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Alarm Fatigue on Medical-Surgical Units

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This is to certify that the doctoral dissertation by

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2021

Abstract

Alarm Fatigue on Medical-Surgical Units

by

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BA, University of Augustana, 1997

MS, Regis University, 2007

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Technology use in the medical-surgical acute care setting has increased and leads to alarm, alert, and notification overload, also known as alarm fatigue, which is one of the top 10 health technology hazards leading to patient harm. Alarm fatigue is a new phenomenon within the acute care health care setting and impacts patients, families, staff, leadership, organizations, and the profession of nursing. The purpose of this descriptive, comparative, quantitative study was to examine the difference in the level of alarm fatigue and its impact on performance for nurses who work on a technology-dedicated, inpatient, medical-surgical unit versus a traditional inpatient medical-surgical unit. Howard's decision theory informed this study as the theoretical framework. Two groups of nurses (N = 141), one group from each unit under study, completed the Alarm Fatigue Questionnaire. Calculated with an independent t test, the results showed no statistical significance regarding the impact of alarm fatigue on nurses' performance between the technology-dedicated and traditional, inpatient, medical-surgical units. Both unit types were impacted by a moderate level of alarm fatigue. Future research could focus on reducing alarm fatigue across inpatient, medical-surgical units. The findings of this study can effect positive social change by defining how the level of alarm fatigue affects medical-surgical nurses' performance. Benefits of this research impact health care individuals, patients/families, and health care organizations to concentrate on reducing alarm fatigue which will promote patient safety within the acute care setting.

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Dedication

This research study is dedicated to all the medical-surgical nurses who work in the acute care setting. Providing quality nursing care to medical-surgical patients has positively impacted my nursing career. Medical-surgical inpatient nurses, it has been an honor to work beside you and provide exceptional care.

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Chapter 1: Introduction to the Study

Technology use in the medical-surgical, acute care setting has increased and leads to alarm, alert, and notification overload, also known as alarm fatigue, which is one of the one of the top 10 health technology hazards leading to patient harm (Baker et al., 2020; Emergency Care Research Institute (ECRI), 2020; Winters et al., 2017). The goal of adding technology to the medical-surgical unit is to allow nursing staff to spend more time providing direct patient care and promoting increasing patient safety (Moore et al., 2020). The Association of Advancement of Medical Instrumentation (AAMI) defined alarm fatigue as when an alarm or alert occurs, the end user may or may not respond in a timely manner due to unnecessary noise within an environment (Winters et al., 2018). Reducing audible alerts will benefit the patient by providing a quieter environment for healing and benefit the nurse by allowing them to critically think clearly (Purbaugh, 2014). When a patient is admitted to an inpatient, medical-surgical unit, maintaining patient safety is the top priority (Baker & Rodger, 2020). The outcome of the current study offers potential for positive social change in that it describes the presence of alarm fatigue and its impact on nurse's performance who work on traditional, inpatient, medical-surgical units versus technology-dedicated, inpatient, medical-surgical units and promote patient safety in the acute health care setting.

In Chapter 1, I provide a synopsis of this study and background information on alarm fatigue in the acute care setting. A discussion of the purpose of the study, research question, theoretical foundation, and nature of the study follows. Chapter 1 concludes

with definitions of terms, assumptions, delimitations, limitations of the study, significance of the study, and a summary of the chapter.

Background

In 1974, the ECRI reported how a patient was severely burned by a piece of equipment due to a provider turning off the alarm in the acute care setting (Deb & Claudio, 2015; Sendelbach & Funk, 2013). After 237 additional alarm-related deaths and injuries, The Joint Commission created a National Patient Safety Goal to ensure that health care facilities were managing clinical alarms appropriately (Healthcare Technology Foundation [HTF], 2004). The literature indicates that in the intensive care unit (ICU), there are over 350 alarms per day/per patient and over 40 types of clinical alarms (Cho et al, 2016; Wilken et al., 2019). Multiple alarms or alerts that occur in the acute health care setting have led to alarm fatigue, which is a newer phenomenon in nursing (Casey et al., 2018; Cho et al., 2016; Deb & Claudio, 2015, Funk et al. 2016; Ruppel et al., 2018).

Knowing that alarm fatigue is one of the top 10 technology hazards that leads to patient harm, several agencies have provided recommendations on how to reduce alarm fatigue (Baker et al. 2020; ECRI, 2020; Winters et al., 2017). The ECRI, Agency for Research and Quality (AHRQ), The Joint Commission, and the AAMI have acknowledged the potential harm to patients due to a lack of response from health care providers to alarms and alerts and provided recommendations to decrease harm (Gaines, 2019; The Joint Commission, 2020). In the HTF survey, health care professionals provided input on how clinical alarms impact patient safety, reporting that many alarms

were false/nonactionable alarms that contributed to noise on the unit, and that there is no current research that demonstrates if evidence-based practice interventions reduce the number of alarms (Casey et al., 2018; Cho et al., 2016). While the HTF survey was created by subject matter experts, it is not a valid and reliable tool to be used to evaluate alarm fatigue. Torabizadeh et al. (2016) created a valid and reliable Alarm Fatigue Questionnaire by evaluating alarm fatigue on nurses' performance. While there is some research literature to support alarm fatigue in the acute care setting, the topic of alarm fatigue is new in the field of nursing.

In this study, I address this gap in knowledge by describing the differences in levels of alarm fatigue in nurses who work on a traditional, medical-surgical, inpatient unit versus on a technology-dedicated, medical-surgical, inpatient unit. Medical-surgical nurses are the largest group of nurses in practice and provide direct patient care for multiple patients during their shifts (Academy of Medical-Surgical Nursing Practice, 2018). The complexity of medical-surgical patients has increased over the past 10 years as 1 in 4 Americans have two or more chronic conditions (Morgan, 2019). Caring for the inpatient, medical-surgical patient is complex and demanding, and decisions made in the inpatient, medical-surgical unit impact the nurse, patient, unit, and organization (Swiger et al., 2016). Adding additional technology to medical-surgical inpatient units allows nurses to spend more time providing direct patient care and promoting increased patient safety (Moore et al., 2020). Currently, there is limited research on alarm fatigue; therefore, I conducted this study to provide additional knowledge on the levels of alarm

fatigue in nurses who work on a traditional, medical-surgical, inpatient unit and nurses who work on a technology-dedicated, medical-surgical, inpatient unit.

Problem Statement

Since 2008, the ECRI (2020) has noted that excessive clinical alarms and alerts leads to alarm fatigue in the acute health care setting and that, at times, health care professionals respond by failing to address or disabling alarms and alerts (Casey et al., 2018; Cho et al., 2016). The ICU has more than 40 alerts and alarms, with responses to alerts and alarms taking 35% of nurses' time, leading to alarm fatigue (Cho et al., 2016; Lewandowska et al., 2020). There is no extant literature regarding alert and alarm response on medical-surgical, inpatient units leading to alarm fatigue (Cho et al., 2016; Lewandowska et al., 2020). Most alarm fatigue literature has focused on providing interventions on how to reduce alarm fatigue in the ICU there is no metric or clear definition of what alarm fatigue is or how to measure the effectiveness of alarm fatigue interventions (Winters et al., 2018). The nursing discipline is just beginning to assess how alarm fatigue impacts nurses. The problem of alarm fatigue is a current, relevant, and significant problem in acute health care that may lead to patient harm or death (Lewandowska et al., 2020).

Current alarm fatigue research has been focused on the ICU; there is no research on alarm fatigue on the medical-surgical, inpatient unit. The HTF survey, an online survey to identify hospital practices and clinicians' perceptions of alarms, has been sent out nationally in 2006, 2011, and 2016. The research from this survey shows a decrease in alarm sensitivity by health care providers, increase in adverse patient events due to

clinical alarms, and alarm fatigue interventions being implemented in the hospital setting (Casey et al., 2018; Cho et al., 2016; Ruppel et al., 2018). While the HTF survey has not been tested for validity or reliability, its results do provide valuable information on alarm fatigue trends. Lewandowska et al. (2020) performed a recent systematic literature review of alarm fatigue on intensive care populations and found the following themes: nurses are exposed to too many false alarms, nurses are overwhelmed by technology monitoring systems, and experienced nurses are not resilient to alarm noise.

In this study, I used the Alarm Fatigue Questionnaire created by Torabizadeh et al. (2016), which is a validated and reliable tool created to measure alarm fatigue within the past 5 years. The Alarm Fatigue Questionnaire was created for use in the ICU: however, the researchers would like to pilot it on other nursing units. Using the Alarm Fatigue Questionnaire to determine the impact of alarm fatigue on nurses' performance on a traditional, medical-surgical, inpatient unit versus on a technology-dedicated, medical-surgical, inpatient unit provides a foundation for further alarm fatigue research in acute care health care facilities.

Purpose of the Study

The purpose of this descriptive, comparative, quantitative study was to describe the difference in the levels of alarm fatigue between registered nurses who work on a traditional, medical-surgical, inpatient unit and registered nurses who work on a technology-dedicated, medical-surgical, inpatient unit. Examining the differences in alarm fatigue between nurses who work on these two units provides the groundwork for the study of alarm fatigue in medical-surgical, inpatient nurses. I defined the amount of

technology that is found on the medical-surgical unit to ensure like medical-surgical units were measured. Nurses who have worked on the respective unit of either the traditional, medical-surgical, inpatient unit or technology-dedicated, medical-surgical, inpatient unit completed the Alarm Fatigue Questionnaire and describing how alarm fatigue impacts their level of performance.

Research Question

The research question that guided this study was: What is the difference in the levels of alarm fatigue between registered nurses who work on a technology-dedicated, medical-surgical, inpatient unit and registered nurses who work on a traditional, medical-surgical, inpatient unit?

Theoretical Framework

The theoretical basis for this study was decision theory developed by Howard (1988). According to decision theory, the decision maker will evaluate the choices or alternatives, look at relevant information, and consider their preferences before making a final decision (Howard, 1988). In a study by Casey et al. (2018), ICU nurses agreed that nonactionable nuisance alarms occur frequently, however, the ICU nurses found that alerts or alarms were adequate to alert staff of a change in the patient's condition. Just like in ICU, when an audible alert or alarm goes off on a medical-surgical, inpatient unit, it is up to the nurse to evaluate why the alert or alarm was audible, review alert or alarm information, and reflect on how alerts or alarms have impacted patients' before determining how to react to the alert or alarm. Medical-surgical nurses' decisions when responding to audible alerts can impact patient safety and outcomes (Casey et al., 2018;

Cho et al., 2016; Cosper, 2017, Petersen & Costanzo, 2017; Sowan, 2015). Use of the decision theory supports how medical-surgical nurses decide to respond to audible alarms or alerts on the inpatient, medical-surgical unit, and the impact of levels of alarm fatigue on their performance. I will provide a more detailed description of decision theory in Chapter 2.

Nature of the Study

In this quantitative study, I employed a descriptive, comparative design to analyze the levels of alarm fatigue and its impact on nurses' performance on either a traditional, medical-surgical, inpatient unit or a technology-dedicated, medical-surgical, inpatient unit. Previous studies have used the HTF survey to measure alarm fatigue in ICU nurses working with more than 40 pieces of equipment with alarms and alerts (Casey et al., 2018; Cho et al., 2016; Lewandowska et al., 2020). To describe levels of alarm fatigue in medical-surgical, inpatient nurses' performance in the current study, I used an electronic survey to collect data, which is comparative to the HTF survey used with the ICU nurses. To meet the G*Power sample size calculation of 64 participants per group, I recruited nurses from several like traditional, medical-surgical, inpatient units and several like technology-dedicated, medical-surgical, inpatient units from a large health care organization in the Western United States. I used the Alarm Fatigue Questionnaire by Torabizadeh et al. (2016) to measure alarm fatigue among nurses working on traditional, medical-surgical, inpatient units versus technology-dedicated, medical-surgical, inpatient units. I analyzed the anonymized data by using the Software Statistical Package for Social Science (SPSS) to identify how traditional, medical-surgical, inpatient unit nurses'

responses compared to technology-dedicated, medical-surgical, inpatient unit nurses' responses.

Definitions

Alarm fatigue: A desensitization to alarms or alerts with a delayed or no response due to an overload of audible alarms or alerts (Association of Critical Care Nurses [ACCN], 2020; Torabizadeh et al., 2017; Winters et al., 2018).

Technology-dedicated, medical-surgical, inpatient unit: Providing care to adults over 18 years of age in an acute care setting with a variety of medical diagnosis and/or providing postoperative care with audible alerts, such as phone, intravenous pumps, call lights, bed alerts, telemetry, hands-free wireless communication device, continuous monitoring device, and tablets (Academy of Medical-Surgical Nurses, 2019).

Traditional, medical-surgical, inpatient unit: Providing care to adults over 18 years of age in an acute care setting with a variety of medical diagnosis and/or providing postoperative care with audible alerts, such as phone, intravenous pumps, call lights, bed alerts, and telemetry (Academy of Medical-Surgical Nurses, 2019).

Assumptions

For this study, I assumed that medical-surgical nurses who have been hired to work on the participant unit for over 90 days would choose the appropriate unit and truthfully answer how many years they had worked on the unit in the Alarm Fatigue Questionnaire as an electronic survey. There was a column created on the Alarm Fatigue Questionnaire that states, "prefer not to answer," and it was monitored for trends with specific questions. Continued research on alarm fatigue included how to reduce

nonactionable/false alarms, determining a clear definition and metric for alarm fatigue, and evaluation on alarm fatigue interventions that informed necessary care for all units in acute care health care organizations (Casey et al., 2016; Lewandowska, 2020; Winters et al. 2018).

Scope and Delimitations

The specific aspects of the research problem included addressing levels of alarm fatigue in nurses who work on a traditional medical-surgical inpatient unit and nurses who work on a technology-dedicated medical-surgical inpatient unit. Describing the level of alarm fatigue in medical-surgical, inpatient nurses provides a starting point for addressing alarm fatigue interventions on medical-surgical inpatient units. I identified participants who had worked on the unit for 90 days to ensure that they had time to gain unit experience prior to completing the Alarm Fatigue Questionnaire. Results from this research study were generalizable for medical-surgical, inpatient nurses in the organization.

Limitations

One limitation was the use of the Alarm Fatigue Questionnaire by Torabizadeh et al. (2016). This questionnaire is new, has not been utilized in medical surgical unit research, and was specifically created for the ICU. Another initial limitation was if medical-surgical nurse participants would have the time to complete the survey in their busy schedules, fortunately they were able to do so.

Significance

This study will contribute to the current literature regarding alarm fatigue for nurses' performance by specifically focusing on inpatient, medical-surgical unit nurses to understand how alarm fatigue impacts their processes and work environment. Most alarm fatigue research has occurred in ICUs; however, there has been some alarm fatigue research completed on cardiac units, emergency departments, children's units, and mother baby units. Currently, the amount of technology used on a medical-surgical unit varies depending on the organization. First, I determined what types of technology are used on a medical-surgical unit, including Smart Pumps, wireless communication devices, bed alarms, continuous monitoring devices, call light system, and phones, which can impact the noise level, including alarms, on an inpatient, medical-surgical unit. While the goal of this technology is to increase patient safety, instead it is causing additional distractions and may be resulting in medical errors. Evaluating alarm fatigue knowledge in medical-surgical nurses through use of Torabizadeh et al.'s (2016) Alarm Fatigue Questionnaire in this study supported whether using more technology with audible alerts on an inpatient medical-surgical floor affects alarm fatigue on nurses' performance. Currently, there are no research studies utilizing the Torabizadeh et al. (2016) Alarm Fatigue Questionnaire in the medical-surgical setting.

This study also supported the professional practice of medical-surgical nurses in determining how technology impacts their processes and work environment because there are currently no existing studies that have investigated alarm fatigue on nurses' performance on an inpatient, medical-surgical unit. As additional technology is

introduced into the inpatient, medical-surgical unit, addressing the number of audible alerts that may lead to alarm fatigue on nurses' performance supports providing a safe patient environment.

Recently, the inpatient, medical-surgical manager from the dedicated technology, inpatient, medical-surgical unit under study went into a patient room and found that the patient was not breathing. Upon further evaluation, the wireless device that the patient had been wearing, the audible alert, had been turned off by the night nurse. While the patient was resuscitated, this is a sentinel event that impacts the patient, family, nursing staff, and organization. Focusing on medical-surgical nurses' performance of alarm fatigue when working with or without technology on the medical-surgical unit has caused nursing practice to create alarm policies, an alarm critique committee, and continuing further research to implement alarm fatigue interventions (Winter et al., 2018). Reducing audible alerts benefits the patient by providing a quieter environment for healing and benefits the nurse by allowing them to critically think clearly (Purbaugh, 2014). When a patient is admitted to an inpatient, medical-surgical unit, maintaining patient safety is the top priority (Baker & Rodger, 2020). The findings from this study impact positive social change through identifying the impact of alarm fatigue on nurses' performance on traditional, inpatient, medical-surgical units versus technology dedicated, inpatient, medical-surgical units.

Summary

The purpose of this descriptive, comparative, quantitative study was to determine the level of alarm fatigue on nurses' performance on a traditional, medical-surgical,

inpatient unit versus technology-dedicated, medical-surgical, inpatient unit. Alarm fatigue is a newer phenomenon in the discipline of nursing, and there is no extant literature on alarm fatigue on medical-surgical, inpatient units. In this study, I applied the decision theory as a lens through which to view nurses' decision making on how to respond to an alarm or alert is dependent on the relevant information and preferences of the nurse. An electronic survey version of the Alarm Fatigue Questionnaire was used to collect data online from nurses who work on medical-surgical units. Chapter 2 will contain a detailed analysis of the literature about alarm fatigue, possible solutions, and theoretical framework.

Chapter 2: Literature Review

Alarm fatigue is one of the top 10 technology hazards that leads to patient harm (Baker et al., 2020; ECRI, 2020; Winters et al., 2017). The use of technology continues to increase in the acute care health setting with the goal of allowing nursing staff to spend more time providing direct patient care and increasing patient safety (Moore et al., 2020). In the acute care health care setting, medical devices are used to alarm or alert health care professionals to potential problem or safety issue with a patient (Casey et al, 2018). Currently in the ICU, there are over 40 possible devices that produce an alarm or alert (Deb & Claudio, 2015). All these alarms or alerts occurring in the acute health care setting has led to alarm fatigue, which is a newer phenomenon in nursing (Casey et al., 2018; Cho et al., 2016; Deb & Claudio, 2015, Funk et al. 2016; Ruppel et al., 2018). The purpose of this study was to determine the different levels of alarm fatigue on nurses' performance on a technology-dedicated, inpatient, medical-surgical unit versus on a traditional, inpatient, medical-surgical unit. The Joint Commission (2020) National Patient Safety Goals, AHRQ, and American ACCN acknowledged that when alarms are not responded to or there is a delayed response, patient safety may be impacted (Gaines, 2019). Using key, related concepts, I conducted a search for literature to review. The theoretical framework of decision theory was chosen to consider how nurses' respond when an audible alarm or alert occurs.

Literature Search Strategy

To locate literature to review, I searched the search engines and databases of ESBCO, Elsevier, CINAHL/MEDLINE, and Thoreau. The following keyword search

terms were used: *alarm management, clinical alarms, alarm fatigue, patient safety, medical-surgical unit, nurses,* and *decision theory.* During the literature search, single words were used or were combined with the Boolean operators of AND and OR. I limited the literature search to peer-reviewed articles and was primarily focused on articles published from 2015 to the present. Seminal literature published prior to 2016 that was critical to understanding the topic was also included. The ACCN (2020) described how current technology, including continuous patient monitoring, impacts alarm fatigue and ICU nurses' responses. Additionally, there are multiple organizations that have started to research alarm fatigue; however, the literature is limited and primarily has been focused on the ICU. There is dearth of literature related to inpatient, medical-surgical units and alarm fatigue. Gross et al. (2011) studied alarm fatigue on a medical-surgical unit 10 years ago; however, they only included the use of a changing alarm limits compared to critical care. Further research on alarm fatigue on inpatient, medical-surgical units is necessary due to an increased use of technology and the complexity of providing care to multiple, inpatient, medical-surgical patients and keeping patients safe.

Theoretical Foundation

The theoretical base for this study was decision theory developed by Howard (1988). According to decision theory, the decision maker will evaluate the choices or alternatives, look at relevant information, and incorporate their own preferences before making a final decision (Howard, 1988). Application of the decision theory allows the inpatient, medical-surgical nurse to be the decision maker and decide when there is an audible alert. When there is an audible alert on the inpatient, medical-surgical unit, it is

the medical-surgical nurse as decision maker who decides how to respond to each alert (Huang & Shachter, 1997). The inpatient, medical-surgical nurse evaluates the choices or alternatives, relevant information, and preferences of how to respond to audible alerts from technology (see Howard, 1988). The number of audible alerts can lead to alarm fatigue and can impact how medical-surgical nurses decide how to respond to audible alerts. Medical-surgical nurses' decision when responding to audible alerts can impact patient safety and lead to better patient outcomes (Casey et al., 2018; Cho et al., 2016; Cosper, 2017, Petersen & Costanzo, 2017; Sowan, 2015). Use of the decision theory as the theoretical framework in this study supports how medical-surgical nurses decide to respond to audible alarms on the inpatient, medical-surgical unit and how alarm fatigue affects them.

Literature Review Key Concepts

In the literature review, the primary concept I researched was alarm fatigue because the level of alarm fatigue was measured from inpatient, medical-surgical nurses in this study. Within alarm fatigue literature, additional key concepts identified included false or nonactionable alarms and noise. These concepts are frequently addressed within the alarm fatigue literature and are part of the Alarm Fatigue Questionnaire by Torabizadeh et al. (2016). In the current study, the Alarm Fatigue Questionnaire by Torabizadeh et al. (2016) was completed by inpatient, medical-surgical nurses to gather descriptive, comparative, quantitative research data addressing levels of alarm fatigue. Additional concepts related to this study included medical-surgical nurses; technology-dedicated, inpatient, medical-surgical unit; and traditional, inpatient, medical-surgical

unit. These concepts were specific to the research question that addressed the level of alarm fatigue for inpatient, medical-surgical nurses who work on a technology-dedicated unit versus a traditional unit.

Alarm Fatigue

The AAMI defined alarm fatigue as when an alarm or alert occurs, the end user may or may not respond in a timely manner due to unnecessary noise within an environment (Winters et al., 2018). However, the literature does not provide a standard definition of alarm fatigue, and after reviewing the literature, I used the following definition for alarm fatigue: a desensitization to alarms or alerts with a delayed or no response due to an overload of audible alarm or alerts (ACCN, 2020; Torabizadeh et al., 2017; Winters et al., 2018). The first reported case of alarm fatigue occurred in 1974 when the ECRI researched an incident when an alarm was disregarded by a health care provider and a patient was severely burned by a piece a of equipment (Deb & Claudio, 2015; Sendelbach & Funk, 2013). Between 2002–2004, there were over 237 adverse events reported where alarms were identified to cause patient harm, including 23 ventilator-related deaths and injuries (HTF, 2004). It is important to note that the ventilator-related deaths and injuries were specific to the ICU. The Joint Commission initially created a National Patient Safety Goal in 2002 to have health care facilities manage clinical alarms; however, by 2004, it became part of The Joint Commission Participation Requirement (HTF, 2004). Working with the ECRI, U.S. Food and Drug Administration (FDA), FDA Manufacturer and User Facility Device Experience Database, and The Joint Commission, a task force of subject matter experts on alarm

management, the HTF (2004), was developed to improve the management of clinical alarms in health care. The HTF created a clinical alarm survey that was sent to health care professionals in 2006, 2011, and repeated with a few additional questions in 2016 (Ruppel et al., 2018; Sendelbach & Funk, 2013; Torabizadeh et al., 2017).

From January 2005 to June 2010, the FDA stated that there were 566 alarm-related patient deaths (The Joint Commission, 2013). These alarm patient deaths were categorized by the ERCI (2020) who further identified alarm, alert, and notification overload as one of the top 10 health technology hazards for health care facilities from 2008 until 2020 and provided possible solutions to each of the hazards. In 2013, The Joint Commission (2013), ECRI, AAMI, and ACCN provided recommendations to heath care organizations to reduce patient harm or death due to alarm management. Torabizadeh et al. (2016) created the Alarm Fatigue Questionnaire, which went through statistical analysis showing it was reliable and validated. Additionally, in 2018, the AACN provided evidence-based recommendations on reducing alarm fatigue and false critical alarms within the acute care setting (Jepsen et al., 2018).

Multiple organizations and associations have provided evidence-based practice interventions to reduce alarm fatigue. The ECRI (2020) recommended health care organizations reduce the total number of alarm or alert notifications and support clinical staff by decreasing cognitive overload due to alarm fatigue. Within the literature, several organizations, such as the AACN, The Joint Commission (2020), and AHRQ (2020), have recommended the reduction of the total number of alarms and alert notifications within health care organizations (Jepsen et al., 2018).

While supporting clinical staff with possible recommendations on alarm management is a common theme, there is no literature that clearly states how to decrease cognitive overload from alarm fatigue for clinical staff. Simpson and Lyndon (2018) completed an alarm fatigue study on a labor and delivery unit and found that monitoring patients based on their condition decreased alarm fatigue. The authors noted that although this may be effective for the labor and delivery unit, it may not be effective for other acute care units.

Providing continuous patient monitoring is crucial when a patient has been admitted to the ICU. The AACN has provided the following evidence-based recommendations: educate staff on proper skin preparation for and placement of electrocardiogram (ECG) electrodes, use of correct placement of oxygen saturation probes, check alarm settings at beginning of the shift, and customize alarm settings for each patient while following the unit and/or hospital policy (Gaines, 2019).

One of the biggest differences between ICUs and medical-surgical units is the continuous monitoring of the patient; however, new technology allows for continuous monitoring of medical-surgical patients just like in ICU (Leenen et al., 2020). Several inpatient, medical-surgical units at the study site have adapted wearable wireless devices to monitor continuous vital signs. The literature addresses the advantages of this type of wearable device as early detection of deteriorating patients on a unit, but there is no literature that addresses how wearable devices' alerts and alarms on an inpatient, medical-surgical unit (e.g., a technology-dedicated, inpatient, medical-surgical unit) affect alarm fatigue (Leenen et al., 2020). On the other hand, in a systematic review,

Leenen et al. (2020) concluded that wearable devices are still being tested for validity and feasibility and the results are inconclusive regarding their clinical benefit or cost effectiveness. It remains unclear if the ICU's evidence-based solutions would benefit patients on an inpatient, medical-surgical unit, and as inpatient medical-surgical units adapt wearable wireless devices, additional research is necessary to see if evidence-based recommendations to reduce alarm fatigue would benefit inpatient, medical-surgical units.

While several organizations and associations have provided evidence-based practice interventions to reduce alarm fatigue, Winters et al. (2018) clearly stated that the weaknesses with reducing the number of alarms, or any interventions related to the reduction of alarm fatigue are that the literature has yet to clearly define alarm fatigue and provide appropriate metrics to measure it. In addition to clearly defining alarm fatigue, Lewandowska et al. (2020) recommended determining a method to measure levels of alarm fatigue and which interventions work best to manage alarms. Providing a comprehensive model on how to manage alarm fatigue within health care organizations would be ideal; however, not having a universal definition of alarm fatigue is a limitation (Wilken et al., 2017). There is evidence to support the reduction of alarm fatigue, especially in the ICU; however, the weaknesses shared within the literature are valid; consequently, I conducted this research study to specifically evaluate the level of alarm fatigue in medical-surgical nurses who work on a technology-dedicated unit versus a traditional unit.

False/Nonactionable Alarms

Most of the alarm fatigue literature reported that 80%–97% of all alarms are false or nonactionable or do not need a response (Bach et al., 2018; Cho et al., 2016; Coster, 2017; Lewandowska et al., 2020; Lukasewicz & Mattox, 2015; Petersen & Costanzo, 2016; Purbaugh, 2014; Wilken et al., 2017). False alarms can be defined as when an alarm or alert occurs when no true event has happened, and nonactionable alarms are defined as when an alarm occurs that has no clinical significance (Lukasewicz, 2015). Casey et al. (2017) found that ICU nurses rated false alarms with a decrease in response as the number one reason for alarm fatigue. Not only have false alarms decreased staff's response to alarms or alerts, but researchers have also discussed how false or nonactionable alarms or alerts have become a nuisance, disrupt patient care, and reduce trust in health care providers (Casey et al., 2017; Ruppel et al., 2018; Torabizadeh et al., 2017). Frequent false/nonactionable alarms have created the "cry wolf" effect in which health care providers disregard the alarm as false and do not respond in a timely manner (Cho et al., 2016; Torabizadeh et al., 2017). The literature provides several evidence-based solutions on how to reduce false/nonactionable alarms; however, there is no extant literature that supports if these evidence-based solutions work. There is also no literature on false/nonactionable alarms that occur on inpatient, medical-surgical units, so evaluating differences between a technology-dedicated versus traditional inpatient, medical-surgical units in the current study provided a foundation for alarm fatigue research on medical-surgical units.

Noise

False/nonactionable alarms are one contributing source to alarm fatigue, and these alarms also contribute to the amount of noise found on an acute care unit. Casey et al. (2018), Cho et al. (2016), Petersen and Costanzo (2017), and Torabizadeh et al. (2016) found environmental background noise and determining which device was creating a noise contributed to alarm fatigue on the ICU unit. The World Health Organization (1999) provided Guidelines for Community Noise, also known as environmental noise, and recommended hospital noise levels should not exceed 35 decibels (dB) during day light hours and 40dB at night. Cho et al. (2016) found that ICU environment noise was slightly above 80dB. On the other hand, Pope (2010) researched four medical-surgical units and found that the sound levels were between 62.2dB–64.6dB. Several studies indicated that in order to reduce noise on a unit, a health care provider will suspend alarms or alerts to decrease frustration or irritation (Deb & Claudio, 2015; Lukasewicz & Mattox, 2015). The World Health Organization stated that an increase in noise can lead to an increase in stress or annoyance, may disturb sleep for patients, and may cause communication interference between health care professionals and patients. Providing a quiet hospital environment may lead to a less stressful work environment for nurses and improve patient satisfaction while reducing alarm fatigue (McGough et al., 2018).

Medical-Surgical Nurses

Medical-surgical nurses are the largest group of nurses in nursing practice providing direct patient care for multiple patients during their shift in the acute care setting (Academy of Medical-Surgical Nursing Practice, 2018). The American Nurses

Association has provided principles for nurse staffing, however, do not specifically state how many patients an inpatient medical-surgical nurse should care for. In California there is a law that mandates that one inpatient medical-surgical nurse can care for an average of five patients (American Nurses Association, 2020; Wolters Kleuwer, 2019). The complexity of medical-surgical patients has increased over the past 10 years as 1 in 4 Americans have two or more chronic conditions (Morgan et al., 2019). Gaffney et al. (2016) agreed that inpatient, medical-surgical nurses care for complex patients and provide several interventions throughout their shift. Caring for the inpatient, medical-surgical patient is complex and demanding, and decisions made in the inpatient, medical-surgical unit impact the nurse, patient, unit, and organization (Swiger et al., 2016). While caring for multiple inpatient medical-surgical patients, having a noisy environment, and responding to alarm or alerts can lead to alarm fatigue. Further research is needed from an inpatient, medical-surgical nurse perspective to determine if there are differences in alarm fatigue between a traditional, inpatient, medical-surgical unit and technology-dedicated, inpatient, medical-surgical unit.

Traditional, Inpatient, Medical-Surgical Unit

Inpatient, medical-surgical units are defined as nursing units that provide care to adults over 18 years of age in an acute care setting with a variety of medical diagnosis and/or providing postoperative care (Academy of Medical-Surgical Nurses, 2019). There is no literature that discusses traditional, inpatient medical-surgical units and alarm fatigue. However, for the purpose of this descriptive, comparative study on alarm fatigue, a traditional, inpatient medical-surgical unit was defined as having technology audible

alerts such as phone, intravenous pumps, call lights, bed alerts, and telemetry. Caring for a variety of medical diagnosis and/or providing postoperative care includes some audible alerts or alarms and medical-surgical nurse's performance impacts alarm fatigue on traditional, inpatient medical-surgical unit.

Technology-Dedicated, Inpatient, Medical-Surgical Unit

The technology-dedicated, inpatient medical-surgical unit was defined like the traditional, inpatient, medical-surgical unit, however, has more technology-dedicated equipment in use. There are few literature articles that have discussed newer technology that is being used in the acute care setting including hands-free wireless communication devices and continuous monitoring devices. Hands-free wireless communication devices have been described as using voice-controlled badges where health care providers can urgently communicate directly from one provider to another provider (Nguyen et al., 2015). Friend et al. (2016) discussed how noise volume increased in the perioperative environment after implementing a hands-free wireless communication device. No other research was identified that described how hands-free wireless communication devices impact noise or alarm fatigue on an inpatient medical-surgical unit. Regarding continuous monitoring devices, Leenen et al. (2020) completed a systematic review on continuous monitoring devices and found there was no significant changes in clinical outcomes when using these devices. There is no literature on how continuous monitoring devices contribute to the noise or alarm fatigue on an inpatient medical-surgical unit. For this descriptive, comparative study on alarm fatigue, a technology-dedicated, inpatient, medical-surgical unit had technology audible alerts such as phone, intravenous pumps,

call lights, bed alerts, telemetry, hands-free wireless communication device, continuous monitoring device, and tablets. Caring for a variety of medical diagnosis and/or providing postoperative care included some audible alerts or alarms impacted and medical-surgical nurses performance creating alarm fatigue on a technology-dedicated, inpatient, medical-surgical unit.

Summary

Alarm fatigue is a new phenomenon in the acute care setting due to increased technology that is being utilized to provide patient care. There is no literature on alarm fatigue for medical-surgical nurses who work in traditional, inpatient, medical-surgical units and technology-dedicated, inpatient, medical-surgical units currently. Additionally, there is no literature that discusses how medical-surgical nurses' performance is affected by alarm fatigue. There is some literature about alarm fatigue from ECRI, ACCN, The Joint Commission, and AHRQ however, there are gaps regarding a clear definition of alarm fatigue and which interventions may alleviate alarm fatigue. Inpatient, medical-surgical nurses completed the Torabizadeh et al. (2016) alarm fatigue questionnaire to determine nurses' level of alarm fatigue. This study filled a gap in the literature by describing the levels of alarm fatigue for inpatient, medical-surgical nurses between a traditional, inpatient, medical-surgical unit and a technology-dedicated, inpatient, medical-surgical unit. Chapter 3 will contain the research methodology including research design and rationale, methodology, data analysis plan, and threats to validity.

Chapter 3: Research Method

Alarm fatigue is a newer phenomenon in the acute health care setting, and as more technology is placed this setting, it is important to continue to research how alarm fatigue levels impact nurses' performance (Winters et al., 2018). Having completed a literature review on alarm fatigue, I conducted a descriptive, comparative research study using the Alarm Fatigue Questionnaire created by Torabizadeh et al. (2016) to determine and compare the levels of alarm fatigue between traditional, inpatient, medical-surgical nurses and technology-dedicated, inpatient medical-surgical nurses. In Chapter 3, I cover the research method, which includes a discussion of the research design and rationale; methodology, including population, sampling/sampling procedures, recruitment, participant data collection, and instrument used for the research study; and threats to validity.

Research Design and Rationale

In this quantitative study, I used a descriptive, comparative design. Quantitative research in the acute care setting is preferred due to "obtaining evidence to support clinical practice" (Brockopp et al., 2020, p. 76). Using the quantitative approach allows for the analysis of numerical data by using an appropriate blueprint through an organized and methodical process (Houser, 2018). A descriptive, comparative study can provide further information about a variable, and a comparison can explain a difference between two variables (Brockopp et al., 2020; Houser, 2018). For the purposes of this study, the descriptive variable was the impact of alarm fatigue on nurses' performance while comparing nurses' performance as affected by alarm fatigue between a traditional,

inpatient, medical-surgical unit and a technology-dedicated, inpatient, medical-surgical unit. Because alarms and alerts continue to increase in the acute care setting, there has been some quantitative research on use of the HTF clinical alert survey to measure alarm fatigue; however, there is no clinical research using Torabizadeh et al.'s (2016) Alarm Fatigue Questionnaire. The Alarm Fatigue Questionnaire by Torabizadeh et al. (2016) is a reliable and valid instrument providing numerical data to determine the level of alarm fatigue in nurses' performance.

Alarm fatigue is a newer phenomenon in the acute health care setting, and there is no research on the impact of alarm fatigue on nurses who work on a traditional, inpatient, medical-surgical nursing unit versus a technology-dedicated, inpatient medical-surgical nursing unit. I conducted this descriptive, comparative study to determine the level of alarm fatigue in medical-surgical nurses and compare the levels of alarm fatigue between the two types of inpatient medical-surgical units to fill the gap in alarm fatigue knowledge.

Methodology

Population

The participants were registered nurses who work on a traditional, inpatient, medical-surgical unit or a technology-dedicated, inpatient, medical-surgical unit from a large health care system in the Western United States. I conducted a power analysis for the population size of the study that resulted in the inclusion of 64 registered nurses from traditional, inpatient, medical-surgical unit and 64 registered nurses from a technology-dedicated, inpatient, medical-surgical unit.

Sampling and Sampling Procedures

I used nonprobability convenience sampling in this study. One of the strengths of using nonprobability convenience sampling is that it allows for studies to be completed in a cost-effective manner because the participants were easily available and smaller samples were used (Glen, n.d.). On the other hand, a weakness of using nonprobability convenience sampling is the risk of lacking an accurate representation of the population, leading to biased results (Glen, n.d.). Employing nonprobability convenience sampling allowed me to use participants that were available via an email distribution list and communicate with the nurses with the support of leadership. Participants in this study were colleagues from my workplace. Having worked for the organization for several years, I knew some of the participants; however, the participants chose which medical-surgical, inpatient unit they work on. For the purposes of this study, I identified which medical-surgical inpatient units are traditional and technology-dedicated within the study site health care system and will utilize the nurses from those units as the sample population.

I identified three traditional, inpatient, medical-surgical units and three technology-dedicated, inpatient, medical-surgical units to recruit participants from. After the Walden University Institutional Review Board (IRB) granted me approval to conduct the study, a link and quick response (QR) code was sent via the work email distribution list to the registered nurses who work on these units. Registered nurses were able to voluntarily participate and complete the survey either via the link or QR code.

The inclusion criteria for this study included registered nurses who had been hired to work on the identified inpatient, medical-surgical units and who had worked on the unit for over 90 days, including charge nurses. The exclusion criteria were any staff who had been hired to the unit in the past 90 days, travelers or any float pool nurses who work on the unit for an occasional shift, educator nurses, and any other staff currently working on the inpatient, medical-surgical unit.

Using G*Power analysis, I determined that there should be 64 participants from the traditional, inpatient, medical-surgical unit and 64 participants from the technology-dedicated, inpatient, medical-surgical unit (see Faul et al. 2007). The effect size was 0.5; the effect size is used to quantitatively measure the relationship between two variables and compare two groups to measure the difference (McLeod, 2019). The alpha level was 0.05, which is commonly used to test for a Type I error and supports rejecting the null hypothesis (see Glen, n.d.). The power level chosen for this research was 0.8, which provided the ability to establish a statistically significant difference (see Meera, n.d.).

Procedures for Recruitment, Participation, and Data Collection

I sent the recruitment participation email, including the consent form and the Alarm Fatigue Questionnaire email link and/or QR code, via the work email distribution list to participants starting on the data collection date. Any communication about the research study was vetted through the Walden University IRB prior to sending. The first question in the electronic survey asked participants which unit they currently work on: traditional or technology dedicated. This allowed for de-identifying the participants and anonymous participation. The collection period occurred for 2 weeks at a time for a total

of 6 weeks or until the sample size was met. I sent weekly emails recruiting participants and with the Alarm Fatigue Questionnaire to email distribution lists. After 2 weeks, I reevaluated how many staff had completed the Alarm Fatigue Questionnaire and if participant numbers were low, I looked at additional units within the health care facility to complete the questionnaire for traditional, medical-surgical, inpatient units because there were more than 200 nurses who worked in such a unit in the system. One of the limitations of this research study was that there were approximately 150 nurses who were working on a technology-dedicated, medical-surgical, inpatient unit in the health care system at the time of the study.

I placed flyers in the identified units along with treats during the data collection phase at nurse shift change of the data collection period. In addition to the Alarm Fatigue Questionnaire, the demographic data collected included: which unit the nurse currently worked on, whether they worked on technology-dedicated or traditional unit, and how many years they had worked on the current, medical-surgical, inpatient unit. All data were collected electronically with a download from the software platform by me every 3 days during data collection to monitor for sample size. At the end of the electronic survey, I thanked the participants for participating, instructed them to hit "submit," and the participants exited the electronic survey.

To increase participation and meet sample size requirement of 64 participants for each group, after participants had completed the Alarm Fatigue Questionnaire and hit the "submit" button, the electronic survey asked them participants if they would like to participate in a drawing for a $50 gift card. There was a total of four $50 gift cards that

were randomly selected at the end of the data collection period. Gift cards were sent electronically to the four participants who fully completed the Alarm Fatigue Questionnaire within 1 week of the data collection period being completed. Providing an incentive to the participants increased participation and provided me with more complete data to determine nurses' level of alarm fatigue in technology-dedicated, medical-surgical, inpatient units versus traditional, medical-surgical, inpatient units.

Instrumentation and Operationalization of Constructs

The instrument used for this study was the Alarm Fatigue Questionnaire (see Appendix A) created by Torabizadeh et al. (2016). This instrument was appropriate for this study because it allowed the nurses to answer 13 questions using a 5-point Likert scale to measure alarm fatigue on their performance on technology-dedicated versus traditional inpatient, medical-surgical units. Administration of the Alarm Fatigue Questionnaire took place using an electronic survey platform online, and the questionnaire took nurses less than 5 minutes to complete. Since responses on the questionnaire were rated from *always* to *never*, I included an additional column that stated, "prefer not to answer." This provided additional information about the instrument used and if staff were comfortable responding to the 13 Likert-scale questions. Additionally, this allowed staff to answer all questions to reduce data inaccuracies and having to discard data if a participant was uncomfortable answering a specific question.

I obtained permission to use the instrument from the copyright holder on January 4, 2021 (see Appendix B). Torabizadeh et al. (2016) tested the questionnaire's internal homogeneity reliability with the following results: Cronbach's alpha was 0.91, test-retest

and Spearman-Brown was 0.99, face validity was determined by subject matter experts and nurses, and content validity of the S-CVI/Ave was 0.92. The Alarm Fatigue Questionnaire was piloted with ICU nurses in Iran. Validity and reliability were established through use of the test-retest, Cronbach's alpha, and principle component analysis during the pilot with the ICU nurses (Torabizadeh et al., 2016). Torabizadeh et al. (2016) reviewed the literature and worked with subject matter experts and professors who were familiar with alarm fatigue and psychometrics while reviewing each questionnaire item's significance for reliability and validity. The Alarm Fatigue Questionnaire was a sufficient instrument to determine the impact of alarm fatigue on nurses' performance because the instrument was created by reviewing the trends in literature about alarm fatigue, utilizing experts, completing a pilot, and then modifying statements, and conducting a final statistical analysis to show it as a reliable and valid instrument (see Torabizadeh et al., 2016).

Use of the Alarm Fatigue Questionnaire was reliable and valid; however, since I used this instrument to evaluate inpatient, medical-surgical units, a few of the statements were revised. While I did reach out to the author several times to ask if I could revise a couple of the statements, I did not receive a response back in return. Changes made to two statements did not impact the reliability or validity of the Alarm Fatigue Questionnaire. The first statement originally read, "I react differently to the low-volume (yellow) and high-volume (red) alarms of the ventilator" (see Appendix A). Medical-surgical nurses do not care for patients on a ventilator and do not identify yellow or red alarms with a ventilator. Revising this statement for this research, it read, "I react

differently to low-volume and high-volume alarms." The second statement originally read, "At visiting hours, I pay less attention to the alarms of the equipment" (see Appendix A). The health care facility where the research took place follows patient-family centered care, which allows for open visiting hours. After revising this statement for this study, it read, "When visitors are present, I pay less attention to the alarms of the equipment." These minor changes in the statements found on the Alarm Fatigue Questionnaire allowed for inpatient, medical-surgical nurses to rate level of alarm fatigue on their performance. I used Cronbach's alpha to measure internal consistency and Cohen's Kappa to measure interrater reliability using SPSS.

Data Analysis Plan

After data collection was completed from the electronic survey, I used IBM SPSS, Version 26 for analyses. By including a column that stated, "prefer not to answer," I encouraged participants to answer each question from the Alarm Fatigue Questionnaire and supported a clean data collection. This led to a decrease in data cleaning necessary for insightful data analysis of the Alarm Fatigue Questionnaire results for the medical-surgical nurse participants. If the participant did not complete the first question about which unit they currently work on, the data were discarded. Data analysis included the number of participants from each unit, how many years of experience they had on the unit, and the mean and standard deviation from the Alarm Fatigue Questionnaire that used the Likert scale. The research question was: What is the difference in the levels of alarm fatigue between registered nurses who work on a technology-dedicated, medical-

surgical, inpatient unit and registered nurses who work on a traditional, medical-surgical, inpatient unit?

I compared the responses from nurses in each unit through use of an independent *t* test. First, using the branching technique in the electronic survey, data were separated that was specific to each unit and analyzed. This met the assumption of independence by having two independent, categorical groups of data (see Glen, 2021). For the purposes of this study, the two independent, categorical groups were nurses' level of performance who work on a technology-dedicated, medical-surgical, inpatient unit and nurses' level of performance who work on a traditional, medical-surgical, inpatient unit.

The second assumption for use of an independent t-test was independence of observations. This assumption assumed that there was no relationship between the two measured groups (Laerd Statistics, n.d.). While this study included three groups from different facilities for each groups studied, one group selected did meet the traditional, medical-surgical, inpatient unit definition and the second group selected did meet the technology-dedicated medical-surgical inpatient unit definition. To meet this assumption, one of the inclusion criteria was that the nurse must have been hired to specifically work on the designated medical-surgical inpatient unit for longer than 90 days. This ensured that the participant only works on one unit and responds to the appropriate group identified in the Alarm Fatigue Questionnaire (Laerd Statistics, n.d.).

Threats to Validity

One of the external threats to validity included sample selection bias. The primary inpatient medical-surgical nurses work at one large western United States multifacility

health care setting, and this did not represent the entire population. Sample selection bias may also be an internal threat to validity. To decrease sample selection bias, I recruited a larger group of participants for statistical analysis. Construct validity is the degree to which a test measures what it expects to measure, the Alarm Fatigue Questionnaire has been found to be a reliable and valid instrument, these measures are more fully described in an earlier section of this chapter.

Ethical Procedures

The approved IRB participation letter was included in the electronic email to the participants to obtain participant agreement.

The data was collected electronically from the IRB software platform of choice. Data was kept confidential as the participants identified which unit they work on, either traditional or technology-dedicated, inpatient, medical-surgical unit as one survey and QR code was shared with the same participants. Having the participants choose which unit they work on allowed for anonymity. All data from traditional, inpatient, medical-surgical units was provided as one unit and not three units and all data from technology-dedicated was provided as one unit and not three units in the final research. Individual inpatient, medical-surgical unit data were not shared as to maintain confidentiality of the participants. Data were saved on the electronic survey database and removable USB flash drive which was placed in my locked safe in my home for 6 years. People who have access to the data collected included the statistician and myself. The electronic survey with collected data will be deleted after completion of this dissertation. The USB flash

drive will be destroyed 6 years after completion of this dissertation. Maintaining confidentiality of participants is my responsibility to maintain quality research.

Another ethical issue is that I completed research at the site where I currently am employed. While I work with inpatient medical-surgical units, I am not a direct supervisor of any of the staff who completed the survey link or QR code. As the professional development supervisor, I am responsible for supporting orientation of new employees and providing education and do not evaluate or provide any feedback regarding inpatient medical-surgical nurses. Having an awareness of what my current role is within the organization did not impact this research.

Summary

Using a quantitative, descriptive, comparative design provided additional research to describe the level of alarm fatigue of registered nurses who work on a traditional, inpatient, medical-surgical unit and a technology-dedicated, inpatient, medical-surgical unit. Chapter 3 provides details of the methodology used, including population, sampling/sampling procedures, recruitment, participant data collection and use of the Alarm Fatigue Questionnaire by Torabizadeh et al. (2016). In Chapter 4, I will discuss data collection and results from the Alarm Fatigue Questionnaire on the level of alarm fatigue on nurses' who work on a traditional, inpatient, medical-surgical unit and technology-based, inpatient, medical-surgical unit.

Chapter 4: Results

The purpose of this descriptive, comparative quantitative study was to determine the difference in the levels of alarm fatigue between registered nurses who work on a traditional, medical-surgical, inpatient unit and registered nurses who work on a technology-dedicated, medical-surgical, inpatient unit. As technology increases in the acute health care setting, researching the impact of alarm fatigue on medical-surgical nurses may lead to safer patient care. The research question was: What are the difference in the levels of alarm fatigue between registered nurses who work on a technology-dedicated, medical-surgical, inpatient unit and registered nurses who work on a traditional, medical-surgical, inpatient unit. I used Torabizadeh et al.'s (2017) Alarm Fatigue Questionnaire to measure the variable of alarm fatigue in nurses who work on a technology-dedicated, medical-surgical, inpatient unit versus those who work on a traditional, medical-surgical, inpatient unit.

In Chapter 4, I provide information on the data collection process for this study, describe the recruitment process, outline the timeframe for collecting data, and present descriptive characteristics of the sample. Results from the study are also discussed and tables that display resulting data are shared. I conclude the chapter with a summary that includes answers to the research question and a transition to Chapter 5.

Data Collection

Timeframe and Recruitment

I received approval to collect data from the Colorado Multiple Institutional Review Board (COMIRB) on August 10, 2021. The COMIRB approval number for this study was 21-3868. After receiving approval from COMIRB, this information was sent to the Walden University IRB, which approved the collection of data on September 3, 2021 (IRB Approval Number 09-03-21-0786223). On September 6, 2021, I sent an email to the chief nurse officers of the medical-surgical units that were invited to participate in this study, per the request of the organization's chief nursing executive. Then on September 7, 2021, I sent a participant email with a QR code and a link to medical-surgical, inpatient nursing unit distribution lists in addition to posting flyers and placing chocolate in the appropriate medical-surgical, inpatient, nursing unit breakrooms. Email reminders were sent weekly, and the study concluded on October 7, 2021, after determining that statistical significance had been met. The response rate was 77 nurses who worked on a technology-dedicated, medical-surgical, inpatient unit and 64 nurses who worked on a traditional, medical-surgical inpatient unit.

Baseline Demographics

The population for the study was from a large health care organization in the western United States and nurses who work on similar technology-dedicated, medical-surgical, inpatient units and nurses who work on similar traditional, medical-surgical, inpatient units. To maintain the privacy and confidentiality of the units, in the electronic survey, nurses who participated chose which unit they currently worked on with similar

medical-surgical inpatient units were grouped together and labeled as technology-dedicated and traditional medical-surgical units. The only discrepancy between process described in Chapter 3 and the way data were collected in the study was that three weekly emails were sent out, and data collection occurred for 4 weeks and 2 days because the statistical G*Power was met.

A target sample of a minimum of 64 participants from nurses who work on a technology-dedicated medical-surgical inpatient unit and 64 participants from nurses who work on a traditional medical-surgical inpatient unit was the recruiting goal for participation in the study. Using a nonprobability convenience sample allowed me to include my colleagues within the health care organization in which I work as participants. Eligible criteria included having worked on the identified inpatient, medical-surgical unit for over 90 days, including charge nurses. From the total number of surveys returned from nurses who worked on the technology-dedicated, medical-surgical, inpatient units, 68 out of 77 were complete and qualified to use in the study. From the total number of surveys returned from nurses who worked on traditional, medical-surgical, inpatient units, 61 out of 64 were complete and qualified to use in the study. Twelve participants data were eliminated from the data set due to their choosing “prefer not to answer” as a response. All participants gave informed consent and agreed to participate in the study by clicking on the electronic link or scanning the QR code. A total number 64 (45.4%) traditional, medical-surgical, inpatient unit nurses and 77 (54.6%) technology-dedicated, medical-surgical, inpatient unit nurses comprised the sample for this study.

Study Results

I used an independent *t* test to calculate the statistical differences between means. I analyzed the Alarm Fatigue Questionnaire scores from 68 nurses who worked on a technology-dedicated, medical-surgical, inpatient unit and 61 nurses who worked on a traditional, medical-surgical, inpatient unit for a total of 129 nurses. The final score for the survey instrument was calculated using the associated scoring rubric for the Alarm Fatigue Questionnaire. Torabizadeh et al. (2016) noted that the minimum score is an 8 and the maximum score is 44. Knowing that the minimum is 8 and the maximum is 44, the mean score would be 26. The statistical assumption of normality for the final score was tested using skewness and kurtosis statistics (see Table 1). The statistical assumptions of normality (skewness = -0.38, kurtosis = -0.02) and homogeneity of variance ($p = 0.58$) were met because skewness and kurtosis were below an absolute value of 2.0. The mean score for the final score was 26.1, with a standard deviation of 5.19.

Table 1

Descriptive Statistics

	N	Min	Max	*M*	*SD*	Skewness		Kurtosis	
						c	*r*	*c*	*r*
Final score	129	12.00	38.00	26.10	5.19	-0.38	0.02	-.015	.423
Valid *N*	129								

I tested the statistical assumption of homogeneity of variance using Levene's Test of Equality of Variances (see Table 2). The output from Levene's test for equality of

variances showed a *F* value of .32 and a *p* value of .58. If $p > 0.05$, accept the null hypothesis (Laerd Statistics, n.d.). This means variances are not statistically significant, so I assumed that alarm fatigue in medical-surgical nurses in technology-dedicated, inpatient, medical-surgical units and traditional, inpatient, medical-surgical units is equal.

Table 2

Levene's Test of Equality of Variances

					p	Mean	Std Error	95% CI	
Final Score	*F*	*p*	*t*	*df*	2-tailed	Diff	Diff	Lower	Upper
Equal variance assumed	.32	.58	-1.6	127	.109	-1.47	.91	-3.27	.333
Equal variance not assumed			.16	124	.110	-1.47	.91	-3.27	.339

When both statistical assumptions were met, then I used an independent samples *t* test to compare independent groups (i.e., units) on the outcome. Means and standard deviations were reported and interpreted for the *t*-test analysis in Table 3. I assumed statistical significance at a *p* value of 0.05, and all analyses were performed using SPSS, Version 26. Using the independent samples *t* test, I found that there was not a statistically significant difference between the traditional ($M = 25.33$, $SD = 5.29$) and technology-dedicated ($M = 26.79$, SD = 5.03) units, $t\ (127) = -1.61$, $p = 0.11$ (see Table 3).

Table 3

Alarm Fatigue Scores Between Technology-Dedicated and Traditional Medical-Surgical Units

		N	*M*	*SD*	Std. Error Mean
Final score	Traditional	61	25.33	5.30	.68
	Technology dedicated	68	26.79	5.03	.61

Summary

The purpose of this descriptive, comparative quantitative study was to determine alarm fatigue between nurses who work on a technology-dedicated, medical-surgical, inpatient unit and nurses who work on a traditional, medical-surgical, inpatient unit using the Alarm Fatigue Questionnaire (see Torabizadeh et al., 2017). In this study, I conducted an independent sample *t* test to analyze data from nurses who work in the two units under study. The use of an independent *t* test was appropriate to compare the two groups and showed that the two groups had similar alarm fatigue results. This finding demonstrated that there was no statistical significance in Alarm Fatigue Questionnaire results of alarm fatigue on nurses' performance between the two types of units.

In this study, I aimed to address the gap in the literature on alarm fatigue in nurses who work on a medical-surgical, inpatient unit. In Chapter 5, I will interpret the study findings, discuss limitations, provide recommendations for further research, and identify implications for positive social change.

Chapter 5: Discussion, Conclusions, and Recommendations

In this quantitative, descriptive, comparative study, I determined the impact of alarm fatigue on nurses' performance on a technology-dedicated, medical-surgical, inpatient unit versus on a traditional, medical-surgical, inpatient unit using the Alarm Fatigue Questionnaire. I analyzed the data using the *t* statistic and *p* values to conduct an independent *t* test. The results showed no statistically significant differences in alarm fatigue in nurses who work on a technology-dedicated, medical-surgical, inpatient unit versus those who work on a traditional, medical-surgical inpatient unit.

The results of this study provide a research foundation on the impact of alarm fatigue on nurses who work on medical-surgical, inpatient units. The use of technology continues to increase in the acute care setting, including in the medical-surgical unit. Describing the impact of alarm fatigue on medical-surgical nurses' performance provides additional knowledge with which to fill the gap in literature on alarm fatigue. Chapter 5 includes a summary of the current study, my interpretation of the findings, a discussion of the limitations of the study, recommendations for further studies, and information regarding the study's potential benefits towards positive social change.

Interpretations of Findings

The results of this descriptive, comparative, quantitative study showed that there were no statistically significant differences in the Alarm Fatigue Questionnaire scores between nurses who worked on a technology-dedicated, medical-surgical, inpatient unit and nurses who worked on a traditional, medical-surgical inpatient unit. I used a new, valid, and reliable instrument, the Alarm Fatigue Questionnaire by Torabizadeh et al.

(2016) to measure alarm fatigue in medical-surgical nurses. No previous research has utilized the Alarm Fatigue Questionnaire instrument (Torabizadeh et al., 2016); however, results from the HTF survey found an increase in alarm fatigue awareness, decreased staff response to alarms, and increased adverse patent events related to alarms (ECRI, 2020; Ruppel et al., 2018; Winters et al., 2018).

Findings from the current study showed that alarm fatigue levels in technology-dedicated, medical-surgical, inpatient unit nurses were 26.8 and in traditional, medical-surgical, inpatient unit nurses were 25.3, which is a 1.5 difference. Torabizadeh et al. (2016) stated that in the Alarm Fatigue Questionnaire, the level of alarm fatigue is 8 = minimum and 44 = maximum, and the mean level of alarm fatigue is 26. Both the technology-dedicated and traditional, medical-surgical, inpatient units level of alarm fatigue is close to the mean level of 26. In my opinion, this would equate to a moderate level of alarm fatigue found on both units.

In Chapter 2, I described a dearth of research on alarm fatigue in medical-surgical, inpatient units, and the findings of the study indicate a mean level of alarm fatigue of 26.1 between technology-dedicated and traditional medical-surgical, inpatient units. As described by Torabizadeh et al. (2016), the mean level of alarm fatigue is at 26. While this is not at the maximum level of 44, the level of alarm fatigue at 26 is meaningful and should be addressed by the organization. From personal observations at two of the study system facilities, one traditional and one technology dedicated, in 6-week span, there have been call lights/bed exit alerts not being answered, phones being placed on vibrate on night shift and reset by information technology on day shift, and

nurse station monitoring units constantly alarming. Researchers have confirmed that false and nonactionable alarms may decrease the response from staff to alarms and alerts and become a nuisance, disrupt patient care, and reduce trust in health care providers (Casey et al., 2017: Ruppel et al., 2018; Torabizadeh et al. 2017). The study site organization must begin to address alarm fatigue to promote patient safety (see Winters et al., 2018).

In the decision theory, Howard (1988) stated that the decision-maker (or the nurse in the case of the current study) will evaluate the choices or alternatives when an alert or alarm goes off. In Chapter 2, I provided some interventions on how ICU nurses can decrease alarm fatigue, including reducing false and nonactionable alarms, educating staff on proper preparation for and placement of equipment, and setting alarm settings that are appropriate for the patient (see Brantley et al., 2016; Coster et al., 2017; Deb & Claudio, 2015; Winters et al., 2018). It would be beneficial to measure if the above interventions are appropriate for the medical-surgical unit. Another part of the decision theory includes looking at relevant information and making a decision (see Howard, 1988). Medical-surgical inpatient nurses can care for various patients at once, and depending on the acuity of the patient(s), this may impact nurse performance when attending to alarms and alerts. I would recommend a technology/alarm/alert committee in which leaders evaluating possible technology collaborate with medical-surgical nurses to work on which alarms and alerts are most necessary within medical-surgical units. Decision theory can be used to support how medical-surgical nurses respond to audible alarms or alerts on the inpatient, medical-surgical unit and the impact of levels of alarm fatigue on medical-surgical nurses' performance.

Limitations of the Study

One of the limitations of this study was that I only collected data from one organization. While I was concerned with meeting the statistical significance for technology-dedicated, medical-surgical, inpatient units, several nurses thanked me for completing this research, and nurses' total response rate was between 50%–60%. However, there were several staffing changes with the traditional, medical-surgical, inpatient units, and responses from these units just met the G*Power statistical significance. Additionally, while the study was being conducted, the study site organization saw another surge of COVID-19 patients amid a nurse staffing shortage that may have impacted nurses' responses to the Alarm Fatigue Questionnaire.

Recommendations

In this study, I determined the differences in alarm fatigue levels between technology-dedicated, medical-surgical, inpatient nurses and traditional, medical-surgical, inpatient nurses. One recommendation for further research is to use the Alarm Fatigue Questionnaire in other organizations and different sized medical-surgical units, both those who have technology-dedicated and traditional medical-surgical, inpatient units. Additionally, Torabizadeh et al.'s (2016) Alarm Fatigue Questionnaire was a new instrument created by ICU nurses and subject matter experts. Perhaps creating an instrument specific to medical-surgical nurses may be more appropriate to addressing the level of alarm fatigue on the medical-surgical, inpatient unit.

Since the level of alarm fatigue was found to be similar in technology-dedicated and traditional medical-surgical, inpatient nurses, it would be beneficial to follow up with

a quantitative study. A quantitative study would be able to identify and clarify specific themes regarding alarm fatigue and allow for the clear determination of which interventions may benefit medical-surgical, inpatient nurses. The findings of such a study may be used to support awareness of alarm fatigue further and work on developing possible interventions for alarm fatigue, not only on the medical-surgical inpatient unit, but also throughout the acute care setting.

Implications

The importance of this study lies in its potential to positively impact nurses, patients, organizations, and society by identifying how alarm fatigue impacts the level of performance in medical-surgical nurses. Individual medical-surgical nurses can benefit the most because their alarm fatigue levels impact their performance while caring for multiple patients. The goals of nurses working on an inpatient, medical-surgical unit include providing and promoting safe, quality care to patients. Patients and/or visitors rely on the response of medical-surgical nurses to address alarms or alerts promptly. From an organizational and social change impact, nurses provide a safe environment for patients and give quality care when they address their level of alarm fatigue.

Determining the levels of alarm fatigue and its impact on medical-surgical nurses' performance can impact positive social change by ensuring patient safety in the acute care setting. Building on Howard's decision theory (1988), the medical-surgical nurse decides what to do with an audible alarm or alert. Even if that alarm or alert is false, the medical-surgical nurse is responsible for responding appropriately to them. Additionally, the organization must monitor, evaluate, provide guidelines, and incorporate feedback

from the medical-surgical nurses to observe the level of alarm fatigue on medical-surgical units. Providing a safe environment focused on how alarm fatigue impacts nurses' performance on medical-surgical inpatient units promotes positive social change in nurses, patients, organizations, and society.

Summary

The purpose of this quantitative, descriptive, comparative study was to determine the levels of alarm fatigue in nurses who work on a technology-dedicated, medical-surgical, inpatient unit and nurses who work on a traditional, medical-surgical, inpatient unit. The findings of this study provide valuable insights on levels of alarm fatigue and its impact on medical-surgical inpatient nurses' performance. The results showed no differences in alarm fatigue between nurses in the two types of units.

Technology will continue to be implemented in the acute care setting to assist nursing staff with providing safe care to patients. Knowing that technology-dedicated and traditional medical-surgical, inpatient nurses have similar levels of alarm fatigue, the organization is responsible for collaborating with medical-surgical nurses to find interventions that help the nurses make good decisions when responding to alarms and alerts. The findings of this study promote positive social change through determining the level of alarm fatigue in medical-surgical nurses, which can be used to increase patient safety by focusing on the impact of alarm fatigue on medical-surgical inpatient nurses' performance.

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Appendix A: Alarm Fatigue on Medical-Surgical Units

Nurses' alarm fatigue questionnaire

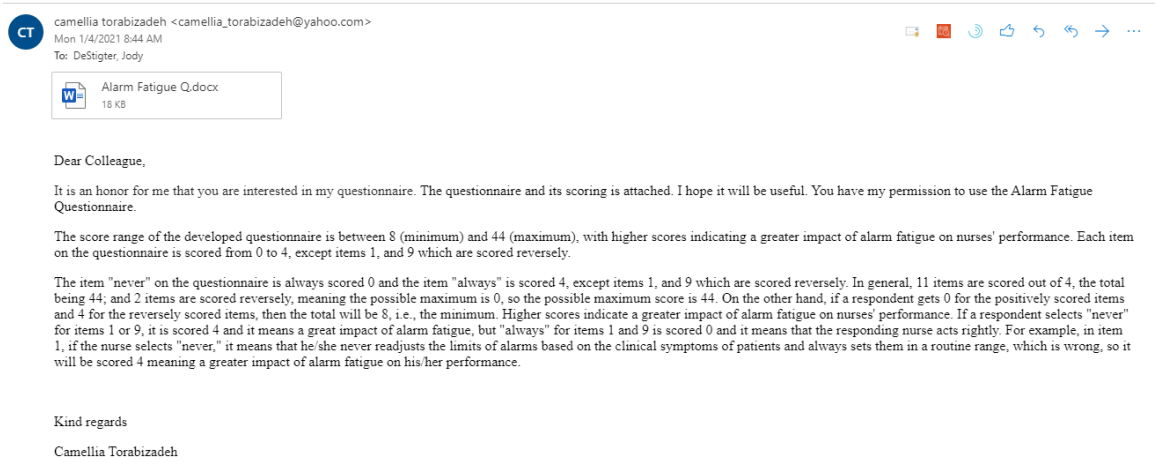
The score range of the developed questionnaire is between 8 (minimum) and 44 (maximum), with higher scores indicating a greater impact of alarm fatigue on nurses' performance. Each item on the questionnaire is scored from 0 to 4, except items 1, and 9 which are scored reversely.

The item "never" on the questionnaire is always scored 0 and the item "always" is scored 4, except items 1, and 9 which are scored reversely. In general, 11 items are scored out of 4, the total being 44; and 2 items are scored reversely, meaning the possible maximum is 0, so the possible maximum score is 44. On the other hand, if a respondent gets 0 for the positively scored items and 4 for the reversely scored items, then the total will be 8, i.e., the minimum. Higher scores indicate a greater impact of alarm fatigue on nurses' performance. If a respondent selects "never" for items 1 or 9, it is scored 4 and it means a great impact of alarm fatigue, but "always" for items 1 and 9 is scored 0 and it means that the responding nurse acts rightly. For example, in item 1, if the nurse selects "never," it means that he/she never readjusts the limits of alarms based on the clinical symptoms of patients and always sets them in a routine range, which is wrong, so it was scored 4 meaning a greater impact of alarm fatigue on his/her performance.

No.	Statement	Always	Usually,	Occasionally	Rarely	Never
1	I regularly readjust the limits of alarms based on the clinical symptoms of patients.					
2	I turn off the alarms at the beginning of every shift.					
3	Generally, I hear a certain amount of noise in the ward.					
4	I believe much of the noise in the ward is from the alarms of the monitoring equipment.					

5	I pay more attention to the alarms in certain shifts					
6	In some shifts the heavy workload in the ward prevents my quick response to alarms.					
7	When alarms go off repeatedly, I become indifferent to them.					
8	Alarm sounds make me nervous.					
9	I react differently to the low-volume (yellow) and high-volume (red) alarms of the ventilator.					
10	When I'm upset and nervous, I'm more responsive to alarm sounds.					
11	When alarms go off repeatedly and continuously, I lose my patience.					
12	Alarm sounds prevent me from focusing on my professional duties.					
13	At visiting hours, I pay less attention to the alarms of the equipment.					

Appendix B: Permission to Use Alarm Fatigue Questionnaire



CT

camellia torabizadeh <camellia_torabizadeh@yahoo.com>
Mon 1/4/2021 8:44 AM
To: DeStigter, Jody

Alarm Fatigue Q.docx
18 KB

Dear Colleague,

It is an honor for me that you are interested in my questionnaire. The questionnaire and its scoring is attached. I hope it will be useful. You have my permission to use the Alarm Fatigue Questionnaire.

The score range of the developed questionnaire is between 8 (minimum) and 44 (maximum), with higher scores indicating a greater impact of alarm fatigue on nurses' performance. Each item on the questionnaire is scored from 0 to 4, except items 1, and 9 which are scored reversely.

The item "never" on the questionnaire is always scored 0 and the item "always" is scored 4, except items 1, and 9 which are scored reversely. In general, 11 items are scored out of 4, the total being 44; and 2 items are scored reversely, meaning the possible maximum is 0, so the possible maximum score is 44. On the other hand, if a respondent gets 0 for the positively scored items and 4 for the reversely scored items, then the total will be 8, i.e., the minimum. Higher scores indicate a greater impact of alarm fatigue on nurses' performance. If a respondent selects "never" for items 1 or 9, it is scored 4 and it means a great impact of alarm fatigue, but "always" for items 1 and 9 is scored 0 and it means that the responding nurse acts rightly. For example, in item 1, if the nurse selects "never," it means that he/she never readjusts the limits of alarms based on the clinical symptoms of patients and always sets them in a routine range, which is wrong, so it will be scored 4 meaning a greater impact of alarm fatigue on his/her performance.

Kind regards

Camellia Torabizadeh