) in conjunction with HRV monitoring. Enabling ICU nurses

to monitor their HRV and practice self-regulation techniques can be an effective strategy to reduce psychological stress and equip them with tools to remain in the ICU workforce.

References

Alabama Board of Nursing. (2016). *Alabama's registered nurse workforce 2016 demographics*. https://www.abn.alabama.gov/wp-content/uploads/2017/10/2016_RN_Renewal.pdf

American Nurses Association. (2020). *What 32,000 nurses want you to know about treating COVID-19*. https://www.nursingworld.org/~4987e5/globalassets/covid19/ana_covid19infographic_dataset1_20200424-final.pdf

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5)*. American Psychiatric Publishing.

Blevins, C. A., Weathers, F. W., Davis, M. T., Witte, T. K., & Domino, J. L. (2015). The Posttraumatic Stress Disorder Checklist for DSM-5 (PCL-5): Development and initial psychometric evaluation. *Journal of Traumatic Stress*, *28*(6), 489–498. https://doi-org.ezproxy3.lhl.uab.edu/10.1002/jts.22059

Brooks Holliday, S., Dubowitz, T., Haas, A., Ghosh-Dastidar, B., DeSantis, A., & Troxel, W. M. (2020). The association between discrimination and PTSD in African Americans: Exploring the role of gender. *Ethnicity & Health*, *25*(5), 717-731. doi https://doi.org/10.1080/13557858.2018.1444150

Colaizzi, P. F. (1978). *Psychological research as the phenomenologist views it*. Oxford University Press.

Creswell J. W., Clark V. L. P. (2017). *Designing and conducting mixed methods research*. Sage Publications.

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches*. Sage Publications.

Crowe, S., Howard, A. F., Vanderspank-Wright, B., Gillis, P., McLeod, F., Penner, C., & Haljan, G. (2021). The effect of COVID-19 pandemic on the mental health of Canadian critical care nurses providing patient care during the early phase pandemic: A mixed method study. *Intensive & Critical Care Nursing, 63*, 102999. https://www-sciencedirect-com.ezproxy3.lhl.uab.edu/science/article/pii/S0964339720302020?via%3Dihub

Data USA. (2019). *Critical care nursing*. https://datausa.io/profile/cip/critical-care-nursing

d'Ettorre, G., Ceccarelli, G., Santinelli, L., Vassalini, P., Innocenti, G. P., Alessandri, F., Koukopoulos, A. E., Russo, A., d'Ettorre, G., & Tarsitani, L. (2021). Post-traumatic stress symptoms in healthcare workers dealing with the COVID-19 pandemic: A systematic review. *International Journal of Environmental Research and Public Health*, *18*(2), 601. https://doi.org/10.3390/ijerph18020601

Dodek, P. M., Norena, M., Ayas, N., & Wong, H. (2019). Moral distress is associated with general workplace distress in intensive care unit personnel. *Journal of Critical Care*, *50*, 122-125. https://doi.org/10.1016/j.jcrc.2018.11.030

Dyball, D., Evans, S., Boos, C. J., Stevelink, S., & Fear, N. T. (2019). The association between PTSD and cardiovascular disease and its risk factors in male veterans of the Iraq/Afghanistan conflicts: A systematic review. *International Review of*

Psychiatry (Abingdon, England), *31*(1), 34–48. https://doi-org.ezproxy3.lhl.uab.edu/10.1080/09540261.2019.1580686

Galehdar, N., Toulabi, T., Kamran, A., & Heydari, H. (2021). Exploring nurses' perception of taking care of patients with coronavirus disease (COVID-19): A qualitative study. *Nursing Open*, *8*(1), 171-179. https://onlinelibrary.wiley.com/doi/10.1002/nop2.616

Gallup, Incorporated. (2020). *U.S. ethics ratings rise for medical workers and teachers*. https://news.gallup.com/poll/328136/ethics-ratings-rise-medical-workers-teachers.aspx

Ge, F., Yuan, M., Li, Y., & Zhang, W. (2020). Posttraumatic stress disorder and alterations in resting heart rate variability: A systematic review and meta-analysis. *Psychiatry Investigation*, *17*(1), 9–20. https://doi-org.ezproxy3.lhl.uab.edu/10.30773/pi.2019.0112

Greenberg, N., Weston, D., Hall, C., Caulfield, T., Williamson, V., & Fong, K. (2021). Mental health of staff working in intensive care during COVID-19. *Occupational Medicine (Oxford, England)*, *71*(2), 62–67. https://doi-org.ezproxy3.lhl.uab.edu/10.1093/occmed/kqaa220

Henrich, N. J., Dodek, P. M., Alden, L., Keenan, S. P., Reynolds, S., & Rodney, P. (2016). Causes of moral distress in the intensive care unit: A qualitative study. *Journal of Critical Care, 35*, 57-62. https://doi.org/10.1016/j.jcrc.2016.04.033

Jameton, A. (1984). *Nursing practice: The ethical issues*. Prentice-Hall.

Jia, Y., Chen, O., Xiao, Z., Xiao, J., Bian, J., & Jia, H. (2021). Nurses' ethical challenges caring for people with COVID-19: A qualitative study. *Nursing Ethics*, *28*(1), 33–45. https://doi-org.ezproxy3.lhl.uab.edu/10.1177/0969733020944453

Kackin, O., Ciydem, E., Aci, O. S., & Kutlu, F. Y. (2020). Experiences and psychosocial problems of nurses caring for patients diagnosed with COVID-19 in Turkey: A qualitative study. *The International Journal of Social Psychiatry*, 20764020942788. Advance online publication. https://doi-org.ezproxy3.lhl.uab.edu/10.1177/0020764020942788

Kim, H. G., Cheon, E. J., Bai, D. S., Lee, Y. H., & Koo, B. H. (2018). Stress and heart rate variability: A meta-analysis and review of the literature. *Psychiatry Investigation*, *15*(3), 235–245. https://doi-org.ezproxy3.lhl.uab.edu/10.30773/pi.2017.08.17

Kyriakopoulos, P., Fedyk, M., & Shamy, M. (2017). Translating futility. *CMAJ : Canadian Medical Association Journal =Journal de l'Association Medicale Canadienne*, *189*(23), E805–E806. https://doi-org.ezproxy3.lhl.uab.edu/10.1503/cmaj.161354

Lapum, J., Nguyen, M., Fredericks, S., Lai, S., & McShane, J. (2021). "Goodbye … through a glass door": Emotional experiences of working in COVID-19 acute care hospital environments. *The Canadian Journal of Nursing Research = Revue Canadienne de Recherche en Sciences Infirmieres*, *53*(1), 5–15. https://doi-org.ezproxy3.lhl.uab.edu/10.1177/0844562120982420

Levi, P., Patrician, P. A., Vance, D. E., Montgomery, A. P., & Moss, J. (2021). Post-traumatic stress disorder in intensive care unit nurses: A concept analysis. *Workplace Health & Safety*, *69*(5), 224–234. https://doi-org.ezproxy3.lhl.uab.edu/10.1177/2165079920971999

Liddell, K., Skopek, J. M., Palmer, S., Martin, S., Anderson, J., & Sagar, A. (2020). Who gets the ventilator? Important legal rights in a pandemic. *Journal of Medical Ethics*, *46*(7), 421–426. https://doi-org.ezproxy3.lhl.uab.edu/10.1136/medethics-2020-106332

Lim, J., Bogossian, F., & Ahern, K. (2010). Stress and coping in Australian nurses: A systematic review. *International Nursing Review*, *57*(1), 22–31. https://doi-org.ezproxy3.lhl.uab.edu/10.1111/j.1466-7657.2009.00765.x

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage Publications.

LoGiudice, J. A., & Bartos, S. (2021). Experiences of nurses during the COVID-19 pandemic: A mixed-methods study. *AACN Advanced Critical Care*, *32*(1), 14-26. https://doi-org.ezproxy3.lhl.uab.edu/10.4037/aacnacc2021816

McKinsey Global Institute. (2021). *2021 Future of Work in Nursing Survey*. https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/nursing-in-2021-retaining-the-healthcare-workforce-when-we-need-it-most

Mealer, M., Jones, J., Newman, J., McFann, K. K., Rothbaum, B., & Moss, M. (2012). The presence of resilience is associated with a healthier psychological profile in intensive care unit (ICU) nurses: Results of a national survey. *International*

Journal of Nursing Studies, *49*(3), 292-299. https://doi.org/10.1016/j.ijnurstu.2011.09.015

Mohammed, A., Sheikh, T. L., Poggensee, G., Nguku, P., Olayinka, A., Ohuabunwo, C., & Eaton, J. (2015). Mental health in emergency response: Lessons from Ebola. *The Lancet. Psychiatry*, *2*(11), 955–957. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/S2215-0366(15)00451-4

Morley, G., Grady, C., McCarthy, J., & Ulrich, C. M. (2020). COVID-19: Ethical challenges for nurses. *Hastings Center Report*, *50*(3), 35-39. https://onlinelibrary-wiley-com.ezproxy3.lhl.uab.edu/doi/full/10.1002/hast.1110#hast1110-bib-0004

Moustakas, C. (1994). *Phenomenological research methods*. Sage Publications.

National Center for PTSD. (n.d.). *Research on women, trauma and PTSD*. U.S. Department of Veterans Affairs. https://www.ptsd.va.gov/professional/treat/specific/ptsd_research_women.asp

National Council of State Boards of Nursing. (2017). *2017 National Nursing Workforce Study*. https://www.ncsbn.org/workforce.htm

Roberts, A. L., Gilman, S. E., Breslau, J., Breslau, N., & Koenen, K. C. (2011). Race/ethnic differences in exposure to traumatic events, development of post-traumatic stress disorder, and treatment-seeking for post-traumatic stress disorder in the United States. *Psychological Medicine*, *41*(1), 71-83. https://doi.org/10.1017/s0033291710000401

Robinson, R., & Stinson, C. K. (2021). The lived experiences of nurses working during the COVID-19 pandemic. *Dimensions of Critical Care Nursing*, *40*(3), 156-163. https://doi-org.ezproxy3.lhl.uab.edu/10.1097/DCC.0000000000000481

Sadler, G. R., Lee, H. C., Lim, R. S., & Fullerton, J. (2010). Recruitment of hard-to-reach population subgroups via adaptations of the snowball sampling strategy. *Nursing & Health Sciences*, *12*(3), 369–374. https://doi-org.ezproxy3.lhl.uab.edu/10.1111/j.1442-2018.2010.00541.x

Salmon, G., & Morehead, A. (2019). Posttraumatic stress syndrome and implications for practice in critical care nurses. *Critical Care Nursing Clinics of North America, 31*(4), 517-526. https://www-sciencedirect-com.ezproxy3.lhl.uab.edu/science/article/pii/S0899588519300589?via%3Dihub

Schneider, M., & Schwerdtfeger, A. (2020). Autonomic dysfunction in posttraumatic stress disorder indexed by heart rate variability: A meta-analysis. *Psychological Medicine*, *50*(12), 1937-1948. https://doi.org/10.1017/s003329172000207x

Schroeder, K., Norful, A. A., Travers, J., & Aliyu, S. (2020). Nursing perspectives on care delivery during the early stages of the COVID-19 pandemic: A qualitative study. *International Journal of Nursing Studies Advances*, *2*, 100006. https://www.sciencedirect.com/science/article/pii/S2666142X20300059?via%3Dihub

Schuster, M., & Dwyer, P. A. (2020). Post-traumatic stress disorder in nurses: An integrative review. *Journal of Clinical Nursing*, *29*(15-16), 2769–2787. https://doi-org.ezproxy3.lhl.uab.edu/10.1111/jocn.15288

Shen, X., Zou, X., Zhong, X., Yan, J., & Li, L. (2020). Psychological stress of ICU nurses in the time of COVID-19. *Critical Care*, *24*(1), 200. https://doi-org.ezproxy3.lhl.uab.edu/10.1186/s13054-020-02926-2

Silverman, H. J., Kheirbek, R. E., Moscou-Jackson, G., & Day, J. (2021). Moral distress in nurses caring for patients with COVID-19. *Nursing Ethics*, 9697330211003217. [*Preprint] Advance online publication. doi https://doi.org/10.1177/09697330211003217

Spiegel, H. X. (1944). Preventive psychiatry with combat troops. *American Journal of Psychiatry*, *101*(3), 310-315. https://ajp.psychiatryonline.org/doi/abs/10.1176/ajp.101.3.310?journalCode=ajp

Tan, B., Chew, N., Lee, G., Jing, M., Goh, Y., Yeo, L., Zhang, K., Chin, H. K., Ahmad, A., Khan, F. A., Shanmugam, G. N., Chan, B., Sunny, S., Chandra, B., Ong, J., Paliwal, P. R., Wong, L., Sagayanathan, R., Chen, J. T., & Sharma, V. K. (2020). Psychological impact of the COVID-19 pandemic on health care workers in Singapore. *Annals of Internal Medicine*, *173*(4), 317–320. https://doi-org.ezproxy3.lhl.uab.edu/10.7326/M20-1083

Vahedian-Azimi, A., Hajiesmaeili, M., Kangasniemi, M., Fornés-Vives, J., Hunsucker, R. L., Rahimibashar, F., Pourhoseingholi, M. A., Farrokhvar, L., & Miller, A. C. (2019). Effects of stress on critical care nurses: A national cross-sectional study. *Journal of Intensive Care Medicine*, *34*(4), 311-322. doi:10.1177/0885066617696853

Yifan, T., Ying, L., Chunhong, G., Jing, S., Rong, W., Zhenyu, L., Zejuan, G., & Peihung, L. (2020). Symptom cluster of ICU nurses treating COVID-19 pneumonia patients in Wuhan, China. *Journal of Pain Symptom Management, 60*(1), e48-e53. https://www-sciencedirect-com.ezproxy3.lhl.uab.edu/science/article/pii/S088392420301925?via%3Dihub

HEART RATE VARIABILITY AND STRESS IN THE INTENSIVE CARE UNIT NURSING WORKPLACE

by

PAULA LEVI, PENG LI, W. CHANCE NICHOLSON,
KAREN HEATON, PENNI WATTS, PARIYA WHEELER,
& JACQUELINE MOSS

In preparation for *Journal of Affective Disorders*

Format adapted for dissertation

MANUSCRIPT 3

HEART RATE VARIABILITY AND STRESS IN THE INTENSIVE CARE UNIT NURSING WORKPLACE

ABSTRACT

Background: Intensive care unit (ICU) nurses work in a demanding environment and face repeated encounters with traumatic and ethical issues, which may negatively impact their psychological health.

Methods: Real-time heart rate variability (HRV) was measured in the ICU workplace by a wearable wireless ECG heart rate monitor for 28 ICU nurses over four hours in this cross-sectional, observational study. Four HRV indices, including standard deviation of normal to normal heartbeats (SDNN), root mean square of successive differences (RMSSD), high frequency (HF), and low frequency (LF) were calculated over time. The association of HRV with workplace events and psychological and clinical outcomes was explored.

Results: HRV parameters of SDNN, RMSSD, and HF tended to have the greatest reduction (stress) to Stat or Routine care events. New nurses tended to have lesser HRV than experienced nurses. We found high rates of perceived stress and peritraumatic dissociative experiences in the ICU nurses, which was not significantly associated with HRV.

Limitations: The small sample size may limit statistical inference. Our sample consisted of young, healthy females; results may not be generalized to other populations. We excluded nurses due to medication use.

Conclusions: Measures of HRV are objective indicators of stress, which can be useful for occupational health nurses and managers in early identification and prevention.

Key words: heart rate variability, intensive care unit nurses, peritraumatic dissociative experiences, post-traumatic stress disorder, occupational stress

Intensive care unit (ICU) nurses work in a demanding environment and face frequent, repetitive stressors due to high patient morbidity and mortality (Salmon & Morehead, 2019). These workplace stressors often involve repeated encounters with traumatic and ethical issues, including death of patients, physical violence by patients or family members, caring for suffering patients, and futile care (Karanikola & Mpouzika, 2018; Levi & Moss, 2022; Moss et al., 2016; Salmon & Morehead, 2019). The constant exposure to psychological stress and trauma place ICU nurses at a high risk for developing post-traumatic stress disorder (PTSD), a trauma- and stress-related disorder that can develop after experiencing a single traumatic event or repetitive episodes (American Psychiatric Association [APA], 2013; Colville et al., 2017; Mealer et al., 2009; Rodríguez-Rey et al., 2019). The *Diagnostic and Statistical Manual of Mental Disorders-5* (*DSM-5)* categorizes symptoms of PTSD into the following four clusters: (a) intrusive and recurring memories of the traumatic event(s); (b) avoidance of reminders of the traumatic event(s); (c) negative alterations in cognition and mood; and (d) hyperarousal symptoms. Symptoms must cause significant distress or impairment lasting longer than one month (APA, 2013).

Consequences of Post-Traumatic Stress Disorder in Intensive Care Unit Nurses

PTSD is a major public health issue with consequences affecting both the individual and society (Al Jowf et al., 2022; Magruder et al., 2017; Nichter et al., 2019). The economic burden in the United States (U.S.) alone was found to be a staggering $232.2 billion (Davis et al., 2022). A previous review of the literature determined that when ICU nurses suffer from PTSD, there are consequences for the nurse, patient care,

and hospitals (Levi et al., 2021). For ICU nurses, their physical and mental health can be adversely impacted by PTSD (Bustamante-Sánchez et al., 2020; Karanikola et al., 2015; Rodríguez-Rey et al., 2020). Individuals with PTSD are at increased risk for the development of adverse long-term physical outcomes, including cardiovascular disease, diabetes, hypertension, cognitive impairment, and sleep disturbance (Brudey et al., 2015; Bustamante-Sánchez et al., 2020; Dedert et al., 2010; Dyball et al., 2019; Hoerster et al., 2019). Sleep disturbance is a hallmark symptom of PTSD, occurring in approximately 80% of those seeking care (Lewis et al., 2020). The DSM-5 criteria for PTSD categorizes nightmares under intrusion symptoms and difficulty sleeping, or insomnia, under hyperarousal symptoms (APA, 2013). Sleep disturbance has been found to have a bidirectional relationship with PTSD, increasing risk for PTSD and worsening PTSD symptoms (Chinoy et al., 2022; Foster et al., 2016; Hertenstein et al. 2019; Richards et al., 2020; Troxel et al., 2015). In the past decade, sleep disturbances have been described as predisposing, precipitating, and perpetuating PTSD (Germain et al., 2017; Lancel et al., 2021).

There is significant risk for substance and alcohol abuse, anxiety, depression, and in severe cases, even suicide ideation with development of PTSD (Al Maqbali et al., 2021; Bensley et al., 2018; Greenberg et al., 2021; Mealer et al., 2012; Ong et al., 2016; Pappa et al., 2020). Substance and alcohol abuse can be an avoidance mechanism whereby individuals attempt to numb or self-medicate PTSD symptoms (Mealer et al., 2012; Karanikola & Mpouzika, 2018). Not only are individuals with PTSD at risk for development of anxiety and depression, but the reverse is also true. Depression and anxiety may increase the risk for PTSD (Spinhoven et al., 2014). Comorbidity may be

due to symptom overlap or may be independent disorders which share common risk factors (Spinhoven et al., 2014). Much of the literature regarding PTSD and actual suicide is conflicting, finding both increased and decreased risk (Gradus et al., 2010; Holliday et al., 2020). However, there is a plethora of findings indicating ICU nurses with symptoms of PTSD are at increased risk of having suicidal thoughts (Ariapooran et al., 2022; Greenberg et al., 2021; Hong et al., 2021; Shen et al., 2020).

Historically, infectious disease epidemics and pandemics, such as the Coronavirus Disease 2019 (COVID-19) pandemic have had overwhelming psychological effects on ICU nurses (Cabarkapa et al., 2020; Lehmann et al., 2015; McAlonan et al., 2007). As of October 15, 2022, there have been 620,878,405 confirmed cases of COVID-19 globally (95,529,652 confirmed cases in the U.S.) with 6,543,138 deaths (1,052,823 deaths in the U.S.) (World Health Organization, 2022). Throughout the pandemic, ICU nurses caring for COVID-19 patients have experienced unprecedented psychological stress, high rates of PTSD, and some have had thoughts of suicide and being better off dead (Feingold et al., 2021; Greenberg et al., 2021; Lai et al., 2020; Shen et al., 2020).

Beyond consequences for nurses with PTSD, there are also consequences for patients and hospitals (American Hospital Association, 2022; Czaja et al., 2012; Salmon & Morehead, 2019; Shah et al., 2021). PTSD symptoms of hyperarousal, for example, can lead to angry outbursts toward patients (de Boer et al., 2014). Sleep disturbances can result in diminished cognitive ability on the job, which has been associated with medication errors and poor patient care (Ong et al., 2016; Shen et al., 2020). Hospitals also suffer consequences from increased absenteeism, decreased reimbursement from poor patient satisfaction ratings, and retention issues. Hospitals in the U.S. are facing a

critical shortage of ICU nurses, more dire than ever due to the COVID-19 pandemic (American Hospital Association, 2022; Nursing Solutions, Incorporated, 2020). An oft-cited rationale ICU nurses report for leaving their job is the desire for a less stressful position (McKinsey & Company, 2022; Shah et al., 2021).

Heart Rate Variability as a Measure of Stress and PTSD

Individuals with PTSD have been observed as having alterations in autonomic nervous system (ANS) function (Ge et al., 2020; Kim et al., 2018; Schneider & Schwerdtfeger, 2020). The ANS is comprised of two branches, the sympathetic nervous system (SNS), which activates the fight-or-flight response (increased heart rate, blood pressure, respiration rate, glucose levels), and the parasympathetic nervous system (PNS), which activates the rest-and-digest response (Alshak, 2019). The unconscious interplay between the SNS and PNS is largely responsible for an individual's ability to adapt to changing environments (Alshak, 2019). Heart rate variability (HRV), the variation in time intervals between adjacent heartbeats (Malik, 1996), is influenced by fluctuations of the SNS and the PNS and reflects an individual's ability to adapt to stress (Ge et al., 2020; Kim et al., 2018; Schneider & Schwerdtfeger, 2020). A higher HRV can indicate self-regulation and adaptation to stress. Reduced (or low) HRV can signal poor ability to respond to stress and indicate health problems (e.g., cardiovascular disease, PTSD, chronic stress) (Colzato et al., 2018; Ge et al., 2020; Kim et al., 2018; Ulmer et al., 2018). The measure of HRV can offer an objective measure of stress and PTSD (Dennis et al., 2016; Ge et al., 2020; Kim et al., 2018) and is superior to using purely retrospective questionnaire methods, which are prone to response bias.

Previous studies have examined the influence of shift work on HRV, including differences between non-rotating night shift nurses and those working permanent day shifts, and differences between nurses working regular and extended work shifts (Burch et al., 2019; Goffeng et al. 2018; Ito et al., 2001; Järvelin-Pasanen et al., 2013). Goffeng and colleagues (2018) examined HRV differences from psychological and physical strain among health care workers during work, leisure time, and sleep. This study is to fill the major gap in the literature on whether HRV is associated with PTSD in ICU nurses and which types of workplace events reduce HRV among ICU nurses.

Methods

Recruitment and Sample

This observational study utilized a convenience sample of ICU nurses working in a large academic health science center. Four ICUs were included: the Medical ICU, Medical Critical Care Unit, Cardiothoracic ICU, and Trauma Burn ICU. The ICU nurses were recruited using flyers posted in the units, work emails, and word of mouth. Additionally, the principal investigator (PI) made visits to the units and explained the purpose of the study, eligibility criteria, participation requirements, and answered any questions. Female ICU nurses, 35 years old or younger, were eligible. This ensured differences detected in HRV measurement of participants were not due to known differences between men and women or large differences in age (Koenig & Thayer, 2016; Spina et al., 2019). Further inclusion criteria included: (a) working at the academic health science center for at least 6 months, and at least 24 hours/week; (b) must work strictly day shift (not picking up night shifts); and (c) must be willing to have two electrodes and

small heart rate monitor placed onto their chest. Exclusion criteria included traumatic brain injury, psychological trauma experienced outside of the ICU workplace lasting longer than one month, treatment for any psychiatric conditions, significant cardiovascular or respiratory comorbidities, diabetes, taking medications/drugs known to affect HRV (e.g., beta blockers, anti-cholinergic agents, sedatives, antidepressants, illicit substances), working night shift, pregnancy, menopause, and post-menopause.

At the onset of the study only two units were to be included, the Medical ICU and Medical Critical Care Unit. During the screening process, approximately 25% ($n = 8$) of potential and willing participants were excluded due to drug treatment with antidepressant medications. The Trauma Burn ICU and Cardiovascular ICU were added to achieve the 30-participant sample. A summary of participant characteristics can be found in Table 3.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Board of X (IRB-300007663-002; see Appendix A). Participants were informed that they had no obligation to participate in the study, participation would not affect their employment, and they could withdraw from the study at any time. All participants provided written informed consent. For the Qualtrics™ cloud-based online survey tool portion of the study, collection of IP addresses was disabled, enhancing confidentiality. Participants were informed that collected data would be coded with a unique study identifier, and that no identifiable personal information would be shared with their employer or anyone else. Participants were compensated for their time with a $60 prepaid debit card.

Measures

The CamNtech Actiheart 5

The CamNtech Actiheart 5 (CamNtech Ltd., Cambridge, United Kingdom), a combined single-lead ECG and activity recorder, was used to collect HRV data. The Actiheart 5 benefits from more than 15 years of research and development and is approved by the American Cardiology Association for research (CamNtech, 2022). The device captured the following date- and time-stamped EKG measurements of HRV: (a) standard deviation of normal to normal heartbeats (SDNN); (b) root mean square of successive differences between normal heartbeats (RMSSD); (c) relative power of the low-frequency band (0.04–0.15 Hz); (d) relative power of the high-frequency band (0.15–0.4); and (e) HR. Brage et al. (2005) evaluated the accuracy between the Actiheart, ECG, and Polar™ measurements during both resting and treadmill exercise. Intra-instrument reliability and validity of the HRV within the Actiheart was also evaluated and determined that the Actiheart was a reliable and valid tool for measuring HRV at rest and during walking and running (α =.99, $p < .001$). While the measures of HF and LF and reported findings are controversial in research (Billman, 2013; Hayano & Yuda, 2019; Thielmann & Böckelmann, 2021), we report them to attempt a broader, more insightful overall picture of HRV. Some basic reasons for limitations with LF and HF include that it is hard to compare between studies, as well as the devices used to capture HRV in the frequency domain; small changes in setup, artifact handling, and calculations can create greater differences in findings (Hayano & Yuda, 2019). Furthermore, while we took movement and respiration rate into account with our calculations, they are known to affect HRV in the frequency domain (Billman, 2013). Additionally, LF demonstrates

both sympathetic and parasympathetic activation, and it is unclear whether a change in HRV had been caused by the SNS or the PNS (Sammito et al., 2015; von Rosenberg, 2017).

Table 1

Heart Rate Variability Parameters Collected and Description

HRV parameter (unit)	Description
Time-domain parameters	
SDNN (ms)	Standard deviation of normal RR (normal-to-normal intervals, NN) intervals; demonstrates overall HRV
RMSSD (ms)	Root mean square of successive differences between consecutive RR intervals; demonstrates parasympathetic activation
Frequency-domain parameters	
HF (ms^2)	Absolute power of the high-frequency band (0.15–0.4 Hz); demonstrates parasympathetic activation
LF (ms^2)	Absolute power of the low-frequency band (0.04–0.15 Hz); demonstrates both sympathetic and parasympathetic activation

Observational Data Collection Tool

An observational data collection tool, accessed on a portable electronic tablet, was utilized to document workplace events the ICU nurses experienced. The electronic Observational Data Collection Tool, originally developed for direct observation in a cardiovascular intensive care unit (Moss et al., 2004; Moss et al., 2007), was modified and utilized to capture events the ICU nurses experienced. The modification of the Observational Data Collection Tool included refining events (they were added, combined, modified, and deleted) based on pre-study observations in the study Medical Intensive Care Unit and Medical Critical Care Unit. Different types of events that can cause ICU nurses stress were systematically developed through the PI's observations of

nursing practice in the study units until a set of reliable events were determined with no new events emerging. Once the events were established, ICU nurses were asked to review them and make recommendations regarding the addition or removal of events. After suggestions were made, further observations were made until no new types of events arose. Through this process, a stable set of events was developed. Finally, observations of nurses in practice were discussed with the last author (JM, an ICU nurse with great experience) and 100% agreement of events was determined. Items on the final list of events (see Table 2; definitions of events and categories can be found in Appendix B) were placed into categories (Routine Care, Emergent Care, Interpersonal), assigned numerical code labels, and programmed into a computerized template on Microsoft Access for rapid documentation. Observational data collected included: category of event, event, time of event, and duration of event.

Table 2

Events and Their Categories

ROUTINE
Routine Patient Care **Category for care that is not stat care (urgent) or unexpected.**
Receiving Report
Giving Report
Discharging Patient to Floor Unit
Discharging Patient to Home
Causing Discomfort or Pain
Blood Administration
Multiple Orders
Assisting Provider with Procedure
Assisting with Telemedicine
Repositioning an Unstable Patient
Withdrawing Life Support
End-of-Life Care
Environmental **Category for occurrences that happen in the ICU environment.**
Personal Protective Equipment Breakdown
Supply Need Problem
Isolation Supply Need
INTERPERSONAL
Interpersonal Communication **Category for the act or process of using words or behaviors to express or exchange information.**
Communicating with Family/Update
Bad News to Family
DNR Counseling with Patient or Family, Palliative Care and Hospice Counseling
Communicating with Provider
Communicating with TeleICU
Frustration with Coworker
Frustration with Family
Frustration with Provider
Frustration with Administration
STAT/UNEXPECTED **Category for care that must be addressed**

immediately and may or may not be unexpected.
Stat/Unexpected Care
Emergent Care
Emergent Orders
Stat Medication
Pain Medication
Patient Code
Behavioral/Violence **Category for actions by patients who are delirious, troubled in mind, disturbed, and upset. Also includes being agitated to the point of using harmful physical force.**
Patient Self-Harm
Agitated/Violent Patient
Agitated/Violent Family Member
Alarm **Category for alarms, false alarms, malfunctioning equipment, and dangerous non-patient related events.**
Alarm Due to Patient Condition
Troubleshooting/False Alarm
Troubleshooting/Equipment Malfunction
Dangerous Non-Patient Event

On unit, pre-study testing of the tool was performed to ensure the tool was valid and could adequately capture events ICU nurses experience. An important feature included the capability of pressing/activating the Start Time button first, and then the type of event, for precise timing of events and rapid documentation. The tool allowed the ability to link workplace events the ICU nurses experienced to their corresponding physiological response measured by their HRV. Documentation of workplace events helped account for differences in individual stress experiences in a given shift, for instance, whether one ICU nurse might have had a more stressful day (e.g., numerous emergent care events) than another ICU nurse (e.g., few events, routine events). Mapping

of time-stamped observed events with participants' corresponding time-stamped HRV recordings was performed using Microsoft Access software.

The PTSD Checklist-5

The PTSD Checklist-5 (PCL-5) was used to assess PTSD symptoms and offer a provisional diagnosis. It is one of the most widely used self-report measures of PTSD (National Center for PTSD, n.d.). The measure has been used in a broad range of populations and has excellent sensitivity and specificity for PTSD (Bovin et al., 2016; Garcia et al., 2021). Initial psychometric testing by Blevins et al. (2015) determined that the PCL-5 proved to have strong test-retest reliability (r = .82, 95% CI [.71, .89]), strong internal consistency (α = .94 and .95), as well as convergent (rs = .74 to .85) and discriminant (rs = .31 to .60) validity. The PCL-5 contains 20 items in four subscales that correspond to the four symptom clusters of PTSD in DSM-5 (APA, 2013). Respondents rate how much they have been bothered by each item over the past month on a 5-point Likert scale ranging from 0 (not at all) to 4 (extremely). Total symptom severity scores can be obtained by summing the scores for each item (ranging from 0 to 80). A provisional diagnosis of PTSD can be made through a preliminary cutoff score of 31-33 (Blevins et al., 2015; National Center for PTSD, n.d.). Garcia and colleagues (2021) determined the PCL-5 demonstrated strong internal consistency (α = .94) with a sample of 392 registered nurses. Participants in this study were determined to have a provisional PTSD diagnosis with scores ≥ 33. Cronbach's alpha for the PCL-5 in this study ranged from .8 to .92.

Perceived Stress Scale 10-Item

The Perceived Stress Scale 10-item (PSS-10) measures stress perception, or the degree to which situations in an individual's life are perceived as stressful (Cohen et al., 1983). Participants rate each item using a 5-point Likert scale. There are six negatively worded items which measure an individual's feelings of a lack of control over their circumstances or their own emotions or reactions (Items 1, 2, 3, 6, 9, and 10); the four positively worded items (Items 4, 5, 7, and 8) measure an individual's perceived inability to handle problems (Taylor, 2015). Totals are achieved by reversing the scores on the four positive items and then summing all scale items. Scores may range from 0 to 40. Scores from 0-13 equate to low perceived stress, from 14-26 are considered moderate perceived stress, and scores ranging from 27-40 indicate high perceived stress (Cohen et al., 1983). Internal consistency was found to be satisfactory (α =.82 and .72) in a population of 229 nurses working in government hospitals (Sandhu et al., 2015). Cronbach's alpha for the PSS-10 in this study was .83.

The Peritraumatic Dissociative Experiences Questionnaire

The Peritraumatic Dissociative Experiences Questionnaire (PDEQ) was used to measure peritraumatic dissociation, or dissociative experiences that occur during (or immediately following) a traumatic event (Marmar et al., 2004). The PDEQ assesses retrospective reports of depersonalization, derealization, amnesia, out-of-body experience, and altered time perception at the time of the traumatic event (Marmar et al., 2004). Peritraumatic dissociative experiences (PDEs) are believed to occur when an individual's ability to cope with trauma is overwhelmed (Marmar et al., 2004). Prior

research has proposed peritraumatic dissociation is a significant antecedent of PTSD (Lensvelt-Mulders et al., 2008; Memarzia et al., 2021). Participants rate each item using a 5-point Likert-type scale. Higher scores indicate greater peritraumatic symptomatology, and a cutoff score greater than 15 was used for detecting symptoms of peritraumatic dissociation. Van der Mei et al. (2020) determined that the PDEQ demonstrated good test-retest reliability ($r = .85$, $p < .01$) and internal consistency ($\alpha = .81$) in a sample of 647 trauma victims evaluated soon after emergency department admission. Cronbach's alpha for the PDEQ in this study was .88.

Brief Trauma Questionnaire

The Brief Trauma Questionnaire (BTQ) was used to determine whether participants had experienced a traumatic event that met the DSM-5 Criterion A for PTSD. Questions ask about possible traumatic events, such as "Have you ever served in a war zone?" and "Have you ever witnessed a situation in which someone was seriously injured or killed?" Respondents reported whether traumatic events occurred, whether they thought their life was in danger or they might be seriously injured at the time of the event, and if they were seriously injured from the event. Scores simply range from 0 to 10. The BTQ is considered a reliable and valid measure of trauma exposure (Schnurr et al., 1999). McCanlies and colleagues (2017) determined the BTQ had excellent internal consistency ($\alpha = .89$) with a sample of 328 police officers.

Connor-Davidson Resilience Scale-10 Item (CD-RISC-10)

The Connor-Davidson Resilience Scale-10 item (CD-RISC-10), a short form of the original 25-item tool, was used to measure resilience (Campbell-Sills & Stein, 2007). The CD-RISC-10 consists of 10 items structured on a 5-point Likert-type scale. Participants completed the scale based on the degree to which they acknowledged each item was applicable to them over the past 30 days. Scores range from 0-40, with higher scores indicating higher levels of resilience (Campbell-Sills & Stein, 2007). Campbell-Sills and Stein (2007) performed the initial psychometric analysis of the CD-RISC-10 with a sample of university students who had suffered childhood maltreatment with ongoing psychiatric symptoms (n = 131). They determined the 10-item version correlated highly with scores on the original 25-item instrument (r = .92) and indicated good internal consistency (α = .85). Kim and colleagues (2021) found the CD-RISC-10 demonstrated good internal consistency (α = .86) in their study with a sample of 320 nurses. Cronbach's alpha for the CD-RISC in this study was .89.

Patient-Reported Outcomes Measurement Information System on Sleep Disturbance

The Patient-Reported Outcomes Measurement Information System® (PROMIS) was developed as a part of the U.S. National Institutes of Health roadmap initiative. The goal of PROMIS measures was to create precise (minimal error in estimate) measurement of commonly studied Patient-Reported Outcomes with standardized measurement that could enable comparisons of the burden of disease and chronic conditions (HealthMeasures, 2022). The PROMIS Sleep Disturbance (SD) 4-item short form was used to measure sleep disturbance (Yu et al., 2011). Dimensions include perceived sleep

quality, depth, and difficulties falling asleep over the past 7 days (Buysse et al., 2010). Participants completed the scale using a 5-point Likert-type scale, with higher scores reflecting greater sleep disturbance. PROMIS measures generate *T*-scores that can be compared to the U.S. general population (HealthMeasures, 2022; Rothrock et al., 2020). A *T*-score of 50 is the average, with a standard deviation of 10; higher *T*-scores represent greater sleep disturbance (HealthMeasures, 2022). Satisfactory internal consistency ($\alpha = .85$) was found by Green and colleagues (2022) in a sample of 121 law enforcement officers. Cronbach's alpha for the PROMIS-SD in this study was .89.

PROMIS Emotional Distress-Anxiety and -Depression 4-Item Short Forms

The PROMIS Emotional Distress-Anxiety (ED-A) and -Depression (ED-D) 4-item short forms were used to measure symptoms of anxiety and depression in the past 7 days. Participants completed the scales using a 5-point Likert-type scale of "never," "rarely," "sometimes," "often," and "always." Higher *T*-scores indicated greater anxiety and depression severity. Cronbach's alpha for PROMIS-ED-A was high ($\alpha = .97$) in a sample of 402 frontline healthcare providers (Reitz et al., 2021). Cronbach's alpha for PROMIS-ED-D for patients in three randomized trials ($n = 651$) in a predominantly veteran sample ranged from .89 to .95 (Kroenke et al., 2020). Cronbach's alpha for the PROMIS-ED-A and -ED-D in this study was .85 and .92, respectively.

Procedures

To minimize participant burden at work, participants completed demographic information, a health information questionnaire, questions on job satisfaction, and the

majority of surveys (PCL-5, BTQ, CD-RISC-10, and three PROMIS measures) on Qualtrics a few days before on-unit study participation. At this time participants were asked to create their own unique study identifier, rather than their name, to enhance confidentiality. Demographics collected included: age, ethnicity, marital status, educational level/degree, years of experience as an ICU nurse, and years at current position. Health information inquired about daily caffeine consumption, alcohol and tobacco use, height, weight, average hours of sleep per night, sleep apnea, medication use, and whether they practiced any type of meditation (e.g., mindfulness, transcendental, spiritual meditation). Job satisfaction was assessed with a 5-point Likert scale from 1 (extremely dissatisfied) to 5 (extremely satisfied). Participants were also asked if they had considered leaving their job in the last 6 months with a "yes" or "no" question.

Participants were contacted 2 days before their day of on-unit participation and reminded to prepare for the study. This included abstaining from alcohol use and extreme physical exercise for a minimum of 24 hours before the study, getting a good night's sleep, and limiting caffeine intake to 12 ounces (or 80 mg). None of the ICU nurses in this sample smoked. The nurses' work schedules consisted of 12-hour shifts, from 6:30 am until 6:30 pm. Participants arrived 40 minutes before the start of their shift for application of the heart rate monitor and baseline measurement.

The PI placed the Actiheart (Figure 3) for each participant and recorded baseline HRV assessment in a private room just off their unit. Participants were asked to not wear necklaces, name tags, their cellphone, personal Bluetooth, or Vocera (hands free communication device) near the Actiheart. The Actiheart was worn on two standard ECG pads (Conmed Ultratrace™) on the chest.

Figure 3

The CamNtech Actiheart 5

After cleaning and light abrasion of the skin for electrode placement, the large end of the Actiheart was positioned at the level of the second intercostal space at the sternum (CamNtech, Ltd, 2022; Rautaharju et al., 1998). The small end was placed approximately 10 cm away on the participant's left side, where the cable was nearly stretched to its full length and as near to horizontal as possible (CamNtech, Ltd, 2022). Once placed, the Actiheart recorded continuously until the end of the study period. For sitting baseline HRV assessment (5 minutes acclimatization/5 minutes measurement), participants were instructed to sit in a chair in a relaxed manner, sitting with knees at a 90-degree angle, both feet flat on the floor, hands on thighs. They were asked not to talk, sleep, or move during this time, but were told they could close their eyes. An idle baseline measurement (10 minutes) was also taken at the beginning of the 4-hour study period, in which activity was limited to non-engagement with unit-specific activities (e.g., walking to nurses' station, sitting while charting) and free of any external stressors.

Each ICU nurse was observed at work between 6:30 and 10:30 am. The PI was the sole observer; only one ICU nurse participated/was observed on any given day. The PI observed the ICU nurses and documented their workplace events on the Observational Data Collection Tool (e.g., receiving report, administering medications, assisting providers with procedures) as they went about their workday. The nurses were asked to

let the PI know if they felt they would inflict pain (e.g., wound care) or if they were titrating vasoactive intravenous medications up (e.g., emergent care) since these actions were not always apparent as different than routine care to the observer. Observational data collection started when participants began to receive report on their patient(s) and ended at 10:30 am unless they were in the middle of an event. The PI attempted to not engage with participants, unless necessary (e.g., clarification). At the end of the observation period, participants completed two questionnaires in a private setting to obtain information on perceived stress (PSS-10) and peritraumatic dissociative experiences (PDEQ) related to their encounters.

Data Analysis

Data processing of HRV parameters followed recommendations of the Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology (Malik, 1996). Data were initially processed with Actiheart v5.0 software and then transferred to Kubios Premium software 3.5.0 (Tarvainen et al., 2014) for HRV analyses. Kubios software for analyzing HRV data has achieved gold-standard status in scientific research (Lipponen & Tarvainen, 2019). Beat-to-beat RR intervals were extracted using an adaptive QRS detector algorithm. Data were inspected using a piecewise cubic spline interpolation method to identify and correct missed beats, extra and misaligned beats, and real artifacts. The approach demonstrated 96.9% accuracy in detecting real artifacts and 99.9% accuracy in identifying normal beats (Lipponen & Tarvainen, 2019). Artifact correction was performed with an artifact identification threshold of 0.35s to minimize overcorrection (Laborde et al., 2017; Malik, 1996).

Data were pre-processed using a smoothness priors method for detrending RR intervals (Lambda = 500, fc = 0.035 Hz), eliminating very low frequency components (Tarvainen et al., 2006). Autoregressive integrated moving average (ARIMA) modeling was used to validate sitting and idle (sitting/standing/mobile) baselines, events, and stress-recovery of dynamic HRV output data. The ARIMA modeling is a preferred method due to its ability to add adaptive point process filtering techniques, thereby detrending select time intervals (original time series applied by a difference operator) until non-stationary trends were absent from the final time series. The ARIMA modeling supported use of "best" analysis windows, fit (Ljung-Box and Q-test), and suitability of residuals and autocorrelations within selected time intervals (Gujral et al., 2020). Periods of strong physical exertion (e.g., pulling a patient up to the head of the bed) were excluded. A Fast Fourier algorithm computed power in the LF and HF spectra using Welch's (1967) periodogram method (150 s Hanning window and overlapping segments at 50%). Because HF HRV data is influenced by breathing, these data were analyzed taking breathing frequency into account in accordance with previous studies to provide more comparable data.

Many of the ICU nurses experienced numerous consecutive events with little to no time for recovery. We created a new category, called "Combined Events," to accommodate these rapid, often short-timed events (e.g., an alarm repeatedly going off). For combined events, we evaluated HRV parameters for the consecutive events from the start time of the first event until the end time of the last event that allowed enough time to evaluate the recovery period.

Demographic descriptive statistics, health information, and survey measure scores were calculated using frequency, mean, and standard deviation. Linear mixed models were used to examine associations between HRV parameters (SDNN, RMSSD, HF, and LF) and types of events (Interpersonal, Routine Care, Emergent Care, and the new category of Combined Events). Linear mixed models were also used to examine associations between HRV parameters to types of events and experience of the nurse (new nurse [< 2 years], experienced nurse [≥ 2 years]). Scores of survey measure outcome variables were also recoded as dichotomous variables according to the criteria of the symptom severity. For example, Total PCL-5 Scores ≥ 31 were recoded as meeting diagnostic criteria for PTSD, whereas scores < 31 were recoded as no PTSD (= 0). Total PDEQ scores > 15 were recoded as high PDE (= 1), whereas scores ≤ 15 were recoded as low PDE (= 0). Total PSS-10 scores ≥ 14 were recoded as moderate/high stress (= 1), whereas scores < 14 were recoded as low stress (= 0). Similarly, total PROMIS-ED-A, -ED-D, and -SD *T*-scores were recoded as dichotomous variables, with scores ≥ 59.5 as "1" (moderate/severe anxiety, depression, and sleep disturbance) and scores < 59 as "0" (none or mild). The CD-RISC-10 scores were recoded as "1" (high resilience; ≥ scores of 30) and "0" (low resilience; scores < 30). Years as an ICU nurse were recoded as dichotomous variables using the cut-point of 2 years.

Spearman's correlation coefficients were used to determine correlations between HRV outcomes and survey measure scores (PTSD, PSS-10, PDEQ, PROMIS-ED-A, PROMIS-ED-D, PROMIS-SD, and CD-RISC-10). The Wilcoxon rank sum test was used to compare HRV between nurses in different groups, such as work experience (≥ 2 years

vs < 2 years), with and without PTSD, etc. All tests were two-sided under α level of 0.05. Statistical analyses were performed using R Software version 4.1.0 (R core team, 2022).

Results

HRV data was collected from 30 participants, however, data from two subjects were excluded due to an unacceptable amount of artifact. The mean age of the ICU nurse sample was 26.5 years (SD 3.7, range 22-35). Mean years as an ICU nurse was 2.6 years (SD 1.6) and mean years at current position was 2.1 years (SD 1.4). Only 1 of the 28 (3.6%) participants had work experience greater than 5 years. The ethnic composition of the sample consisted of 71.4% Caucasian (*n* = 20), 7.1% Black (*n* = 2), 14.3% Hispanic (*n* = 4), and 7.1% Asian (*n* = 2). The majority of nurses in this sample were single (*n* = 18; 64.3%). Regarding job satisfaction, 64% (*n* = 18) of the nurses were only somewhat satisfied with their job, with only 14% (*n* = 4) of nurses being very satisfied. Reflecting retention problems in the U.S., 75% (*n* = 21) of the nurses in this sample had thoughts of leaving their job in the past 6 months. Most (*n* = 25; 89%) participants were regular drinkers of caffeinated beverages. In this sample, 18 (64%) reported consuming 1 to 4 alcoholic beverages per week, 3 (11%) consumed 5 to 9 alcoholic beverages per week, while 7 (25%) were nondrinkers. See Table 3 for demographic and lifestyle characteristics.

The majority of ICU nurses in this sample (78.5%; *n* = 22) reported sleeping 6 to 7 hours on average per night, with 18% (*n* = 5) sleeping more than 7 hours and only one nurse (3.5%) reporting less sleep per night. Measurement of PROMIS scores are scored on a *T*-score metric (50 = U.S. population mean score), with *T*-scores less than 55

considered within normal limits, scores of 55–59 as mild sleep disturbance, 60–65 as moderate, and scores of 66 and greater as severe sleep disturbance (Rothrock et al., 2020). In this sample, 64% (*n* = 18) of the ICU nurses scored within normal limits, whereas 18% (*n* = 5) reported mild sleep disturbance, and 5 (18%) described moderate sleep disturbance. A complete list of survey measure scores can be found in Table 4.

A little over half of the ICU nurses (57%; *n* = 16) reported experiencing a previous trauma, with 36% (*n* = 10) having experienced multiple traumas. A probable PTSD diagnosis was determined using overall score ≥ 31 and following the DSM-5 diagnostic rule of treating each item rated as 2 or higher as an endorsed symptom, having at least one intrusion symptom, one avoidance symptom, two negative alterations in cognition and mood symptoms, and two arousal symptoms (APA, 2013). Based on the above criteria, 3 (11%) ICU nurses were identified as having probable PTSD. Nearly two-thirds of the ICU nurses (64%; *n* = 18) reported moderate stress when answering questions on the PSS-10, with 36% (*n* = 10) answering positively to mild stress. Perhaps one of the most insightful findings of the scales measuring PTSD and psychological stress was that of the PDEQ, in that 54% (*n* = 15) of ICU nurses in this sample had previous peritraumatic dissociative experiences, or experiences where "what was happening seemed unreal to me, like I was in a dream, or watching a movie or play."

For anxiety, one nurse (3.5%) scored as having as having moderately severe anxiety, 29% (*n* = 8) scored as having moderate anxiety, and 25% (*n* = 7) having mild anxiety. Depression scores indicated scant depression among the study sample, with only 7% (*n* = 2) reporting moderate depression and 25% (*n* = 7) having mild depression. Results for resilience using CD-RISC-10 scores for the ICU nurses in this sample

determined a mean score of 30.11 (SD 5.08). Scores ranged from 17 to 40 and can be classified into four categories comparable to the U.S. general population: lowest (0–29), low (30–32), moderate (33–36), and highest (37–40) (Campbell-Sills et al., 2007). Lastly, 21% (n = 6) of the ICU nurses in this sample practiced some type of meditation.

Table 3

Study Population Demographics and Lifestyle Characteristics

Characteristic	Total Population (*n* = 28) *n* (%)
Age	
21 to 25	14 (50%)
26 to 30	8 (29%)
31 to 35	6 (21%)
Race	
Caucasian	20 (71.5%)
Black	2 (7%)
Hispanic	4 (14.5%)
Asian	2 (7%)
Marital Status	
Married	9 (32%)
Single	18 (64%)
Widowed	1 (4%)
Education	
BSN	23 (82%)
AD	3 (11%)
MSN	2 (7%)
Years ICU Nurse	
<1 year	2 (7%)
1 to 2 years	14 (50%)
>2 years	12 (43%)
New Nurse	8 (28.6%)
Experienced Nurse	20 (71.4%)
Years at Job	
<1 year	5 (18%)
1 to 2 years	16 (57%)
>2 years	7 (25%)
Job Satisfaction	
Very Satisfied	4 (14.3%)
Somewhat Satisfied	18 (64.3%)
Neutral	2 (7.1%)
Somewhat Dissatisfied	4 (14.3%)
Very Dissatisfied	0 (0%)
Thoughts of Leaving Job	
Yes	21 (75%)
No	7 (25%)
Alcohol Consumption (Drinks/Week)	
None/Nondrinkers	7 (25%)
1 to 4	18 (64.3%)
5 to 9	3 (10.7%)
10 or more	0 (0%)
Caffeine Consumption	
Caffeine consumption	25 (89%)
No caffeine	3 (11%)
Average Daily Sleep Hours	
5 hours or less	1 (3.6%)
6 to 7 hours	22 (78.6%)

8 to 9 hours	4 (14.3%)
>9hours	1 (3.6%)
Practice Meditation	
Yes	6 (21%)
No	22 (79%)

Table 4

Measure Scores

Measure	Total Population (n = 28) n (%)
Criterion A Trauma	
None	12 (43%)
One	6 (21%)
Multiple	10 (36%)
PCL-5 (PTSD)	
Score ≥ 31	3 (10.7%)
20 – 30	5 (17.9%)
10 – 20	7 (25%)
0 – 10	13 (46.4%)
PROMIS ED-Depression	
None	19 (67.9%)
Mild	7 (25%)
Moderate	2 (7.1%)
PROMIS ED-Anxiety	
None	12 (42.8%)
Mild	11 (39.3%)
Moderate	4 (14.3%)
Moderately Severe	1 (3.6%)
PROMIS Sleep Disturbance	
None	18 (64.3%)
Mild	9 (32.1%)
Moderate	1 (3.6%)
PSS-10 (Perceived Stress)	
Mild	10 (35.7%)
Moderate	18 (64.3%)
PDEQ (Peritraumatic Dissociation)	
>15	15 (53.6%)
≤15	13 (46.4%)
CD-RISC-10 (Resilience level)	
Lowest (0–29)	14 (50%)
Low (30–32)	5 (18%)
Moderate (33–36)	7 (25%)
Highest (37–40)	2 (7%)

In total, there were 111 events recorded for the 28 participants after merging combined events into the Combined Events category. Idle Baseline was chosen for

comparisons instead of Baseline (sitting) because HRV is affected by movement and, therefore, comparisons are more just/fair when compared to Idle baseline. HRV parameters in RMSSD, HF (reflecting parasympathetic activity), and SDNN (demonstrating overall HRV) tended to have the greatest reduction from Idle Baseline to Stat or Routine events (see Figure 4 and Table 5). A tendency for a lesser decrease was seen in RMSSD and HF to Interpersonal or Combined Events, with an increase in SDNN. For LF (reflecting both sympathetic and parasympathetic activity), the largest increase from Idle Baseline tended to be seen for Interpersonal Events, with a lesser increase for Routine and Stat events.

Figure 4

Change in HRV Parameters From Baseline to Events and Recovery

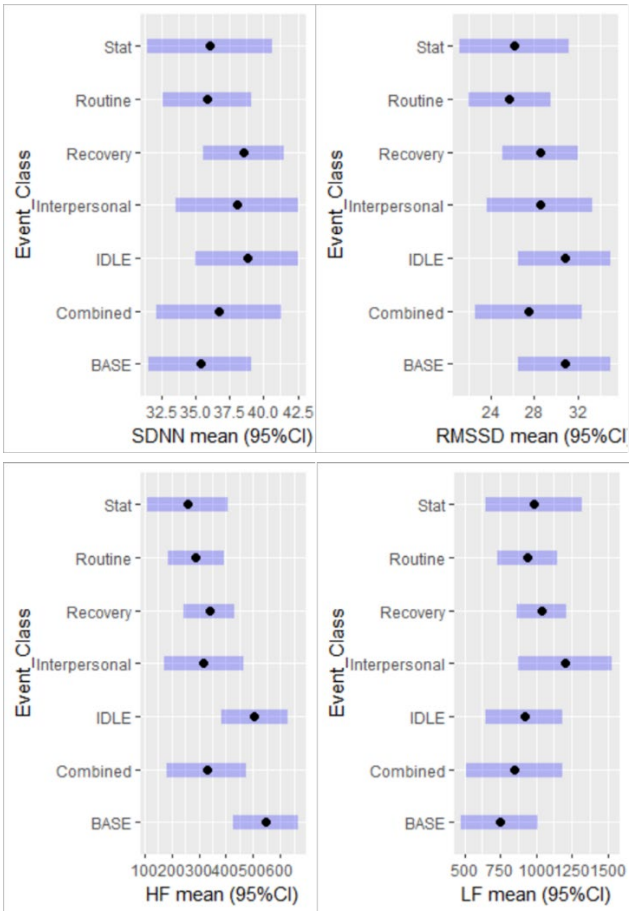


Table 5

Change in ICU Nurses' HRV Parameters From Idle Baseline to Events

Change in HRV	SDNN Mean (95% CI)	RMSSD Mean (95% CI)	HF Mean (95% CI)	LF Mean (95% CI)
IDLE - Routine	**2.92 (-0.67, 6.51)**	**5.05 (1.38, 8.72)**	**215.76 (98.16, 333.36)**	**-21.5 (-323.34, 280.34)**
IDLE - Stat	**2.73 (-2.07, 7.53)**	**4.62 (-0.28, 9.52)**	**245.05 (88.25, 401.85)**	**-66.3 (-466.14, 333.54)**
IDLE - Interpersonal	**0.76 (-3.98, 5.5)**	**2.26 (-2.52, 7.04)**	**185.98 (28.02, 343.76)**	**-288.6 (-680.6, 103.4)**
IDLE - Combined	**2.09 (-2.71, 6.89)**	**3.3 (-1.56, 8.16)**	**176.26 (19.26, 333.26)**	**69.5 (-330.34, 469.34)**

Note. CI = confidence interval.

When differentiating HRV parameters between new nurses versus experienced nurses, new nurses had reduced Idle Baseline when compared to experienced nurses' Idle Baseline. New nurses also had reduced HRV to events and recovery than experienced nurses (see Figure 5 and Table 5). Experienced nurses tended to have a larger reduction to events from Idle Baseline than new nurses in SDNN (2.51 vs 0.81, respectively) and HF (220.1 vs 143.1, respectively); however, a negligible reduction was seen between groups in RMSSD (3.78 vs 3.72, respectively). In LF, a lesser increase tended to be seen in experienced nurses vs new nurses (56.5 vs 88.5, respectively). Regarding recovery from the events, experienced nurses tended to recover closer to Idle Baseline post event than new nurses for SDNN (2.46 vs 0.97, respectively) and RMSSD (2.31 vs 0.86, respectively). In HF, a slight beneficial recovery post event tended to be seen in new nurses (35.9 vs 66.6, respectively). An even greater increase in LF was seen post event in both groups, with a tendency for experienced nurses to have a lesser increase post event (42.1 vs 131.6, respectively). None of the above comparisons were statistically significant, possibly due to the small sample size.

Figure 5

Differences in Change in HRV Parameters Between New Nurses and Experienced Nurses

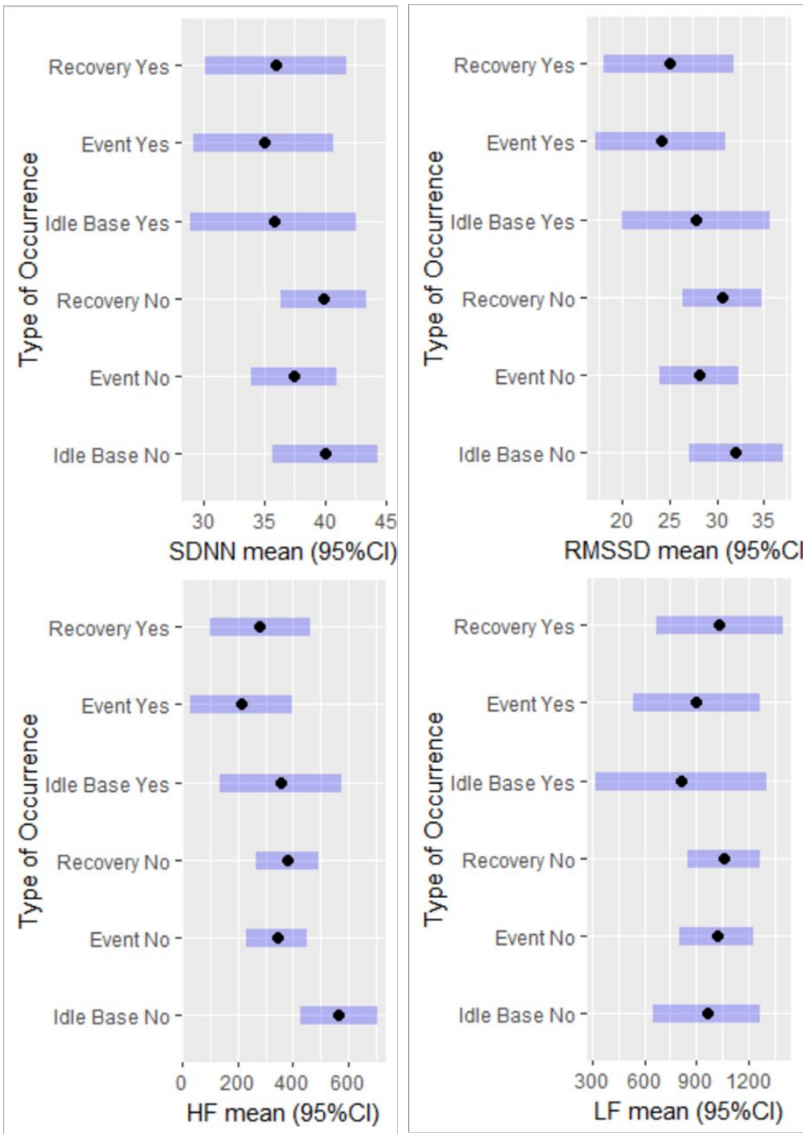


Table 6

Change in HRV Parameters in ICU Nurses by Work Experience

Change in HRV	SDNN Mean (95% CI)	RMSSD Mean (95% CI)	HF Mean (95% CI)	LF Mean (95% CI)
Idle Base - Event Experienced Nurse	**2.51 (-0.94, 5.96)**	**3.78 (0.1, 7.46)**	**220.1 (105.24, 334.96)**	**-56.5 (-358.93, 245.93)**
Event - Recovery Experienced Nurse	**-2.46 (-4.54, -0.38)**	**-2.31 (-4.52, -0.1)**	**-35.9 (-106.66, 34.86)**	**-42.1 (-225.36, 141.16)**
Idle Base – Event New Nurse	**0.81 (-4.89, 6.51)**	**3.72 (-2.38, 9.82)**	**143.1 (-47.02, 333.22)**	**-88.5 (-590.65, 413.65)**
Event – Recovery New Nurse	**-0.97 (-4.87, 2.93)**	**-0.86 (-4.98, 3.26)**	**-66.6 (-196.35, 63.15)**	**-131.6 (-475.19, 211.99)**

Note. CI = confidence interval.

No significant association of HRV and psychometric study variables was found, either by subgroup comparisons or Spearman correlation analysis.

Table 7

Spearman Correlations Between Heart Rate Variability Indices and Psychometric Measures

	SDNN	RMSSD	HF	LF
PCL-5	-0.0759	-0.0940	-0.0153	0.094
PDEQ	-0.1959	-0.1501	-0.0145	-0.1021
PSS	-0.1136	0.0181	-0.1111	-0.0697
PROMIS-ED-A	-0.1016	-0.1275	-0.1016	0.1895
PROMIS-ED-D	-0.3355	-0.3564	-0.3355	-0.1322
PROMIS-SD	-0.0306	-0.0945	-0.184	0.0978
CD-RISC-10	0.3182	0.1456	0.1244	0.2945

Note. PTSD = Post-traumatic Stress Disorder Checklist; PDEQ = Peritraumatic Dissociative Experiences Questionnaire; PSS = Perceived Stress Scale; PROMIS = Patient-Reported Outcomes Measurement Information System; ED = Emotional Distress; A = Anxiety; D = Depression; SD = Sleep Disturbance; CD-RISC-10 = Connor-Davidson Resilience Scale-10 item; * $p < .05$

Discussion

The main objectives of this study were twofold: to investigate and quantify the association of HRV to events ICU nurses experience in the workplace, as well as examine the association between HRV and PTSD. The association between HRV and perceived stress, peritraumatic dissociative experiences, anxiety, depression, sleep disturbance, and resilience were also explored. We found ICU nurses' HRV parameters of SDNN, RMSSD, and HF tended to have the greatest reduction from Idle Baseline to Stat and Routine Events. Greater reduction from Idle Baseline to these events shows that, overall, these were more stressful for the ICU nurses. An increase in LF to events was also observed. Increases in the HRV parameter of LF can reflect an increase in SNS activity. The reduction from Idle Baseline to Stat events was expected. These are the events that require prompt attention, and may include emergent care (i.e., if care were not given, would likely result in physical danger or grave disability) or unexpected care events (e.g., an unexpected drop in blood pressure requiring an immediate intravenous vasopressor). What was not expected was that even though reductions in HRV parameters were observed with Combined Events (those that occurred in rapid succession, allowing little to no time for recovery), Routine Events tended to cause more of a reduction in HRV parameters.

Our findings are in accordance with others in the scientific literature. Kim and colleagues' (2018) meta-analysis and review also found stress caused a decrease in the HF band and an increase in the LF band, and further noted that it was the most frequently reported factor associated with HRV variables. Järvelin-Pasanen and colleagues' (2013) study with a sample of female nurses, which investigated the differences between and

within normal and extended work shifts, also determined lower mean RMSSD and HF power, and higher LF values of HRV. Goffeng and colleagues' (2018) study used similar time-domain HRV as this study and found a reduction in SDNN and RMSSD parameters in a sample of health care workers during extended work shifts. Li and colleagues' (2022) study investigated workplace stress in nurses using similar HRV parameters of RMSSD and LF to those in this study. They, too, found reductions in RMSSD and increases in LF during the nurses' work shift, meaning a reduction was seen in parasympathetic activity with RMSSD, and increased sympathetic activity with LF.

Of particular interest was that we found new ICU nurses tended to have lower baseline HRV than experienced ICU nurses, as indicated by Idle Baseline. New nurses also had reduced HRV to events and recovery than experienced nurses. One explanation is that new nurses' HRV parameters may be more reduced because the work environment is more unpredictable for them. New nurses tended to have greater increases from Idle Baseline to events than experienced nurses in the parameter of LF, and both groups showed further increases in LF post event to recovery. New nurses may possibly have been thinking harder about the uncertainty of their workday. Previous literature has determined that increased mental tasks can result in reduced HRV (Li et al., 2020; Szakonyi et al., 2021). It can be difficult to tease out the complex sympathetic and parasympathetic aspects in LF, especially in the dynamic state, such as movement or recovery. Some recommendations in the literature state that frequency-domain HRV data should be used as a complement, particularly since there are no clear assignments of these parameters (Billman, 2013; Hayano & Yuda, 2019; Thielmann & Böckelmann, 2021).

We combined events that occurred in rapid succession, allowing little to no time for recovery (e.g., alarms repeatedly going off, being addressed by the ICU nurse, and then going off again). Even though these events ranked below Stat Events or Routine Care Events, they did reduce HRV parameters. For example, the constant alarming of technological equipment is well known to cause ICU nurses stress, as well as the noise stress, and the many false alarms ICU nurses endure (Konkani & Oakley, 2012; Lewandowska et al., 2020; Storm, & Chen, 2021). Lewandowska and colleagues' (2020) systematic review on the impact of alarm fatigue on the work of ICU nurses demonstrated the need for strategies of alarm management and for measuring the alarm fatigue level in ICU nurses.

Ge and colleagues' (2020) systematic review and meta-analysis found reductions in HF and RMSSD in PTSD, with a more robust reduction in RMSSD, and declared reduced HRV may be regarded as an endophenotype in PTSD research. Hauschildt and colleagues (2011) showed that a lower HF is significantly associated with PTSD. Kim and colleagues' (2018) meta-analysis supported prior reviews indicating that PTSD is associated with lower HRV. Most study findings relating to PTSD and HRV have been conducted on participants with chronic PTSD, whereas our sample was comprised of healthy, young females. Furthermore, our sample size in this pilot study was small, limiting statistical inference.

This sample of ICU nurses reported low symptoms of PTSD (mean PCL-5 score 14.25, SD 11.97), with only 3 (11%) participants meeting the threshold for a provisional diagnosis of PTSD. Previous epidemiological studies have reported lifetime PTSD prevalence rates of 8.0%–11.2% for women (Goldstein et al., 2016; Kessler et al., 1995).

Schuster and Dwyer's pre-COVID-19 pandemic (2020) integrative review of PTSD prevalence in nurses reported 8.5%–20.8% of registered nurses and 18.2%–24% of ICU nurses met criteria for PTSD. Of consideration, approximately 25% of potential participants were excluded due to their using antianxiety or antidepressant agents, perhaps reducing the number reporting symptoms of PTSD.

Although this sample reported low PTSD symptoms, more than half (54%) of ICU nurses in this study reported having significant dissociative symptoms (scores above 15). For example, some ICU nurses answered positively to questions such as, "I had moments of losing track of what was going on," or "Things seemed to be happening in slow motion," or "What was happening seemed unreal to me, like I was in a dream, or watching a movie or play." Individuals who experience dissociation at the time of the traumatic event, or soon after, report alterations in time, place, person, and a sense of unreality to the event (Marmar, 2004). It is thought that dissociation functions as a protective mechanism for the individual, reducing conscious awareness of the traumatic event, and ultimately blocking painful emotions (Howell, 2013; van der Kolk, 1987). Repetitive exposure to witnessing pain, suffering, and potentially traumatic incidents places ICU nurses at high risk for peritraumatic dissociative states (Geuzinge et al., 2020). Prior research has identified peritraumatic dissociation as a significant antecedent or predictor of PTSD (Lensvelt-Mulders et al., 2008; Memarzia et al., 2021; Thompson-Hollands et al., 2017). This measure may be a useful early indicator of PTSD and demonstrate the need for intervention in this population.

Perceived stress of the ICU nurses was measured by the PSS-10, with nearly two-thirds (n = 18; 64.3%) reporting moderate stress and approximately one-third (n = 10;

35.7%) having low stress. Mean score for the group was 15.57 (SD 5.56). Higher levels as measured by the PSS-10 have been associated with increased cortisol levels and suppressed immune function (Cohen & Janicki-Deverts, 2012).

Our sample of ICU nurses reported mostly mild symptoms of sleep disturbance, (*n* = 9; 30%), with only 1 (3%) nurse reporting moderate sleep disturbance. The prevalence of sleep disturbance among "frontline" nurses (comprising 9 studies) in Al Maqbali and colleagues' (2021) systematic review and meta-analysis was 47%. Of note, during this post-COVID-19 pandemic era, it can be difficult to make comparisons without regressing in the literature.

Our sample of ICU nurses reported mostly mild anxiety symptoms (*n* = 11; 39.3%), with 4 (14.3%) participants having moderate anxiety symptoms, and only 1 (3.6%) answering positively for severe anxiety symptoms. For depression, 7 (25%) ICU nurses reported mild symptoms, while 2 (7.1%) had moderate symptoms. These values are much reduced from the peak of the COVID-19 pandemic, when nearly a third of ICU nurse respondents (31.1%) in Guttormson and colleagues' (2022) study met criteria for moderate to severe anxiety, while 44.6% met criteria for moderate to severe depression. Our study's low depression finding may likely be due to study exclusion criterion excluding ICU nurses with a diagnosis of depression and/or taking antidepressants. The prevalence of anxiety among "frontline" nurses in Al Maqbali and colleagues' (2021) systematic review and meta-analysis was 39%, whereas prevalence of depression was 33%.

In this sample of ICU nurses, the total mean CD-RISC-10 score was 30.11, which, according to the suggested interquartile cut-off points (Davidson, 2018), is the

lowest point in the second quartile of the average score distribution. Half of the ICU nurses' (50%) total score was ≤ 29 (Table 4), which falls in the lowest quartile, meaning lowest resilience. This suggests difficulties in coping with stress or bouncing back from adversity for those nurses who scored in the lowest group. Similar results using the CD-RISC-10 were found with a sample of U.S. nurses working during the COVID-19 pandemic (Petzel, 2021), with nearly half of the respondents' (46.4%) total score ≤ 29.

No association of HRV and psychometric study variables (PTSD, PDEs, perceived stress, anxiety, depression, sleep, and resilience) was found. Possible explanations for the absence of a relationship between psychometric study variables and HRV could be due to limitations of self-report measures. Also, most findings relating to PTSD (and the other study measures we investigated) and HRV have been in studies conducted among participants with an associated chronic condition, whereas our sample was comprised of healthy, young females.

Summary

Despite the lack of association in study variables, the ICU nurses did have reductions in HRV to events at work. Stress is regulated by the ANS, increasing sympathetic modulation and the fight-or-flight response to stressors. There should also be a return to homeostasis with parasympathetic modulation and the rest-and-digest response once the stress event has resolved. It is important to identify ICU nurses with symptoms of PTSD, perceived stress, and PDEs, as individuals with chronic stress (and PTSD) have been observed as having alterations in ANS function (Schneider & Schwerdtfeger, 2020).

Chronic stress can lead to adaptations (allostasis) and pathophysiology due to allostatic load or overload (McEwen, 1998). These adaptations to stress over time can result in a blunted response to stress and adverse long-term pathophysiology (McEwen, 1998).

Strengths

A strength of this study was that HRV measurements of ICU nurses were obtained in the ecological setting of the ICU while they experienced work events. Monitoring HRV in this manner can reveal the level of workplace stress-reactivity and stress-recovery ICU nurses experience. Another strength is that multiple types of measures were utilized, including objective and self-report.

Limitations

The nature of the cross-sectional design of this study means we cannot infer causality. Also, the cross-sectional nature of our study may not reflect the true direction of the relationships between survey measures, as symptoms and/or responses may be transient. This was a convenience sample, so there may be selection bias. Furthermore, we had a small sample size in this pilot study, limiting detection of true relationships. Our sample was comprised of young and healthy female participants; therefore, our results may not generalize to males, older populations, other occupations, or those with adverse health issues. There may have been confounding variables inducing stress during HRV measurement. Lastly, approximately 25% of nurses had to be excluded from the study due to the use of antidepressant medications; this could have skewed our results toward a less stress-affected population of nurses.

Clinical Implications

The findings from our study have several potential clinical implications. Indicators of stress and recovery of ICU nurses at work, such as HRV parameters, are useful for occupational health nurses and nurse managers in the early identification and prevention of stress. Information on types of stress events and recovery obtained by HRV can help identify strategies to reduce stress, which is beneficial for promotion of health at work.

Recommendations for Future Research

This study had the methodological approach of eliminating the influence of antidepressant medication use as a confounding variable on HRV. Due to the small sample size and limited funding of this pilot study, potential participants were excluded if taking antidepressant medications or given a diagnosis of depression. Future prospective, longitudinal designs, measuring HRV over at least 24 hours, and with a large sample size are needed to evaluate the relationship between HRV and workplace stress and PTSD in ICU nurses. Research with ICU nurses given a diagnosis of depression and/or taking medications versus those with no depression are needed. Furthermore, more research is needed to investigate HRV and stress differences in new nurses versus experienced nurses.

References

Agency for Clinical Innovation. (2022). *Discharging a person from intensive care.* https://aci.health.nsw.gov.au/networks/icnsw/patients-and-families/treatment-and-monitoring/discharging-a-person-from-intensive-care

Al Jowf, G. I., Ahmed, Z. T., An, N., Reijnders, R. A., Ambrosino, E., Rutten, B., de Nijs, L., & Eijssen, L. (2022). A public health perspective of post-traumatic stress disorder. *International Journal of Environmental Research and Public Health*, *19*(11), 6474. https://doi.org/10.3390/ijerph19116474

Al Maqbali, M., Al Sinani, M., & Al-Lenjawi, B. (2021). Prevalence of stress, depression, anxiety and sleep disturbance among nurses during the COVID-19 pandemic: A systematic review and meta-analysis. *Journal of Psychosomatic Research*, *141*, 110343. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.jpsychores.2020.110343

Alshak, M. N. (2019). *Neuroanatomy, sympathetic nervous system.* StatPearls. https://www.ncbi.nlm.nih.gov/books/NBK553141/

American Hospital Association. (2022). *AHA letter re: challenges facing America's health care workforce as the U.S. enters third year of COVID-19 pandemic*. https://www.aha.org/lettercomment/2022-03-01-aha-provides-information-congress-re-challenges-facing-americas-health

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5)*. American Psychiatric Publishing.

Ariapooran, S., Ahadi, B., & Khezeli, M. (2022). Depression, anxiety, and suicidal ideation in nurses with and without symptoms of secondary traumatic stress

during the COVID-19 outbreak. *Archives of Psychiatric Nursing*, *37*, 76-81. https://doi.org/10.1016/j.apnu.2021.05.005

Bensley, K. M., Seelig, A. D., Armenta, R. F., Rivera, A. C., Peterson, A. V., Jacobson, I. G., Littman, A. J., Maynard, C., Bricker, J. B., Boyko, E. J., Rull, R. P., & Williams, E. C. (2018). Posttraumatic stress disorder symptom association with subsequent risky and problem drinking initiation. *Journal of Addiction Medicine*, *12*(5), 353–362. https://doi.org/10.1097/ADM.0000000000000420

Billman G. E. (2013). The LF/HF ratio does not accurately measure cardiac sympatho-vagal balance. *Frontiers in Physiology*, *4*, 26. https://doi-org.ezproxy3.lhl.uab.edu/10.3389/fphys.2013.00026

Blevins, C. A., Weathers, F. W., Davis, M. T., Witte, T. K., & Domino, J. L. (2015). The Posttraumatic Stress Disorder Checklist for *DSM-5* (PCL-5): Development and initial psychometric evaluation. *Journal of Traumatic Stress, 28*(6), 489-498. https://doi.org/10.1002/jts.22059

Bovin, M. J., Marx, B. P., Weathers, F. W., Gallagher, M. W., Rodriguez, P., Schnurr, P. P., & Keane, T. M. (2016). Psychometric properties of the PTSD Checklist for Diagnostic and Statistical Manual of Mental Disorders-Fifth Edition (PCL-5) in veterans. *Psychological Assessment*, *28*(11), 1379–1391. https://doi.org/10.1037/pas0000254

Brage, S., Brage, N., Franks, P. W., Ekelund, U., & Wareham, N. J. (2005). Reliability and validity of the combined heart rate and movement sensor Actiheart. *European Journal of Clinical Nutrition*, *59*(4), 561–570. https://doi-org.ezproxy3.lhl.uab.edu/10.1038/sj.ejcn.1602118

Brudey, C., Park, J., Wiaderkiewicz, J., Kobayashi, I., Mellman, T. A., & Marvar, P. J. (2015). Autonomic and inflammatory consequences of posttraumatic stress disorder and the link to cardiovascular disease. *American Journal of Physiology. Regulatory, Integrative, and Comparative Physiology, 309*(4), R315-321. https://doi.org/10.1152/ajpregu.00343.2014

Burch, J. B., Alexander, M., Balte, P., Sofge, J., Winstead, J., Kothandaraman, V., & Ginsberg, J. P. (2019). Shift work and heart rate variability coherence: Pilot study among nurses. *Applied Psychophysiology and Biofeedback, 44*(1), 21-30. https://doi.org/10.1007/s10484-018-9419-z

Bustamante-Sánchez, A., Tornero-Aguilera, J. F., Fernández-Elías, V. E., Hormeño-Holgado, A. J., Dalamitros, A. A., & Clemente-Suárez, V. J. (2020). Effect of stress on autonomic and cardiovascular systems in military population: A systematic review. *Cardiology Research and Practice, 2020,* 7986249. https://doi.org/10.1155/2020/7986249

Buysse, D. J., Yu, L., Moul, D. E., Germain, A., Stover, A., Dodds, N. E., Johnston, K. L., Shablesky-Cade, M. A., & Pilkonis, P. A. (2010). Development and validation of patient-reported outcome measures for sleep disturbance and sleep-related impairments. *Sleep*, *33*(6), 781–792. https://doi-org.ezproxy3.lhl.uab.edu/10.1093/sleep/33.6.781

Cabarkapa, S., Nadjidai, S. E., Murgier, J., & Ng, C. H. (2020). The psychological impact of COVID-19 and other viral epidemics on frontline healthcare workers and ways to address it: A rapid systematic review. *Brain, Behavior, & Immunity*, *8*, 100144. https://doi.org/10.1016/j.bbih.2020.100144

Cambridge Dictionary. (2022). *Unstable*. https://dictionary.cambridge.org/us/dictionary/english/unstable

CamNtech, Ltd. (2022). *The Actiheart guide to getting started.* https://www.camntech.com/Products/Actiheart/The%20Actiheart%20Guide%20to%20Getting%20Started.pdf

Campbell-Sills, L., & Stein, M. B. (2007). Psychometric analysis and refinement of the Connor–Davidson Resilience Scale (CD-RISC): Validation of a 10-item measure of resilience. *Journal of Traumatic Stress*, *20*(6), 1019-1028. https://doi-org.ezproxy3.lhl.uab.edu/10.1002/jts.20271

Cleveland Clinic. (2022). *What is a code blue?* https://my.clevelandclinic.org/health/articles/23532-code-blue-hospital

Chinoy, E. D., Carey, F. R., Kolaja, C. A., Jacobson, I. G., Cooper, A. D., & Markwald, R. R. (2022). The bi-directional relationship between post-traumatic stress disorder and obstructive sleep apnea and/or insomnia in a large US military cohort. *Sleep Health*. S2352-7218(22)00131-0. Advance online publication. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.sleh.2022.07.005

Cohen, S., & Janicki-Deverts, D. (2012). Who's stressed? Distributions of psychological stress in the United States in probability samples from 1983, 2006, and 2009. *Journal of Applied Social Psychology*, *42*(6), 1320–1334. https://doi.org/10.1111/j.1559-1816.2012.00900.x

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, 385-396.

Colzato, L. S., Jongkees, B. J., de Wit, M., van der Molen, M. J. W., & Steenbergen, L. (2018). Variable heart rate and a flexible mind: Higher resting-state heart rate variability predicts better task-switching. *Cognitive, Affective & Behavioral Neuroscience, 18*(4), 730-738. https://doi.org/10.3758/s13415-018-0600-x

Czaja, A. S., Moss, M., & Mealer, M. (2012). Symptoms of posttraumatic stress disorder among pediatric acute care nurses. *Journal of Pediatric Nursing*, *27*(4), 357-365. https://doi.org/10.1016/j.pedn.2011.04.024

Davidson, J. R. T. (2018). *Connor-Davidson Resilience Scale (CDRISC) manual.* http://www.connordavidson-resiliencescale.com/CD-RISC%20Manual%2008-19-18.pdf

Davis, L. L., Schein, J., Cloutier, M., Gagnon-Sanschagrin, P., Maitland, J., Urganus, A., Guerin, A., Lefebvre, P., & Houle, C. R. (2022). The economic burden of posttraumatic stress disorder in the United States from a societal perspective. *The Journal of Clinical Psychiatry*, *83*(3), 21m14116. https://doi-org.ezproxy3.lhl.uab.edu/10.4088/JCP.21m14116

de Boer, J., van Rikxoort, S., Bakker, A. B., & Smit, B. J. (2014). Critical incidents among intensive care unit nurses and their need for support: Explorative interviews. *Nursing in Critical Care*, *19*(4), 166-174. https://doi.org/10.1111/nicc.12020

Dennis, P. A., Dedert, E. A., Van Voorhees, E. E., Watkins, L. L., Hayano, J., Calhoun, P. S., Sherwood, A., Dennis, M. F., & Beckham, J. C. (2016). Examining the crux of autonomic dysfunction in posttraumatic stress disorder: Whether chronic or situational distress underlies elevated heart rate and attenuated heart rate

variability. *Psychosomatic Medicine*, *78*(7), 805–809. https://doi-org.ezproxy3.lhl.uab.edu/10.1097/PSY.0000000000000326

Dictionary.com. (2022). *Administer*. https://www.dictionary.com/browse/administering

Dictionary.com. (2022). *Pain*. https://www.dictionary.com/browse/pain#:~:text=to%20cause%20physical%20pain%20to,to%20have%20or%20give%20pain

Dyball, D., Evans, S., Boos, C. J., Stevelink, S. A. M., & Fear, N. T. (2019). The association between PTSD and cardiovascular disease and its risk factors in male veterans of the Iraq/Afghanistan conflicts: A systematic review. *International Review of Psychiatry*, *31*(1), 34-48. https://doi.org/10.1080/09540261.2019.1580686

Encyclopædia Britannica, Inc. (2022). *Communication*. https://www.britannica.com/dictionary/communication

Encyclopædia Britannica, Inc. (2022). *Frustration*. https://www.britannica.com/dictionary/frustration

Encyclopedia.com. (2019). *Post-mortem care.* https://www.encyclopedia.com/medicine/encyclopedias-almanacs-transcripts-and-maps/postmortem-care

Encyclopedia.com. (2019). *Withdraw support*. https://www.encyclopedia.com/caregiving/encyclopedias-almanacs-transcripts-and-maps/withdrawing-support

Feingold, J. H., Peccoralo, L., Chan, C. C., Kaplan, C. A., Kaye-Kauderer, H., Charney, D., Verity, J., Hurtado, A., Burka, L., Syed, S. A., Murrough, J. W., Feder, A.,

Pietrzak, R. H., & Ripp, J. (2021). Psychological impact of the COVID-19 pandemic on frontline health care workers during the pandemic surge in New York City. *Chronic Stress*, *5*, 2470547020977891. https://doi-org.ezproxy3.lhl.uab.edu/10.1177/2470547020977891

Foster, S. N., Brock, M. S., Hansen, S., Collen, J. F., Walter, R., O'Connor, P., Wall, P., & Mysliwiec, V. (2016). Sleep disorders related to deployment in active duty service members and veterans. *Current Pulmonology Reports*, *5*(2), 101-110. https://link.springer.com/article/10.1007/s13665-016-0147-7

Garcia, O., Slavish, D. C., Dietch, J. R., Messman, B. A., Contractor, A. A., Haynes, P. L., Pruiksma, K. E., Kelly, K., Ruggero, C., & Taylor, D. J. (2021). What goes around comes around: Nightmares and daily stress are bidirectionally associated in nurses. *Stress and Health*, *37*(5), 1035–1042. https://doi-org.ezproxy3.lhl.uab.edu/10.1002/smi.3048

Ge, F., Yuan, M., Li, Y., & Zhang, W. (2020). Posttraumatic stress disorder and alterations in resting heart rate variability: A systematic review and meta-analysis. *Psychiatry Investigation, 17*(1), 9–20. https://doi-org.ezproxy3.lhl.uab.edu/10.30773/pi.2019.0112

Germain, A., McKeon, A. B., & Campbell, R. L. (2017). Sleep in PTSD: Conceptual model and novel directions in brain-based research and interventions. *Current Opinion in Psychology*, *14*, 84–89. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.copsyc.2016.12.004

Geuzinge, R., Visse, M., Duyndam, J., & Vermetten, E. (2020). Social embeddedness of firefighters, paramedics, specialized nurses, police officers, and military

personnel: Systematic review in relation to the risk of traumatization. *Frontiers in Psychiatry*, *11*, 496663. https://doi.org/10.3389/fpsyt.2020.496663

Goffeng, E. M., Nordby, K. C., Tarvainen, M. P., Järvelin-Pasanen, S., Wagstaff, A., Goffeng, L. O., Bugge, M., Skare, Ø., & Sigstad Lie, J. A. (2018). Fluctuations in heart rate variability of health care workers during four consecutive extended work shifts and recovery during rest and sleep. *Industrial Health*, *56*(2), 122–131. https://doi-org.ezproxy3.lhl.uab.edu/10.2486/indhealth.2017-0100

Goldstein, R. B., Smith, S. M., Chou, S. P., Saha, T. D., Jung, J., Zhang, H., Pickering, R. P., Ruan, W. J., Huang, B., & Grant, B. F. (2016). The epidemiology of DSM-5 posttraumatic stress disorder in the United States: Results from the National Epidemiologic Survey on Alcohol and Related Conditions-III. *Social Psychiatry and Psychiatric Epidemiology*, *51*(8), 1137–1148. https://doi-org.ezproxy3.lhl.uab.edu/10.1007/s00127-016-1208-5

Gradus, J. L., Qin, P., Lincoln, A. K., Miller, M., Lawler, E., Sørensen, H. T., & Lash, T. L. (2010). Posttraumatic stress disorder and completed suicide. *American Journal of Epidemiology*, *171*(6), 721–727. https://doi-org.ezproxy3.lhl.uab.edu/10.1093/aje/kwp456

Green, K., Eddy, A., Flowers, J., & Christopher, M. (2022). A confirmatory factor analysis of the PROMIS sleep disturbance among law enforcement officers. *Journal of Police and Criminal Psychology*, *37*(1), 141-145. https://doi-org.ezproxy3.lhl.uab.edu/10.1007/s11896-021-09471-w

Greenberg, N., Weston, D., Hall, C., Caulfield, T., Williamson, V., & Fong, K. (2021). Mental health of staff working in intensive care during COVID-19. *Occupational*

Medicine, *71*(2), 62–67. https://doi-org.ezproxy3.lhl.uab.edu/10.1093/occmed/kqaa220

Gujral, H., Kushwaha, A. K., & Khurana, S. (2020). Utilization of time series tools in life-sciences and neuroscience. *Neuroscience Insights*, *15*, 2633105520963045. https://doi-org.ezproxy3.lhl.uab.edu/10.1177/2633105520963045

Guttormson, J. L., Calkins, K., McAndrew, N., Fitzgerald, J., Losurdo, H., & Loonsfoot, D. (2022). Critical care nurse burnout, moral distress, and mental health during the COVID-19 pandemic: A United States survey. *Heart & Lung*, *55*, 127–133. https://doi.org/10.1016/j.hrtlng.2022.04.015

Hauschildt, M., Peters, M. J., Moritz, S., & Jelinek, L. (2011). Heart rate variability in response to affective scenes in posttraumatic stress disorder. *Biological Psychology*, *88*(2-3), 215–222. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.biopsycho.2011.08.004

Hayano, J., & Yuda, E. (2019). Pitfalls of assessment of autonomic function by heart rate variability. *Journal of Physiological Anthropology*, *38*(1), 3. https://doi-org.ezproxy3.lhl.uab.edu/10.1186/s40101-019-0193-2

HealthMeasures. (2022). *Promis: Measure development & research.* https://www.healthmeasures.net/explore-measurement-systems/promis/measure-development-research

Hertenstein, E., Feige, B., Gmeiner, T., Kienzler, C., Spiegelhalder, K., Johann, A., Jansson-Fröjmark, M., Palagini, L., Rücker, G., Riemann, D., & Baglioni, C. (2019). Insomnia as a predictor of mental disorders: A systematic review and

meta-analysis. *Sleep Medicine Reviews*, *43*, 96–105. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.smrv.2018.10.006

Hoerster, K. D., Campbell, S., Dolan, M., Stappenbeck, C. A., Yard, S., Simpson, T., & Nelson, K. M. (2019). PTSD is associated with poor health behavior and greater body mass index through depression, increasing cardiovascular disease and diabetes risk among U.S. veterans. *Preventive Medicine Reports, 15*, 100930. https://doi.org/10.1016/j.pmedr.2019.100930

Holliday, R., Borges, L. M., Stearns-Yoder, K. A., Hoffberg, A. S., Brenner, L. A., & Monteith, L. L. (2020). Posttraumatic stress disorder, suicidal ideation, and suicidal self-directed violence among US military personnel and veterans: A systematic review of the literature from 2010 to 2018. *Frontiers in Psychology*, *11*, 1998. https://doi-org.ezproxy3.lhl.uab.edu/10.3389/fpsyg.2020.01998

Hong, S., Ai, M., Xu, X., Wang, W., Chen, J., Zhang, Q., Wang, L., & Kuang, L. (2021). Immediate psychological impact on nurses working at 42 government-designated hospitals during COVID-19 outbreak in China: A cross-sectional study. *Nursing Outlook*, *69*(1), 6–12. https://doi.org/10.1016/j.outlook.2020.07.007

Howell, E. F. (2013). *The dissociative mind.* Routledge.

Ito, H., Nozaki, M., Maruyama, T., Kaji, Y., & Tsuda, Y. (2001). Shift work modifies the circadian patterns of heart rate variability in nurses. *International Journal of Cardiology, 79*(2-3), 231-236. https://doi.org/10.1016/s0167-5273(01)00439-9

Järvelin-Pasanen, S., Ropponen, A., Tarvainen, M. P., Karjalainen, P. A., & Louhevaara, V. (2013). Differences in heart rate variability of female nurses between and

within normal and extended work shifts. *Industrial Health*, *51*(2), 154–164. https://doi-org.ezproxy3.lhl.uab.edu/10.2486/indhealth.ms1368

John-Hopkins Medicine. (2022). *Hospital discharge*. https://www.hopkinsmedicine.org/health/treatment-tests-and-therapies/hospital-discharge#:~:text=When%20you%20leave%20a%20hospital,to%20another%20type%20of%20facility

Karanikola, M., Giannakopoulou, M., Mpouzika, M., Kaite, C. P., Tsiaousis, G. Z., & Papathanassoglou, E. D. (2015). Dysfunctional psychological responses among intensive care unit nurses: A systematic review of the literature. *Revista da Escola de Enfermagem da U S P*, *49*(5), 847–857. https://doi-org.ezproxy3.lhl.uab.edu/10.1590/S0080-623420150000500020

Karanikola, M. N. K., & Mpouzika, M. D. A. (2018). Time to create a healthy work environment in ICU: A review of current evidence and commentary. *CONNECT: The World of Critical Care Nursing*, *12*(2), 44-47. https://doi:10.1891/1748-6254.12.2.4

Kessler, R. C., Sonnega, A., Bromet, E., Hughes, M., & Nelson, C. B. (1995). Posttraumatic stress disorder in the National Comorbidity Survey. *Archives of General Psychiatry*, *52*(12), 1048–1060. https://doi-org.ezproxy3.lhl.uab.edu/10.1001/archpsyc.1995.03950240066012

Kim, H.-G., Cheon, E.-J., Bai, D.-S., Lee, Y. H., & Koo, B.-H. (2018). Stress and heart rate variability: A meta-analysis and review of the literature. *Psychiatry Investigation*, *15*(3), 235-245. https://doi.org/10.30773/pi.2017.08.17

Kim, S. C., Quiban, C., Sloan, C., & Montejano, A. (2021). Predictors of poor mental health among nurses during COVID-19 pandemic. *Nursing Open*, *8*(2), 900–907. https://doi-org.ezproxy3.lhl.uab.edu/10.1002/nop2.697

Koenig, J., & Thayer, J. F. (2016). Sex differences in healthy human heart rate variability: A meta-analysis. *Neuroscience and Biobehavioral Reviews, 64*, 288-310. https://doi.org/10.1016/j.neubiorev.2016.03.007

Konkani, A., & Oakley, B. (2012). Noise in hospital intensive care units--A critical review of a critical topic. *Journal of Critical Care*, *27*(5), 522.e1–522.e5229. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.jcrc.2011.09.003

Kroenke, K., Stump, T. E., Chen, C. X., Kean, J., Bair, M. J., Damush, T. M., Krebs, E. E., & Monahan, P. O. (2020). Minimally important differences and severity thresholds are estimated for the PROMIS depression scales from three randomized clinical trials. *Journal of Affective Disorders*, *266*, 100–108. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.jad.2020.01.101

Laborde, S., Mosley, E., & Thayer, J. F. (2017). Heart rate variability and cardiac vagal tone in psychophysiological research–recommendations for experiment planning, data analysis, and data reporting. *Frontiers in Psychology*, *8*, 213. https://doi-org.ezproxy3.lhl.uab.edu/10.3389/fpsyg.2017.00213

Lai, J., Ma, S., Wang, Y., Cai, Z., Hu, J., Wei, N., Wu, J., Du, H., Chen, T., Li, R., Tan, H., Kang, L., Yao, L., Huang, M., Wang, H., Wang, G., Liu, Z., & Hu, S. (2020). Factors associated with mental health outcomes among health care workers exposed to Coronavirus Disease 2019. *JAMA*, *3*(3), e203976. https://doi.org/10.1001/jamanetworkopen.2020.3976

Lancel, M., van Marle, H., Van Veen, M. M., & van Schagen, A. M. (2021). Disturbed sleep in PTSD: Thinking beyond nightmares. *Frontiers in Psychiatry*, *12*, 767760. https://doi-org.ezproxy3.lhl.uab.edu/10.3389/fpsyt.2021.767760

Law Insider. (n.d.). *Emergent care*. https://www.lawinsider.com/dictionary/emergent-care

Law Insider. (n.d.). *Medical order definition*. https://www.lawinsider.com/dictionary/medical-order?cursor=CloSVGoVc35sYXdpbnNpZGVyY29udHJhY3RzcjYLEhpEZWZpbml0aW9uU25pcHBldEdyb3VwX3YzNSIWbWVkaWNhbC1vcmRlciMwMDAwMDAwMDAwYQyiAQJlbhgAIAA%3D

Lehmann, M., Bruenahl, C. A., Löwe, B., Addo, M. M., Schmiedel, S., Lohse, A. W., & Schramm, C. (2015). Ebola and psychological stress of health care professionals. *Emerging Infectious Diseases, 21*(5), 913-914. https://doi.org/10.3201/eid2105.141988

Lensvelt-Mulders, G., van der Hart, O., van Ochten, J. M., van Son, M. J., Steele, K., & Breeman, L. (2008). Relations among peritraumatic dissociation and posttraumatic stress: A meta-analysis. *Clinical Psychology Review, 28*(7), 1138-1151. https://doi.org/10.1016/j.cpr.2008.03.006

Levi, P., & Moss, J. (2022). Intensive care unit nurses' lived experiences of psychological stress and trauma caring for COVID-19 patients. *Workplace Health & Safety*, *70*(8), 358–367. https://doi.org/10.1177/21650799211064262

Levi, P., Patrician, P. A., Vance, D. E., Montgomery, A. P., & Moss, J. (2021). Post-traumatic stress disorder in intensive care unit nurses: A concept analysis.

Workplace Health & Safety, *69*(5), 224–234. https://doi.org/10.1177/2165079920971999

Lewandowska, K., Weisbrot, M., Cieloszyk, A., Mędrzycka-Dąbrowska, W., Krupa, S., & Ozga, D. (2020). Impact of alarm fatigue on the work of nurses in an intensive care environment—A systematic review. *International Journal of Environmental Research and Public Health*, *17*(22), 8409. https://doi-org.ezproxy3.lhl.uab.edu/10.3390/ijerph17228409

Lewis, C., Lewis, K., Kitchiner, N., Isaac, S., Jones, I., & Bisson, J. I. (2020). Sleep disturbance in post-traumatic stress disorder (PTSD): A systematic review and meta-analysis of actigraphy studies. *European Journal of Psychotraumatology*, *11*(1), 1767349. https://doi-org.ezproxy3.lhl.uab.edu/10.1080/20008198.2020.1767349

Li, M., Chen, S., Gao, Z., Wu, W., & Xu, L. (2020). Physiological explicit of delayed psychological stress response induced by extra neural regulation. *Computer Methods and Programs in Biomedicine*, *196*, 105610. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.cmpb.2020.105610

Lipponen, J. A., & Tarvainen, M. P. (2019). A robust algorithm for heart rate variability time series artefact correction using novel beat classification. *Journal of Medical Engineering & Technology*, *43*(3), 173-181. https://doi-org.ezproxy3.lhl.uab.edu/10.1080/03091902.2019.1640306

Magruder, K. M., McLaughlin, K. A., & Elmore Borbon, D. L. (2017). Trauma is a public health issue. *European Journal of Psychotraumatology*, *8*(1), Article 1375338. https://doi.org/10.1080/20008198.2017.1375338

Malik, M. (1996). Heart rate variability: Standards of measurement, physiological interpretation, and clinical use: Task Force of the European Society of Cardiology and the North American Society for Pacing and Electrophysiology. *Annals of Noninvasive Electrocardiology*, *1*(2), 151-181. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1542-474X.1996.tb00275.x?casa_token=t7Kl0Ii4vj8AAAAA%3Aw_6m7TfF9Vb33ccm3trfnK5ABPwddt8A562s-QMSIxB3S4sPN_Pv0zNfDs1H6OJA57QzChmViInpHbI

Marmar, C. R., Metzler, T. J., & Otte, C. (2004). *The peritraumatic dissociative experiences questionnaire.* The Guilford Press.

McAlonan, G. M., Lee, A. M., Cheung, V., Cheung, C., Tsang, K. W., Sham, P. C., Chua, S. E., & Wong, J. G. (2007). Immediate and sustained psychological impact of an emerging infectious disease outbreak on health care workers. *Canadian Journal of Psychiatry*, *52*(4), 241–247. https://doi.org/10.1177/070674370705200406

McCanlies, E. C., Sarkisian, K., Andrew, M. E., Burchfiel, C. M., & Violanti, J. M. (2017). Association of peritraumatic dissociation with symptoms of depression and posttraumatic stress disorder. *Psychological Trauma*, *9*(4), 479–484. https://doi.org/10.1037/tra0000215

McEwen, B. S. (1998). Protective and damaging effects of stress mediators. *New England Journal of Medicine*, *338*(3), 171-179.

McKinsey & Company. (2022). *Surveyed nurses consider leaving direct patient care at elevated rates*. https://www.mckinsey.com/industries/healthcare-systems-and-

services/our-insights/surveyed-nurses-consider-leaving-direct-patient-care-at-elevated-rates

Mealer, M., Burnham, E. L., Goode, C. J., Rothbaum, B., & Moss, M. (2009). The prevalence and impact of post traumatic stress disorder and burnout syndrome in nurses. *Depression and Anxiety*, *26*(12), 1118-1126. https://doi.org/10.1002/da.20631

Mealer, M., Jones, J., & Moss, M. (2012). A qualitative study of resilience and posttraumatic stress disorder in United States ICU nurses. *Intensive Care Medicine*, *38*(9), 1445-1451. https://doi:10.1007/s00134-012-2600-6

Memarzia, J., Walker, J., & Meiser-Stedman, R. (2021). Psychological peritraumatic risk factors for post-traumatic stress disorder in children and adolescents: A meta-analytic review. *Journal of Affective Disorders*, *282*, 1036–1047. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.jad.2021.01.016

Merriam-Webster, Incorporated. (2022). *Agitated*. https://www.merriam-webster.com/dictionary/agitated

Merriam-Webster, Incorporated. (2022). *Alarm*. https://www.merriam-webster.com/dictionary/alarm

Merriam-Webster, Incorporated. (2022). *Assisting*. https://www.merriam-webster.com/dictionary/assisting

Merriam-Webster, Incorporated. (2022). *Breakdown*. https://www.merriam-webster.com/dictionary/breakdown

Merriam-Webster, Incorporated. (2022). *Dangerous*. https://www.merriam-webster.com/dictionary/danger

Merriam-Webster, Incorporated. (2022). *False*. https://www.merriam-webster.com/dictionary/false

Merriam-Webster, Incorporated. (2022). *Reposition*. https://www.merriam-webster.com/dictionary/reposition

Merriam-Webster, Incorporated. (2022). *Supply*. https://www.merriam-webster.com/dictionary/supply

Merriam-Webster, Incorporated. (2022). *Violent*. https://www.merriam-webster.com/dictionary/violent

Moss, J., Berner, E. S., & Savell, K. (2007). A mobile data collection tool for workflow analysis. *IOS Press Ebooks*, *129*(Pt 1), 48–52. https://ebooks-iospress-nl.ezproxy3.lhl.uab.edu/publication/10932

Moss, J., & Xiao, Y. (2004). Improving operating room coordination: Communication pattern assessment. *The Journal of Nursing Administration*, *34*(2), 93–100. https://doi-org.ezproxy3.lhl.uab.edu/10.1097/00005110-200402000-00008

Moss, M., Good, V. S., Gozal, D., Kleinpell, R., & Sessler, C. N. (2016). An official Critical Care Societies collaborative statement-Burnout syndrome in critical care health-care professionals: A call for action. *Chest, 150*(1), 17–26. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.chest.2016.02.649

National Center for PTSD. (2022). *PTSD checklist for DSM-5 (PCL-5).* U.S. Department of Veterans Affairs. https://www.ptsd.va.gov/professional/assessment/documents/using-pcl5.pdf 2020

National Institute on Aging. (2022). *What are palliative care and hospice care?* https://www.nia.nih.gov/health/what-are-palliative-care-and-hospice-care#hospice

Nichter, B., Norman, S., Haller, M., & Pietrzak, R. H. (2019). Physical health burden of PTSD, depression, and their comorbidity in the US veteran population: Morbidity, functioning, and disability. *Journal of Psychosomatic Research*, *124*, 109744. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.jpsychores.2019.109744

Nursing Solutions, Incorporated. (2020). *Retention & RN staffing report.* https://www.nsinursingsolutions.com/Documents/Library/NSI_National_Health_Care_Retention_Report.pdf

Ong, Y. Z., Siddiqui, S., John, S., Chen, Z., & Chang, S. (2016). The prevalence of post-traumatic stress disorder in intensive care unit staff and the common coping strategies used. *Annals of the Academy of Medicine, Singapore*, *45*(5), 215-218. https://annals.edu.sg/pdf/45VolNo5May2016/V45N5p215.pdf

Pappa, S., Ntella, V., Giannakas, T., Giannakoulis, V. G., Papoutsi, E., & Katsaounou, P. (2020). Prevalence of depression, anxiety, and insomnia among healthcare workers during the COVID-19 pandemic: A systematic review and meta-analysis. *Brain, Behavior, and Immunity*, *88*, 901–907. https://doi.org/10.1016/j.bbi.2020.05.026

Petzel, J. (2021). *Resilience of regional hospital nursing staff working during the COVID-19 pandemic measured by the Connor-Davidson resilience scale.* MaineHealth. https://knowledgeconnection.mainehealth.org/cgi/viewcontent.cgi?article=3148&context=mmc

R Core Team. (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

Rautaharju, P. M., Park, L., Rautaharju, F. S., & Crow, R. (1998). A standardized procedure for locating and documenting ECG chest electrode positions: Consideration of the effect of breast tissue on ECG amplitudes in women. *Journal of Electrocardiology*, *31*(1), 17–29. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/s0022-0736(98)90003-6

Registered Nursing.org. (2022). *Continuity of care: NCLEX-RN*. https://www.registerednursing.org/nclex/continuity-care/#providing-receiving-report-assigned-clients

Reitz, K. M., Terhorst, L., Smith, C. N., Campwala, I. K., Owoc, M. S., Downs-Canner, S. M., Diego, E. J., Switzer, G. E., Rosengart, M. R., & Myers, S. P. (2021). Healthcare providers' perceived support from their organization is associated with lower burnout and anxiety amid the COVID-19 pandemic. *PloS One*, *16*(11), e0259858. https://doi-org.ezproxy3.lhl.uab.edu/10.1371/journal.pone.0259858

Richards, A., Kanady, J. C., & Neylan, T. C. (2020). Sleep disturbance in PTSD and other anxiety-related disorders: An updated review of clinical features, physiological characteristics, and psychological and neurobiological mechanisms. *Neuropsychopharmacology*, *45*(1), 55-73. https://doi.org/10.1038/s41386-019-0486-5

Rodríguez-Rey, R., Garrido-Hernansaiz, H., & Bueno-Guerra, N. (2020). Working in the times of COVID-19. Psychological impact of the pandemic in frontline workers in

Spain. *International Journal of Environmental Research and Public Health*, *17*(21). https://doi.org/10.3390/ijerph17218149

Rodríguez-Rey, R., Palacios, A., Alonso-Tapia, J., Pérez, E., Álvarez, E., Coca, A., Mencia, S., Marcos, A., Mayordomo-Colunga, J., Fernandez, F., Gomez, F., Cruz, J., Ramos, V., & Olmedilla, M. (2019). Are pediatric critical personnel satisfied with their lives? Prediction of satisfaction with life from burnout, posttraumatic stress, and posttraumatic growth, and comparison with noncritical pediatric staff. *Pediatric Critical Care Medicine, 20*(3), e160-e169. https://doi.org/10.1097/PCC.0000000000001861

Rothrock, N. E., Amtmann, D., & Cook, K. F. (2020). Development and validation of an interpretive guide for PROMIS scores. *Journal of Patient-reported Outcomes*, *4*(1), 16. https://doi-org.ezproxy3.lhl.uab.edu/10.1186/s41687-020-0181-7

RxList Inc. (2022). *Definition of stat*. https://www.rxlist.com/stat/definition.htm#:~:text=STAT%3A%20A%20common%20medical%20abbreviation,statim%2C%20meaning%20%22immediately.%22

Salmon, G., & Morehead, A. (2019). Posttraumatic stress syndrome and implications for practice in critical care nurses. *Critical Care Nursing Clinics of North America, 31*(4), 517-526. https://www-sciencedirect-com.ezproxy3.lhl.uab.edu/science/article/pii/S0899588519300589?via%3Dihub

Sammito, S., Thielmann, B., Seibt, R., Klussmann, A., Weippert, M., & Böckelmann, I. (2015). Guideline for the application of heart rate and heart rate variability in occupational medicine and occupational science. *ASU International*, *2015*(06). https://d1wqtxts1xzle7.cloudfront.net/68597313/Guideline_for_the_application_o

f_heart_r20210804-15097-7ragud-with-cover-page-v2.pdf?Expires=1666034659&Signature=caVPgJrk-af~3BdEAt4Fq-Iv9BkUZQZAbzGIJX9HRdoYSW~qLEgWmzoOF~XfcXJN8MbjTxyazLPssVJuCQSVC4jnPAWCGqt3rZse80~Na3vktABb52rO~FZs5l3FKNGtlrK2sGuqQrOiKxqZe9p0eP2Gjh5uKUYnsu8impTjgGop0AD28Z5iSX~FE0oaPqR65odcQr~UrUySujW1Eu53cymc~vklUICHHHztrF26ivvy2YaJu6bQbzVEgnzTbI80Hw3Rduk74R6oFMLEJF9B0Zn2PBLZJdIKaXCz-8UI-DzOvsnl6DQZDiQ3sRmU8x9~ALwck-7w3l9vbw4GiIDQnw__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA

Sandhu, S. S., Ismail, N. H., & Rampal, K. G. (2015). The Malay version of the perceived stress scale (PSS)-10 is a reliable and valid measure for stress among nurses in Malaysia. *The Malaysian Journal of Medical Sciences: MJMS*, *22*(6), 26.

Schnurr, P., Vielhauer, M., Weathers, F., & Findler, M. (1999). The Brief Trauma Questionnaire (BTQ) [Measurement instrument]. https://www.ptsd.va.gov/professional/assessment/te-measures/brief_trauma_questionnaire_btq.asp

Schneider, M., & Schwerdtfeger, A. (2020). Autonomic dysfunction in posttraumatic stress disorder indexed by heart rate variability: A meta-analysis. *Psychological Medicine, 50*(12), 1937-1948. https://doi.org/10.1017/s003329172000207x

Schuster, M., & Dwyer, P. A. (2020). Post-traumatic stress disorder in nurses: An integrative review. *Journal of Clinical Nursing*, *29*(15-16), 2769–2787. https://doi-org.ezproxy3.lhl.uab.edu/10.1111/jocn.15288

Shah, M. K., Gandrakota, N., Cimiotti, J. P., Ghose, N., Moore, M., & Ali, M. K. (2021). Prevalence of and factors associated with nurse burnout in the US. *JAMA*, *4*(2), e2036469. https://doi-org.ezproxy3.lhl.uab.edu/10.1001/jamanetworkopen.2020.36469

Shen, X., Zou, X., Zhong, X., Yan, J., & Li, L. (2020). Psychological stress of ICU nurses in the time of COVID-19. *Critical Care*, *24*(1), 200. https://doi.org/10.1186/s13054-020-02926-2

Spina, G. D., Gonze, B. B., Barbosa, A. C. B., Sperandio, E. F., & Dourado, V. Z. (2019). Presence of age- and sex-related differences in heart rate variability despite the maintenance of a suitable level of accelerometer-based physical activity. *Brazilian Journal of Medical and Biological Research, 52*(8), e8088. https://doi.org/10.1590/1414-431x20198088

Spinhoven, P., Penninx, B. W., van Hemert, A. M., de Rooij, M., & Elzinga, B. M. (2014). Comorbidity of PTSD in anxiety and depressive disorders: Prevalence and shared risk factors. *Child Abuse & Neglect*, *38*(8), 1320–1330. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.chiabu.2014.01.017

Storm, J., & Chen, H. C. (2021). The relationships among alarm fatigue, compassion fatigue, burnout and compassion satisfaction in critical care and step-down nurses. *Journal of Clinical Nursing*, *30*(3-4), 443-453. https://doi-org.ezproxy3.lhl.uab.edu/10.1111/jocn.15555

Sunnybrook. (2022). *Explaining delirium*: *Why patients may become confused during recovery*. https://health.sunnybrook.ca/navigator/delirium-patients-confused-recovery/

Szakonyi, B., Vassányi, I., Schumacher, E., & Kósa, I. (2021). Efficient methods for acute stress detection using heart rate variability data from Ambient Assisted Living sensors. *Biomedical Engineering Online*, *20*(1), 73. https://doi-org.ezproxy3.lhl.uab.edu/10.1186/s12938-021-00911-6

Tarvainen, M. P., Georgiadis, S. D., Ranta-Aho, P. O., & Karjalainen, P. A. (2006). Time-varying analysis of heart rate variability signals with a Kalman smoother algorithm. *Physiological Measurement*, *27*(3), 225.

Tarvainen, M. P., Niskanen, J. P., Lipponen, J. A., Ranta-Aho, P. O., & Karjalainen, P. A. (2014). Kubios HRV-heart rate variability analysis software. *Computer Methods and Programs in Biomedicine, 113*, 210–220. https://doi.org/10.1016/j.cmpb.2013.07.024

Taylor, J. M. (2015). Psychometric analysis of the Ten-Item Perceived Stress Scale. *Psychological Assessment*, *27*(1), 90–101. https://doi.org/10.1037/a0038100

Thielmann, B., Pohl, R., & Böckelmann, I. (2021). Heart rate variability as a strain indicator for psychological stress for emergency physicians during work and alert intervention: A systematic review. *Journal of Occupational Medicine and Toxicology*, *16*(1), 24. https://doi-org.ezproxy3.lhl.uab.edu/10.1186/s12995-021-00313-3

Thompson-Hollands, J., Jun, J. J., & Sloan, D. M. (2017). The association between peritraumatic dissociation and PTSD symptoms: The mediating role of negative beliefs about the self. *Journal of Traumatic Stress, 30*(2), 190-194. https://doi.org/http://dx.doi.org/10.1002/jts.22179

Troxel, W. M., Shih, R. A., Pedersen, E. R., Geyer, L., Fisher, M. P., Griffin, B. A., Haas, A. C., Kurz, J., & Steinberg, P. S. (2015). Sleep in the military: Promoting healthy sleep among U.S. servicemembers. *Rand Health Quarterly*, *5*(2), 19. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5158299/

Ulmer, C. S., Hall, M. H., Dennis, P. A., Beckham, J. C., & Germain, A. (2018). Posttraumatic stress disorder diagnosis is associated with reduced parasympathetic activity during sleep in US veterans and military service members of the Iraq and Afghanistan wars. *Sleep, 41*(12). https://doi.org/10.1093/sleep/zsy174

van der Kolk, B. A. (1987). The drug treatment of post-traumatic stress disorder. *Journal of Affective Disorders*, *13*(2), 203–213. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/0165-0327(87)90024-3

van der Mei, W. F., Barbano, A. C., Ratanatharathorn, A., Bryant, R. A., Delahanty, D. L., deRoon-Cassini, T. A., Lai, B. S., Lowe, S. R., Matsuoka, Y. J., Olff, M., Qi, W., Schnyder, U., Seedat, S., Kessler, R. C., Koenen, K. C., Shalev, A. Y., & International Consortium to Predict PTSD. (2020). Evaluating a screener to quantify PTSD risk using emergency care information: A proof of concept study. *BMC Emergency Medicine*, *20*(1), 16. https://doi-org.ezproxy3.lhl.uab.edu/10.1186/s12873-020-00308-z

von Rosenberg, W., Chanwimalueang, T., Adjei, T., Jaffer, U., Goverdovsky, V., & Mandic, D. P. (2017). Resolving ambiguities in the LF/HF Ratio: LF-HF scatter plots for the categorization of mental and physical stress from HRV. *Frontiers in*

Physiology, 8, 360. https://doi-org.ezproxy3.lhl.uab.edu/10.3389/fphys.2017.00360

Welch, P. (1967). The use of fast Fourier transform for the estimation of power spectra: A method based on time averaging over short, modified periodograms. *IEEE Transactions on Audio and Electroacoustics*, *15*(2), 70-73.

Woolner, V., Ahluwalia, R., Lum, H., Beane, K., Avelino, J., & Chartier, L. B. (2020). Improving timely analgesia administration for musculoskeletal pain in the emergency department. *BMJ Open Quality*, *9*(1), e000797. https://doi.org/10.1136/bmjoq-2019-000797

World Health Organization. (2022). *WHO Coronavirus COVID-19 Dashboard*. https://covid19.who.int/

Yu, L., Buysse, D. J., Germain, A., Moul, D. E., Stover, A., Dodds, N. E., Johnston, K. L., & Pilkonis, P. A. (2011). Development of short forms from the PROMIS™ Sleep Disturbance and Sleep-Related Impairment item banks. *Behavioral Sleep Medicine*, *10*(1), 6–24. https://doi-org.ezproxy3.lhl.uab.edu/10.1080/15402002.2012.636266

CHAPTER 5

DISCUSSION

The purpose of this dissertation was to investigate the association between PTSD and psychological stress in ICU nurses to events experienced in the workplace. This was achieved by a concept analysis review paper (Manuscript One), findings of preliminary pilot research to support the dissertation research (Manuscript Two), and the major findings of the dissertation research (Manuscript Three). Manuscript One described the findings of a concept analysis through a thorough review of the literature concerning PTSD in ICU nurses. Manuscript Two provided the findings of a qualitative study which explored the phenomenon of the lived experiences of ICU nurses caring for COVID-19 patients. Manuscript Three presented the quantitative findings of the dissertation research, which examined stress (both objective measures and self-reports) ICU nurses experience due to events in the workplace. The objective of this final chapter is to: (a) provide an overview of findings from each of the three manuscripts, (b) discuss how the findings advance knowledge in the scientific field, (c) discuss strengths and limitations of the dissertation research, (d) offer recommendations for mitigating and/or preventing development of psychological stress and PTSD, and (e) provide implications and foundations for future research.

Summary of the Three Manuscripts

Manuscript 1: - Post-Traumatic Stress Disorder in Intensive Care Unit Nurses: A Concept Analysis

Manuscript One served as a review paper for this dissertation and followed Walker and Avant's (2011) eight-step concept analysis method. The rigorous analysis method culminated in better comprehension of the concept of PTSD in ICU nurses and its impact on their personal and professional lives, patient care, and hospitals for which they work. Antecedents identified for ICU nurses with PTSD were the stressful work environment, cumulative exposure to traumatic episodes, and a lack of support from coworkers, their manager, and/or the organization. Defining attributes were found to be re-experiencing of the traumatic event(s), avoidance of similar situations, negative alterations in cognition and mood, and symptoms of hyperarousal. Consequences of PTSD in ICU nurses included long-lasting psychological and physical consequences, substandard patient care, and financial consequences for hospitals. Calls for future research included development of interventions and policies to reduce the risk of PTSD for ICU nurses.

Manuscript 2 - Intensive Care Unit Nurses' Lived Experiences Caring for COVID-19 Patients

Manuscript Two employed a phenomenological method to gain a complex and detailed understanding of the lived experiences of ICU nurses caring for COVID-19 patients. Semi-structured interviews, using open-ended questions, were transcribed and

analyzed using Colaizzi's (1978) seven-step method. Analysis of interview transcripts revealed six recurring themes: *Change in Practice*, *Emotion*, *Patient's Family*, *Isolation*, *Job Satisfaction*, and *Public Reaction*. *Change in Practice* included four subthemes: Overburden, Knowledge, Quality of Care, and Futility.

The most notable *Changes in Practice* were that ICU nurses were overburdened, lacked knowledge (initially) of the COVID-19 virus, felt care was not up to their usual standard, and care was often futile. *Emotion* was the emotional toll the ICU nurses experienced caring for COVID-19 patients, including emotions of grief, worry, sadness, fear, and anger. *Patient's Family* encompassed added responsibilities of taking a primary role in discussing patient status and care with families, as well as witnessing families' heart-wrenching final goodbyes to their loved ones. *Isolation* comprised self-imposed isolation due to fear of spreading the virus to their families and friends. For *Job Satisfaction*, there were mixed feelings; 7 (70%) of the ICU nurses were only somewhat satisfied with their job. *Public Reaction* included being angered when individuals in society disregarded the importance of social distancing or when shunned by friends and/or family while caring for COVID-19 patients. In this sample 7 of 10 participants (70%) met the diagnostic criteria for PTSD. More research and policies are needed to prevent PTSD in ICU nurses during stressful emergency surges in intensive care.

Manuscript 3 - Heart Rate Variability and Stress in the Intensive Care Unit Nursing Workplace

Manuscript Three investigated physiological and psychological effects of stress events ICU nurses experienced at work and determined which types of events were most stressful. HRV was used as an objective biomarker to evaluate stress via ICU nurses' physiological response and recovery to workplace events. Participants' HRV was measured in the ICU workplace by a wearable wireless ECG heart rate monitor. Four indices of HRV, including SDNN, RMSSD, HF, and LF were calculated over 4 hours. An observational data collection tool, accessed on a portable electronic tablet, enabled documentation of workplace events the ICU nurses experienced in real-time, allowing the workplace events they experienced to be linked with their HRV activity. Categories of events included Routine Events, Interpersonal Events, Stat Events, and Combined Events. The association of HRV with workplace events and psychological and clinical outcomes was explored. HRV parameters of SDNN, RMSSD, and HF tended to have the greatest reduction (stress) from Stat or Routine Care Events. New nurses had reduced Idle Baseline when compared to experienced nurses' Idle Baseline. New nurses also had reduced HRV to events and recovery than experienced nurses. Despite the lack of significant associations in study variables investigated, the ICU nurses did have reductions in HRV (stress) to events at work.

Summary and Integration of Dissertation Findings

Findings from this body of research add new knowledge to our scientific understanding of psychological stress and trauma ICU nurses experience in the workplace. Manuscript One utilized a novel concept analysis approach to investigate what is known about PTSD in ICU nurses and identified a conceptual definition. Findings included a cumulative exposure to stressful and traumatic episodes, high prevalence of psychological stress and trauma from caring for critically ill patients, and a lack of support from coworkers, their manager, or the organization. These findings were also noted in the qualitative research of Manuscript Two. Importantly, these all stem from their experiences in the workplace. This can be especially difficult for ICU nurses who suffer from PTSD as a result of trauma in the workplace, because they spend their workday in the environment where the trauma occurred.

Symptoms of re-experiencing, avoidance, negative alterations in cognition and mood, and hyperarousal were also found to be antecedents in Manuscript One. Hyperarousal is a hallmark symptom of PTSD and is similar to a chronic stressed state. A high-stress workload adds to further stress for the ICU nurse with PTSD, especially if they have no tools or intervention to manage their symptoms. Other consequences from the concept analysis review that occurred from ICU nurses' psychological stress and trauma in the workplace is decreased job satisfaction, and the desire to leave their job. These findings were evident in all three manuscripts.

Manuscript Two revealed a comprehensive understanding of the lived experiences of ICU nurses caring for COVID-19 patients. Findings brought to light the psychological stress and trauma they endured caring for the most critically ill COVID-19 patients, and

how caring for these patients affected both their professional and personal lives. Additional findings included a lack of support (from co-workers, managers, and/or the organization) and overburden of job responsibilities, both risk factors for PTSD. A lack of support is related to job satisfaction and how ICU nurses feel in their work environment. A lack of support was described in both Manuscript One and Two.

Manuscript Three examined stress through both objective HRV measurement and self-report to events ICU nurses experience in the workplace. Findings revealed reduced HRV (stress) to events at work. Additionally, high rates of perceived stress and peritraumatic dissociative experiences and lower level of resilience was revealed. Sustained work-related stress and/or chronic symptoms of work-related trauma are associated with adverse psychological and physical health outcomes. This may affect ICU nurses' ability to work, their ability to provide quality care, and consequently extend to their personal lives.

Longstanding Job Satisfaction and Retention Issues

Nurses and nursing care are the backbone of the healthcare system in the United States. A critical factor for quality patient care is that the ICU nursing workforce continues to work at their jobs and meet the demands of hospitals and critical care patients nationwide. In 2006, The World Health Organization's (2006) "Working Together for Health" report attributed the nursing shortage largely to the stressful work environment, yet fundamentally little appears to have improved (Karanikola & Mpouzika, 2018). ICU nurses are still frequently exposed to psychosocial hazards (e.g.,

violence, aggression), high workload, and long work hours, and they voice that they feel unsupported. An American Association of Critical-Care Nurses (2021) survey found 92% of ICU nurses believed the pandemic caused nurses at their hospitals to leave their jobs, leaving them short-staffed, and, as a result, they believe their own careers will be shorter than they intended. On September 30, 2022, Chief Executive Officer Howard Catton of the International Council of Nurses addressed the alarmingly high levels of psychological stress and burnout in nurses due to the COVID-19 pandemic and the resultant nursing shortage, stating the "workforce shortage is the greatest single threat to global health" (International Council of Nurses, 2022).

Long Work Shifts

It is essential that working conditions for ICU nurses be improved to reduce job-related stress. It is well recognized in the literature that long work shifts (especially those shifts longer than 12.5 hours) place ICU nurses at risk for occupational fatigue, medication errors, and job dissatisfaction (Joint Commission, 2014; Stimpfel et al., 2012). Furthermore, working overtime was found to be associated with higher perceived stress levels among nurses (Atefi et al., 2015). Reducing work shifts to 8 hours, limiting overtime, restrictions on maximum number of days worked consecutively, and no mandatory overtime are in order to reduce job-related stress and conceivably prevent the development of PTSD and/or mitigate PTSD symptoms in ICU nurses.

Long work shifts not only impact well-being by interrupting ICU nurses' sleep and circadian rhythms, but they also increase health risks by reducing time for family

(Caruso et al., 2015). Nurses determining their own work schedules could be a strategic effort supporting a healthy work environment (Moss et al., 2016). Also, modifying hours to shorter work shifts of 8 hours could alleviate stress in nurses who prefer such a schedule. Allowing nurses who prefer to work 8-hour shifts could allow them to attend family events, their children's after-school events (dance, sports, birthday party), or not have to pay for excessive childcare. Such benefits may contribute to less workplace stress and a healthier, more productive work environment. Prior research found that nurses working 10-hour or longer shifts were 2.5 times more likely to report job dissatisfaction, reduced well-being, and greater likelihood of quitting their job compared to nurses working shorter shifts (Stimpfel et al., 2012).

Overburden or High Workload

The overarching cause of workplace stress is workload (American Institute of Stress, 2022). Specific initiatives to reduce workload in the ICU are needed. Two sources of workload for ICU nurses stem from high patient acuity and retention issues. When ICU nurses leave their job, nurses who remain must bear the burden of additional workload until replacement nurses are hired. Strategies and policies to reduce occupational exhaustion, long work hours, and high workload must be developed to maintain a healthy work environment. One method to reduce workloads for ICU nurses is appointing one to two extra nurses per shift without patient loads, as exercised by the academic health science center in the dissertation research. Rostering on two additional nurses to "float" through the ICU, assisting where needed, would allow nurses with

patient assignments to have a lesser workload and to receive assistance with unexpected care and/or additional patient care needs.

Rest Breaks During Shifts

Long work shifts and high workload contribute to both fatigue on the job and stress, which are linked to poor patient safety, poor health, and job dissatisfaction (Bergman et al., 2021; Gifkins et al., 2020). When ICU nurses have a high workload or staffing is short due to nurse shortages, they can feel guilty or reluctant to place additional burden on coworkers to help with their patients while they take a break, or they just forego their break (Bae et al., 2018; Monaghan et al., 2018). Transportation industries understand the danger of worker fatigue and have policies and regulations in place for safety, but no such policies and regulations are in place in nursing. Wendsche and colleagues' (2017) scoping review found that in seven of the 15 review studies, over half of the nurses described problems of deficient rest break time or none at all; however, for those studies where nurses did take rest breaks, it had a positive impact on nurses' well-being. Particularly, following an event that an ICU nurse deems stressful or traumatic (e.g., patient code or death), they should be given a mental/emotional break, or a time-out, to decompress in a quiet room. An ICU nurse's reality is that after their patient dies they will be getting a phone call from the emergency department about the new patient they are to receive (Nurse Liz, 2022). Organizational-level policies should be put in place to ensure managers limit patient assignments with high workloads, that ICU nurses are able to take their break, and that there is adequate staffing for nurses to take rest breaks or emotional breaks.

Virtual reality 360-degree videos could offer a stress-reducing break, and prior studies have had success with stress reduction in ICU nurses (Nijland et al., 2021). Videos might consist of video footage of calming environments, such as beaches, tropical fish swimming around coral, or meadows on a mountain (Veling et al., 2021). Virtual reality is easy to use, requires little concentration or mental effort, and has been found to quickly decrease stress (even in as little time as 10 minutes) and increase relaxation (Blum et al., 2019; Nijland et al., 2021; Veling et al., 2021).

Support

This body of research revealed that ICU nurses do not feel supported by nurse managers and administration and that their concerns are not sufficiently addressed. Nurse managers can establish a healthy work environment and support by recognizing efforts on a good job, encouraging collaboration on work issues, and ensuring ICU nurses' voices are heard. Giving nurses the opportunity to help identify strategies and solutions for issues experienced in their units would likely make nurses feel more supported and more in control over their work environment. But most importantly, nurse managers should support ICU nurses after traumatic or critical, unexpected incidents. Support should involve, foremost, immediately and periodically (1 and 6 months post event) evaluating for signs and symptoms of PTSD and the need for professional counseling and treatment. Nurse managers should offer the support of available mental healthcare and counseling programs and have ongoing open communication. Open communication and listening can foster ICU nurses in feeling supported (de Boer et al., 2014).

The National Institute for Occupational Safety and Health (2011) introduced the Total Worker Health Program in 2011, realizing overall health and well-being of the worker is greatly impacted by the work environment, and that policies and practices proven to protect and improve worker health are needed. The Center for the Promotion of Health in the New England Workplace (a NIOSH Center of Excellence in Total Worker Health) supports the above recommendations by proposing managerial and supervisor support of staff through informing employees of available sources of support within organizations, increasing control over one's own work schedules and responsibilities, and through dedication of organizational commitment to improving stress and mental health at work (Punnett, 2022).

Pretrauma Vulnerability

ICU nurses caring for severely injured or critically ill patients are constantly subjected to witnessing pain, suffering, and potentially traumatic incidents. The repetitive exposure to these incidents places them at high risk for PTSD, peritraumatic dissociative states, and other mental health problems (e.g., anxiety, depression) associated with traumatization (Geuzinge et al., 2020). Peritraumatic dissociative experiences can compromise an individual's ability to process at least some of the traumatizing event (Marmar et al., 2004). And, importantly, the presence of dissociation increases the risk of trauma-related disorders, such as PTSD (Geuzinge et al., 2020). In Manuscript Three of the dissertation research, more than half (54%) of the ICU nurses reported having significant dissociative symptoms (scores above 15), answering positively to questions such as, " I had moments of losing track of what was going on. I 'blanked out' or 'spaced

out' or in some way felt that I was not part of what was going on," or "I found that I was on 'automatic pilot.' I ended up doing things that I later realized I hadn't actively decided to do," or "I felt disoriented; that is, there were moments when I felt uncertain about where I was or what time it was." Individuals who experience dissociation at the time of the traumatic event, or soon after, often report alterations in time, place, person, and a sense of unreality to the event (Marmar, 2004). French psychiatrist Pierre Janet (1859-1947) contributed perhaps the most detailed and articulate explanation for dissociation, and many of our theories of PTSD are based on or align with Janet's ideas (Howell, 2013). According to Janet's theory of dissociation, peritraumatic dissociation indicates that the traumatic experience is not available to normal conscious representation; therefore, it cannot be processed in the usual manner but rather remains separate, or split off, from consciousness and alters future perceptions and behaviors (Van der Hart & Horst, 1989).

Resilience

In the past few decades, the construct of resilience has expanded in the scientific literature as a skill that can be learned to reduce vulnerability to stress (Mealer et al., 2017). The COVID-19 pandemic has adversely impacted the mental health of nurses, but perhaps none so much as frontline healthcare workers who cared for COVID-19 patients in their final hours during the height of the pandemic. As a result of the trauma many nurses endured, widespread attention is now focused on resilience and how to promote well-being. In the dissertation research, Manuscript Three, the total mean resilience score for the ICU nurses was 30.11, which the CD-RISC manual outlines as the lowest point in

the second quartile as compared to the U.S. general population average score distribution. This mean score may suggest problems in coping with stress or bouncing back from adversity for those nurses who scored below the group mean.

Cheng and colleagues' (2022) systematic review, meta-analysis, and meta-regression found that higher prevalence rates of low resilience have been noted in more studies in the post-COVID-19 pandemic period than those before the COVID-19 pandemic period (31% versus 25% pre-COVID-19). The authors linked the low resilience levels to the demanding healthcare environment. The review cited nursing shortages, high turnover rates, long work hours, heavy workload, and frequent psychological stress associated with pain and suffering of patients (Cheng et al., 2022). Hart and colleagues' (2012) integrative review from a decade ago also found the challenging work environment as an important contributing factor impacting resilience in nursing practice. Specifically, nursing shortages/staffing issues, high patient acuity, need for proficient knowledge of new technology, ethical dilemmas, and physical and psychological demands impacted nurse resilience (Hart et al., 2012).

Strategies shown to be effective to increase resilience and prevent PTSD include support groups, cognitive-behavioral therapy, and mindfulness-based stress reduction (Heath et al., 2020; Mealer et al., 2014). However, a high resilience score does not necessarily indicate an ICU nurse is not at risk of developing PTSD. Additionally, organizations and nurse managers should not require their ICU nurse employees to attend such programs. Instead, they should be offered and strongly encouraged, but never made mandatory.

Screening for Early Identification and Treatment

Pre-trauma vulnerability warrants further attention. Research on PTSD has had an over-reliance on retrospective reports of experienced trauma. Screening for early identification and treatment of those most at risk is essential. While it may not be possible to reduce or avoid the exposure of traumatic events in the ICU, immediate assessment and quantification of dissociative experiences following a traumatic event (or upon hire) may identify ICU nurses at highest risk for developing PTSD. For individuals whose PDEQ scores are above the suggested threshold of 15, it is recommended that they be referred to a mental health professional specializing in the assessment and treatment of traumatized individuals (Marmar et al., 2004). Referrals should be made with the objective of mitigating or preventing the development of PTSD.

Strengths and Limitations

First, this body of research had some major strengths. Manuscript One was a thorough review of the literature analyzing how the concept of PTSD pertains specifically to ICU nurses. To our knowledge, this was the first concept analysis of PTSD exclusively for ICU nurses. Walker and Avant's rigorous eight-step method was used to generate knowledge and refine the concept, which resulted in an in-depth comprehension of the concept, as well as its impact on ICU nurses' personal and professional lives, patient care, and healthcare organizations for which they work.

Strengths of the qualitative study, Manuscript Two, which described the lived experiences of ICU nurses caring for COVID-19 patients are the methods used in the

research. The phenomenological approach allowed an in-depth analysis, revealing a complex and detailed understanding of the phenomenon (Creswell & Poth, 2018). This method enabled gaining knowledge and insight into the psychological trauma the ICU nurses endured and how caring for COVID-19 patients impacted both their personal and professional lives. Additionally, Colaizzi's (1978) seven-step method procedural framework was used to guide the data collection and analysis to enhance credibility and trustworthiness.

Limitations for the concept analysis include that there were relatively few peer-reviewed articles regarding PTSD with a strict sample of ICU nurses, and some articles included physicians, or other ICU personnel. Limitations in the qualitative study include the small sample size and lack of sexual and racial diversity. There were 10 participants, nine female ICU nurses and one male, all White. Ten participants is a good sample size for a study employing a phenomenological approach (Creswell & Poth, 2018), but not enough to be generalizable to other populations. Critical incidents and experiences reported may have been reported differently had there been more men in the sample. They also may have been reported differently had there been participants of other races. For instance, Blacks experience higher levels of violent victimization and a higher lifetime prevalence of PTSD when compared with Whites, and Asians experience considerably lower levels of trauma and are at lower risk for developing PTSD (Brooks Holliday et al., 2020; Roberts et al., 2011). Lastly, both the PI and second author of the qualitative study attempted to bracket any prior knowledge and beliefs about the phenomenon of ICU nurses caring for COVID-19 patients; however, there possibly was some researcher bias.

Strengths of Manuscript Three, the dissertation research, are that several types of measures were utilized for stress and the other research variables, including objective (HRV) and self-report measures. Another major strength is that stress ICU nurses experienced was measured in the ecological setting of the ICU, as they experienced typical workplace events while at work. Limitations include the small sample size, the convenience sample, and that monitoring HRV in the dynamic (ambulatory) state is not perfect. There can be artifact from movement, posture, and breathing. Furthermore, there are many things that can affect HRV (e.g., age, gender, health status), and while we tried to control for many of them through exclusion criteria, it is possible that there may have been confounding variables, such as nurses taking medications that were on the exclusion list, for example. One exclusion that possibly limited study findings was the exclusion of a diagnosis of depression and/or taking antidepressants. Future research hopes to have a large enough size to determine differences in PTSD, stress, and HRV, between those who do and do not have depression.

Advancement of Health Science Knowledge and Implications for Future Research

This dissertation has promising possibilities to advance health science knowledge through the dissemination of the three manuscripts. The three manuscripts provide in-depth and novel information on PTSD and psychological stress in ICU nurses from their experiences in the workplace. The concept analysis, Manuscript One, is the first to describe PTSD as it relates specifically to ICU nurses. Findings of this manuscript identified the stressful work environment as the antecedent for PTSD, where exposure to traumatic events is experienced. Findings also identified a lack of support from their

manager, coworkers, and organization. Consequences were found to be burnout, job dissatisfaction, and the intention to leave their job. Unfortunately, retention is a critical problem in this country. Finally, Manuscript One unveiled that PTSD in ICU nurses not only adversely impacts the nurse, but patients, and hospitals where they work. The dissemination of this work has already begun to advance knowledge in health science, both as a continuing nursing education article in *Workplace Health and Safety* journal and as an on-demand webinar broadcast via the Center for Occupational and Environmental Health at the University of California at Berkeley.

Manuscript Two will advance health science knowledge by describing the psychological stress and trauma ICU nurses experience in the workplace during infectious disease outbreaks. Findings described: (a) a change in their normal nursing practice during the height of the COVID-19 pandemic, (b) emotions they experienced (e.g., frustration, fear, anger), (c) new responsibilities, including a primary role in discussing patient status and care and assisting families with a final call to say goodbye to their loved one, (d) isolation from family, friends, and at times, their coworkers, (e) most experienced job dissatisfaction, and (f) a negative public reaction. These findings took a toll on the ICU nurses' personal and professional lives.

Manuscript Three, the dissertation research, will advance health science knowledge by objective and subjective measures of stress, and the other study variables investigated. Few studies measure ICU nurses' HRV in the ecological setting of the work environment, and to our knowledge, ours is the first to measure HRV to events ICU nurses encounter in a typical day. We found HRV parameters tended to have the greatest reduction (indicating stress) from Stat or Routine Care Events. We also observed that

experienced nurses tended to have a larger reduction in HRV than new nurses. High rates of perceived stress and peritraumatic dissociative experiences were noted in the study ICU nurses but were not significantly associated with HRV. The small sample size may have limited statistical inference.

Knowledge gained from this body of research can guide future research questions, policy, and development of interventions to help ICU nurses work in a healthier work environment and mitigate or prevent the development of PTSD. There is much work that needs to be done for ICU nurses. Future studies are needed to inform organizational-level interventions for ICU nurses and reduce stress in the ICU environment.

Summary

PTSD continues to exert a toll on ICU nurses, and its health implications have great consequences for nurses, patients, and hospitals. Promoting a healthy work environment and protecting the mental health of ICU nurses at risk for PTSD is essential. It is the responsibility of nurse managers and administration to identify work-related risk factors of PTSD to protect and promote ICU nurses' mental health. The risk of PTSD in their ICU nurse employees can be mitigated through screening for early intervention. Screening could be made available through HRV monitoring and measures such as the Peritraumatic Dissociative Experiences Questionnaire. Confidential access to mental healthcare and counseling programs for ICU nurses with symptoms of PTSD should be provided.

LIST OF GENERAL REFERENCES

Aburn, G., Gott, M., & Hoare, K. (2016). What is resilience? An integrative review of the empirical literature. *Journal of Advanced Nursing*, *72*(5), 980–1000. https://doi-org.ezproxy3.lhl.uab.edu/10.1111/jan.12888

Al Maqbali, M., Al Sinani, M., & Al-Lenjawi, B. (2021). Prevalence of stress, depression, anxiety and sleep disturbance among nurses during the COVID-19 pandemic: A systematic review and meta-analysis. *Journal of Psychosomatic Research*, *141*, 110343. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.jpsychores.2020.110343

American Association of Critical-Care Nurses. (2021). *Hear Us Out Campaign.* https://www.aacn.org/newsroom/hear-us-out-campaign-reports-nurses-covid-19-reality

The American Institute of Stress. (2022). *Workplace stress.* https://www.stress.org/workplace-stress

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). https://doi.org/10.1176/appi.books.9780890425596

American Psychological Association. (2022a). *Anxiety*. https://www.apa.org/topics/anxiety

American Psychological Association. (2022b). *Resilience*. https://www.apa.org/topics/resilience

APA Dictionary of Psychology. (2022). *Sleep disorder.* https://dictionary.apa.org/sleep-disorder

Ariapooran, S., Ahadi, B., & Khezeli, M. (2022). Depression, anxiety, and suicidal ideation in nurses with and without symptoms of secondary traumatic stress during the COVID-19 outbreak. *Archives of Psychiatric Nursing*, *37*, 76-81. https://doi.org/10.1016/j.apnu.2021.05.005

Atefi, N., Lim Abdullah, K., Wong, L. P., & Mazlom, R. (2015). Factors influencing job satisfaction among registered nurses: A questionnaire survey in Mashhad, Iran.

Journal of Nursing Management, *23*(4), 448–458. https://doi-org.ezproxy3.lhl.uab.edu/10.1111/jonm.12151

Babore, A., Lombardi, L., Viceconti, M. L., Pignataro, S., Marino, V., Crudele, M., Candelori, C., Bramanti, S. M., & Trumello, C. (2020). Psychological effects of the COVID-2019 pandemic: Perceived stress and coping strategies among healthcare professionals. *Psychiatry Research*, *293*, 113366. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.psychres.2020.113366

Bae, S. H., Hwang, S. W., & Lee, G. (2018). Work hours, overtime, and break time of registered nurses working in medium-sized Korean hospitals. *Workplace Health & Safety*, *66*(12), 588–596. https://doi-org.ezproxy3.lhl.uab.edu/10.1177/2165079918769683

Bensley, K. M., Seelig, A. D., Armenta, R. F., Rivera, A. C., Peterson, A. V., Jacobson, I. G., Littman, A. J., Maynard, C., Bricker, J. B., Boyko, E. J., Rull, R. P., & Williams, E. C. (2018). Posttraumatic stress disorder symptom association with subsequent risky and problem drinking initiation. *Journal of Addiction Medicine*, *12*(5), 353–362. https://doi.org/10.1097/ADM.0000000000000420

Bergman, L., Falk, A. C., Wolf, A., & Larsson, I. M. (2021). Registered nurses' experiences of working in the intensive care unit during the COVID-19 pandemic. *Nursing in Critical Care*, *26*(6), 467–475. https://doi-org.ezproxy3.lhl.uab.edu/10.1111/nicc.12649

Bhatraju, P. K., Ghassemieh, B. J., Nichols, M., Kim, R., Jerome, K. R., Nalla, A. K., Greninger, A. L., Pipavath, S., Wurfel, M. M., Evans, L., Kritek, P. A., West, T. E., Luks, A., Gerbino, A., Dale, C. R., Goldman, J. D., O'Mahony, S., & Mikacenic, C. (2020). COVID-19 in critically ill patients in the Seattle region - Case series. *The New England Journal of Medicine*, *382*(21), 2012–2022. https://doi.org/10.1056/NEJMoa2004500

Blum, J., Rockstroh, C., & Göritz, A. S. (2019). Heart rate variability biofeedback based on slow-paced breathing with immersive virtual reality nature scenery. *Frontiers in Psychology*, *10*, 2172. https://doi-org.ezproxy3.lhl.uab.edu/10.3389/fpsyg.2019.02172

Brooks, S. K., Dunn, R., Amlôt, R., Rubin, G. J., & Greenberg, N. (2018). A systematic, thematic review of social and occupational factors associated with psychological outcomes in healthcare employees during an infectious disease outbreak. *Journal of Occupational and Environmental Medicine*, *60*(3), 248-257.

Brooks Holliday, S., Dubowitz, T., Haas, A., Ghosh-Dastidar, B., DeSantis, A., & Troxel, W. M. (2020). The association between discrimination and PTSD in African Americans: Exploring the role of gender. *Ethnicity & Health, 25*(5), 717-731. https://doi.org/10.1080/13557858.2018.1444150

Brudey, C., Park, J., Wiaderkiewicz, J., Kobayashi, I., Mellman, T. A., & Marvar, P. J. (2015). Autonomic and inflammatory consequences of posttraumatic stress disorder and the link to cardiovascular disease. *American Journal of Physiology. Regulatory, Integrative, and Comparative Physiology, 309*(4), R315-321. https://doi.org/10.1152/ajpregu.00343.2014

Cabarkapa, S., Nadjidai, S. E., Murgier, J., & Ng, C. H. (2020). The psychological impact of COVID-19 and other viral epidemics on frontline healthcare workers and ways to address it: A rapid systematic review. *Brain, Behavior, & Immunity*, *8*, 100144. https://doi.org/10.1016/j.bbih.2020.100144

Caruso, C. C., Geiger-Brown, J., Takahashi, M., Trinkoff, A., & Nakata, A. (2015). NIOSH training for nurses on shift work and long work hours. In (DHHS (NIOSH) Publication No. 2015-115). US Department of Health and Human Services, Centers for Disease Control and Prevention. National Institute for Occupational Safety and Health, Cincinnati, OH. https://www.cdc.gov/niosh/work-hour-training-for-nurses/longhours/mod2/25.html

Centers for Medicare & Medicaid Services. (2021). *HCAHPS fact sheet.* https://hcahpsonline.org/globalassets/hcahps/facts/hcahps_fact_sheet_march_2021.pdf

Chegini, Z., Asghari Jafarabadi, M., & Kakemam, E. (2019). Occupational stress, quality of working life and turnover intention amongst nurses. *Nursing in Critical Care*, *24*(5), 283–289. https://doi-org.ezproxy3.lhl.uab.edu/10.1111/nicc.12419

Cheng, C., Chua, J. H., Cheng, L. J., Ang, W., & Lau, Y. (2022). Global prevalence of resilience in health care professionals: A systematic review, meta-analysis and meta-regression. *Journal of Nursing Management*, *30*(3), 795–816. https://doi-org.ezproxy3.lhl.uab.edu/10.1111/jonm.13558

Cleveland Clinic. (2022). *Heart rate variability.* https://my.clevelandclinic.org/health/symptoms/21773-heart-rate-variability-hrv

Colaizzi, P. F. (1978). *Psychological research as the phenomenologist views it*. Oxford University Press.

Colville, G. A., Smith, J. G., Brierley, J., Citron, K., Nguru, N. M., Shaunak, P. D., Tam, O., & Perkins-Porras, L. (2017). Coping with staff burnout and work-related posttraumatic stress in intensive care. *Pediatric Critical Care Medicine*, *18*(7), e267-e273. https://doi:10.1097/pcc.0000000000001179

Colzato, L. S., Jongkees, B. J., de Wit, M., van der Molen, M. J. W., & Steenbergen, L. (2018). Variable heart rate and a flexible mind: Higher resting-state heart rate

variability predicts better task-switching. *Cognitive, Affective & Behavioral Neuroscience, 18*(4), 730-738. https://doi.org/10.3758/s13415-018-0600-x

Connor, K. M., & Davidson, J. R. (2003). Development of a new resilience scale: The Connor-Davidson resilience scale (CD-RISC). *Depression and Anxiety*, *18*(2), 76-82. https://onlinelibrary.wiley.com/doi/pdf/10.1002/da.10113

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches*. Sage Publications.

Crocq, M. A., & Crocq, L. (2000). From shell shock and war neurosis to posttraumatic stress disorder: A history of psychotraumatology. *Dialogues in Clinical Neuroscience, 2*(1), 47-55. https://doi.org/10.31887/DCNS.2000.2.1/macrocq

Crowe, S., Howard, A. F., Vanderspank-Wright, B., Gillis, P., McLeod, F., Penner, C., & Haljan, G. (2021). The effect of COVID-19 pandemic on the mental health of Canadian critical care nurses providing patient care during the early phase pandemic: A mixed method study. *Intensive and Critical Care Nursing*, *63*, 102999. https://doi.org/10.1016/j.iccn.2020.102999

Czaja, A. S., Moss, M., & Mealer, M. (2012). Symptoms of posttraumatic stress disorder among pediatric acute care nurses. *Journal of Pediatric Nursing*, *27*(4), 357-365. https://doi.org/10.1016/j.pedn.2011.04.024

de Boer, J., van Rikxoort, S., Bakker, A. B., & Smit, B. J. (2014). Critical incidents among intensive care unit nurses and their need for support: Explorative interviews. *Nursing in Critical Care*, *19*(4), 166-174. https://doi.org/10.1111/nicc.12020

Dedert, E. A., Calhoun, P. S., Watkins, L. L., Sherwood, A., & Beckham, J. C. (2010). Posttraumatic stress disorder, cardiovascular, and metabolic disease: A review of the evidence. *Annals of Behavioral Medicine, 39*(1), 61-78. https://doi.org/10.1007/s12160-010-9165-9

De los Santos, J. A. A., & Labrague, L. J. (2020). Impact of COVID-19 on the psychological well-being and turnover intentions of frontline nurses in the community: A cross-sectional study in the Philippines. *Traumatology, 27*(1), 52-59. https://doi.org/10.1037/trm0000294

Finstad, G. L., Giorgi, G., Lulli, L. G., Pandolfi, C., Foti, G., León-Perez, J. M., Cantero-Sánchez, F. J., & Mucci, N. (2021). Resilience, coping strategies and posttraumatic growth in the workplace following COVID-19: A narrative review on the positive aspects of trauma. *International Journal of Environmental Research and Public Health*, *18*(18), 9453. https://doi-org.ezproxy3.lhl.uab.edu/10.3390/ijerph18189453

Fjølner, J., Haaland, Ø. A., Jung, C., de Lange, D. W., Szczeklik, W., Leaver, S., Guidet, B., Sviri, S., Van Heerden, P. V., Beil, M., Hartog, C. S., & Flaatten, H. (2022). Who gets the ventilator? A multicentre survey of intensivists' opinions of triage during the first wave of the COVID-19 pandemic. *Acta Anaesthesiologica Scandinavica*, *66*(7), 859–868. https://doi.org/10.1111/aas.14094

Fulton, J. J., Calhoun, P. S., Wagner, H. R., Schry, A. R., Hair, L. P., Feeling, N., Elbogen, E., & Beckham, J. C. (2015). The prevalence of posttraumatic stress disorder in Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) veterans: A meta-analysis. *Journal of Anxiety Disorders, 31*, 98-107. https://doi.org/10.1016/j.janxdis.2015.02.003

Ge, F., Yuan, M., Li, Y., & Zhang, W. (2020). Posttraumatic stress disorder and alterations in resting heart rate variability: A systematic review and meta-analysis. *Psychiatry Investigation, 17*(1), 9-20. https://doi.org/10.30773/pi.2019.0112

Geuzinge, R., Visse, M., Duyndam, J., & Vermetten, E. (2020). Social embeddedness of firefighters, paramedics, specialized nurses, police officers, and military personnel: Systematic review in relation to the risk of traumatization. *Frontiers in Psychiatry*, *11*, 496663. https://doi.org/10.3389/fpsyt.2020.496663

Gifkins, J., Johnston, A., Loudoun, R., & Troth, A. (2020). Fatigue and recovery in shiftworking nurses: A scoping literature review. *International Journal of Nursing Studies*, *112*, 103710. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.ijnurstu.2020.103710

Gillie, B. L., & Thayer, J. F. (2014). Individual differences in resting heart rate variability and cognitive control in posttraumatic stress disorder. *Frontiers in Psychology, 5*, 758. https://doi.org/10.3389/fpsyg.2014.00758

Goffeng, E. M., Nordby, K. C., Tarvainen, M. P., Järvelin-Pasanen, S., Wagstaff, A., Goffeng, L. O., Bugge, M., Skare, Ø., & Sigstad Lie, J. A. (2018). Fluctuations in heart rate variability of health care workers during four consecutive extended work shifts and recovery during rest and sleep. *Industrial Health*, *56*(2), 122–131. https://doi-org.ezproxy3.lhl.uab.edu/10.2486/indhealth.2017-0100

Green, A. A., & Kinchen, E. V. (2021). The effects of mindfulness meditation on stress and burnout in nurses. *Journal of Holistic Nursing*, *39*(4), 356–368. https://doi-org.ezproxy3.lhl.uab.edu/10.1177/08980101211015818

Greenberg, N., Weston, D., Hall, C., Caulfield, T., Williamson, V., & Fong, K. (2021). Mental health of staff working in intensive care during COVID-19. *Occupational Medicine (Oxford, England)*, *71*(2), 62–67. https://doi-org.ezproxy3.lhl.uab.edu/10.1093/occmed/kqaa220

Guttormson, J. L., Calkins, K., McAndrew, N., Fitzgerald, J., Losurdo, H., & Loonsfoot, D. (2022). Critical care nurse burnout, moral distress, and mental health during

the COVID-19 pandemic: A United States survey. *Heart & Lung*, *55*, 127–133. https://doi.org/10.1016/j.hrtlng.2022.04.015

Handfield, R., Finkenstadt, D. J., Schneller, E. S., Godfrey, A. B., & Guinto, P. (2020). A commons for a supply chain in the post-COVID-19 era: The case for a reformed strategic national stockpile. *The Milbank Quarterly*, *98*(4), 1058-1090. https://doi.org/10.1111/1468-0009.12485

Hart, P. L., Brannan, J. D., & De Chesnay, M. (2014). Resilience in nurses: An integrative review. *Journal of Nursing Management*, *22*(6), 720–734. https://doi.org/10.1111/j.1365-2834.2012.01485.x

Hauschildt, M., Peters, M. J., Moritz, S., & Jelinek, L. (2011). Heart rate variability in response to affective scenes in posttraumatic stress disorder. *Biological Psychology*, *88*(2-3), 215–222. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.biopsycho.2011.08.004

Heath, C., Sommerfield, A., & von Ungern-Sternberg, B. S. (2020). Resilience strategies to manage psychological distress among healthcare workers during the COVID-19 pandemic: A narrative review. *Anaesthesia*, *75*(10), 1364–1371. https://doi-org.ezproxy3.lhl.uab.edu/10.1111/anae.15180

Heesakkers, H., Zegers, M., van Mol, M., & van den Boogaard, M. (2021). The impact of the first COVID-19 surge on the mental well-being of ICU nurses: A nationwide survey study. *Intensive & Critical Care Nursing*, *65*, 103034. https://doi.org/10.1016/j.iccn.2021.103034

Hoerster, K. D., Campbell, S., Dolan, M., Stappenbeck, C. A., Yard, S., Simpson, T., & Nelson, K. M. (2019). PTSD is associated with poor health behavior and greater body mass index through depression, increasing cardiovascular disease and diabetes risk among U.S. Veterans. *Preventive Medicine Reports, 15*, 100930. https://doi.org/10.1016/j.pmedr.2019.100930

Hong, S., Ai, M., Xu, X., Wang, W., Chen, J., Zhang, Q., Wang, L., & Kuang, L. (2021). Immediate psychological impact on nurses working at 42 government-designated hospitals during COVID-19 outbreak in China: A cross-sectional study. *Nursing Outlook*, *69*(1), 6–12. https://doi.org/10.1016/j.outlook.2020.07.007

Hourani, L. L., Davila, M. I., Morgan, J., Meleth, S., Ramirez, D., Lewis, G., Kizakevich, P. N., Eckhoff, R., Morgan, T., Strange, L., Lane, M., Weimer, B., & Lewis, A. (2020). Mental health, stress, and resilience correlates of heart rate variability among military reservists, guardsmen, and first responders. *Physiology & Behavior*, *214*, 112734. https://doi.org/10.1016/j.physbeh.2019.112734

Howell, E. F. (2013). *The dissociative mind.* Routledge.

Hu, T., Zhang, D., & Wang, J. (2015). A meta-analysis of the trait resilience and mental health. *Personality and Individual Differences*, *76*, 18-27. https://www.sciencedirect.com/science/article/abs/pii/S0191886914006710?casa_token=-XcTEzEcFM0AAAAA:uaJkR9yUtZa5Kzt3mCQZIpBLdPPIOYqJaHEWCovea2MAzfhA6n5rxDTPU1srxT1fErQRJV26rP0

International Council of Nurses. (2022). *ICN calls for nurses to be at centre of new WHO global agreement on pandemic prevention and response*. https://www.icn.ch/news/icn-calls-nurses-be-centre-new-who-global-agreement-pandemic-prevention-and-response

Johnston, M. C., Porteous, T., Crilly, M. A., Burton, C. D., Elliott, A., Iversen, L., McArdle, K., Murray, A., Phillips, L. H., & Black, C. (2015). Physical disease and resilient outcomes: A systematic review of resilience definitions and study methods. *Psychosomatics*, *56*(2), 168–180. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.psym.2014.10.005

Joint Commission. (2014). Health care worker fatigue and patient safety. The Joint Commission Sentinel Event Alert. 2011; 48. https://www.jointcommission.org/-/media/tjc/documents/resources/patient-safety-topics/sentinel-event/sea_48_hcw_fatigue_final_w_2018_addendum.pdf

Jones, G., Colville, G. A., Ramnarayan, P., Woolfall, K., Heward, Y., Morrison, R., Savage, A., Fraser, J., Griksaitis, M. J., & Inwald, D. P. (2020). Psychological impact of working in paediatric intensive care. A UK-wide prevalence study. *Archives of Disease in Childhood*, *105*(5), 470–475. https://doi.org/10.1136/archdischild-2019-317439

Karanikola, M. N. K., & Mpouzika, M. D. A. (2018). Time to create a healthy work environment in ICU: A review of current evidence and commentary. *CONNECT: The World of Critical Care Nursing*, *12*(2), 44-47. https://doi.org/10.1891/1748-6254.12.2.4

Kim, H.-G., Cheon, E.-J., Bai, D.-S., Lee, Y. H., & Koo, B.-H. (2018). Stress and heart rate variability: A meta-analysis and review of the literature. *Psychiatry Investigation, 15*(3), 235-245. https://doi.org/10.30773/pi.2017.08.17

Kim, W., Bae, M., Chang, S. J., Yoon, J. H., Jeong, D. Y., Hyun, D. S., Ryu, H. Y., Park, K. S., Kim, M. J., & Kim, C. (2019). Effect of burnout on post-traumatic stress disorder symptoms among firefighters in Korea: Data from the Firefighter Research on Enhancement of Safety & Health (FRESH). *Journal of Preventive Medicine and Public Health*, *52*(6), 345–354. https://doi.org/10.3961/jpmph.19.116

Lamotte, G., Shouman, K., & Benarroch, E. E. (2021). Stress and central autonomic network. *Autonomic Neuroscience*, *235*, 102870. https://doi.org/10.1016/j.autneu.2021.102870

Lavoie-Tremblay, M., Gélinas, C., Aubé, T., Tchouaket, E., Tremblay, D., Gagnon, M. P., & Côté, J. (2022). Influence of caring for COVID-19 patients on nurse's turnover, work satisfaction and quality of care. *Journal of Nursing Management*, *30*(1), 33–43. https://doi-org.ezproxy3.lhl.uab.edu/10.1111/jonm.13462

Lehmann, M., Bruenahl, C. A., Löwe, B., Addo, M. M., Schmiedel, S., Lohse, A. W., & Schramm, C. (2015). Ebola and psychological stress of health care professionals. *Emerging Infectious Diseases, 21*(5), 913-914. https://doi.org/10.3201/eid2105.141988

Levi, P., & Moss, J. (2022). Intensive care unit nurses' lived experiences of psychological stress and trauma caring for COVID-19 patients. *Workplace Health & Safety*, *70*(8), 358–367. https://doi.org/10.1177/21650799211064262

Levi, P., Patrician, P. A., Vance, D. E., Montgomery, A. P., & Moss, J. (2021). Post-traumatic stress disorder in intensive care unit nurses: A concept analysis. *Workplace Health & Safety*, *69*(5), 224–234. https://doi.org/10.1177/2165079920971999

Lewis, C., Lewis, K., Kitchiner, N., Isaac, S., Jones, I., & Bisson, J. I. (2020). Sleep disturbance in post-traumatic stress disorder (PTSD): A systematic review and meta-analysis of actigraphy studies. *European Journal of Psychotraumatology, 11*(1), 1767349. doi:10.1080/20008198.2020.1767349

Livingston, E., Desai, A., & Berkwits, M. (2020). Sourcing personal protective equipment during the COVID-19 pandemic. *JAMA*, *323*(19), 1912–1914. https://doi.org/10.1001/jama.2020.5317

Marmar, C. R., Metzler, T. J., & Otte, C. (2004). *The peritraumatic dissociative experiences questionnaire.* The Guilford Press.

McAlonan, G. M., Lee, A. M., Cheung, V., Cheung, C., Tsang, K. W., Sham, P. C., Chua, S. E., & Wong, J. G. (2007). Immediate and sustained psychological impact of an emerging infectious disease outbreak on health care workers. *Canadian Journal of Psychiatry*, *52*(4), 241–247. https://doi.org/10.1177/070674370705200406

McEwen, B. S. (2005). Stressed or stressed out: What is the difference? *Journal of Psychiatry & Neuroscience, 30*(5), 315-318.

Mealer, M., Burnham, E. L., Goode, C. J., Rothbaum, B., & Moss, M. (2009). The prevalence and impact of post traumatic stress disorder and burnout syndrome in nurses. *Depression and Anxiety*, *26*(12), 1118-1126. https://doi.org/10.1002/da.20631

Mealer, M., Conrad, D., Evans, J., Jooste, K., Solyntjes, J., Rothbaum, B., & Moss, M. (2014). Feasibility and acceptability of a resilience training program for intensive care unit nurses. *American Journal of Critical Care*, *23*(6), e97-e105. https://doi.org/10.4037/ajcc2014747

Mealer, M., Jones, J., & Meek, P. (2017). Factors affecting resilience and development of posttraumatic stress disorder in critical care nurses. *American Journal of Critical Care, 26*(3), 184-192. doi:10.4037/ajcc2017798

Mealer, M., Jones, J., & Moss, M. (2012). A qualitative study of resilience and posttraumatic stress disorder in United States ICU nurses. *Intensive Care Medicine*, *38*(9), 1445-1451. https://doi.org/10.1007/s00134-012-2600-6

Michopoulos, V., Norrholm, S. D., & Jovanovic, T. (2015). Diagnostic biomarkers for posttraumatic stress disorder: Promising horizons from translational neuroscience research. *Biological Psychiatry, 78*(5), 344-353. https://doi.org/10.1016/j.biopsych.2015.01.005

Milligan-Saville, J., Choi, I., Deady, M., Scott, P., Tan, L., Calvo, R. A., Bryant, R. A., Glozier, N., & Harvey, S. B. (2018). The impact of trauma exposure on the development of PTSD and psychological distress in a volunteer fire service. *Psychiatry Research*, *270*, 1110–1115. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.psychres.2018.06.058

Monaghan, T., Dinour, L., Liou, D., & Shefchik, M. (2018). Factors influencing the eating practices of hospital nurses during their shifts. *Workplace Health & Safety*, *66*(7), 331-342. https://journals.sagepub.com/doi/full/10.1177/2165079917737557

Moss, M., Good, V. S., Gozal, D., Kleinpell, R., & Sessler, C. N. (2016). An official critical care societies collaborative statement-burnout syndrome in critical care health-care professionals: A call for action. *Chest*, *150*(1), 17-26. https://doi.org/10.1016/j.chest.2016.02.649

Moustakas, C. (1994). *Phenomenological research methods*. Sage Publications.

National Institute of Mental Health. (2022). *Post-traumatic stress disorder.* https://www.nimh.nih.gov/health/topics/post-traumatic-stress-disorder-ptsd

Nijland, J., Veling, W., Lestestuiver, B. P., & Van Driel, C. (2021). Virtual reality relaxation for reducing perceived stress of intensive care nurses during the

COVID-19 pandemic. *Frontiers in Psychology*, *12*, 706527. https://doi-org.ezproxy3.lhl.uab.edu/10.3389/fpsyg.2021.706527

Nurse Liz. (2022, October, 26). *The reality for nurses after patient death - Was this TikTok nurse dramatic or realistic?* [Video] https://www.youtube.com/watch?v=6P7azphpJyk

Nursing Solutions, Incorporated. (2020.) *Retention & RN staffing report.* https://www.nsinursingsolutions.com/Documents/Library/NSI_National_Health_Care_Retention_Report.pdf

Nursing Solutions, Incorporated. (2022). *2022 NSI national health care retention & RN staffing report.* https://www.nsinursingsolutions.com/Documents/Library/NSI_National_Health_Care_Retention_Report.pdf

Ong, Y. Z., Siddiqui, S., John, S., Chen, Z., & Chang, S. (2016). The prevalence of post-traumatic stress disorder in intensive care unit staff and the common coping strategies used. *Annals of the Academy of Medicine, Singapore*, *45*(5), 215-218. https://annals.edu.sg/pdf/45VolNo5May2016/V45N5p215.pdf

Pai, A., Suris, A. M., & North, C. S. (2017). Posttraumatic stress disorder in the DSM-5: Controversy, change, and conceptual considerations. *Behavioral Science* (Basel), *7*(1). https://doi.org/10.3390/bs7010007

Pappa, S., Ntella, V., Giannakas, T., Giannakoulis, V. G., Papoutsi, E., & Katsaounou, P. (2020). Prevalence of depression, anxiety, and insomnia among healthcare workers during the COVID-19 pandemic: A systematic review and meta-analysis. *Brain, Behavior, and Immunity*, *88*, 901–907. https://doi.org/10.1016/j.bbi.2020.05.026

Park, Y. M., & Kim, S. Y. (2013). Impacts of job stress and cognitive failure on patient safety incidents among hospital nurses. *Safety and Health at Work*, *4*(4), 210-215. https://doi.org/10.1016/j.shaw.2013.10.003

Patrician, P. A., Peterson, C., & McGuinness, T. M. (2020). Original Research: Suicide among RNs: An analysis of 2015 data from the National Violent Death Reporting System. *The American Journal of Nursing*, *120*(10), 24–28. https://doi-org.ezproxy3.lhl.uab.edu/10.1097/01.NAJ.0000718624.25806.3f

Phillips, A. C. (2013). Perceived stress. In M. D. Gellman & J. R. Turner (Eds.), *Encyclopedia of Behavioral Medicine* (pp. 1453-1454). Springer.

Punnett, L. (2022). Response to NIOSH request for information on interventions to prevent work-related stress and support health worker mental health. *New*

Solutions, 10482911221126271. Advance online publication. https://doi-org.ezproxy3.lhl.uab.edu/10.1177/10482911221126271

Ranney, M. L., Griffeth, V., & Jha, A. K. (2020). Critical supply shortages - The need for ventilators and personal protective equipment during the COVID-19 pandemic. *The New England Journal of Medicine*, *382*(18), e41. https://doi.org/10.1056/NEJMp2006141

Richardson, S., Hirsch, J. S., Narasimhan, M., Crawford, J. M., McGinn, T., Davidson, K. W., the Northwell COVID-19 Research Consortium, Barnaby, D. P., Becker, L. B., Chelico, J. D., Cohen, S. L., Cookingham, J., Coppa, K., Diefenbach, M. A., Dominello, A. J., Duer-Hefele, J., Falzon, L., Gitlin, J., Hajizadeh, N., Harvin, T. G., … Zanos, T. P. (2020). Presenting characteristics, comorbidities, and outcomes among 5700 patients hospitalized with COVID-19 in the New York City area. *JAMA*, *323*(20), 2052–2059. https://doi.org/10.1001/jama.2020.6775

Roberts, A. L., Gilman, S. E., Breslau, J., Breslau, N., & Koenen, K. C. (2011). Race/ethnic differences in exposure to traumatic events, development of post-traumatic stress disorder, and treatment-seeking for post-traumatic stress disorder in the United States. *Psychological Medicine*, *41*(1), 71-83. https://doi.org/10.1017/s0033291710000401

Rodney, T., Heidari, O., Miller, H. N., Thornton, C. P., Jenkins, E., & Kang, H. K. (2022). Posttraumatic stress disorder in nurses in the United States: Prevalence and effect on role. *Journal of Nursing Management*, *30*(1), 226-233. https://doi.org/10.1111/jonm.13478

Rodríguez-Rey, R., Palacios, A., Alonso-Tapia, J., Pérez, E., Álvarez, E., Coca, A., Mencia, S., Marcos, A., Mayordomo-Colunga, J., Fernandez, F., Gomez, F., Cruz, J., Ramos, V., & Olmedilla, M. (2019). Are pediatric critical personnel satisfied with their lives? Prediction of satisfaction with life from burnout, posttraumatic stress, and posttraumatic growth, and comparison with noncritical pediatric staff. *Pediatric Critical Care Medicine, 20*(3), e160-e169. https://doi.org/10.1097/PCC.0000000000001861

Salmon, G., & Morehead, A. (2019). Posttraumatic stress syndrome and implications for practice in critical care nurses. *Critical Care Nursing Clinics of North America, 31*(4), 517-526. https://doi.org/10.1016/j.cnc.2019.07.007

Schneider, M., & Schwerdtfeger, A. (2020). Autonomic dysfunction in posttraumatic stress disorder indexed by heart rate variability: A meta-analysis. *Psychological Medicine*, *50*(12), 1937-1948. https://doi.org/10.1017/s003329172000207x

Schuster, M., & Dwyer, P. A. (2020). Post-traumatic stress disorder in nurses: An integrative review. *Journal of Clinical Nursing*, *29*(15-16), 2769–2787. https://doi.org/10.1111/jocn.15288

Shaffer, F., & Ginsberg, J. P. (2017). An overview of heart rate variability metrics and norms. *Frontiers in Public Health, 5*, 258. https://doi.org/10.3389/fpubh.2017.00258

Shechter, A., Diaz, F., Moise, N., Anstey, D. E., Ye, S., Agarwal, S., Birk, J. L., Brodie, D., Cannone, D. E., Chang, B., Claassen, J., Cornelius, T., Derby, L., Dong, M., Givens, R. C., Hochman, B., Homma, S., Kronish, I. M., Lee, S. A., & Abdalla, M. (2020). Psychological distress, coping behaviors, and preferences for support among New York healthcare workers during the COVID-19 pandemic. *General Hospital Psychiatry*, *66*, 1-8. https://doi.org/10.1016/j.genhosppsych.2020.06.007

Shen, X., Zou, X., Zhong, X., Yan, J., & Li, L. (2020). Psychological stress of ICU nurses in the time of COVID-19. *Critical Care, 24*(1), 200. https://doi.org/10.1186/s13054-020-02926-2

Smith, R., Thayer, J. F., Khalsa, S. S., & Lane, R. D. (2017). The hierarchical basis of neurovisceral integration. *Neuroscience and Biobehavioral Reviews*, *75*, 274–296. https://doi.org/10.1016/j.neubiorev.2017.02.003

Stimpfel, A. W., Sloane, D. M., & Aiken, L. H. (2012). The longer the shifts for hospital nurses, the higher the levels of burnout and patient dissatisfaction. *Health Affairs (Project Hope), 31*(11), 2501–2509. https://doi-org.ezproxy3.lhl.uab.edu/10.1377/hlthaff.2011.1377

Tan, B., Chew, N., Lee, G., Jing, M., Goh, Y., Yeo, L., Zhang, K., Chin, H. K., Ahmad, A., Khan, F. A., Shanmugam, G. N., Chan, B., Sunny, S., Chandra, B., Ong, J., Paliwal, P. R., Wong, L., Sagayanathan, R., Chen, J. T., & Sharma, V. K. (2020). Psychological impact of the COVID-19 pandemic on health care workers in Singapore. *Annals of Internal Medicine*, *173*(4), 317–320. https://doi.org/10.7326/M20-1083

Tang, L., Pan, L., Yuan, L., & Zha, L. (2016). Prevalence and related factors of post-traumatic stress disorder among medical staff members exposed to H7N9 patients. *International Journal of Nursing Sciences*, *4*(1), 63–67. https://doi.org/10.1016/j.ijnss.2016.12.002

Thayer, J. F., Hansen, A. L., Saus-Rose, E., & Johnsen, B. H. (2009). Heart rate variability, prefrontal neural function, and cognitive performance: The neurovisceral integration perspective on self-regulation, adaptation, and health. *Annals of Behavioral Medicine*, *37*(2), 141-153. https://doi.org/10.1007/s12160-009-9101-z

Thayer, J. F., & Lane, R. D. (2000). A model of neurovisceral integration in emotion regulation and dysregulation. *Journal of Affective Disorders, 61*(3), 201-216. https:/doi.org/10.1016/s0165-0327(00)00338-4

Thayer, J. F., & Lane, R. D. (2007). The role of vagal function in the risk for cardiovascular disease and mortality. *Biological Psychology*, *74*(2), 224–242. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.biopsycho.2005.11.013

Thayer, J. F., & Lane, R. D. (2009). Claude Bernard and the heart–brain connection: Further elaboration of a model of neurovisceral integration. *Neuroscience & Biobehavioral Reviews, 33*(2), 81-88. doi:https://doi.org/10.1016/j.neubiorev.2008.08.004

Thompson-Hollands, J., Jun, J. J., & Sloan, D. M. (2017). The association between peritraumatic dissociation and PTSD symptoms: The mediating role of negative beliefs about the self. *Journal of Traumatic Stress*, *30*(2), 190–194. https://doi.org/10.1002/jts.22179

Tolksdorf, K. H., Tischler, U., & Heinrichs, K. (2022). Correlates of turnover intention among nursing staff in the COVID-19 pandemic: A systematic review. *BMC Nursing*, *21*(1), 174. https://doi.org/10.1186/s12912-022-00949-4

Ulmer, C. S., Hall, M. H., Dennis, P. A., Beckham, J. C., & Germain, A. (2018). Posttraumatic stress disorder diagnosis is associated with reduced parasympathetic activity during sleep in US veterans and military service members of the Iraq and Afghanistan wars. *Sleep, 41*(12). https://doi.org/10.1093/sleep/zsy174

Uppal, A., Silvestri, D. M., Siegler, M., Natsui, S., Boudourakis, L., Salway, R. J., Parikh, M., Agoritsas, K., Cho, H. J., Gulati, R., Nunez, M., Hulbanni, A., Flaherty, C., Iavicoli, L., Cineas, N., Kanter, M., Kessler, S., Rhodes, K. V., Bouton, M., & Wei, E. K. (2020). Critical care and emergency department response at the epicenter of the COVID-19 pandemic. *Health Affairs (Project Hope)*, *39*(8), 1443–1449. https://doi.org/10.1377/hlthaff.2020.00901

Van der Hart, O., & Horst, R. (1989). The dissociation theory of Pierre Janet. *Journal of Traumatic Stress*, *2*(4), 397-412. https://www.academia.edu/20486973/The_dissociation_theory_of_Pierre_Janet?auto=citations&from=cover_page

Vahedian-Azimi, A., Hajiesmaeili, M., Kangasniemi, M., Fornés-Vives, J., Hunsucker, R. L., Rahimibashar, F., Pourhoseingholi, M. A., Farrokhvar, L., & Miller, A. C. (2019). Effects of stress on critical care nurses: A national cross-sectional study. *Journal of Intensive Care Medicine*, *34*(4), 311-322. https://doi.org/10.1177/0885066617696853

Van Steenkiste, E., Schoofs, J., Gilis, S., & Messiaen, P. (2022). Mental health impact of COVID-19 in frontline healthcare workers in a Belgian tertiary care hospital: A prospective longitudinal study. *Acta Clinica Belgica*, *77*(3), 533–540. https://doi.org/10.1080/17843286.2021.1903660

Walker, L., & Avant, K. (2011). *Strategies for theory construction in nursing*. Pearson/Prentice Hall.

Wendsche, J., Ghadiri, A., Bengsch, A., & Wegge, J. (2017). Antecedents and outcomes of nurses' rest break organization: A scoping review. *International Journal of Nursing Studies, 75,* 65–80. https://doi-org.ezproxy3.lhl.uab.edu/10.1016/j.ijnurstu.2017.07.005

Wikipedia. (2022). *Autonomic Nervous System*. https://en.wikipedia.org/wiki/Autonomic_nervous_system

World Health Organization. (2006). *World health report: Working together for health.* http://www.who.int/whr/2006/06_overview_en.pdf

World Health Organization. (2020). *Mental health and psychosocial considerations during the COVID-19 outbreak*. https://www.who.int/docs/default-source/coronaviruse/mental-health-considerations.pdf

World Health Organization. (2021). *WHO Coronavirus (COVID-19) dashboard.* https://covid19.who.int/

Worldometer. (2022). *COVID live – Coronavirus statistics.* https://www.worldometers.info/coronavirus/country/us/

Yifan, T., Ying, L., Chunhong, G., Jing, S., Rong, W., Zhenyu, L., Zejuan, G., & Peihung, L. (2020). Symptom cluster of ICU nurses treating COVID-19 pneumonia patients in Wuhan, China. *Journal of Pain Symptom Management, 60*(1), e48-e53. https://doi.org/10.1016/j.jpainsymman.2020.03.039

Yu, F., Raphael, D., Mackay, L., Smith, M., & King, A. (2019). Personal and work-related factors associated with nurse resilience: A systematic review. *International Journal of Nursing Studies*, *93*, 129–140. https://doi.org/10.1016/j.ijnurstu.2019.02.014

Zeiher, W., Sego, E., Trimmer, D., & Bowers, C. (2022). Posttraumatic stress disorder in nurses during a pandemic: Implications for nurse leaders. *Journal of Nursing Administration, 52*(2), E3-e8. https://doi.org/10.1097/nna.0000000000001112

APPENDIX A

UNIVERSITY OF ALABAMA AT BIRMINGHAM INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

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

470 Administration Building
701 20th Street South
Birmingham, AL 35294-0104
205.934.3789 | Fax 205.934.1301 |
irb@uab.edu

Levi, Paula Miller

University of Alabama at Birmingham Institutional Review Board
Federalwide Assurance # FWA00005960
IORG Registration # IRB00000196 (IRB 01)
IORG Registration # IRB00000726 (IRB 02)
IORG Registration # IRB00012550 (IRB 03)

01-May-2022

IRB-300007663
IRB-300007663-005
Heart Rate Variability and Stress in the Intensive Care Unit
Nursing Workplace

The IRB reviewed and approved the Revision/Amendment submitted on 22-Apr-2022 for the above referenced project. The review was conducted in accordance with UAB's Assurance of Compliance approved by the Department of Health and Human Services.

	Expedited
	4, 7
Determination:	Approved
Approval Date:	01-May-2022
Expiration Date:	30-Apr-2025

Although annual continuing review is not required for this project, the principal investigator is still responsible for (1) obtaining IRB approval for any modifications before implementing those changes except when necessary to eliminate apparent immediate hazards to the subject, and (2) submitting reportable problems to the IRB. Please see the IRB Guidebook for more information on these topics.

APPENDIX B

CATEGORIES OF EVENTS, TYPES OF EVENTS, AND DEFINITIONS OF EVENTS

ROUTINE	
Routine Patient Care	**Category for care that is not stat care (urgent) or unexpected.**
Receiving Report	Handoff report/ bedside shift report received from the nurse previously taking care of the patient. The process includes transfer of patient information and plan of care, along with authority and responsibility (Registered Nursing.org., 2022).
Giving Report	Handoff report given to the nurse that will be taking over care for the patient. The process includes transfer of patient information and plan of care, along with authority and responsibility (Registered Nursing.org., 2022).
Discharging Patient to Floor Unit	Discharging a patient to a floor unit from the ICU includes, among others, giving report to nurse taking patient on, gathering patient belongings and medications, notifying family members of transfer, notifying all providers of transfer, calling for transport team member to take patient to new room, or transferring patient to new unit themselves (Agency for Clinical Innovation, 2022).
Discharging Patient to Home	Discharging a patient to home directly from the ICU includes, among others, preparing the patient to leave the hospital by taking out peripheral intravenous lines, dressing patient in street clothes, gathering belongings, coordinating their ride home with family or friends, reviewing patient discharge instructions and educational material with the patient and family, reviewing the current medication list and time of next dose, reviewing follow-up appointments (John-Hopkins Medicine, 2022).
Causing discomfort or pain	To cause physical pain; to hurt (Dictionary.com, 2022). Procedures that nurses perform which can cause pain

	include wound care, nasogastric tube insertion, drawing blood, turning a patient with internal or external wounds. Also, assisting provider with painful procedures can include chest tube placement or withdrawal, arterial or central venous catheterization.
Blood Administration	To make application of; to give (Dictionary.com, 2022) blood. Administering blood components includes, among others, reviewing provider's order to transfuse, acquiring informed consent from patient/family for transfusion, picking up blood from hospital blood bank, pre-transfusion safety check with a second nurse verifying positive patient identification on the product to the patient using the patient's identification band, ensuring compatibility between the patient and a blood component, volume or amount to be administered, ensuring appropriate IV access, proper administration set with filter for blood components, pre-transfusion patient assessment of baseline vital signs within 30 minutes prior to transfusion, remaining with the patient and observing for any reactions for the first 15 minutes following the start of each unit.
Multiple Orders	Diagnostic or treatment directives generated by a physician or physician assistant that commands the execution of specific activities to be performed or delivered as part of a diagnostic or therapeutic regimen of a patient (Law Insider, n.d.). Multiple is defined as receiving more than two new orders after initial morning orders have been executed/fulfilled.
Assisting Provider with Procedure	An act or action that helps someone; an act of assistance (Merriam-Webster, Incorporated, 2022). Assisting provider with procedures can include, among others, intubation, central line placement, apnea test, chest tube

	insertion.
Assisting with TeleMedine	An act or action that helps someone; an act of assistance (Merriam-Webster, Incorporated, 2022) with Telemedicine video platform to connect patient and family with virtual visit or update on plan of care. Includes searching on unit for TeleMedicine equipment.
Re-positioning an unstable patient	To change the position of (Merriam-Webster, Incorporated, 2022). Repositioning of a patient with unstable, or not firm and therefore not strong, safe, or likely to last (Cambridge Dictionary, 2022) vital signs includes among others, that they may experience desaturation of oxygen level, develop an irregular heart rhythm, or cardiac arrest.
Withdrawing life support	The stopping or removing of various devices or treatments used to sustain vital body processes (Encyclopedia.com. (2019). Withdrawal of support for life, including life-sustaining medications, mechanical ventilation.
End-of Life Care	Care given after withdrawal of life-support, care given when death is imminent, and post-mortem care (Encyclopedia.com, 2019).
Environmental	**Category for occurrences that happen in the ICU environment.**
Personal Protective Equipment Breakdown	To stop functioning because of breakage or wear (Merriam-Webster, Incorporated, 2022). Personal protective equipment (PPE) breakdown occurs when PPE becomes compromised and is no longer completely protective. Examples include a tear or rip in gown or gloves.
Supply Need Problem	The need of a commodity or of a vanquished supply (Merriam-Webster, Incorporated, 2022). Supply need problem occurs when a supply is needed but cannot be found.
Isolation Supply Need	The need of a commodity or of a vanquished supply (Merriam-Webster, Incorporated, 2022). Isolation supply

	need problem occurs when a supply is needed when the nurse is fully gowned in PPE in the patient's room and discovers a supply is needed outside of the patient's room.
INTERPERSONAL	
Interpersonal Communication	**Category for the act or process of using words or behaviors to express or exchange information (Encyclopædia Britannica, Inc. (2022). This category includes verbal communications of frustration.**
Communicating with Family/Update	The act or process of using words or behaviors to express or exchange information (Encyclopædia Britannica, Inc. (2022). Verbal communication with family regarding patient care. Examples include plan of care, routine updates to family on patient condition, obtaining informed consent if patient is not of sound mind/sedated, addressing patient wishes/advance directives.
Bad News to Family	The act or process of using words or behaviors to express or exchange information (Encyclopædia Britannica, Inc. (2022). Verbal communication with family regarding decline in patient condition.
DNR Counseling with Patient or Family, Palliative Care and Hospice Counseling	The act or process of using words or behaviors to express or exchange information (Encyclopædia Britannica, Inc. (2022). Verbal communication with patient and/or family regarding "Do Not Resuscitate" orders, or a request not to have cardiopulmonary resuscitation if the patient's heart stops or if they stop breathing. Also includes Palliative Care counseling (comfort care with or without curative intent) and hospice care (without curative intent) (National Institute on Aging, 2022).
Communicating with Provider	The act or process of using words or behaviors to express or exchange information (Encyclopædia Britannica, Inc. (2022). Verbal communication with provider regarding patient care.

	Examples include patient status/condition, order initiation or clarification, plan of care.
Communicating with TeleICU	The act or process of using words or behaviors to express or exchange information (Encyclopædia Britannica, Inc. (2022). Verbal communication with tele-ICU team regarding patient care. Examples include patient status/condition, order initiation, or order clarification.
Frustration with Coworker	A feeling of being upset or annoyed, particularly caused by being unable to do something (Encyclopædia Britannica, Inc. (2022). Verbal declaration to another of perceived negative issues that arise from the nurse-coworker relationship. Examples include coworker on previous shift not doing their job (not giving medications that were due, not doing scheduled dressing changes), coworker doing their job poorly, not willing to help when asked.
Frustration with Family	A feeling of being upset or annoyed, particularly caused by being unable to do something (Encyclopædia Britannica, Inc. (2022). Verbal declaration to another of perceived negative issues that arise from the nurse-family relationship. Examples include not agreeing with family wishes for plan of care, end-of-life decisions, prolonging life in patient with short life expectancy, family chooses not to visit patient who is in critical condition.
Frustration with Provider	A feeling of being upset or annoyed, particularly caused by being unable to do something (Encyclopædia Britannica, Inc. (2022). Verbal declaration to another of perceived negative issues that arise from the nurse-provider relationship. Examples include provider not available, not following proper hospital protocol, violating the patient's or family's

	wishes regarding treatment (e.g., cardiopulmonary resuscitation or prolonged mechanical ventilation), ordering treatment or plan-of-care the nurse is morally opposed to (e.g., unnecessary painful procedures, end-of-life decisions, procedures to prolong life in patient with short life expectancy).
Frustration with Administration	A feeling of being upset or annoyed, particularly caused by being unable to do something (Encyclopædia Britannica, Inc. (2022). Verbal declaration to another of perceived negative issues that arise from the nurse-administration relationship. Examples include insufficient staffing, being told you are to work on a different unit, ever-changing hospital policies, increasing documentation responsibilities.
STAT/UNEXPECTED	
Stat/Unexpected Care	**Category for care that must be addressed immediately and may or may not be unexpected (RxList Inc., 2022).**
Emergent Care	Type of care, if not provided, would likely result in the need for crisis intervention due to concerns of potential danger to self, or grave disability (Law Insider, 2022).
Emergent Orders	Orders given by the provider to prevent potential danger or grave disability to the patient (Law Insider, 2022).
Stat Medication	An abbreviation for the Latin word statim, meaning immediately, urgent, or rush (RxList Inc., 2022), in this case, the immediate administration of a medication.
Pain Medication	The administration of pain medication. This was placed under Stat/Unexpected category because delays to pain medication administration result in worse patient care, decreased patient, satisfaction, increased patient complaints (Woolner et al., 2020). Therefore, pain medication should be

	administered quickly, if within the ordered timeframe.
Patient Code	Cardiac or respiratory arrest, medical emergency of patient (Cleveland Clinic, 2022).
Behavioral/Violence	**Category for actions by patients who are delirious, troubled in mind, disturbed, and upset. Also includes being agitated to the point of using harmful physical force (Merriam-Webster, Incorporated, 2022; Sunnybrook, 2022). Actions of family members are also included in this category.**
Patient Self-Harm	Some patients in the ICU may suffer from delirium or poor judgment, which can stem from, among others, lack of sleep, pain medications, and sedating drugs. This poses a risk for danger to themselves (Sunnybrook, 2022). Self-harm may be accidental, as well. Examples include pulling out their intravenous lines, pulling out sutured tubes, getting out of bed and falling.
Agitated/Violent Patient	Patients who are agitated are defined as troubled in mind, disturbed and upset (Merriam-Webster, Incorporated, 2022). Patients who are violent are defined as emotionally agitated to the point of using harmful physical force (Merriam-Webster, Incorporated, 2022).
Agitated/Violent Family Member	Family members who are agitated are defined as troubled in mind, disturbed and upset (Merriam-Webster, Incorporated, 2022). Family members who are violent are defined as emotionally agitated to the point of using harmful physical force (Merriam-Webster, Incorporated, 2022).
Alarm	**Category for alarms, false alarms, malfunctioning equipment, and dangerous non-patient related events (Merriam-Webster, Incorporated, 2022).**
Alarm Due to Patient Condition	A loud noise that warns or alerts (Merriam-Webster, Incorporated, 2022)

	as part of vital sign monitoring system, or equipment, such as mechanical ventilator, for example.
Troubleshooting/False Alarm	A loud noise that warns or alerts (Merriam-Webster, Incorporated, 2022) and is deemed to be a false, or untrue warning (Merriam-Webster, Incorporated, 2022). This results in the nurse troubleshooting the equipment, or investigating (Merriam-Webster, Incorporated, 2022) why this is occurring.
Troubleshooting/Equipment Malfunction	Troubleshooting equipment, or investigating equipment malfunction (Merriam-Webster, Incorporated, 2022) is done when equipment is not working properly.
Dangerous Non-Patient Event	Defined as an unforeseen circumstance involving possible injury or harm that calls for immediate action (Merriam-Webster, Incorporated, 2022). Examples include a fire or active shooter.