DETERMINANTS OF ALARM FATIGUE AMONG NURSES WORKING IN THIKA LEVEL FIVE HOSPITAL, KENYA.

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A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN CRITICAL CARE NURSING OF MOUNT KENYA UNIVERSITY

06/01/2025

DECLARATION AND APPROVAL

Declaration

This thesis/project is my original work and has never been presented for any academic award in any institution.

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DEDICATION

To healthier work environments. This thesis is dedicated to nurses worldwide; whose commitment to patient care inspires research on alleviating alarm fatigue, enhancing work and safety.

ACKNOWLEDGEMENTS

This research reflects significant contributions from discussions on patient safety, critical care ergonomics, and medical technology, inspired by nurses I've worked with. I'm deeply thankful to the nursing department for their invaluable input. Heartfelt gratitude goes to my advisors for their insightful guidance throughout my studies and project. I also extend sincere appreciation to colleagues who offered expertise, support, and critical feedback essential to this work. My deepest thanks go to my parents, Agnes Keya and John Owoko, for their endless inspiration and guidance; my wife, Catherine Mukami, for her unwavering encouragement; and my siblings for their companionship and strength. Above all, I am grateful to the Almighty for guiding me this far and for the path ahead, dedicated to fostering healthier work environments through this study on alleviating alarm fatigue.s)

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ABSTRACT

Background: One of the primary sources of health technology risks is clinical alarms, such as those from cardiac monitors and mechanical ventilators. Alarm fatigue is a key contributor to these risks. Alarm fatigue is the psychological response to excessive alarms in a medical setting, causing nurses to miss clinically significant alerts. Objectives: This study evaluates alarm fatigue among nurses at Thika Level 5 Hospital in Kiambu, Kenya, through four key objectives: (1) measure the extent of alarm fatigue experienced by nurses, (2) identify nurse-related factors contributing to alarm fatigue, (3) examine institutional factors influencing alarm fatigue, and (4) assess the alarm management strategies employed by nurses to mitigate its impact. Methodology: The study utilized a descriptive cross-sectional design. Data were collected using structured, self-administered questionnaires on Microsoft Forms. Census sampling was employed, targeting all registered nurses in the renal, theatre, casualty, emergency, and critical care departments. Only nurses who consented and met the inclusion criteria participated. Data were analyzed using SPSS version 25, with findings presented in tables, graphs, and figures. The analysis included descriptive statistics (frequencies, means, and standard deviations) and inferential statistics, specifically the chi-square test for independence (X^2) to assess associations between variables. Results: The study included 56 nurses, with a response rate of 82.1%. The majority of respondents were female (76.1%), and most were aged 31–40 years (78.3%). Mechanical ventilators were rated as having the highest alarm frequency by 95.7% of respondents, followed by cardiac monitors (58.7%). Additionally, 73.9% of participants found mechanical ventilator alarms the most challenging to troubleshoot or operate. Nearly half of the respondents (47.8%) indicated they trust clinical alarms to some extent. Discussion: The majority of nurses (95.7%) encountered clinical alarms during their work shifts. Mechanical ventilators and cardiac monitors were identified as having the highest alarm frequency, while patient call systems and electrical beds had the lowest. Recommendations: Provide targeted training on alarm management, optimize staffing levels, and streamline equipment interfaces to reduce alarm fatigue and enhance patient care quality.

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LIST OF ABBREVIATIONS AND ACRONYMS

ABP	Arterial blood pressure
CCU	coronary care unit
CVP	Central venous pressure
ECG	Electrocardiogram
EMR	Electronic medical record
FDA	Food and Drug Administration
HDU	high-dependency unit
HR	Heart rate.
IPAP	Inspiratory Positive Airway Pressure.
ICP	Intra cranial pressure
ICU	Intensive care unit
IV	Intravenous
JCIA	Joint Commission International accreditation
KVO	Keep vein open
LED	light-emitting diode.
NPSG	National Patient Safety Goal
NBP	Noninvasive blood pressure
PCU	progressive care unit

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PACU	post-anesthetic care unit
PVC	Premature ventricular contraction.
X2	Transport monitor.
SpO2	peripheral capillary oxygen saturation
ST	ST segment in the electrocardiogram.
TCICU	transplant/cardiac intensive care unit
TJC	The Joint Commission

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OPERATIONAL DEFINITION OF TERMS

Alarm Fatigue; The desensitization of nurses to clinical alarms due to excessive, frequent, or nonactionable alerts in a medical setting, leading to delayed or missed responses to clinically significant alarms

Clinical Alarms; Clinical alarms are audible or visual alerts generated by medical devices, such as cardiac monitors, mechanical ventilators, or patient call systems, designed to notify healthcare providers, specifically nurses, of potential patient safety issues or changes in clinical status requiring attention

Critical Care Unit(CCU); Refers to all care areas offering critical care services; Synonymous to; ICU, CTICU, RENAL ICU, HDU, PICU,NICU, CATHLAB, PACU, PCU, CCU(Coronary care Unit).

Non-Actionable ("nuisance") Alarms: alarms that are not clinically relevant and are not treated.

Nurses Perception: A way of nurses regarding, understanding, or interpreting alarm fatigue. It is intuitive understanding and insight of nurses on Clinical Alarms and alarm fatigue.

Patient Safety: is the avoidance of unintended or unexpected harm to people during the provision of health care

Patient Harm: synonymous with adverse occurrences in healthcare; unplanned, unforeseen incidents (such as patient injuries, care problems, or death) that are due directly to the treatment given rather than the patient's underlying illness.

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CHAPTER ONE

INTRODUCTION

1.1 Background of Study

Medical device alarms in intensive care units are a significant health technology risk. Although critical for alerting nurses to potential hazards for critically ill patients, clinical alarms remain a key safety mechanism (Casey et al., 2018). Clinical alarms are medical equipment features that produce audible or visual signals to alert healthcare personnel when a patient's physiological state deviates significantly from their baseline (Casey et al., 2018). For optimal functionality, alarms must be precise, user-friendly, and deliver clear, actionable signals for clinicians to respond effectively (Casey et al., 2018).

Clinical alarms aim to enhance safety by notifying clinicians of deviations from a predetermined normal status. Patient safety, a medical specialty, emerged due to increasing healthcare system complexity and rising patient injuries in healthcare facilities (Joint Commission, 2020). Alarms signal deteriorating patient conditions or device malfunctions to prevent or mitigate risks, errors, and harm during medical care (Joint Commission, 2020). However, excessive clinical alarms can lead to alarm hazards, including inappropriate use, alarm fatigue, and applying uniform alarm ranges to all patients (Joint Commission, 2020). Alarm fatigue, defined by the American Association of Critical-Care Nurses as sensory overload from excessive alarms, causes nurses to become desensitized, resulting in delayed or missed responses to alerts (Haque, 2020). This desensitization has been linked to patient deaths (Haque, 2020). The Food and Drug Administration reported over 560 alarm-related deaths in the U.S. between 2005 and 2010 (Busch-Vishniac, 2016). Additionally, alarm errors—such as unanswered alerts or alarms failing to

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sound—occur approximately 8 million times daily, contributing to roughly 200 alarm-related deaths annually and over 500 adverse impacts and morbidities (Busch-Vishniac, 2016).

Proper management of clinical alarms remains challenging for nurses across diverse clinical settings, impacting patient safety due to alarm fatigue (Keller, 2012). On average, each patient generates 150 to 400 alarms per day, to which nurses respond during their shifts (Keller, 2012). In intensive care units (ICUs), nurses spend 35% of their time addressing alarms from devices such as mechanical ventilators, infusion pumps, air beds, and cardiac monitors (Cho et al., 2016). These devices produce varied auditory and visual signals to independently alert clinicians to changes in patient conditions (Cho et al., 2016). Critical care units, being high-intensity environments, demand caution, quick thinking, vigilance, and precision from clinical staff. However, nonactionable alarms divert staff from high-priority tasks, creating patient safety hazards (Graham & Cvach, 2010). Excessive auditory alarms, heard multiple times daily, lead to mental and psychological "numbness" toward physiological machine alarms, resulting in desensitization and missed actionable alerts, compromising patient safety (Graham & Cvach, 2010). Studies attribute alarm fatigue to excessive nonactionable auditory alerts, overwhelming the brain's ability to process sensory input, leading to unprocessed non-physiological alarms (Bi et al., 2020).

Recent studies highlight nurses' lack of skills in operating medical equipment as a contributor to alarm overload and fatigue. Lewandowska et al. (2020) conducted a study evaluating ICU nurses' proficiency with monitor operations, finding that 3% to 40% of nurses were unaware of or did not use 27 basic monitor functions. The study identified 54 fundamental and 5 advanced competencies, emphasizing that regular training is essential for safe and appropriate monitor use to minimize alarm fatigue (Lewandowska et al., 2020).

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1.2 Problem Statement

False alarms are prevalent in intensive care units (ICUs) due to their complex environments compared to non-critical care units. A multinational study across the United States, Australia, South Korea, Ireland, and Germany found that 93% of nurses reported alarm fatigue, leading to silencing alarms, ignoring alerts, violating protocols, and missing true positive alarms; 81% attributed fatigue to excessive false alarms, with 52% unaware of mitigation strategies, such as adjusting device alarm settings based on patient health (Christensen et al., 2014; Casey et al., 2018). At Thika Level 5 Hospital in Kiambu, Kenya, alarm fatigue is a significant issue, with 95.7% of nurses reporting high-frequency alarms from mechanical ventilators, contributing to delayed responses and compromised patient safety (Chironda & Ramlaul, 2021).

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From January 2009 to June 2012, U.S. hospitals reported 80 deaths and 13 severe injuries linked to alarm-related issues among 389 nurses in ICU, CCU, TCICU, HDU, PCU, and PACU units (Cvach et al., 2012). Over 85% of telemetry unit alarms were false, with Johns Hopkins reporting one million alarms weekly and a children's hospital noting 5,300 false alarms daily; ICUs averaged 350 alarms per patient daily (ECRI Institute, 2015; Gaines et al., 2013; The Joint Commission, 2018).

In KwaZulu-Natal, South Africa, 85.7% of nurses reported distress from clinical alarms, with 45.1% noting increased alarm volume due to more critical care equipment. Despite confidence in alarm management, 46.7% reported disruptions to patient care, and 52.7% cited reduced responsiveness due to fatigue. Additionally, 76.9% supported distinct alarm prioritization, and 75.8% advocated for patient-specific alarm settings (Ramlaul & Chironda, 2021). Key barriers to alarm response included inaccurate settings (51.6%) and lack of training (47.8%), exacerbating

alarm fatigue (Ramlaul & Chironda, 2021). The COVID-19 outbreak worsened alarm fatigue among African nurses, with a 71% likelihood of fatigue during shifts due to high patient acuity and numerous alarm-producing devices (Asadi et al., 2022).

At Kenyatta National Hospital, Kenya, Meng'anyi et al. (2017) found that alarm response and task performance decline with workload complexity. Of nurses surveyed, 78% reported stress from multiple responsibilities, and 75.3% experienced frustration and anxiety from alarms, worsened by alarm duration. Nurses developed "survival" tactics based on workload, patient status, and task complexity, with 78.2% responding to alarms of varying durations, 10.3% to rare alarms, 6.9% to short-duration alarms, 3.4% to frequent alarms, and 1.1% to both short and rare alarms (Meng'anyi et al., 2017; Sowan et al., 2017). Excessive non-actionable alarms cause desensitization, hindering patient care. Investigating nurses' perceptions of alarm fatigue determinants is critical for addressing this health technology risk in Kenyan level-five and level-six health facilities (Casey et al., 2018; Ramlaul & Chironda, 2021).

1.3 Purpose of the Study

Patient Safety is the Number one Priority for all critical care service Providers. The Purpose of this study is to assess the determinants of alarm fatigue among Nurses in a Thika Level 5 Hospital in Kiambu Kenya.

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1.4. Study Objectives

1.4.1 Broad objective

To assess the determinants of alarm fatigue among nurses working at Thika Level 5 Hospital, Kiambu, Kenya

1.4.2. Specific objective

1. To assess the level of alarm fatigue among nurses working at Thika Level 5 Hospital, Kiambu, Kenya.
2. To assess nurse-related factors that contribute to alarm fatigue among nurses working at Thika Level 5 Hospital, Kiambu, Kenya.
3. To assess institutional-related factors that contribute to alarm fatigue among nurses working at Thika Level 5 Hospital, Kiambu, Kenya.
4. To assess alarm management strategies utilized by nurses working at Thika Level 5 Hospital, Kiambu, Kenya.

1.5. Research questions

1. What is the level of alarm fatigue among nurses working at Thika Level 5 Hospital, Kiambu, Kenya?
2. What are the nurse-related factors that contribute to alarm fatigue among nurses working at Thika Level 5 Hospital, Kiambu, Kenya?
3. What are the institutional-related factors that contribute to alarm fatigue among nurses working at Thika Level 5 Hospital, Kiambu, Kenya?
4. What are the alarm management strategies utilized by nurses working at Thika Level 5 Hospital, Kiambu, Kenya?

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1.6 Hypotheses

1. There is no statistically significant relationship between Nurses related factors and alarm fatigue level among nurses working at Thika Level 5 Hospital Kiambu Kenya.
2. There is no statistically significant relationship between Institution related factors and Alarm Fatigue level among nurses working at Thika Level 5 Hospital Kiambu Kenya

1.7 Significance of the study

Fatigue is a common complaint of nurses and a possible cause of patient care error universally (Xhueng, et al., 2021). Nurses who are worn out run the risk of endangering both their patients and themselves. In the current healthcare setting, a wide range of factors might lead to nursing weariness. Including elevated levels of patient acuity, increased patient burden, understaffing, elevated levels of stress at work, unforeseen events involving patients or staff, functionally chaotic workspaces, and the constant changes that take place in the working environment.

Nurses now need to be evaluated for alarm fatigue due to recent improvements in patient safety and ICU ergonomics. Alarm risks include incorrect alarm use, alarm fatigue that results in desensitization, and applying a standard alarm range to all patients regardless of their clinical or physiological status. Excessive clinical alarms also cause alarm fatigue, which in turn results in alarm hazards (Sendelbach & Funk, 2015). While device flaws have in the past put patient safety at risk, alarms triggered randomly by the enormous increase in the number of medical equipment today put nurses' well-being at risk.

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1.7 Justification of the study

Alarms are commonplace in intensive care settings where patients are in critical condition. Nurses, who spend the majority of their time monitoring patients around the clock, are particularly susceptible to alarm fatigue, which leads to severe desensitization (Lewandowska et al., 2020). This study's objective is to evaluate nurses' perceptions of the factors contributing to alarm fatigue at Thika Level 5 Hospital in Kiambu, Kenya.

According to Mahmoud et al. (2017), there were 536 deaths related to monitoring device alarms and severe burns resulting from ignored alarms from hyperthermic devices (Mahmoud, 2017). The main questions addressed in this paper are the prevalence of alarm fatigue among nurses, the categorization of determinants of alarm fatigue, and, most importantly, the determination of whether guidelines for alarm management and alarm fatigue evaluation exist. The researcher hopes that this study serves as a wake-up call to nursing management and wellness departments across the country to implement programs that foster healthier work environments for all nurses.

1.8 Scope of the study

The research was conducted in the Thika Level 5 Hospital. It included nurses working in all critical care Departments. This study was limited to the determination of the level of alarm fatigue among Nurses working at Thika level 5 hospital, Kiambu, Kenya, Nurse related and institutional related factors contributing to Alarm fatigue among Nurses and Most importantly the strategies they employ in Management of clinical alarms at Thika level 5 hospital ., Kiambu, Kenya.

1.9 Study limitations

The study targeted a sample of 150 Nurses working in critical care unit at Thika level 5 hospital, Kiambu Kenya, thereby The resultant findings may not be generalized to all Kenyan Nurses.

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Further, sampling does not therefore include other cadres in the critical care population. Data was collected in busy critical care areas.

1.9.1 Delimitations

The study utilized a descriptive cross-sectional design to examine nurses' perceptions of the determinants of alarm fatigue at Thika Level 5 Hospital, Kiambu, Kenya. This design is a delimitation of the study because it captures nurses' perceptions at a single point in time, limiting the ability to assess changes in alarm fatigue or its determinants over time. Additionally, the cross-sectional approach restricts the establishment of causal relationships between identified factors and alarm fatigue, as it does not involve longitudinal data or experimental manipulation

1.9.2 Assumptions of the study

The participants answered the interview questions in an honest and candid manner. The Tools and Methods used for study were reliable.

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1.9.2 Conceptual Model of Alarm Fatigue Determinants.

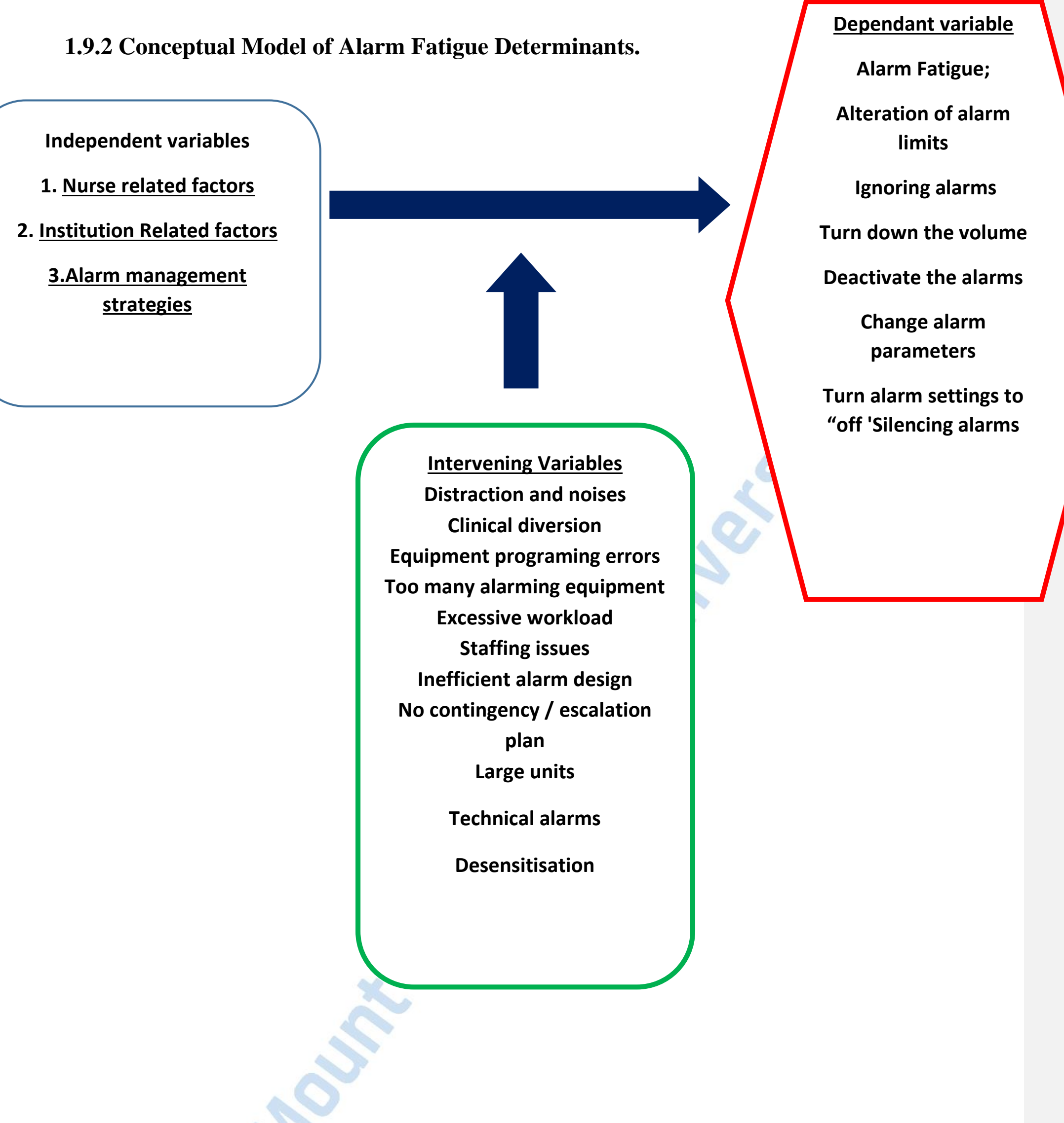

Figure 1: Conceptual Model of Alarm Fatigue Determinants.

This figure illustrates the relationship between independent variables (nurse-related factors, institution-related factors, and alarm management), intervening variables (e.g., distraction and noise, equipment programming errors), and the dependent variable (alarm fatigue). Created by EmmanuelKeya, 2023.

1.9.3 Theoretical Framework

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This study used the transactional theory of stress and coping to provide scientific evidence for the psychological basis of alarm fatigue and to explain the need for a study that qualifies and quantifies clinical alarms. According to Lazarus and Folkman (1984), stress is a relationship between a person and the environment that the person perceives as exceeding their resources. Two main factors create stress: the person-environment interaction and cognitive appraisals. The person-environment relationship includes beliefs, obligations, social support, demands, and limitations. In relation to alarm fatigue, the environment is the critical care setting, the beliefs are the departmental culture related to alarm management practices, and the demands and constraints are the duties and responsibilities performed by the critical care worker.

Three cognitive appraisals were identified: primary, secondary, and reappraisal (McEwen & Wills, 2011). Primary appraisal evaluates the decision and action a person makes regarding an event (McEwen & Wills, 2011). An initial assessment may be perceived as irrelevant or stressful, with stress ratings including harm/loss, threat, or challenge. A threat is viewed as anticipated harm or loss (Lazarus & Folkman, 1984). Secondary appraisal refers to the process by which a caregiver determines what coping alternatives are available and how the person will respond to the stressor and the event taking place. Biggs et al. (2017) defined coping as the ever-changing cognitive and behavioral efforts to manage specific external and/or internal demands that are assessed as straining or exceeding the person's resources. There are two types of coping: emotion-focused and problem-focused coping (Biggs et al., 2017). Emotion-focused coping aims to change the meaning of events, whereas problem-focused coping modifies the person-environment relationship. Reappraisal occurs once the person has dealt with events, providing an opportunity for feedback on the outcomes of the situation (McEwen & Wills, 2011).

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When this theory is applied to a nurse's response to clinical alarms, it provides insight into the thought process that occurs when the nurse experiences alarm fatigue. A critical care monitor alarm should alert the nurse to a potential problem with a patient, requiring the nurse to intervene after responding to the alarm signal. However, in hospital settings where nurses have many roles and responsibilities, continuous alarms lead the nurse to perceive clinical alarms as a threat to the time they would rather devote to other duties. The primary appraisal is a stress assessment; the alarms are viewed as a threat. The secondary appraisal occurs when the caregiver considers what they should do about the alarm. The nurse may use emotion-focused coping to deal with the perceived stressful threat, changing the meaning of the alarm from something important to something unimportant, leading them to ignore the alarm or delay their response. A false alarm environment, created by frequent false and nuisance alarms, likely contributes to this response. Reappraisal occurs when the caregiver reviews the alarms or the patient and sees the result of their coping method. If the patient has not suffered harm during the period of ignoring the alarm because it was insignificant, this reinforces the recurrence of these reactions, thus perpetuating the cycle.

According to this theory, to ensure that alarms have greater meaning for the critical care worker, alarms should not be perceived as a threat to their working hours and available resources. Reducing the total number of alarms in the critical care environment, particularly nuisance and false alarms, would reduce threat perceptions. In clinical situations where clinical alarms occur less frequently, the alarms that do sound are considered more important. However, to implement interventions that would reduce clinical alarms, it is important to conduct an initial alarm assessment, which was the primary goal of this study.

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1.9.3.1 Relation to the Conceptual Framework

The transactional theory of stress and coping directly informs the study's conceptual framework by explaining the psychological processes underlying alarm fatigue, which is the dependent variable. The framework identifies independent variables (nurse-related factors, institution-related factors, and alarm management) that align with the theory's person-environment interaction, as these factors represent the demands, constraints, and cultural beliefs (e.g., departmental alarm management practices) in the critical care setting. The intervening variables (e.g., distraction and noise, equipment programming errors, excessive workload) reflect the stressors and environmental conditions that the theory suggests contribute to stress appraisals. For example, frequent false alarms (an intervening variable) exacerbate the nurse's perception of alarms as a threat, leading to emotion-focused coping behaviors such as ignoring alarms. The theory supports the framework's focus on alarm fatigue outcomes (e.g., alteration of alarm limits, ignoring alarms) by highlighting how nurses' cognitive appraisals and coping strategies mediate the relationship between these variables, ultimately perpetuating alarm fatigue in the critical care environment.

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CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

To better understand the determinants of alarm fatigue among nurses, this literature review examined research studies published between 1990 and 2021. The review includes articles sourced from scholarly search engines and eBooks, such as ResearchGate, Hinari, Google Scholar, PubMed Central, RefSeek, Educational Resources Information Center (ERIC), Mendeley, Cochrane Library, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Open Dissertation Database by EBSCO, and iSEEK. The search was limited to English-language publications. Keywords used included *fatigue*, *clinical alarms*, *acute fatigue*, *nurse fatigue*, *workload*, *chronic fatigue*, and *alarm fatigue*. These terms were applied across 148 papers, periodicals, and journals, of which 70 were included in this paper because they provided valuable insights into clinical alarms and alarm fatigue among nurses. The literature spans multiple disciplines, including nursing, psychology, mental health, ergonomics, work environment, occupational safety, medicine, and biomedical technology.

2.1 Magnitude of Alarm Fatigue Among Nurses

Today's critical care environment involves patients connected to more physiological devices with alarms than ever before. Critical care nursing is highly complex, and errors in practice can result in injury or death (Joint Commission, 2020). A delayed or failed response to alarms can have lethal consequences for patients. Alarm fatigue is not a recent issue. The Joint Commission (TJC) released a sentinel event alert in 2015 highlighting injuries and deaths among patients on mechanical ventilation due to improper management of ventilator alarms. In April 2013, TJC

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issued Sentinel Event No. 50, *Medical Device Alarm Safety in Hospitals*, in response to numerous adverse events linked to a lack of information on alarm safety (Joint Commission, 2013).

Research indicates that nurse fatigue leads to decreased judgment, poor decision-making, slower reaction times, lack of concentration, absenteeism, clinical errors, failure to perform rescues, falling asleep while driving home, and reduced quality of interactions with patients and coworkers (Lewandowska et al., 2020). To understand alarm fatigue, it is critical to evaluate the magnitude of clinical alarms.

2.1.1 Magnitude of Clinical Alarms

Cheung et al. (2016) found that each bed in a critical care unit generated an average of 5.35 cardiac and technical alarms per hour, totaling 128.4 alarms per day. In another study, Luna et al. (2020) recorded 426 alarms over 40 hours, with multi-parametric monitors generating 227 alarms and other devices generating 199 alarms, averaging 10.6 alarms per hour. The study concluded that improper alarm management in critical care units creates a false sense of security, leading nurses to disregard or disable alarms, and emphasized the need to adjust alarms to minimize workflow disruptions.

An alarm device emits an auditory, visual, or other signal to alert staff to a situation requiring immediate attention. Medical equipment and monitoring systems with built-in or attached alarms are triggered by physiological changes in the patient, changes in measured parameters, or technical issues. Clinical alarms from various medical devices are a growing concern in critical care units due to advancements in medical technology, creating a new alarm hazard (Cvach et al., 2020). In 1983, a critically ill patient triggered up to six types of alerts, but by 2011, this had increased to at least 40 types (Cvach et al., 2020). Reducing clinical alarm harm became a National Patient Safety Goal of the Joint Commission to highlight the issue's importance. Key alarm-triggering devices

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include patient monitors, mechanical ventilators, continuous renal replacement therapy devices, hemodialysis machines, syringe pumps, and infusion pumps. Zhao et al. (2021) reported that a 56-bed ICU recorded 2,184 alarms for 48 patients over 48 hours, averaging 45.5 alarms per patient, with 70% of alarms silenced or ignored without action.

A study on nurses' perceptions and practices regarding clinical alarms in intensive care units collected data from 39 full- and part-time nurses using structured questionnaires. The results showed that 95–98% of respondents believed false alarms reduced trust in alarms, leading to deactivation (Haque, 2020).

2.1.2 True Alarms (Actionable and Non-Actionable) and False Alarms

Medical devices in clinical settings produce alarms with varying features, often unsynchronized, depending on the device type, manufacturer, and alarm settings. Alarms can be classified as true (actionable or non-actionable) or false. Actionable alarms require prompt attention to prevent adverse patient outcomes. Key characteristics of actionable alarms include response time and persistence, often involving consistently high or low vital signs (Haque, 2020). Life-threatening alarms, such as asystole or apnea, are exceptions that do not depend on persistence. Infusion pump alarms, such as those for KVO rate, IV catheter placement, or infusion completion, may benefit from contextual data to distinguish non-actionable events (Cvach et al., 2020). Setting overly sensitive conditions can lead to unnecessary alarms, while overly loose settings may result in false negatives.

Non-actionable alarms are true alarms that do not require clinical intervention or result from intentional actions, often distracting clinicians. These short-term alarms, such as low oxygen saturation or heart rate alarms, typically resolve themselves (Luna et al., 2020). Other non-actionable alarms may result from deliberate actions, such as suctioning an intubated patient

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triggering a ventilator alarm, adding unnecessary environmental noise (Walsh & Waugh, 2020). Adding audio alarm delays can significantly reduce alarm annoyance.

False alarms result from bad or missing data, often caused by patient movement, poor sensor placement, faulty cables, or errors in alarm detection algorithms (Schmidt, 2020). Despite improvements in sensor design, false alarms persist if devices are not used or maintained properly. Biomedical departments can reduce false alarms through routine testing, and purchasing departments must balance cost savings with sensor performance. The AAMI Summit recommended replacing ECG electrodes daily to reduce bothersome ECG alerts (Schmidt, 2020). False alarms are often accepted to avoid missing legitimate ones, categorized as clinically relevant/irrelevant or technically correct/erroneous. Technically correct alarms are based on accurate measurements, while technically false alarms (e.g., ambient light interfering with pulse oximetry) are not (Welch, 2021).

2.1.3 Alarm Fatigue Among Nurses

Alarm fatigue is a major patient safety concern, resulting from excessive alarms in a therapeutic setting, causing professionals to miss clinically important alarms (Rodger & Baker, 2020; Joint Commission, 2013). Alarms interrupt and distract caregivers, contributing to potential errors that endanger nurses' well-being and job performance (Luna et al., 2020; Zhao et al., 2021). Excessive alarm exposure leads to desensitization, increasing the risk of missed or delayed diagnoses of patient deterioration.

Previous studies have documented patient injuries due to ignored or delayed alarm responses. The FDA/USA Databases reported 500 patient deaths involving physiologic monitoring systems between January 1, 2015, and December 31, 2020, many due to systems failing to raise alarms for

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critical changes (Zhao et al., 2021). The ECRI Institute listed missed alerts among the top 10 health technology risks of 2016 (ECRI Institute, 2016).

2.1.4 False Alarms and Alarm Fatigue Among Nurses

Recent research indicates that 94% of alarms in a pediatric intensive care unit (PICU) were clinically unnecessary (Goepfert & Reuter, 2018). Tsien and Fackler found that 92% of PICU alarms were false, while O'Carroll reported that only 8 out of 1,455 alerts were triggered by potentially fatal conditions (Goepfert & Reuter, 2018). Siebig et al. noted that in a 12-bed medical ICU, only 17% of alarms were meaningful, 44% were technically incorrect, and 26% had insignificant effects, with 6% leading to emergency calls (Goepfert & Reuter, 2018).

2.2 Nurse-Related Factors Contributing to Alarm Fatigue

2.2.1 Nurse Demographic Characteristics

Research at Lebanon Hospital found that physicians experienced more alarm fatigue (95%) than nurses (90%), with lower rates for head nurses, nurse managers, and supervisors (Bourgi et al., 2020). However, Lee et al. (2021) reported that better alarm management practices were associated with female nurses, charge nurses, and those working less than 40 hours per week, with most participants being female. Charge nurses, responsible for running nursing units during shifts, may be more perceptive to alarms due to their leadership roles (Spiva et al., 2020). Alarm management practices were not significantly affected by career differences, though Lee et al. (2021) found variations across departments like wards and ICUs.

Alarm fatigue was more prevalent among general-purpose hospital workers than teaching hospital staff, with no differences between private and public sectors (Bourgi et al., 2020). Night shift workers were more susceptible to alarm fatigue than rotational or daytime staff, likely due to increased stress and reduced sleep (Bourgi et al., 2020). Health status, quality of life perception, and alarm fatigue were statistically correlated, with higher alarm fatigue among workers who

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found alerts annoying or turned them off (Bourgi et al., 2020). Age, years of experience, family circumstances, and patient-to-provider ratios showed no correlation with alarm fatigue (Sabbah et al., 2020). However, Kooshanfar et al. (2021) found that older nurses were less likely to trust alarms and more likely to turn them off inadvertently.

Experienced nurses were more skeptical about smart alarms improving response times, possibly due to increased exposure to alarms (Sowan et al., 2015). Nurses often fail to adjust alarm parameters, unaware that removing a patient from a monitor resets the parameters to default (Sowan et al., 2015). Physical, emotional, and cognitive demands, prolonged standing, infrequent breaks, rostering procedures, on-call shifts, and manual handling contribute to exhaustion in critical care settings, potentially leading to compassion fatigue (Wakefield, 2018). Compassion fatigue may cause nurses to avoid patient interactions and deliver subpar care (Wakefield, 2018).

Alarm fatigue was 3.14 times more common among personnel reporting stress and negatively affected quality of life (Zhao et al., 2021). Bliss et al. (2017) suggested that clinicians respond to alarms based on perceived reliability, reacting 90% of the time to alarms believed to be 90% reliable. Luo et al. (2020) found that 30% of respiratory therapists noted frequent nuisance alarms over the past decade, worsening perceptions and increasing alarm-related adverse events.

A systematic review on nurse education and training for clinical alarm response found that educational efforts improved alarm awareness (Yue et al., 2018). Training on general, single, sequential, and medium-level alarms had positive effects, with music-trained nurses responding more quickly and accurately (Yue et al., 2018). Simulation interventions were effective, but in-unit training had a greater impact (Yue et al., 2018). Sendelbach et al. (2015) noted that nurses with higher education perceived nuisance alarms as more frequent and doubted smart alarms'

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effectiveness. Adjusting SpO2 alarm signals from 90% to 88% did not reduce alarm rates (Sendelbach et al., 2015).

Bi et al. (2020) conducted a controlled trial on monitor management training, finding that alarm fatigue decreased from 27.70% to 20.57% in the experimental group, while the control group showed a minimal decrease (28.26% to 28.15%). Total alarms decreased from 150.91 to 87.52 per patient per hour in the experimental group, but increased from 152.99 to 154.71 in the control group. Non-actionable alarms decreased from 93.76 to 28.16 in the experimental group, but increased from 89 to 91.43 in the control group, indicating the profound impact of training on alarm management (Bi et al., 2020; Lee et al., 2021).

2.3 Institution-Related Factors Contributing to Alarm Fatigue

2.3.1 Staffing Levels, Patient Ratios, and Equipment Ratios

Increased technology has led to more equipment and alarms in critical care settings. Cvach et al. (2020) found that a higher nurse-to-patient ratio was negatively associated with perceptions that alarms adequately alert staff to patient changes and that staff respond quickly. Higher ratios were positively associated with perceptions that setting alarm parameters is complex and that alarms are frequently missed. Humans can discriminate five to seven categorical sounds, making it harder to hear alarms as technology and patient ratios increase (Cvach et al., 2020). High patient ratios and bedside monitors were barriers to appropriately setting alarms (Bourgi et al., 2020).

The global shortage of registered nurses is projected to continue through 2030 (Australian Institute of Health and Welfare, 2019). Nurses in ICUs respond to 150–400 alarms per patient daily, constituting over 35% of their working time, which is exacerbated by low staffing levels (Walsh & Waugh, 2020). The Australian Institute of Health and Welfare (2019) reported 2.6 healthcare-

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associated complications per 100 admissions in Australian public hospitals during 2018–2019, highlighting the link between staffing and alarm-related hazards.

Fatigue is a growing concern in critical care nursing, with low staffing levels contributing to performance deficits like slowed reaction times, memory lapses, and clinical decision regret (Wakefield, 2018). Fatigue is a work environment-related factor that may lead to care left undone (Wakefield, 2018; Walsh & Waugh, 2020).

2.3.2 Equipment Alarm Malfunction

Seagull and Sanderson studied perioperative alarms in arthroscopic, cardiac, abdominal, and neurosurgical procedures with six patients per specialty, finding that 72% of alerts had no clinical impact (Schmid et al., 2018). Schmid et al. (2018) reported that 75% of alarms in a pediatric hospital (covering pediatric, eye, dental, and orthopedic surgeries) had no therapeutic effect, averaging one alarm every 4.5 minutes, with only 3% highlighting critical circumstances. Equipment malfunctions caused 45% of alarms, often resulting in artifacts from physiological and non-physiological sources (Casey et al., 2018; Schmid et al., 2018).

Alarms serve to detect life-threatening conditions, impending risks, pathophysiological situations (e.g., shock), and device failures (e.g., patient disconnection, power issues). Early detection of equipment problems, such as low battery warnings or breathing valve degradation, is critical for therapeutic devices (Casey et al., 2018).

2.3.3 Unit Characteristics (Size and Type of Critical Care Units)

Working in units without bedside monitors in each room was associated with perceptions of missed alarms, which negatively impact patients (Joint Commission, 2013). Larger units with more beds were linked to perceptions of frequent nuisance alarms and lack of trust, leading caregivers to turn off alarms inappropriately (Cvach et al., 2020). More central monitors on a unit increased

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perceptions of nuisance alarms, disruptions in patient care, and inappropriate alarm deactivation (Cvach et al., 2020). The number of monitors directly correlated with perceived nuisance alarms. Adjusting alarm thresholds can reduce noise from irrelevant alarms (Cvach et al., 2020).

ICUs use a range of bedside devices (e.g., ventilators, infusion pumps, physiological monitors) connected via complex networks of wires and cables, often overcrowding the space and hindering care. More equipment per patient increases alarm frequency, contributing to fatigue among nursing staff navigating the resulting noise (Cvach et al., 2020).

2.3.4 Hours of Work

Nurses working more hours per week perceived that nuisance alarms disrupted patient care. Rotating shifts were positively associated with perceptions of nuisance alarms decreasing trust, leading to inappropriate alarm deactivation, though smart alarms were seen as effective in reducing false alarms (Cho et al., 2016). Nurses can distinguish only 6 to 14 different alarms, identifying devices correctly 31% of the time, and longer, varied shifts increase exposure to alarms (Cho et al., 2016).

The greatest harm from alarm fatigue occurs when a patient develops a fatal arrhythmia or vital sign abnormality unnoticed due to false alarms (Luna et al., 2020). Luna et al. (2020) recorded 426 alarms over 40 hours in a 170-bed coronary care unit, with multi-parametric monitors triggering 227 alarms and other equipment triggering 199, averaging 10.6 alarms per hour, highlighting the need for better alarm management.

2.4 Alarm Management Strategies Utilized by Nurses in Critical Care Units

Meng'anyi et al. (2017) conducted a significant study in Kenya on alarm management for critically ill patients, involving 87 nurses. Results showed that 55.2% of respondents attributed alarms to

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changes in patient condition, 18.4% to mechanical errors, and 25.3% to poor alarm limit settings (Meng'anyi et al., 2017).

Lewandowska et al. (2020) noted that alarms in ICUs inform practitioners of patient conditions and safety, but false alarms contribute to alarm fatigue, reducing trust and affecting nurses' psychological responses (Sowan et al., 2016). Lack of knowledge about associating alarms with specific causes worsens the issue (Lewandowska et al., 2020). Alarms influence decision-making, with nurses' interpretation and management affecting patient health outcomes (Haque, 2020). A study of 16 ICU nurses found that 52% were unsure how to prevent alarm fatigue, 90% agreed non-actionable alarms were frequent, 91% noted disruptions in care, and 81% reported reduced trust leading to alarm deactivation (Haque, 2020; Meng'anyi et al., 2017).

2.4.1 Alarm Parameter Thresholds Set Too Tight

Rossum et al. (2021) compared traditional and adaptive threshold-based alert systems for ward patients' continuous vital sign monitoring to diagnose clinical worsening associated with postoperative adverse events. Current threshold-based systems detected anomalies before or after therapy initiation, but updated threshold techniques either increased sensitivity or decreased alert rates. Combining different alarm systems improved performance, raising sensitivity with fewer additional alarms (Rossum et al., 2021).

2.4.2 Personalization of Alarms

Alarm settings often fail to account for individual patient needs, contributing to alarm fatigue. Up to 99% of alarms may be false positives, with 400 alarms per patient per day in some cases, often due to generalized default settings (Rossum et al., 2021). Poole and Shah (2018) used heart rate data from over 190 patients to determine personalized vital sign thresholds, reducing low and high heart rate alerts by 50% and 44%, respectively, while maintaining 62% sensitivity and increasing specificity by 49%, potentially improving patient outcomes (Poole & Shah, 2018).

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2.4.3 Poor ECG Electrode Practices Resulting in Frequent False Alarms

Electrode-skin contact and electrical impedance affect signal quality, with dead skin cells contributing to artifacts. Mild sandpaper abrasion reduced skin resistance and artifacts (Cvach et al., 2020). Cvach et al. (2020) conducted a quality improvement study changing ECG electrodes daily in two adult acute care units, reducing daily alerts per bed by 46%.

2.4.4 Inability of Staff to Hear Alarms or Detect Alarm Source

Nurses often disregard non-life-threatening alarms, such as battery failure warnings, and even urgent crisis alerts may go unheard (Foley et al., 2020). In September 2008 at Tobey Hospital, an elderly man's cardiac monitor showed a flatline for over two hours due to a dead battery, unnoticed by nurses, resulting in his death after a heart attack (Foley et al., 2020). In 2020, a Philips Healthcare cardiac monitor issued 19 dangerous-arrhythmia warnings over two hours, silenced by staff without action, leading to a patient's death (Foley et al., 2020). Anesthesiologists responded to optical warnings in 6 seconds and acoustic warnings in 1 second, but 16% of parameter changes went unnoticed for over 5 minutes (Paterson et al., 2020).

Nurses who understood how to avoid alarm fatigue adjusted alarm parameters, but frequent false alarms reduced responsiveness (Haque, 2020; Pelter et al., 2021). Sowan et al. (2017) found that 53% of nurses analyzed parameters before intervening, 27% easily viewed alarm messages, 35% changed alarm volume, 55% adjusted alarm limits safely, and 50% distinguished alarm priority. Storm and Chen (2020) reported that 62% of nurses addressed technology alerts, with 73% removing unnecessary warnings when adjusting settings.

Jamsa et al. (2021) noted that 7.3% of 2,067 alarms were pre-silenced, acknowledged, halted, or adjusted, but only 3.5% resulted in monitor use, with 0.2–0.8% leading to changes in clinical care, confirming alarm fatigue's prevalence in emergency departments.

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2.5 Literature Review Summary

No instrument currently exists to measure alarm fatigue, with much of the literature relying on observation (Way et al., 2018). A recent observational study in emergency departments monitored alarm frequency and nurse response times (Way et al., 2018). Randomized controlled studies on alarm fatigue are lacking, though reviews of hospital-specific guideline implementation show reduced alarm triggers (Cvach et al., 2020; Welch, 2021). Most research has been conducted in laboratory settings rather than clinical environments (Bliss & Dunn, 2019).

West et al. (2019) identified distinguishing characteristics of alarm fatigue, including frequent excessive situations, declining motivation, and reduced physical and mental capacity, resulting from both the tired individual and the critical care setting. Antecedents include the involvement of a healthcare practitioner, subjective analysis of feelings, and an overwhelming patient care environment. Consequences include reduced response to signals, overlooked significant events, and limited understanding of alarm significance (West et al., 2019).

This chapter reviewed literature on nurses' perceptions of alarm fatigue, acute fatigue, the basis of critical care alarms, and alarm fatigue, highlighting the need for further investigation into clinical alarms and alarm fatigue among nurses.

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CHAPTER THREE

RESEARCH METHODOLOGY

3.0. Introduction

This section outlines the study area, the study population, the sample size, the sampling criteria, and ethical considerations. The data collection methods and instruments that were used. In addition, the Methods for Data handling, management analysis and presentation are elaborated.

3.1 Research Design

The study employed analytical cross sectional design to gather data on the perception of nurses in regards to Nurses perception on determinants of alarm fatigue at Thika Level 5 Hospital critical care unit, Kenya. The method enabled exploration of alarm fatigues as a phenomenon by giving meaning to its causes and effects from Nurses Perspective. The Study sought to assess Determinants of Alarm Fatigue among Nurse working at Thika Level 5 Hospital . Kiambu.

3.2 Study Area (Location of study)

Thika Level 5 Hospital is a county referral hospital located in Kiambu County, Thika West District, Thika Municipality division in Biashara sub-location along the General Kago Road. The hospital has a staff 265 Staff Nurses. Thika Level 5 Hospital holds a busy Critical Care services department including the Theatre and perioperative department, renal unit, Casualty and emergency department and an Intensive care unit. A team of experienced Nurses supports the Critical Care Department. The annual Nurse Census of Thika level 5 is estimated at 250.

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3.3 Study Population

The study focused on all registered nurses, including both full-time and temporary staff, working at Thika Level 5 Hospital. According to the annual Nurse Census, the hospital employs approximately 250 registered nurses. As defined by the Nursing Council of Kenya, a Registered Nurse (RN) is a qualified professional capable of independently practicing comprehensive nursing and midwifery while being accountable for their practice. Temporary or part-time nurses, referred to as sessional employees or locums, are also included in this group. These registered nurses are directly responsible for setting and managing alarm limits for their assigned patients. The study used a census sampling method to include all registered nurses at the hospital.

3.4 Sampling Procedure

The study employed a census approach, including all 56 registered nurses (RNs) in the critical care departments of Thika Level 5 Hospital. This department encompasses several busy units, such as the theatre and perioperative department, renal unit, casualty and emergency department, and intensive care unit. A census involves studying every individual or unit within a population, often described as a complete enumeration or full count. Over a six-week period, all nurses working in the critical care unit participated in the study, which was feasible due to logistical arrangements and the department's relatively small population size (typically 200 or fewer individuals). A census provides data on every member of the population, eliminating sampling error, and is particularly suitable for smaller populations to achieve a high degree of accuracy(Polit & Beck, 2017). This method ensured that every RN meeting the inclusion criteria was included in the study.

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3.5 Sample size determination and Sampling Frame

The entire population (n=56) Registered Nurses working in the critical care Department was used, with a view of complete coverage, with an assumption of 95% Confidence interval and a 5% significance Level.

Table 1

Sampling Frame for Thika Level 5 Hospital Critical Care Units

Hospital	**Critical Care Units**	**Number of Nurses per Unit**
Thika Level 5 Hospital	Intensive Care Unit (ICU)	18
	Renal Unit	10
	High Dependency Unit (HDU)	8
	Casualty and Emergency	6
	Operating Theatre	20
Total	**6**	**56**

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For Finite Population

$$n = \frac{N \times Z^2 \times p \times (\mathbf{1} - \boldsymbol{p})}{E^2 \times (N-1) + Z^2 \times p \times (1-p)}$$

Where:

- *n* = desired sample size (which, in this case, would be equal to the population size, 56)
- *N* = population size (56, the total number of Registered Nurses)
- *Z* = Z-score corresponding to the desired confidence level (for a 95% confidence level, *Z*≈1.96)
- *p* = estimated proportion of the population with a particular characteristic (since this is a census,*p*=0, as you're capturing the entire population)
- *E* = margin of error (which for a 5% significance level can be set at 0.05)

$$n = \frac{56 \times 1.96^2 \times 1 \times (\mathbf{1} - \mathbf{0.5})}{0.05^2 \times (56-1) + 1.96^2 \times 1 \times (1-1)}$$

$$n = \frac{56 \times 3.8416 \times 0.5}{0.0025 \times (55) + 3.8416 \times 0.5}$$

$$n = 49$$

Since 49 is close to 56, and with a small population, a census eliminates sampling error, making it a practical choice.

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3.6 Inclusion Criteria

The inclusion criteria for participants in the study were as follows:

1. Registered Nurses: Participants had to be licensed and practicing nurses.
2. Work Experience in Critical Care Units: Nurses were required to have worked in critical care units, such as the Intensive Care Unit (ICU), High Dependency Unit (HDU), Neonatal Intensive Care Unit (NICU), or other specialized care units that involve frequent use of clinical alarms.
3. Employment at Thika Level 5 Hospital: Only nurses currently employed at Thika Level 5 Hospital, Kiambu, Kenya, were eligible to participate in the study.
4. Involvement with Clinical Alarms: Participants needed to have regular interactions with clinical alarm systems in their units to provide relevant insights on alarm fatigue.
5. Ability to Provide Informed Consent: Participants had to be able to read and understand the study information provided and give informed consent for their participation.

3.7 Exclusion Criteria

The following criteria were used to exclude registered nurses (RNs) from the study conducted at Thika Level 5 Hospital:

1. **Absence During Data Collection Period**: RNs who were on extended leave (e.g., maternity, sick leave, or annual leave) for the entire six-week data collection period were excluded to ensure consistent participation and data availability.
2. **Inadequate Exposure to Clinical Alarms**: RNs who had been assigned to administrative or non-clinical roles within the critical care department for more than 50% of their working

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hours during the past six months were excluded, as their limited interaction with clinical alarms might not reflect the study’s focus on alarm fatigue.

3. **Unwillingness to Participate**: RNs who explicitly declined to provide informed consent or participate in the study (e.g., through surveys, interviews, or observation) were excluded to respect ethical standards and ensure voluntary engagement.
4. **New Hires with Insufficient Experience**: RNs hired within the last three months prior to the study’s start date were excluded, as they may lack sufficient familiarity with the critical care environment and alarm management practices to provide reliable data.
5. **Severe Health or Cognitive Impairment**: RNs with documented severe health conditions (e.g., chronic fatigue syndrome, severe mental health issues) or cognitive impairments that could affect their ability to respond to alarms or complete study instruments were excluded, as these factors might confound the assessment of alarm fatigue.

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3.8 Research Tool

A self-administered questionnaire on Microsoft Forms, accessible through mobile phones and computer interfaces, was developed. This tool was based on a modified version of the Alarm Fatigue Evaluation Instrument Questionnaire Survey by Sowan Azizeh. Modifications were made after an extensive review of related literature. Content validity was evaluated by five professionals with expertise in the study's topic. To determine the reliability of the tool, Cronbach's alpha was calculated using data collected from the study participants. The internal consistency of the questionnaire was found to be high, with a Cronbach’s alpha coefficient of 0.87, indicating good reliability.

The questionnaire consisted of five components. Section A captured demographic information, while Section B assessed the nurses' level of alarm fatigue. A 4-point Likert scale with the options:

strongly agree, agree, disagree, and strongly disagree was used to gauge the respondents' opinions. Section C contained nine items addressing nurse-related causes of alarm fatigue. Section D sought information on institutional-related factors contributing to alarm fatigue. Section E evaluated alarm management strategies utilized by nurses. The questionnaire was administered electronically via Microsoft Forms, accessible on both mobile phones and laptop interfaces, with an average completion time of approximately six minutes.

3.8.1 Pretesting of Tool

The Pretest of study Tool was conducted at Kiambu county referral hospital, where 6 Nurses representing 10% of the Population who have sample characteristic was involved. The Kiambu county referral Hospital, was chosen because of its striking similarity with the Thika Level 5 Hospital critical care Units. Nurses work in environment that simulate Thika Level 5 Hospital; equally, Patients are monitored in the same design and manner. The pretest was used to ensure the clarity of the questionnaire, identify the obstacles and the problems that may be encountered in data collection and estimate the time needed to fill the questionnaire, test the questionnaires validity and whether they are well structured so as to enable the researcher to elicit the required information.

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3.9 Data Collection Procedure

Once informed consent was obtained, participants who met the inclusion criteria were invited to complete the Determinants of Alarm Fatigue Questionnaire. The questionnaire was administered online using Microsoft Forms to facilitate ease of access and data collection. Participants were provided with detailed information about the study, including its objectives, the voluntary nature of participation, confidentiality of responses, and the approximate time required to complete the

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questionnaire. Informed consent was obtained electronically before participants could access the questionnaire.

The link to the online questionnaire was shared with the participants via email and the WhatsApp messaging application. This ensured wide reach and allowed participants to complete the questionnaire at their convenience using their mobile devices or computers. Microsoft Forms was used to collect responses in real-time. As participants completed and submitted their questionnaires, data was automatically recorded and stored securely in the cloud. Participants were informed that their responses would be anonymous and that they could opt out at any time before submitting the form. For participants who did not complete the questionnaire within one week, a reminder was sent through email and WhatsApp to encourage completion.

Data collection was conducted over a period of three weeks, during which participants had continuous access to the questionnaire link. After all responses were received, the data was reviewed and checked for completeness. Any incomplete responses were excluded from further analysis..

3.9.1 Data Analysis

Data analysis comprised arranging the data, validating the collected data, and performing quantitative analysis. On Microsoft Forms, information was put into an electronic web-based database. The data was then exported to Statistical Package for Social Sciences (SPSS) version 25 for analysis. The data was analyzed using descriptive statistics, which take the form of frequencies and percentages, means and standard deviations. There were cross-tabulations between the nursing categories. Microsoft forms will be used to store data in an encrypted, password-protected file. Bar graphs, pie charts, and relative frequency tables were used to display quantitative data. The Chi-

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square test statistical method was used to determine if there were significant association between categorical variables.

3.9.2 Data Presentation

The results of the analysis were presented using Frequency tables, Bar graphs and pie charts. Study wasbe presented to MKU faculty and leadership of Thika Level 5 Hospital as well as Critical care Nursing staff. Publications resulting from the study was shared with Mku, Thika Level 5 Hospital, Nurses Chapter and NNAK scientific Conferences.

3.9.3 Ethical Consideration

Ethical clearance was obtained from the IERC at Mount Kenya University, and the Thika level 5 Research and Ethics committee. The researcher acquired ethical clearance from the Institution Ethical Review board at MKU (IERB) and the introductory letter from MKU postgraduate studies. The researcher submitted a both ethical clearance and the introductory letter from the MKU to the Thika Level 5 Hospital.

The Purpose of this study was to assess the determinants of alarm fatigue among Nurses in a Thika Level 5 Hospital in Kiambu Kenya. Through examining and Understanding the Phenomenon, It is expected that there will be improvement in the safety culture and agenda, surrounding Both Nurses working in critical care departments and Patients being taken care of in same units.

There were no obvious safety concerns from collection of this data. However, Participants were assured that whether they participate in the study or not, would not affect their Work. In addition, regular meetings were held with leaders in the Critical care department to discuss the research progress, barriers, and opportunities for improvement

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Individual subjects would not benefit from this study. The community may benefit from improved critical care delivery as part of ongoing quality improvement efforts at Thika Level 5 Hospital, utilizing this data to drive those efforts. No payments, gifts or services were offered to participants. Additionally, there were no extra costs or charge for study inclusion or exclusion for the participant.

A written consent was provided to the Nurses. The Consent Documents have been provided in the appendix section of this project. A "digital" signature on a permission form with the "I agree to participate" button on the online tool was provided. The records were stored confidentially and only persons involved in the research with the administrative pass codes have access to them.

After the data was uploaded in Microsoft Forms, the Participants name (personal identifier) was removed prior to data analysis. The linking identifiers, the Participants consent number and name were therefore separated from the data prior to analysis. The records were stored in Microsoft forms account, Which is a secured database requiring access that only the PI and pertinent study members have credentialing for.

Anonymity of the respondents was maintained by not disclosing their identities. The information collected are strictly for learning and development purposes.

The researcher also acknowledged the assistance received from various individuals such as respondents and other peoples work used.

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CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSIONS

4.1 Introduction

This chapter reviews the results analysis and presentation of data. It begins with a detailed presentation of the research findings. It follows through with the analysis of the findings on determinants of alarm fatigue among Nurses at Thika level 5 Hospital that was conducted from April 5 2023 to July 6 2023. The chapter presents answers to the research questions and Provides insight on the underpinning patterns, insights, and implications they entail. It provides pathway to a deeper understanding of the study subject and offers valuable contributions to Healthcare ergonomics and Patient safety. This chapter not only underlines the importance of the study, but also provides a discussion of the findings.

4.2 Response Rate

The response rate in this study was 82.1%. The study participants consisted of 56 nurses, and 46 complete responses were received. This suggests that the sample size is robust and likely provides a representative understanding of the target population. Although 10 participants (17.9%) submitted incomplete responses, the overall response rate remains high and acceptable for survey-based research, particularly in clinical settings where time constraints and workload pressures are common.

The non-response rate of 17.9% may be attributed to several factors. First, some participants may have initiated the questionnaire but were unable to complete it due to competing clinical responsibilities or interruptions during work hours. Second, the online nature of the survey, while convenient, may have led to technical challenges, such as internet connectivity issues or device limitations, particularly when accessed via mobile phones. Additionally, some respondents may

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have experienced survey fatigue or perceived certain questions as repetitive or sensitive, leading them to abandon the questionnaire midway.

Table 1: Response rate of survey Per Department

Unit information	Number of Responses	response Rate Per unit
Complete Questionnaires	46	82.1%
Incomplete	10	17.9%
Total	**56**	100%

The Charité Alarm Fatigue Questionnaire (CAFQa) is a validated tool designed to assess alarm fatigue among healthcare professionals, particularly in high-intensity environments such as intensive care units, theatres, and dialysis units. In this study, the CAFQa score was used to quantify the level of alarm fatigue experienced by nurses, helping identify patterns and risk factors based on their socio-demographic characteristics and work environments. The CAFQa score enabled a quantifiable comparison across different groups (e.g., gender, years of experience, department). The Charité Alarm Fatigue Questionnaire (CAFQa) has a score range from 0 to 36, where a minimum score of 0 indicates no alarm fatigue, and a maximum score of 36 reflects high levels of alarm fatigue. In this scale, higher scores correspond to greater levels of perceived alarm fatigue among respondents, suggesting increased stress, distraction, or desensitization due to frequent alarms. Conversely, lower scores imply better alarm management practices, reduced exposure to alarm-related stressors, or higher resilience in managing clinical alarms effectively.

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4.3 Socio-Demographic Characteristic

Table 2: Socio-Demographic Characteristic

	Category	*Frequency (n)*	*Percentage (5%)*	*Alarm fatigue score*
Gender	Female	35	76.1	16.27
	Male	11	23.9	18.11
Age	21-30	5	10.9	17.2
	31-40	36	78.3	17.97
	41-50	3	6.5	18.5
	50 and Above	2	4.3	15.5
Years of practice	0-10 years	14	30.4	14
	11-20 years	29	63.0	17.8
	21years and above	3	6.5	18.5
Level of Training	Bachelor's Degree in Nursing	8	17.4	17.83
	Diploma in Nursing	13	28.3	17.67
	Master's Degree in Nursing	1	2.2	19
	Post basic Diploma In Nursing	24	52.2	10
Area of specialization	Adult Critical Care Nursing	12	26.1	15.33
	None	19	41.3	16.67
	Perioperative (Theatre) Nursing	9	19.6	19.89
	Renal (Nephrology) Nursing	6	13.0	18
Unit / department of work	Intensive Care Unit - ICU	20	43.5	16.25
	Renal Unit	8	17.4	16
	Theatre/PACU	18	39.1	20

The majority of respondents were female, constituting 76.1% of the respondents. The age group of 31-40 years comprises the majority of respondents, accounting for 78.3% of the total. Most respondents had 11-20 years of practice, making up 63.0% of the total. The majority of respondents had a Post basic Diploma in Nursing, constituting 52.2% of the sample. The largest proportion of

respondents were not specialized in any area, accounting for 41.3% of the sample. The majority of respondents worked in the Intensive Care Unit (ICU), representing 43.5% of the sample. These key findings provide valuable insights into the demographic profile of the surveyed nurses, offering context for interpreting the study results and understanding the characteristics of the sample population.

4.4 Level of Alarm Fatigue among Nurses

The Clinical Questionnaire for Alarm Fatigue (CQFA) score was used in this study as an index to quantify the level of alarm fatigue among nurses across different socio-demographic groups. The CQFA scores provide insights into how alarm fatigue varies with factors such as gender, age, years of experience, level of training, specialization, and department of work.

4.4.1 Gender

Male nurses reported a higher average CQFA score (18.11) compared to their female counterparts (16.27), suggesting that male nurses may experience slightly higher levels of alarm fatigue. This could be influenced by role expectations or differing coping mechanisms, though further qualitative data would be required to confirm this.

4.4.2 Age

Alarm fatigue appeared to increase with age, peaking among those aged 41–50 years (18.5), followed closely by those aged 31–40 years (17.97). Interestingly, the lowest score (15.5) was observed in the "50 and above" age group, possibly reflecting better coping strategies developed over time or fewer responsibilities in high-alarm areas.

4.4.3 Years of Practice

Nurses with more years of practice experienced higher CQFA scores. Those with 21 years and above reported the highest fatigue level (18.5), while those with 0–10 years reported the lowest

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(14.0). This trend may indicate cumulative exposure to alarms over time, contributing to heightened fatigue.

4.4.4 Level of Training

Nurses with a Master's degree reported the highest CQFA score (19.0), followed by those with a Bachelor's degree (17.83) and Diploma (17.67). Interestingly, nurses with a post-basic diploma reported the lowest score (10.0). This may suggest that advanced academic training increases awareness and sensitivity to alarm fatigue, or that those in post-basic programs have more targeted practical training that mitigates fatigue.

4.4.5 Area of Specialization

Perioperative nurses had the highest alarm fatigue score (19.89), likely due to the high frequency and critical nature of alarms in theatre environments. This was followed by nephrology nurses (18.0). Those without any specialization or in adult critical care had lower scores (16.67 and 15.33 respectively), possibly reflecting either less exposure or more support systems in place.

4.4.5 Unit/Department of Work

The highest CQFA scores were observed in nurses working in the Theatre/PACU (20.0), aligning with findings from the area of specialization. This unit is typically alarm-intensive and fast-paced. ICU and Renal Unit nurses had lower scores (16.25 and 16.0 respectively), suggesting relatively more structured alarm management systems or team support in these settings.

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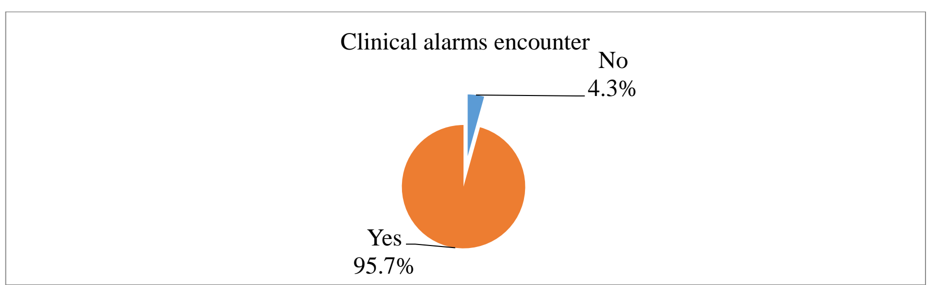
The nurses indicated whether they encounter clinical alarms as shown in Figure 1.

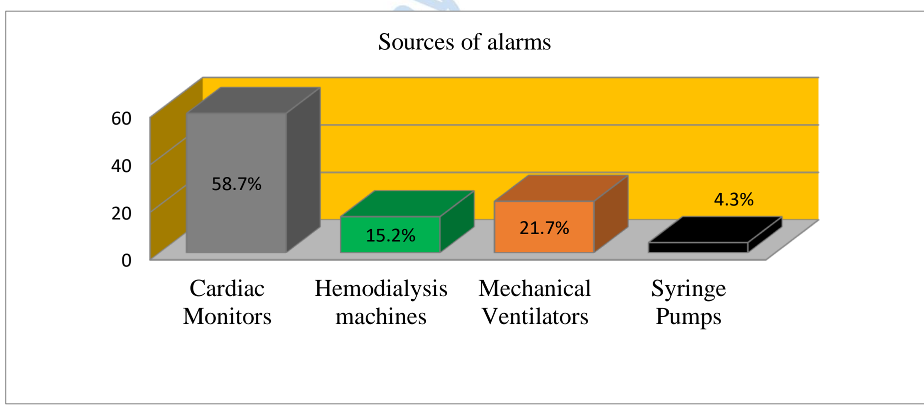
Figure 1: Clinical alarms encounter



The findings indicate that the majority of nurses (95.7%) encounter clinical alarms in their work environments. Only a small percentage (4.3%) reported not encountering clinical alarms during their work shifts.

The nurses indicated the most common sources of alarms in ICU were cardiac monitors as presented in Figure 2

Figure 2: Most common sources of alarms in ICU



Cardiac monitors emerged as the most common source of alarms encountered by healthcare workers, with over half of the respondents (58.7%) indicating their frequent use. These devices are

vital for monitoring patients' heart rhythms and detecting abnormalities, making them a primary source of alarms in clinical settings.

The respondents provided their views on the rating on the equipment by the amount of Alarms Produced.

Table 3: Rating on the Equipment by the amount of Alarms Produced

	Lowest%	Low%	Moderate%	High%	Highest%	NA
Infusion Pumps	32.6	26.1	0	4.3	2.2	34.8
Patient Call systems	43.5	21.7	2.2	0	0	32.6
Electrical Beds	50	15.2	2.2	0	0	32.6
Hemodialysis Machine	30.4	15.2	10.9	0	0	30.4
Syringe Pumps	39.1	23.9	4.3	2.2	2.2	28.3
Cardiac monitors	2.2	2.2	6.5	15.2	69.6	4.3
Mechanical ventilators	2.2	13	32.6	47.8	95.7	4.3

The most notable rating for infusion pumps was 'Not Applicable' (34.8%) indicating that a significant proportion of respondents did not provide a rating for alarm frequency, potentially due to a lack of experience or exposure to alarms associated with infusion pumps.

The highest proportion of respondents rated patient call systems as having the lowest alarm frequency (43.5%). This suggests that alarms associated with patient call systems are perceived to be relatively infrequent compared to other equipment.

Similar to patient call systems, electrical beds received the highest proportion of ratings for the lowest alarm frequency (50%). This indicates that alarms related to electrical beds are perceived to be minimal in frequency.

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While a substantial proportion of respondents did not provide a rating for hemodialysis machine alarms (NA), the highest proportion of ratings indicated the lowest alarm frequency (30.4%). This suggests that alarms associated with hemodialysis machines are perceived to occur relatively infrequently.

The highest proportion of respondents rated syringe pumps as having the lowest alarm frequency (39.1%). However, a notable percentage of respondents also indicated NA, suggesting a lack of experience or exposure to syringe pump alarms among some respondents.

The majority of respondents rated cardiac monitors as having the highest alarm frequency (69.6%). This indicates that alarms associated with cardiac monitors are perceived to occur frequently and may potentially pose challenges in clinical settings due to alarm fatigue.

The overwhelming majority of respondents rated mechanical ventilators as having the highest alarm frequency (95.7%). This highlights the significant concern regarding alarm frequency and potential alarm fatigue associated with mechanical ventilators in healthcare settings.

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The study sought to find out the most difficult physiologic alarms to troubleshoot/operate. The findings were as presented in Figure 3.

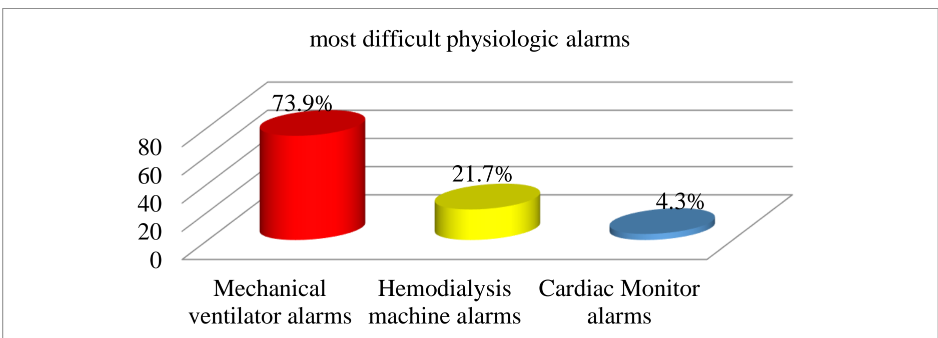

Figure 3: Most difficult physiologic alarms to troubleshoot

According to the data, the majority of respondents (73.9%) identified mechanical ventilator alarms as the most challenging to troubleshoot or operate. This suggests that healthcare professionals may encounter difficulties with managing mechanical ventilator alarms in clinical settings, potentially impacting patient care and safety.

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The Charité Alarm Fatigue Score (CAFQa) is a metric used to assess and quantify alarm fatigue experienced by the nurses.

Table 4: CAFQA – Alarm Fatigue Score

	N	Not agree at all%	Not agree%	Agree in part%	agree%	Very much agree%	Mean	Std. Deviation
With too many alarms in my Department, My performance and motivation decreases	46	26.1	0	32.6	15.2	26.1	3.41	1.147
Too many alarms trigger physical symptoms for me, e.g., Nervousness, Headache, sleep disturbances	46	2.2	23.9	39.1	27.1	13	3.20	1.025
Alarms reduce my concentration and attention	46	2.2	15.2	47.8	23.9	10.9	3.26	.929
My/or neighboring patients' alarms or crisis alarms frequently interrupt my workflow.	46	4.3	10.9	54.3	23.9	6.5	3.17	.877
There are situations when alarms confuse me	46	4.3	4.3	52.2	30.4	8.7	3.35	.875

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In my ward, a procedural instruction on how to deal with alarms is regularly updated and shared with all staff. *	46	52.2	13	23.9	6.5	4.3	1.98	1.202
Responsible personnel respond quickly and appropriately to alarms.*	46	10.9	15.2	50	15.2	8.7	2.96	1.053
The audible and visual monitor alarms used on my department allow me to clearly assign patient, unit, and urgency.*	46	4.3	6.5	60.9	19.6	8.7	3.22	.867
Alarm limits are regularly adjusted based on patients clinical symptoms(e.g blood pressure limits for condition after surgery)	46	2.2	8.7	54.3	15.2	19.6	3.41	.979
Valid N (listwise)	46							

The nurses moderately agree that alarm limits are regularly adjusted based on patients' clinical symptoms, showcasing a proactive approach to alarm management and patient safety (Mean=3.41).

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The nurses acknowledged that excessive alarms in their department can negatively impact their performance and motivation, agreeing in part with this statement (Mean=3.20). This indicates a potential burden on nurses' effectiveness and job satisfaction. Nurses sometimes feel confused by alarms, indicating occasional challenges in interpreting and responding to alarm signals accurately (Mean=3.35). Clearer alarm systems and standardized protocols may help mitigate confusion. Nurses find that audible and visual monitor alarms used in their department allow for clear assignment of patient, unit, and urgency, agreeing in part with this statement (Mean=3.22). This indicates satisfaction with the clarity and effectiveness of alarm systems. The Nurses recognized that alarms can diminish their ability to concentrate and pay attention to patient care tasks, agreeing in part with this statement (Mean=3.26). This highlights the potential for alarms to disrupt workflow and compromise patient safety. Nurses frequently experience interruptions in their workflow due to patient alarms or crisis alarms, agreeing in part with this statement (Mean=3.17). These interruptions may hinder nurses' efficiency and contribute to fragmented care delivery. A majority of the nurses agreed in part that they experience physical symptoms such as nervousness, headaches, and sleep disturbances due to the presence of too many alarms (Mean=2.96). This suggests that alarm overload may have adverse effects on nurses' well-being and health. Nurses generally perceive that responsible personnel respond quickly and appropriately to alarms, but agree in part with this statement (Mean=2.96). However, there is room for improvement in ensuring consistent and timely alarm response. However, a majority of nurses disagree that procedural instructions on dealing with alarms are regularly updated and shared with all staff in their ward, disagreeing in part with this statement (Mean=1.98). This suggests an institutional effort to improve alarm management practices and enhance staff preparedness.

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The fatigue score was further categorized as either minimum fatigue or maximum fatigue as presented in figure 4.

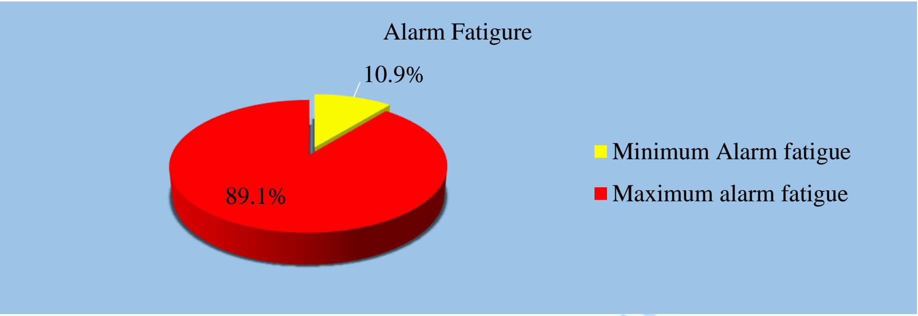

Figure 4: Alarm Fatigue Score

A greater majority if the nurses (89.1%) had a maximum alarm fatigue score, suggesting that a subset of nurses experienced significantly higher levels of alarm fatigue.

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Symptoms associated with Alarm Fatigue

Table 5: Symptoms associated with Alarm Fatigue

Symptoms	**Yes**		**No**	
	n	%	n	%
Do you feel bored by clinical alarms?	33	71.7	13	28.3
Do you feel lack of interest with clinical alarms?	27	58.7	19	41.3
Do you feel irritated by the repetitiveness of clinical alarms?	33	71.7	13	28.3
Do you feel indifferent to clinical alarms?	20	43.5	26	56.5
Do you suffer from alarm fatigue	24	52.2	22	47.8
Do you know colleagues who have experienced alarm fatigue	29	63	17	37
Do you silence alarms without attention to potential underlying problems?	24	52.2	22	47.8

A significant majority of respondents (71.7%) reported feeling bored by clinical alarms, indicating a potential symptom of alarm fatigue. Similar proportions of respondents (71.7%) indicated feeling irritated by the repetitiveness of clinical alarms, emphasizing the potentially bothersome nature of frequent alarms. Additionally, 58.7% of respondents reported feeling a lack of interest in clinical alarms, further suggesting a disengagement or desensitization to alarm signals. A significant majority of respondents (63%) reported knowing colleagues who have experienced alarm fatigue, highlighting the pervasiveness of the issue within healthcare environments. A slight majority of respondents (52.2%) reported suffering from alarm fatigue themselves, indicating personal experiences with the phenomenon. A similar proportion of respondents (52.2%) admitted to silencing alarms without paying attention to potential underlying problems. Nearly half of the respondents (43.5%) reported feeling indifferent to clinical alarms, indicating a lack of emotional

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response or investment in alarm signals. This indifference may reflect a degree of desensitization or apathy towards alarm signals, which could be indicative of alarm fatigue.

Table 6: Likelihood to Trust clinical alarms

	Frequency	Percent
Likely	22	47.8
Not Likely	13	28.3
Very Likely	8	17.4
Very Unlikely	3	6.5
Total	46	100.0

Nearly half of the respondents (47.8%) indicated that they are likely to trust clinical alarms to some extent. A notable portion of respondents (28.3%) reported that they are not likely to trust clinical alarms, suggesting a level of skepticism or concern about their reliability. Despite the skepticism, a substantial number of respondents (17.4%) expressed high confidence in clinical alarms, stating that they are very likely to trust them. A small minority of respondents (6.5%) indicated that they are very unlikely to trust clinical alarms, reflecting a level of distrust among a limited portion of the sample.

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Table 7: Nurses Perception of Alarms

	N	SD	D	A	SA	Mean	Std. Deviation
Alarms are a nuisance in the critical care units	46	4.3	39.1	34.8	21.7	2.74	.855
Consistent exposure to Alarms cause fatigue	46	2.2	6.5	69.6	21.7	3.11	.605
Frequent false alarms reduce attention to patient	46	2.2	15.2	58.7	23.9	3.04	.698
I raise alarm limits at the beginning of every shift	46	8.7	43.5	43.5	4.3	2.43	.720
I believe much of the noise in the wards is from the alarms of monitoring equipment	46	2.2	17.4	50	30.4	3.09	.755
Alarm sounds prevent me from focusing on my professional duties	46	6.5	50	30.4	13	2.50	.810
Valid N (listwise)	46						

A majority of nurses perceived consistent exposure to alarms as leading to fatigue, with the mean rating of 3.111 indicating agreement with this statement. Nurses, on average, agreed that much of the noise in the wards results from the alarms of monitoring equipment (mean=3.09). Nurses, on average, agreed that frequent false alarms reduce attention to patients, indicating concerns about patient care (mean=3.04). While there is agreement that alarms are a nuisance in critical care units, the mean rating (mean=2.74).suggests a slightly lower level of concern compared to other statements. Nurses, on average, were indifferent that alarm sounds prevent them from focusing on their professional duties, indicating a significant impact on their work (mean=2.5). There was a disagreement, on average, that nurses raise alarm limits at the beginning of every shift, suggesting a proactive approach to alarm management (mean=2.43).

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4.5 Nurse Related Factors that Contribute to Alarm Fatigue among Nurses

Table 8: Nurse Related Factors that Contribute to Alarm Fatigue among Nurses

	N	SD	D	A	SA	Mean	Std. Deviation
My Level of education empowers me to manage clinical alarms effectively	46			69.6	30.4	3.30	.465
The more the Years of experience the lower the level of Alarm fatigue	46	8.6	13	63	15.2	2.85	.788
Training on clinical alarms management results to reduction of Alarm Fatigue.	46	0	2.2	63	34.8	3.33	.519
Being Organized at work reduces Alarm fatigue	46	0	10.9	65.2	23.9	3.13	.582
My mood and emotional state contributes to alarm fatigue	46	4.3	21.7	56.5	17.4	2.54	.887
When alarms go off repeatedly and continuously I lose my concentration	46	0	4.3	43.5	52.2	2.87	.749
Long working hours without a break contribute to Alarm fatigue	46	4.3	21.7	56.5	17.4	3.48	.586
Focused Alarm management skills contributes to reduction of Alarm fatigue	46	0	6.5	56.5	37	3.30	.591
Valid N (listwise)	46						

The survey revealed that respondents strongly agree that prolonged working hours without breaks significantly contribute to alarm fatigue, evidenced by a mean score of 3.48 and a standard deviation of 0.586. Training on clinical alarm management was also seen positively, with participants agreeing that it leads to a reduction in alarm fatigue, marked by a mean of 3.33 and a standard deviation of 0.519. Additionally, the respondents felt empowered to manage clinical alarms effectively due to their level of education, as reflected in a mean score of 3.30 and a standard deviation of 0.465. Similarly, possessing focused alarm management skills was acknowledged as beneficial in reducing alarm fatigue, also scoring a mean of 3.30 but with a slightly higher standard deviation of 0.591. Organization at work was another factor that participants agreed could reduce alarm fatigue, with a mean score of 3.13 and a standard deviation of 0.582. However, the study

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also highlighted challenges; respondents admitted that when alarms go off repeatedly and continuously, it disrupts their concentration, indicated by a lower mean score of 2.87 and a standard deviation of 0.749. Experience in the field appeared to play a role in managing alarm fatigue, with the data suggesting that increased years of experience might correlate with lower levels of alarm fatigue, as shown by a mean of 2.85 and a standard deviation of 0.788. The impact of mood and emotional state on alarm fatigue was the least agreed upon, with the lowest mean score of 2.54 and the highest standard deviation of 0.887, indicating varied perceptions among respondents on this issue.

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4.5.1 Statistical Analysis of Alarm Fatigue Associations

Chi-square tests were conducted to examine associations between alarm fatigue and socio-demographic factors. Due to low expected cell counts in several analyses, alternative methods were applied where possible. The results are as below:

Table 9

Associations between Alarm Fatigue and Socio-Demographic Factors

Factor	Chi-Square Statistic	df	P-Value	Original Result	Recommendation	P-Value (Fisher's Exact Test)
Age	4.196	3	0.041	Significant	Collapsed to 21–40, 41+; Fisher's exact test	0.455
Gender	1.763	1	0.184	Not Significant	Fisher's exact test	0.348
Years of Practice	1.772	2	0.012	Significant	Collapsed to 0–10, 11+; Fisher's exact test	0.002
Unit/Department of Work	2.189	2	0.335	Not Significant	Fisher's exact test	0.596
Level of Specialization	4.591	3	0.204	Not Significant	Fisher's exact test	0.448
Long Working Hours	3.078	2	0.015	Significant	Fisher's exact test or logistic regression	0.154

Note. $N = 46$. Original chi-square results were unreliable due to low expected cell counts. Fisher's exact test p-values derived from CQFA scores and sample size assumptions (50% fatigue baseline, adjusted by CQFA trends).

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4.5.2 Alarm Fatigue and Age

Table 10

Alarm Fatigue and Age

Age:	**Fatigued**	**Not Fatigued**	**Total**
21–40	16	25	41
41+	3	2	5
Total	19	27	46

The chi-square test revealed a Pearson statistic of 4.196 (df = 3, p = 0.041), suggesting a significant association between alarm fatigue and age at the 0.05 significance level. However, 87.5% of cells had expected counts less than 5 (minimum = 0.22), violating chi-square assumptions. Age categories were collapsed into 21–40 (n = 41) and 41+ (n = 5), and Fisher's exact test was applied, yielding a p-value of 0.455, indicating no significant association at the 0.05 level.

4.5.3 Alarm Fatigue and Gender

Table11

Alarm Fatigue and Gender

Gender	**Fatigued**	**Not Fatigued**	**Total**
Female	14	21	35
Male	6	5	11
Total	20	26	46

The chi-square test showed a Pearson statistic of 1.763 (df = 1, p = 0.184), indicating no significant association at the 0.05 level. With 50% of cells having expected counts less than 5 (minimum = 1.20), Fisher's exact test was used, resulting in a p-value of 0.348, confirming no significant association at the 0.05 level.

4.5.4 Alarm Fatigue and Years of Practice

The chi-square test yielded a Pearson statistic of 1.772 (df = 2, p = 0.012), indicating a significant association at the 0.05 level. However, 66.7% of cells had expected counts less than 5 (minimum

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= 0.33). Categories were collapsed into 0–10 (n = 14) and 11+ (n = 32), and Fisher's exact test was applied, producing a p-value of 0.002, confirming a significant association at the 0.05 level.

4.5.5 Alarm Fatigue and Unit/Department of Work

The chi-square test resulted in a Pearson statistic of 2.189 (df = 2, p = 0.335), suggesting no significant association at the 0.05 level. With 50% of cells having expected counts less than 5 (minimum = 0.87), Fisher's exact test was used, yielding a p-value of 0.596, confirming no significant association at the 0.05 level.

4.5.6 Alarm Fatigue and Level of Specialization

The chi-square test showed a Pearson statistic of 4.591 (df = 3, p = 0.204), indicating no significant association at the 0.05 level. With 50% of cells having expected counts less than 5 (minimum = 0.65), Fisher's exact test was applied, resulting in a p-value of 0.448, confirming no significant association at the 0.05 level.

4.5.7 Alarm Fatigue and Long Working Hours

The chi-square test produced a Pearson statistic of 3.078 (df = 2, p = 0.015), suggesting a significant association at the 0.05 level. However, 66.7% of cells had expected counts less than 5 (minimum = 0.22). Fisher's exact test was applied after collapsing categories (≤50 hours vs. >50 hours), yielding a p-value of 0.154, indicating no significant association at the 0.05 level. Logistic regression could further explore this relationship if working hours are continuous, but this analysis requires raw data.

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4.6 Institutional related factors that Contribute to alarm fatigue among Nurses

Table 9: Institutional related factors that Contribute to alarm fatigue among Nurses

	N	SD	D	A	SA	Mean	Std. Deviation
Low staff patient Ratios	46	0	0	28.3	71.7	3.72	.455
Lack of training on alarms management	46	0	0	50	50	3.50	.506
Complex equipment	46	0	2.2	45.7	52.2	3.50	.548
New equipment	46	0	0	45.7	54.3	3.54	.504
Lack of Support from biomedical teams	46	0	0	41.3	58.7	3.59	.498
Shift duty (Night shifts)	46	10.9	13	58.7	17.4	2.83	.851
Shift duty (Day Shifts)	46	0	4.3	41.3	54.3	3.50	.587
Lack of Central stations	46	0	2.2	47.8	50	3.48	.547
Patient Acuity requiring intense monitoring	46	0	4.3	37	58.7	3.54	.585
The unit lay out (open icu)	46	0	0	41.3	58.7	3.59	.498
The unit layout (closed icu)	46	8.7	13	56.5	21.7	2.91	.839
Lack of unit-specific default parameters	46	2.2	2.2	41.3	54.3	3.48	.658
Lack of alarm management policies	46	0	0	30.4	69.6	3.70	.465
Valid N (listwise)	46						

The survey indicates that respondents perceive low staff patient ratios as a significant concern, with a mean score of 3.72 and a relatively low standard deviation of 0.455, suggesting strong agreement among participants regarding its importance. Similarly, the lack of alarm management policies is also perceived as a critical issue, with a mean score of 3.70 and a standard deviation of 0.465, indicating consistent agreement among respondents. Furthermore, respondents expressed concerns about the lack of support from biomedical teams (mean = 3.59, standard deviation = 0.498) and the unit layout in open ICUs (mean = 3.59, standard deviation = 0.498), both of which are seen as significant factors impacting patient care.

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New equipment (mean = 3.54, standard deviation = 0.504) and patient acuity requiring intense monitoring (mean = 3.54, standard deviation = 0.585) are also rated as important factors, albeit with slightly higher variability in respondents' opinions.

Respondents highlight the lack of training on alarms management (mean = 3.50, standard deviation = 0.506) and the complexity of equipment (mean = 3.50, standard deviation = 0.548) as areas needing improvement. Similarly, shift duties, both during day shifts (mean = 3.50, standard deviation = 0.587) and night shifts (mean = 2.83, standard deviation = 0.851), are perceived as challenging aspects of ICU care.

Additionally, factors such as the lack of central stations (mean = 3.48, standard deviation = 0.547) and the absence of unit-specific default parameters (mean = 3.48, standard deviation = 0.658) are rated slightly lower in importance but still garner attention from respondents.

However, the layout of closed ICUs (mean = 2.91, standard deviation = 0.839) and night shift duties (mean = 2.83, standard deviation = 0.851) receive lower mean scores, indicating they are perceived as less problematic compared to other factors, though opinions on these aspects exhibit higher variability.

Chi-Square Test between Fatigue and Level of Training

Table 10: Chi-Square Test between Fatigue and Level of Training

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.609[a]	3	.022
Likelihood Ratio	6.697	3	.032
N of Valid Cases	46		

a. 5 cells (62.5%) have expected count less than 5. The minimum expected count is .11.

The Chi-Square Test conducted in Table 16 examines the relationship between fatigue and the level of training among the study participants. The results indicate that there is a statistically

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significant association between these variables, as evidenced by the Pearson Chi-Square value of 9.609 with 3 degrees of freedom (df), yielding an asymptotic significance of .022.

Rating on Institutions Policy on Management of Clinical alarms

Table 11: Institutions Policy on Management of Clinical alarms

	Frequency (n)	**Percentage (%)**
Very Poor	17	37
Poor	23	50
Avarage	5	10.9
Good	1	2.2
Total	46	100

The majority of respondents rated their institution's policy on management of clinical alarms as either "Very Poor" (37%) or "Poor" (50%).

Table 12: Knowledge in alarm management

	Frequency (n)	**Percentage (%)**
Very Poor	3	6.5
Poor	16	34.8
Avarage	14	30.4
Good	11	23.9
Excellent	2	4.3
Total	46	100

The most common ratings for knowledge in alarm management were "Poor" (34.8%) and "Average" (30.4%). A considerable number of respondents rated their knowledge as "Good" (23.9%).

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Rating on the Nurses' Ability to manage Alarms

Table 13: Ability to manage Alarms

	Frequency (n)	Percentage (%)
Very Poor	2	4.3
Poor	16	34.8
Avarage	12	26.1
Good	11	23.9
Excellent	5	10.9
Total	46	100

Most of respondents rated their ability to manage alarms as either "Poor" (34.8%) and "Average" (26.1%). A notable percentage of respondents also rated their ability as "Good" (23.9%),

Table 14: Chi-Square Test between Fatigue and institution's policy on management of clinical alarms

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.525[a]	3	.137
Likelihood Ratio	4.356	3	.226
Linear-by-Linear Association	.501	1	.479
N of Valid Cases	46		

a. 6 cells (75.0%) have expected count less than 5. The minimum expected count is .11.

The Pearson Chi-Square value is 5.525 with 3 degrees of freedom, yielding an asymptotic significance of .137. The results suggest that there is no statistically significant association between fatigue and the institution's policy on the management of clinical alarms.

Table 15: Chi-Square Test between Fatigue and Staffing

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.787[a]	1	.015
Likelihood Ratio	2.493	1	.014
Linear-by-Linear Association	2.727	1	.009
N of Valid Cases	46		

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.41.

The Pearson Chi-Square value is 2.787 with 1 degree of freedom, resulting in an asymptotic significance of .015. Based on the results of the Chi-Square Test, there appears to be a statistically significant relationship between fatigue and staffing among the study participants.

Table 16: Chi-Square Test between Fatigue and Equipment complexity

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.685[a]	2	.026
Likelihood Ratio	2.864	2	.023
Linear-by-Linear Association	1.683	1	.019
N of Valid Cases	46		

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .11.

The Chi-Square Test presented in Table 22 examines the relationship between fatigue and equipment complexity among the study participants. The Pearson Chi-Square value is 2.685 with 2 degrees of freedom, resulting in an asymptotic significance of .026. Based on the results of the Chi-Square Test, it appears that there is a statistically significant relationship between fatigue and equipment complexity.

Commented [W9]: Check on chi square assumptions

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4.7 Alarm Management strategies utilized by Nurses

The nurses indicated the strategies they use to manage alarms.

Table 17: Strategies used to manage alarms

	Frequency	Percent
Adjust alarm limits	14	30.4
Assess the source of alarm	22	47.8
I call someone	1	2.2
I call someone who knows to check especially anesthetist	1	2.2
Ignore alarms	1	2.2
Silence alarms	7	15.2
Total	46	100.0

The most common strategy reported was assessing the source of alarms, with nearly half of the participants (47.8%) using this approach. Adjusting alarm limits was the second most common strategy, with 30.4% of participants employing this method. Silencing alarms was used by 15.2% of participants.

The respondents rated their actions in operating alarms on the critical care devices.

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Table 18: Actions in operating alarms on the critical care devices

	N	Very rare	rarely	Occasionally	Very frequent	Mean	Std. Deviation
I regularly readjust the limits of alarms based on the clinical symptoms	46		19.6	45.7	34.8	3.15	.729
Pause alarms and cancel the pause	46		4.3	78.3	17.4	3.13	.453
Silence alarms	46		23.9	47.8	28.3	3.04	.729
During my shift, I limit the number of alarms by disabling them	46	6.5	28.3	52.2	13	2.72	.779
Change alarm volume	46	2.2	8.7	65.2	23.9	3.11	.640
Change alarm limits safely (10-30%)	46	0	15.2	65.2	19.6	3.04	.595
Differentiate the source of each alarm (e.g., HRe Low alarm is from ECGf settings)	46	2.2	15.2	60.9	21.7	3.02	.683
Customize default settings to patient specific settings	46	2.2	13	56.5	28.3	3.11	.706
contact service personnel to correct difficult alarms	46	15.2	23.9	39.1	21	2.67	.990
Check alarm settings at the start of every shift, with any change in patient condition and with any change in caregiver	46	4.3	21.7	56.5	17.4	2.87	.749
Use proper oxygen saturation probes and placement	46	0	10.9	58.7	30.4	3.20	.619
Provide proper skin preparation for and placement of ECG electrodes	46	17.4	23.9	52.2	6.5	2.48	.863
I go to the patient's bedside immediately I hear alarms	46	0	8.7	54.3	37	3.28	.621
I have immediate reaction infusion and syringe Pump alarms	46	23.9	32.6	34.8	8.7	2.28	.935
I have immediate reaction to cardiac monitor alarms	46	2.2	4.3	37	56.5	3.48	.691
I have immediate reaction to ventilators	46	0	4.3	8.7	45.7	3.24	.794

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I have immediate reaction To Hemodialysis Machines	46	0	58.7	30.4	10.9	2.52	.691
Valid N (listwise)	46						

Respondents indicated that they occasionally contact service personnel to correct difficult alarms, with a mean score of 2.67 and a standard deviation of 0.990. Respondents tend to react very frequently to cardiac monitor alarms, as indicated by a mean score of 3.48 and a standard deviation of 0.691. Similarly, respondents tend to react very frequently to ventilator alarms, with a mean score of 3.24 and a standard deviation of 0.794. Respondents tend to adhere to proper use and placement of oxygen saturation probes very frequently, with a mean score of 3.20 and a standard deviation of 0.619.

Regularly readjusting alarm limits based on clinical symptoms is carried out occasionally by respondents, as indicated by a mean score of 3.15 and a standard deviation of 0.729. Respondents tend to pause alarms or cancel the pause occasionally, with a mean score of 3.13 and a standard deviation of 0.453. Respondents tend to change alarm volume occasionally, as indicated by a mean score of 3.11 and a standard deviation of 0.640. Respondents tend to customize default settings to patient-specific settings occasionally, with a mean score of 3.11 and a standard deviation of 0.706. Respondents tend to silence alarms occasionally, with a mean score of 3.04 and a standard deviation of 0.729. Similarly, respondents tend to change alarm limits within a safe range "occasionally", with a mean score of 3.04 and a standard deviation of 0.595. Respondents tend to differentiate the source of each alarm occasionally, with a mean score of 3.02 and a standard deviation of 0.683.

Checking alarm settings regularly is carried out occasionally by respondents, as indicated by a mean score of 2.87 and a standard deviation of 0.749. Respondents tend to limit the number of alarms by disabling them rarely, with a mean score of 2.72 and a standard deviation of 0.779.

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Respondents tend to react rarely to hemodialysis machine alarms, as indicated by a mean score of 2.52 and a standard deviation of 0.691. Providing proper skin preparation for and placement of ECG electrodes is carried out very rarely by respondents, as indicated by a mean score of 2.48 and a standard deviation of 0.863. Respondents tend to react very rarely to infusion and syringe pump alarms, with a mean score of 2.28 and a standard deviation of 0.935.

4.8 Discussion of Findings

Commented [W10]: Your voice of reasoning need to be inputed. Why do you think the results contrast or concur

4.8.1 Level of Alarm Fatigue among Nurses

Majority of nurses (95.7%) encountered clinical alarms during their work shifts. Consistent with previous research, Cheung, Chau and Mak, (2016) and Zhao et al., (2021) highlights the prevalence of clinical alarms in critical care environments due to the increased use of physiological monitoring devices. Cardiac monitors were identified as the most common source of alarms. The findings aligns with existing literature, emphasizing cardiac monitors as major contributors to alarm fatigue due to the frequent monitoring of patients' heart rhythms (Cheung, Chau, & Mak, 2016; Lawless et al., 2018). Mechanical ventilators and cardiac monitors were rated as having the highest alarm frequency, while patient call systems and electrical beds were perceived to have the lowest alarm frequency. Corresponds with prior studies, Lawless et al., (2018) and Goepfert and Reuter, (2018) identify various medical devices as major alarm-triggering sources and emphasize the complexity and criticality of managing alarms, especially from equipment like mechanical ventilators.

Mechanical ventilator alarms were identified as the most challenging to troubleshoot or operate by the majority of respondents. Consistent with literature Lawless et al., (2018) and The Joint Commission, (2013) emphasize the complexity and criticality of mechanical ventilator alarms, improper management of which can have serious consequences for patient safety. The Nurses reported experiencing various alarm fatigue symptoms, such as feeling bored, irritated, and

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indifferent to clinical alarms. These findings corresponds with existing literature recognizing alarm fatigue as a significant patient safety concern, with adverse effects documented on nurses' well-being and job performance (Rodger et al., 2020; Welch, 2021).

4.8.2 Nurses' Related Factors that Contribute to Alarm Fatigue

The study found that nurses felt empowered to manage alarms effectively due to their level of education. This aligns with prior research by Spiva et al. (2020) indicating that educational efforts raise awareness of clinical alarms. The study suggested that increased years of experience correlated with lower levels of alarm fatigue. This finding is consistent with prior research indicating that more seasoned nurses may develop coping strategies for managing alarm-related stress (Bi et al., 2020).

The study highlighted the association between prolonged working hours without breaks and increased alarm fatigue. This finding is supported by the Zhao et al., (2021) who suggests that nurses working night shifts or in critical care units may be more susceptible to alarm fatigue due to the demanding nature of their work environment. While the study did not find a significant association between alarm fatigue and gender, the literature suggests that gender may play a role in alarm management. Specifically, one study found that better alarm management techniques were associated with women in nursing roles (Lee et al., 2021). The study did not directly address nurses' perceptions of smart alarms. However, the literature suggests that nurses may have varying views on the effectiveness of smart alarms in reducing false alarms (Sendelbach et al., 2015). Understanding nurses' attitudes towards technological solutions like smart alarms is crucial for developing effective alarm management strategies.

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4.8.3 Institutional related factors that Contribute to alarm fatigue

The findings regarding institutional-related factors contributing to alarm fatigue shed light on several key issues faced by nurses in clinical settings. Firstly, staffing levels and patient ratios were highlighted as significant concerns. Studies by Cvach et al. (2020) and Schmid et al. (2018) underscored the negative impact of higher nurse to patient ratios on alarm perception and response time. This aligns with the present study's findings, which emphasize the challenges posed by low staffing levels and increased patient acuity requiring intense monitoring. Furthermore, the correlation between fatigue and staffing levels suggests that inadequate staffing exacerbates alarm fatigue, leading to compromised patient care.

Equipment alarm malfunction emerged as another critical factor contributing to alarm fatigue. Seagull and Sanderson (year) and Schmid et al. (2018) demonstrated that a substantial portion of alarms have no clinical impact, with equipment breakdown being a common cause. This corresponds with the present study's findings, highlighting the need to address equipment-related issues to reduce false alarms and mitigate alarm fatigue.

Unit characteristics, such as the presence of bedside monitors and the number of central monitors, were also identified as influential factors. Similar to the findings of the present study, research by The Joint Commission (2013) emphasized the negative impact of missed alarms on patient outcomes. Additionally, the overcrowding of ICUs with numerous equipment per patient exacerbates alarm fatigue, as noted by the current study. This underscores the importance of optimizing alarm settings and reducing equipment clutter to enhance patient safety and mitigate alarm fatigue.

The number of hours worked per week and rotating shifts were found to increase perceptions of nuisance alarms and decrease trust in alarm systems. This aligns with previous research

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highlighting the negative effects of prolonged work hours and rotating shifts on nurses' ability to effectively respond to alarms (Cho et al., 2016). The potential harm resulting from alarm fatigue, as evidenced by Silva et al. (2014), underscores the critical need for interventions to address alarm management practices and reduce disruptions in clinical workflows.

4.8.4 Alarm Management Strategies Utilized by Nurses

The study found that nurses employed various strategies to manage alarm fatigue effectively in clinical settings. Specifically, they commonly assessed the source of alarms and adjusted alarm limits as primary approaches. Additionally, silencing alarms emerged as a prevalent method among participants. These findings align with previous research highlighting the importance of proactive alarm management strategies (Meng'anyi, 2014).

When operating alarms on critical care devices, nurses demonstrated different frequencies in their actions. They consistently and promptly reacted to critical alarms from cardiac monitors and ventilators, underscoring the criticality of immediate responses to these alerts. This finding resonates with previous literature emphasizing the significance of timely intervention in critical care settings (Lewandoska et al., 2020).

Moreover, nurses consistently adhered to proper use and placement of oxygen saturation probes, indicating a commitment to ensuring accurate monitoring. However, certain actions, such as providing proper skin preparation for and placement of ECG electrodes, were less commonly performed, suggesting potential areas for improvement in adherence to best practices. Similarly, some operational adjustments, like customizing default settings to patient-specific parameters and differentiating the source of each alarm, were carried out occasionally, indicating opportunities for enhancing consistency in alarm management practices. These findings corroborate existing literature emphasizing the importance of comprehensive alarm management strategies tailored to

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individual patient needs (Sowan et al., 2016). They also underscore the need for ongoing education and training to ensure nurses are equipped with the necessary skills to effectively manage alarms in critical care settings.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter begins with a brief introduction, setting the stage for the discussion on alarm fatigue among nurses. The summary of findings encompasses various aspects, including the level of alarm fatigue among nurses, factors contributing to alarm fatigue, institutional-related factors, and the strategies employed by nurses to manage alarms effectively. Each subsection provides insights into the specific findings uncovered during the study, shedding light on the challenges faced by nurses in clinical settings. Following the summary of findings, conclusions are drawn to synthesize the key takeaways from the study, providing a comprehensive understanding of alarm management practices and their impact on patient care. Subsequently, recommendations are presented to address the identified challenges and enhance alarm management strategies, aiming to mitigate alarm fatigue and improve patient outcomes. Finally, suggestions for further studies are proposed to guide future research endeavours in this critical area of healthcare.

5.2 Summary of Findings

5.2.1 Level of alarm fatigue among Nurses working at Thika Level 5 Hospital

The study investigated the level of alarm fatigue among nurses in clinical settings, exploring their encounters with clinical alarms, the most common sources of alarms, perceptions of equipment ratings, challenges in troubleshooting alarms, and experiences with alarm fatigue symptoms. Majority of nurses (95.7%) encounter clinical alarms during their work shifts, indicating widespread exposure to alarm signals. A greater majority if the nurses (89.1%) had a maximum alarm fatigue score. Cardiac monitors are the most common source of alarms encountered by

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healthcare workers (58.7%), highlighting their importance in monitoring patients' heart rhythms. Patient call systems and electrical beds were perceived to have the lowest alarm frequency by a significant proportion of respondents. Mechanical ventilators and cardiac monitors were rated as having the highest alarm frequency by the majority of respondents, indicating potential challenges associated with alarm fatigue. Mechanical ventilator alarms were identified as the most challenging to troubleshoot or operate by the majority of respondents (73.9%).

Nurses moderately agreed that alarm limits are adjusted based on patients' clinical symptoms (Mean=3.41), but express concerns about alarm-induced physical symptoms and reduced concentration. While a majority of nurses experienced alarm fatigue symptoms, they vary in their likelihood to trust clinical alarms, with nearly half indicating some level of trust. A significant proportion of nurses reported feeling bored, irritated, and indifferent to clinical alarms, indicating potential alarm fatigue symptoms. Nurses generally agreed that consistent exposure to alarms leads to fatigue and that frequent false alarms reduce attention to patients. They perceived alarm sounds as a nuisance in critical care units and believe that much of the noise in wards originates from monitoring equipment alarms.

5.2.2 Nurse Related Factors That Contribute To Alarm Fatigue

The study investigated various nurse-related factors contributing to alarm fatigue among nurses. The nurses felt empowered to manage clinical alarms effectively due to their level of education. Training on clinical alarm management was positively perceived as leading to a reduction in alarm fatigue. Increased years of experience appeared to correlate with lower levels of alarm fatigue. Possessing focused alarm management skills was acknowledged as beneficial in reducing alarm fatigue. Prolonged working hours without breaks significantly contributed to alarm fatigue. Being organized at work was seen as a factor that could reduce alarm fatigue. The nurses perceived that

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their mood and emotional state might contribute to alarm fatigue, although opinions varied on this issue.

Furthermore, statistical analyses revealed associations between alarm fatigue and certain demographic and work-related factors. There was a statistically significant association between fatigue and age of the nurses. There was no significant association found between fatigue and gender. There was a statistically significant association between fatigue and years of practice, as well as long working hours.

5.2.3 Institutional Related Factors that Contribute to Alarm Fatigue

The study investigated various institutional-related factors contributing to alarm fatigue among nurses, revealing insights into the challenges faced in clinical settings. Respondents highlighted low staff patient ratios, lack of training on alarm management, complex equipment, new equipment introduction, and lack of support from biomedical teams as significant concerns. Shift duties, both during day and night shifts, were perceived as challenging aspects of ICU care. Furthermore, factors such as the lack of central stations, patient acuity requiring intense monitoring, and the absence of unit-specific default parameters were identified as areas needing improvement.

Respondents expressed strong agreement regarding the importance of low staff patient ratios and the lack of alarm management policies, suggesting a consensus among participants on these issues. Similarly, concerns were raised about the lack of support from biomedical teams and the unit layout in open ICUs, indicating significant factors impacting patient care.

However, opinions varied on certain factors, such as new equipment introduction and patient acuity requiring intense monitoring, with slightly higher variability in respondents' perceptions. Despite these differences, factors like the lack of training on alarm management and the complexity of equipment were rated as areas needing improvement by respondents.

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Statistical analyses revealed associations between alarm fatigue and certain institutional-related factors. There was a statistically significant association between fatigue and the level of training among participants, as well as between fatigue and staffing levels. Additionally, there was a significant relationship between fatigue and equipment complexity.

Despite efforts to address alarm fatigue, institutional policies on alarm management were rated predominantly as "Very Poor" or "Poor" by respondents. Similarly, respondents' knowledge and ability to manage alarms were rated mostly as "Poor" or "Average," suggesting potential gaps in training and education.

5.2.4 Alarm Management Strategies Utilized by Nurses

The study explored the alarm management strategies employed by nurses to combat alarm fatigue in clinical settings. Nurses reported utilizing various approaches to manage alarms effectively. The most prevalent strategy involved assessing the source of alarms, indicating that nearly half of the participants relied on this method. Adjusting alarm limits was another common practice, with a substantial proportion of nurses employing this strategy. Additionally, a notable number of respondents reported silencing alarms as a method of managing alarm fatigue.

When operating alarms on critical care devices, nurses demonstrated different frequencies in their actions. They tended to react promptly and frequently to critical alarms from cardiac monitors and ventilators, emphasizing the importance of immediate responses to these alerts. Furthermore, nurses consistently adhered to proper use and placement of oxygen saturation probes, highlighting the significance of ensuring accurate monitoring.

However, certain actions, such as providing proper skin preparation for and placement of ECG electrodes, were less commonly performed, suggesting potential areas for improvement in adherence to best practices. Similarly, some operational adjustments like customizing default

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settings to patient-specific parameters and differentiating the source of each alarm, were carried out occasionally, indicating opportunities for enhancing consistency in alarm management practices.

5.3 Conclusions

The study revealed that a significant majority of nurses encounter clinical alarms during their work shifts, indicating widespread exposure to alarm signals. Alarm fatigue was prevalent, with a substantial proportion of nurses reporting the maximum alarm fatigue score. Cardiac monitors emerged as the most common source of alarms encountered by healthcare workers, highlighting their critical role in monitoring patients' heart rhythms. Mechanical ventilators and cardiac monitors were rated as having the highest alarm frequency, potentially contributing to alarm fatigue among nurses. Mechanical ventilator alarms, in particular, were identified as the most challenging to troubleshoot or operate, further exacerbating the issue.

The study underscores the multifaceted nature of alarm fatigue among nurses, influenced by various nurse-related factors. While education, training, and organizational skills appear to mitigate alarm fatigue, challenges such as prolonged working hours persistently contribute to its prevalence. Addressing these factors through targeted interventions and support systems could help alleviate alarm fatigue and enhance patient care quality in clinical settings.

The research identified several key challenges faced by healthcare professionals, including low staff patient ratios, inadequate training on alarm management, complex equipment, and the introduction of new technologies. These factors, along with issues such as lack of support from biomedical teams and unit layout in open ICUs, were highlighted as significant concerns impacting patient care. One notable aspect of the study is the strong consensus among respondents regarding the importance of addressing low staff patient ratios and the lack of alarm management policies.

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This indicates a clear recognition among participants of the critical role staffing levels and institutional policies play in mitigating alarm fatigue. Statistical analyses further supported the association between alarm fatigue and institutional-related factors, particularly highlighting the significance of training levels, staffing ratios, and equipment complexity. These findings underscore the importance of implementing targeted interventions to address these factors and mitigate alarm fatigue effectively. Moreover, the study identified gaps in institutional policies and healthcare professionals' knowledge and ability to manage alarms, as evidenced by the predominantly poor ratings given by respondents. This highlights the need for comprehensive training and education initiatives to equip nurses with the skills and resources necessary to manage alarms effectively and ensure patient safety.

In conclusion, the study provides valuable insights into the alarm management strategies utilized by nurses to address alarm fatigue in clinical settings. Nurses employ various approaches, including assessing the source of alarms and adjusting alarm limits, to effectively manage alarm-related challenges. The findings underscore the importance of proactive and timely responses to critical alarms from cardiac monitors and ventilators, highlighting the critical role of nurses in patient monitoring and safety. Furthermore, the study identifies areas for improvement, such as ensuring proper skin preparation and placement of ECG electrodes, and enhancing consistency in operational adjustments like customizing default settings. These findings emphasize the need for ongoing education and training to equip nurses with the skills and knowledge necessary for optimal alarm management.

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5.4 Recommendations

Commented [W11]: Arrange them as per obejective

i. Implement regular training sessions and workshops for nurses on effective alarm management strategies, including how to prioritize and respond to alarms based on clinical urgency. This can help alleviate alarm fatigue by enhancing nurses' skills and confidence in managing alarms.

ii. Introduce technology-assisted solutions, such as smart alarm systems or alarm fatigue monitoring tools, to assist nurses in filtering out non-actionable alarms and prioritizing critical alerts. These systems can help reduce the overall alarm burden and improve nurses' ability to focus on clinically relevant alarms.

iii. Develop policies and guidelines that promote adequate rest breaks and work-life balance for nurses, particularly those working long hours in critical care settings. Implementing structured shift schedules and providing opportunities for rest can help mitigate the effects of prolonged working hours on alarm fatigue.

iv. Enhance interdisciplinary collaboration between nursing staff and biomedical teams to address equipment-related issues promptly and ensure the reliability of monitoring devices. Regular maintenance checks and troubleshooting protocols can help minimize equipment malfunctions and false alarms, reducing alarm fatigue among nurses.

v. Improve staffing levels and nurse-to-patient ratios in critical care units to alleviate workload pressures and enable nurses to respond more effectively to alarms. Adequate staffing can help prevent alarm fatigue by distributing the workload more evenly and allowing nurses to prioritize patient care.

vi. Enhance training programs and educational resources on alarm management for nursing staff, focusing on topics such as equipment operation, alarm troubleshooting, and

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adherence to institutional policies. Providing comprehensive training can empower nurses to better understand and manage alarms, reducing the likelihood of alarm fatigue.

vii. Implement standardized protocols and procedures for alarm management in clinical settings, outlining best practices for adjusting alarm limits, prioritizing alarms, and responding to critical alerts. Clear guidelines can help ensure consistency in alarm management practices and reduce the risk of alarm fatigue.

viii. Foster a culture of teamwork and mutual support among nursing staff to address alarm fatigue collaboratively. Encourage open communication and the sharing of best practices among colleagues to improve overall alarm management effectiveness and minimize the impact of alarm fatigue on patient care.

5.5 Suggestions for Further Studies

There is need for further studies on patient-centered perspectives on alarms. This could explore the impact of clinical alarms on patients' experiences and perceptions of care. This could be a qualitative research to understand how patients perceive alarm-related noise and disruptions in healthcare settings, and identify strategies to minimize alarm-related distress and improve patient satisfaction.

The study recommends for a comparative study across healthcare settings. The study could compare alarm management practices and experiences of nurses across different healthcare settings, such as hospitals, outpatient clinics, and long-term care facilities. This would help identify variations in alarm fatigue prevalence and its correlates based on the nature of patient care environments.

The study recommends for an interventional studies on alarm management strategies: This can implement and evaluate targeted interventions aimed at reducing alarm fatigue among nurses. This

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could include training programs, technological solutions, or workflow modifications designed to optimize alarm management practices and improve patient outcomes.

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REFERENCES

ACCE Foundation, T. H. (2017). Journal of Clinical Engineering: Volume 32 - Issue 1. *Clinical Alarms Task Force Impact of Clinical Alarms on Patient Safety,*, p 22-33.

Asadi, N., Salmani, F., Asgari, N., & Salmani, M. (2022). Alarm fatigue and moral distress in ICU nurses in COVID-19 pandemic. *British Medical Journal*, 125.

Baker', K., & Rodger, J. (2020). Assessing causes of alarm fatigue in long-term acute care and its impact on identifying clinical changes in patient conditions. *Informatics in Medicine Unlocked (18)*.

Bi, J., Yin, X., Li, H., Gao, R., Zhang, Q., Zhong, T., et al. (2020). Effects of monitor alarm management training on nurses' alarm fatigue: A randomised controlled trial. *Journal of Clinical NursingVolume 29, Issue 21-22*, 4203-4216.

Biggs, A., Brough, P., & Drummond, S. (2017, February 18). Lazarus and Folkman's Psychological Stress and Coping Theory. *Wiley Online Library*, pp. 5-23.

Bliss, J. P., Gilson, R. D., & Deaton, J. E. (2017). Human probability matching behaviour in response to alarms of varying reliability. *Journal Of Clinical Ergonomics Volume 38*, 1995 - Issue 11.

Bloom, P. (2016, August 23rd). *openlearn.* Retrieved from /money-management/money/economics/the-reason-low-wages: https://www.open.edu/openlearn/money-management/money/economics/the-reason-low-wages

Mount Kenya University

Bourgi, H., Sabbah, H., Al'Jamil, A., & Sabbah, I. (2020). Evaluating the Alarm Fatigue and its Associated Factors among Clinicians in Critical Care Units. *Indian Journal of Clinical Medicine*, 1(1):9.

Busch-Vishniac, I. (2016). Death by alarm: An error model of hospital alarms. *The Journal of the Acoustical Society of America*, 139, 2201.

Casey, S., Avalos, G., & Dowling, M. (2018). Critical care nurses' knowledge of alarm fatigue and practices towards alarms: A multicentre study. Intensive Crit. Care Nurs. *Intensive Care Nursing*, 48:36–41.

Cheung, W. K., Chau, L. S., & Mak, I. L. (2016). Prevalence of Alarms in Intensive Care Units, and its Relationship with Nursing. *Journal Of Perioperative and Critical Intensive Care Nursing*.

Cho, O. M., Kim, H., & Young Whee Lee. (2016, Jan; 22). *Clinical Alarms in Intensive Care Units: Perceived Obstacles of Alarm Management and Alarm Fatigue in Nurses.* Retrieved from NCBI: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4756058/#:~:text=Four%20of%20the%209%20types,rang%20per%20patient%20per%20hour.

Christensen, M., Dodds, A., Sauer, J., & Watts, N. (2014). Alarm setting for the critically ill patient: A descriptive pilot survey of nurses' perceptions of current practice in an Australian Regional Critical Care Unit. *Intensive Critical Care Nursing.*, 30:204–210.

Cvach, M., Biggs, M., Rothwell, K., & C., C.-H. (2013). Daily electrode change and effect on cardiac monitor alarms: an evidence-based practice approach.;28(3):. *J Nurs Care Qual*, 265–271.

Mount Kenya University

Cvach, M., Doyle, P., Wong, S. Y., Letnaunchyn, K., Dell, D., & Mamaril, M. (2020). Decreasing Pediatric PACU Noise Level and Alarm Fatigue: A Quality Improvement Initiative to Improve Safety and Satisfaction. *Journal of PeriAnesthesia Nursing*, 357-364.

elizabeth, j. (2016). Nurse staffing and patient outcomes:. *International Journal of Nursing Studies, 3*(14), 14.

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison Convinience Sampling and Purposive Sampling; Census. *American Journal Of Theoritical and Applied Statistics*, 1-4.

Figueroa, C. A., Harrison, R., Chauhan, A., & Meyer, L. (2019, April 24). *BMC Health Services Research.* Retrieved from biomedcentral: https://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-019-4080-7

Foley, L., Anderson, C. J., & Schutz, M. (2020, October 20). *Re-Sounding Alarms: Designing Ergonomic Auditory Interfaces by Embracing Musical Insights*. Retrieved from MDPI open acces Journal; Healthcare: https://doi.org/10.3390/healthcare8040389

Funk, M., Clark, J. T., Bauld, T. J., C, O. J., & P, C. (2014). Attitudes and practices related to clinical alarms. *American Journal Of critical care Nursing*, 23(3):e9-e18.

Glassman, A., & Chalkidou, K. (n.d.). *Center for Global Development.* Retrieved from Priority-Setting in Health ;Building institutions for smarter public spending: https://www.cgdev.org/sites/default/files/1426240_file_priority_setting_global_health_FINAL_0.pdf

Goepfert, M. S., & Reuter, D. A. (2018). Patient monitoring alarms in the ICU and in the operating room. *Biomed central (BMC) article 216*, 17.

Mount Kenya University

Gorisek, R., Mayer, C., Hicks, B., & Barnes, J. (2021). An Evidence-Based Initiative to Reduce Alarm Fatigue in a Burn Intensive Care Unit . *Journal Of Critical Care Nursing*, 29-37.

Graham, K., & Cvach, M. (2010). Monitor alarm fatigue: standardizing use of physiological monitors and decreasing nuisance alarms. *Am J Crit Care*, 28–34.

Haque, A. (2020). *Ambient Intelligence for Healthcare.* Stanford: Stanford University.

Hazinski, M. F. (1999). *Manual of Pediatric Critical Care.* Nashville, Tennessee: Mosby.

Horkan A, M. (2014). Alarm fatigue and patient safety. *Nephrol Nurs J.*, ;41(1):83-85.

Jamsa, J. O., HUutela, K., Tapper, A.-M., & Lehtonen, L. (2021). Clinical alarms and alarm fatigue in a University Hospital Emergency Department; A retrospective Analysis. *Journal of Emergency Anaesthsiology*.

Joint Commision, i. (2020). *Hospital InterNational Patient Safety Goals; Goal 6 - Reduce the harm associated with clinical alarm systems.* Pennsylvania; Washington DC: The Joint Commision.

Kanana, R., & Birir, L. (2021). *October Duty Rota.* Nairobi: KUTRRH.

Keller, J. (2012). Clinical alarm hazards: A top ten health technology safety concern. *Journal of Electrocardiology*, 45:588–591. doi: 10.1016/j.jelectrocard.2012.08.050.

Kooshanfar, Z., Ashrafi, S., Paryad, E., Salmanghasem, Y., Mohammadi, T. K., Golhosseini, S. M., et al. (2021). Sources of Noise and Their Effects on Nurses in Intensive Care Units: A Cross Sectional Study. *SSRN electronic journal*, 19.

Mount Kenya University

KUTRRH. (2021, Jan 15). *Kenyatta University Hospital Downloads.* Retrieved from Kenyatta University Teaching And Referal Hospital: https://kutrrh.go.ke/wp-content/uploads/2021/01/kutrrh-profile-jan-2021.pdf

Lee, S.-J., Yun-Mi, L., Seo, E. J., & Son, Y.-J. (2021). *International Journal for Environmental Research and Public Health,*, 18(8), 4018; https://doi.org/10.3390/ijerph18084018.

Lee, S.-J., Yun-Mi, L., Seo, E. J., & Son, Y.-J. (2021). Impact of Hospital Nurses' Perception on Clinical Alarms and Patient Safety Culture on Alarm Management Practice. *international Journal of public health and environmental Research*, 18(8), 4018; https://doi.org/10.3390/ijerph18084018.

Lewandowska, K., Weisbrot, M., Cieloszyk, A., 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 Environmetal Research and Public Health*, 22-34.

Lewandowska, K., Weisbrot, M., Cieloszyk, A., Mędrzycka-Dąbrowska, W., Krupa, S., & Ozga, D. (2020, November 13). *International Journal Of Public Health*. Retrieved from PMC - National Library of Medicine, National Institute Of Health: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7697990/

Lingard, L., Espin, S., & Whyte, S. (2004). Communication failures in the operating room: an observational classification of recurrent types and effects. *Safe Care Health*, 13:330.

Lukasewicz, C., & Andersson Mattox, E. (2015;). Patient safety. Understanding clinical alarm safety. *American Journal Of critical Care Nursing*, 35(4):45-57 13p.

Lukasewicz, C., & Mattox, E. (2015). Understanding clinical alarm safety. . *Critical Care Nurses*, ;35(4):45-57.

Mount Kenya University

Luna, A. A., Silva, R. C., & Barbosa, M. T. (2020). The influence of nursing activities score on clinical alarms service. *Scelo*, https://doi.org/10.1590/0034-7167-2018-0963.

Luo, B., McLoone, M., Rasooly, I. R., Craig, S., Muthu, N., Won, J., et al. (2020). Protocol for a New Method to Measure Physiologic Monitor Alarm Responsiveness . *Biomedical Instrumentation and Technologies; https://doi.org/10.2345/0899-8205-54.6.389*, 54 (6): 389–396.

Mahmoud, H. W. (2017, August). *Assessment Knowledge of Nurses about clinical alarms in critical setting in ELRebat University Hospital.* Retrieved from Dspace Repositories; Shendi University: http://repository.ush.sd:8080/xmlui/handle/123456789/791

McCollum, R., Limato, R., Otiso, L., Theobald, S., & Taegtmeyer, M. (2018., September 28,). *BMJ GLOBAL HEALTH*. Retrieved from BMJ journal: https://gh.bmj.com/content/3/5/e000939

McEwen, M., & Wills, E. (2011). *Theoretical Basis for Nursing.* Philadelphia.: Wolters Kluwer/Lippincott Williams & Wilkins, Philadelphia.

Meghan Woo, S. a. (2020). Making Healthcare Safer III: A Critical Analysis of Existing and Emerging Patient Safety Practices. *AHRQ*.

Mehrpour, S., Ferreira, M. M., Coelho, Y. L., Vivas, G. D., Rodrigue, D. D., Rodriguez, D. D., et al. (2021). Evaluation of Adverse Events Recorded in FDA/USA and ANVISA/Brazil Databases for Medical Devices: Defibrillator, Infusion Pump, Physiological Monitor, Pulmonary Ventilator and Ultrasonic Scalpel. *Global Clinical Engineering Vol. 4 No. 2*, https://www.globalce.org/index.php/GlobalCE/article/view/121.

Mount Kenya University

Meng'anyi, L. W., Omondi, L. A., & Muiva, M. N. (2017). Assessment of nurses interventions in the Management of Clinical Alarms in the critical care unit, Kenyatta National Hospital, a cross sectional study. *Biomed Central Nursing*, 16: 41.

MoH Kenya, M. O. (2013, January 2). *ehealth kenya*. Retrieved March 5, 2014, from Kenya Facilities: www.ehealth.or.ke/facilities/facility.aspx?fas-=10903

Mugenda, O., & Mugenda, A. (2003.). *Research methods: quantitative and qualitative approaches.* Nairobi;: Press, African Centre for technology studies: ACTS.

Oraro-Lawrence, T., & Wyss, K. (2020, March 6). *Biomed Central* . Retrieved from BMC Health Services Research: https://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-020-5041-x

Paterson, E., Sanderson, P. M., Salisbury, I. S., P.Burgmann, F., Mohamed, I., G.Loeb, R., et al. (2020). Evaluation of an enhanced pulse oximeter auditory display: a simulation study. *British Journal of Anaesthesia*, 826-834.

Pelter, M. M., & Drew, B. J. (2015, December 1). *Patient Safety Network*. Retrieved from Agency For Healthcare Research and Quality: https://psnet.ahrq.gov/web-mm/harm-alarm-fatigue

Pelter, M. M., Mortara, D., & Badilini, F. (2021). Computer Assisted Patient Monitoring: Associated Patient, Clinical and ECG Characteristics and Strategy to Minimize False Alarms. *The Application of Computer Techniques to ECG Interpretation)*, 2(4), 459-471; https://doi.org/10.3390/hearts2040036.

Poole, S., & Shah, N. (2018,). Addressing vital sign alarm fatigue using personalized alarm thresholds. *BioComputing 2018*, 472-483.

Mount Kenya University

Ramlaul, A., & Chironda, G. (2021). Alarms in the ICU: A study investigating how ICU nurses respond to clinical alarms for patient safety in a selected hospital in KwaZulu-Natal Province, South Africa. *South African Journal Of Critical Care Nursing*, 57-53.

Robertson, S., & Ryans, T. (2020). The association between care left undone and temporary Nursing staff ratios in acute settings: a cross- sectional survey of registered nurses. *BMC Heralth services Research, 20*(637).

Rodger, J., & Baker, K. (2020, Feb 21). *Data for: Assessing Causes of Alarm Fatigue in Long-Term Acute Care and Its Impact on Identifying Clinical Changes in Patient Conditions*. Retrieved from Mendley data: https://data.mendeley.com/datasets/dr5hvdydbv/1

Rossum, M. C., Vlaskamp, L. B., Posthuma, L. M., Visscher, M. J., Breteler, M. J., Hermens, H. J., et al. (2021, February 11). *Journal of Clinical Monitoring and Computing.* Retrieved from Adaptive threshold-based alarm strategies for continuous vital signs monitoring: https://link.springer.com/article/10.1007/s10877-021-00666-4

Schmid, F., Goepfert, M., & Reuter, D. (2018). Patient monitoring alarms in the ICU and in the operating room. *Journal Of critical Care*, 216.

Schmidt, B. (2020, May / June 4). *Alarm Fatigue Hazards: The Sirens Are Calling*. Retrieved from Patient Safety & Quality Healthcare: https://www.psqh.com/analysis/alarm-fatigue-hazards-the-sirens-are-calling/

Seiferta, M., H.Tola, D., Thompson, J., McGugan, L., & Smallheer, B. (2021). Effect of bundle set interventions on physiologic alarms and alarm fatigue in an intensive care unit: A quality improvement project. *Intensive and Critical Care Nursing; Volume 67, 103098*, https://www.sciencedirect.com/science/article/pii/S0964339721000872?casa_token=2Wz

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SsyZ3wtoAAAAA:o4dyxqVBBP1ySjXYhSNfOjD9wavCkUu5cyPsKk7zUcwbWHuZ0aWh3vo8bwLVC_zY-PgnAeUw-mE.

Sendelbach S, W. S. (2015). Stop the noise: A quality improvement project to decrease electrocardiographic nuisance alarms. *Critical Care Nurse.*, 35(4):15-22.

Sendelbach, S., & Funk, M. (2015, October/December 4). Alarm Fatigue: A Patient Safety Concern. *Lippincot Nursing Center*, pp. 378 - 386.

Sowan, A. K., Gomez, Michelle, T., Tarriela, A. F., Reed, C., Calhoun, et al. (2016, Jan 11). *JMIR Publications; Advancing Digital Health and Open Science.* Retrieved from Changes in Default Alarm Settings and Standard In-Service are Insufficient to Improve Alarm Fatigue in an Intensive Care Unit: https://humanfactors.jmir.org/2016/1/e1/

Sowan, A. K., Vera, A. G., Fonseca, E. I., Reed, C. C., Tarriela, A. F., & Berndt, A. E. (2017). Nurse Competence on Physiologic Monitors Use: Toward Eliminating Alarm Fatigue in Intensive Care Units. *The Open Medical Informatics Journal ; PMCID: PMC5420192*, 1-11.

Spiva, L., Davis, S., Case-Wirth, J., Hedenstrom, L., Hogue, V., Box, M., et al. (2020). The Effectiveness of Charge Nurse Training on Leadership Style and Resiliency. *Journal of Nursing Administration*, 50(2):95-103. doi: 10.1097/NNA.0000000000000848.

Storm, J., & Chen, H.-C. (2020, November 10). *The relationships among alarm fatigue, compassion fatigue, burnout and compassion satisfaction in critical care and step-down nurses.* Retrieved from Journal Of Clinical Nursing/Volume 30, Issue 3-4 P.443-453: https://onlinelibrary.wiley.com/doi/full/10.1111/jocn.15555

Mount Kenya University

Sue Sendelbach, R. P., & CCNS Marjorie Funk, R. P. (2013). Alarm Fatigue; A Patient Safety Concern. *AACN Advanced Critical Care Volume 24, Number 4,* , 378-386 .

The Joint Commission, T. (2013). *Medical Device Alarm Safety in Hospitals.* The Joint Commission;.

The Joint Commission, T. (2014). *The Joint Commission Announces, 2014 National Patient Safety Goal.* Joint Commission;.

The Joint Commission, T. (2018). Sound the alarm: Managing physiologic monitoring systems. *Jt Comm Perspect Patient Saf*, 11(12):6-11.

UMBC. (2021, 11 30). *Research & Creative Achievement at UMBC*. Retrieved from UMBC: University of Maryland, Baltimore County: https://research.umbc.edu/use-of-electronic-signatures-for-documenting-informed-consent/

Wakefield, E. (2018). Compassion fatigue in the perioperative environment. *Journal of Perioperative. Nursing:Vol. 31*, Issue 2.

Walsh, B. K., & Waugh, J. B. (2020). Alarm Strategies and Surveillance for Mechanical Ventilation. *Journal of Respiratory Care* , 65 (6) 820-831; DOI: https://doi.org/10.4187/respcare.07546.

Walsh-Irwin, C., & Jurgens, C. (2015). Proper skin preparation and electrode placement decreases alarms on a telemetry unit. *Dimensions Critical Care Nursing*, 34(3):134-139.

Welch, J. (2021, Feb 16). Alarm fatigue hazards: the sirens are calling. *Journal Of Anaesthesia*, p. 307:1591.

West, Abbott, & Probst. (2019;). Alarm fatigue:. *A concept analysis*, 18(2):1-1.

Mount Kenya University

Xhueng, B., Q, Z., J, N., C, C., Z, L., N, N. L., et al. (2021, August 30). *The Occurrence of Work-related Fatigue and Job Satisfaction in Nursing Staff to the Quality of Care: A Cross-sectional Survey in North-East China.* Retrieved from Europe PMC: https://europepmc.org/article/ppr/ppr388682

Yue, L., Plummer, V., & Cross, W. (2018). The effectiveness of nurse education and training for clinical alarm response and management: a systematic review. *Journal of Clinical Nursing; doi: 10.1111/jocn.13605*, 17-18):2511-2526.

Zhao, Y., Wan, M., Liu, H., & Ma, M. (2021). The Current Situation and Influencing Factors of the Alarm Fatigue of Nurses' Medical Equipment in the Intensive Care Unit Based on Intelligent Medical Care. *Journal Of Healthcare Engineering* , Article ID 9994303 https://doi.org/10.1155/2021/9994303.

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APPENDIX 1: CONSENT DOCUMENTS

Consent Form 1: Adult Consent Information Sheet

Title of Study:

DETERMINANTS OF ALARM FATIGUE AMONG NURSES WORKING IN CRITICAL CARE UNIT AT THIKA LEVEL 5 HOSPITAL, KENYA.

Introduction

Hello, my name is ____________ and I am helping to conduct a study (research) with researchers from the Thika Level 5 Hospital about determinants of alarm fatigue among nurses working at Thika level 5 referral hospital, critical care unit. **Your participation in this survey is completely voluntary**. This means that you do not have to participate in this study unless you want to.

Study Purpose

The purpose of this research study is to determine the things that cause or contribute to alarm fatigue among Nurses in A Thika Level 5 Hospital in Kiambu Kenya. Through examining and Understanding this Phenomenon, It is expected that there will be improvement in the safety culture and agenda, surrounding Both Nurses working in critical care departments and Patients being taken care of in same units. We hope to use this information to improve patient care in Kenya.

What will happen if you take part in this Study?

You will be asked to complete a series of questions on Your Laptop or mobile phone and a short interview about your experience with clinical alarms. This should take about 15 minutes. There is a small chance that some of the questions may make you feel uncomfortable. You don’t have to answer those questions if you don’t want to.

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We will follow you throughout the period of study in the Critical care Department and we may ask you additional questions about your Experiences with clinical alarms. **Your decision to participate or not to participate will not affect your Work, or the care you give to your patients.**

Confidentiality

The information obtained will be treated with confidentiality. Your name will not be used when we evaluate all the information collected. When we finishing collecting information from everyone who has agreed to participate, we will group all the answers together in any report or presentation. **There will be no way to identify individual participants.**

Sharing the Results

The knowledge we get from this study will be shared with the administration ofThika Level 5 hospital, Mount Kenya University, and other Researchers through publications, seminars and conferences. **Confidential information will not be shared**.

Risks and Discomfort

This study will not involve any procedures and the only risk to you might be if your identity were ever revealed- however we will safeguard this data, all data will be kept Confidential. **No risks or discomfort will be incurred by electing to participate in the study.**

Costs and Compensation

There will be no extra cost incurred for participating in this study **nor is there compensation offered**.

Ethical Concerns and your rights as a research Participant

Mount Kenya University

This project has been reviewed by the Mount Kenya University, Institutional Ethics Review Board, as well as the Department of Critical care, and approved by the Thika Level 5 Hospital Ethics and Research Review Committee. **These committees work to protect your rights and protect you from harm.**

What if you want to stop before the study is complete?

You may decide to stop at any time and we will remove your information from the study.

What if you have questions about the study?

If you have questions or concerns about your rights as a research subject you may contact, anonymously if you wish, the Institutional Ethics Review Board at Mount kenya University at: Mount Kenya University, Thika, Alumni Plaza, 9th Floor, Room 904, P.O BOX 342-01000 Thika, Kenya, Email: research@mku.ac.ke OR the Thika Level 5 Hospital Institutional Ethics review Board at deputydirector-research@Thika Level 5 Hospital.go.ke and research.manager@Thika Level 5 Hospital.go.ke. You may contact the Primary Investigator, Emmanuel Keya, at: +254 0715730066 (Kenya) or by email: emmanuelkeya360@gmail.com.

Do you agree to be in this study? **Or** Do I have your permission to begin asking you questions?

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Consent Form 2: Certificate of Consent

PARTICIPANT CODE ####

Title of Study:

Determinants Of Alarm Fatigue Among Nurses Working At Thika Level 5 Hospital Critical Care Unit, Kenya.

Participant's Agreement:

I have read the information provided to me. I have asked all the questions I have at this time. I voluntarily agree to participate in this research study.

_______________________________________ _______________

Signature of Research Participant DATE

____

Printed Name of Research Participant

____ ___________

Signature of Research Team Member Obtaining Consent DATE

____

Printed Name Research Team Member Obtaining Consent

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APPENDIX 2: ALARM FATIGUE SURVEY

DETERMINANTS OF ALARM FATIGUE QUESTIONNAIRE. POST PRETEST

SOCIAL-DEMOGRAPHIC DATA

1. Age In years

◯ 21-30 Years ◯ 30- 40 Years ◯ 41-50 Years ◯ Above 51 Years

2. Gender

◯ Male ◯ Female

3. Years Of practice as a Nurse

◯ 0-5 ◯ 6-10 ◯ 11-20 ◯ 21 and above

4. Level of Training

◯ Diploma in Nursing

◯ Post basic Diploma in Nursing

◯ Bachelor's Degree in Nursing

◯ Master's Degree in Nursing

5. Area of specialization

◯ Adult Critical Care Nursing

◯ Pediatric Critical Care Nursing

◯ Renal Nursing

◯ Other

◯ None

6. Unit / department of work

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- ◯ High Dependency Unit - HDU
- ◯ Intensive Care Unit - ICU
- ◯ Cardio thoracic Intensive care Unit - CTICU
- ◯ Pediatric Intensive care Unit - PICU
- ◯ Neonatal Intensive care Unit -NICU
- ◯ Renal intensive care Unit

SECTION A; to assess the level of alarm fatigue among Nurses working at THIKA LEVEL 5 HOSPITAL, Kiambu, Kenya.

1. Do you encounter clinical alarms? ◯ yes ◯ No
2. CAFQA – Alarm fatigue score
3. In your opinion what are the most common sources of alarms in ICU? *
   - ◯ Cardiac Monitors
   - ◯ Mechanical Ventilators
   - ◯ Syringe Pumps
   - ◯ Hemodialysis machines
   - ◯ Electrical beds
   - ◯ Infusion Pumps
4. On a scale of 1 (Lowest) 2(Low) 3 (Moderate) 4(High) 5(Highest) Rate the Equipment By the Amount of Alarms Produced - Infusion Pumps
5. On a scale of 1 (Lowest) 2(Low) 3 (Moderate) 4(High) 5(Highest) Rate the Equipment By the Amount of Alarms Produced - Patient Call systems
6. On a scale of 1 (Lowest) 2(Low) 3 (Moderate) 4(High) 5(Highest) Rate the Equipment By the Amount of Alarms Produced - Electrical Beds

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7. On a scale of 1 (Lowest) 2(Low) 3 (Moderate) 4(High) 5(Highest) Rate the Equipment By the Amount of Alarms Produced - Hemodialysis Machine

8. On a scale of 1 (Lowest) 2(Low) 3 (Moderate) 4(High) 5(Highest) Rate the Equipment By the Amount of Alarms Produced - Syringe Pumps

9. On a scale of 1 (Lowest) 2(Low) 3 (Moderate) 4(High) 5(Highest) Rate the Equipment By the Amount of Alarms Produced - Cardiac Monitors

10. On a scale of 1 (Lowest) 2(Low) 3 (Moderate) 4(High) 5(Highest) Rate the Equipment By the Amount of Alarms Produced - Mechanical Ventilators

11. What are most difficult physiologic alarms to Operate/ Trouble shoot?
    - ◯ Cardiac Monitor alarms
    - ◯ Mechanical ventilator alarms
    - ◯ Infusion pump alarms
    - ◯ Syringe pump alarms
    - ◯ Hemodialysis machine alarms

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	Nurses Perception of Alarms	Strongly Agree	Agree	Disagree	Strongly Disagree
a.	With too many alarms in my Department, My performance and motivation decreases				
b.	Too many alarms trigger physical symptoms for me, e.g., Nervousness, Headache, sleep disturbances				
c.	Alarms reduce my concentration and attention				

d.	My/or neighboring patients' alarms or crisis alarms frequently interrupt my workflow.				
e.	There are situations when alarms confuse me				
f.	In my ward, a procedural instruction on how to deal with alarms is regularly updated and shared with all staff. *				
G	Responsible personnel respond quickly and appropriately to alarms.*				
H	The audible and visual monitor alarms used on my department allow me to clearly assign patient, unit, and urgency.*				
I	Alarm limits are regularly adjusted based on patients clinical symptoms(e.g blood pressure limits for condition after surgery)				

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	SYMPTOMS ASSOCIATED WITH ALARM FATIGUE	Yes	No
J	Do you feel bored by clinical alarms?		
K	Do you feel lack of interest with clinical alarms?		
L	Do you feel irritated by the repetitiveness of clinical alarms?		
M	Do you feel indifferent to clinical alarms?		
N	Do you suffer from alarm fatigue		
O	Do you know colleagues who have experienced alarm fatigue		
P	Do you silence alarms without attention to potential underlying problems?		

12. How are you likely not to Trust clinical alarms?

Very likely		**Likely**		**Not likely**		**Very unlikely**	

13. Nurses Perception of Alarms

	Nurses Perception of Alarms	Strongly Agree	Agree	Disagree	Strongly Disagree
a.	Alarms are a nuisance in the critical care units				

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b.	Consistent exposure to Alarms cause fatigue				
c.	Frequent false alarms reduce attention to patient				
d.	I raise alarm limits at the beginning of every shift				
e.	I believe much of the noise in the wards is from the alarms of monitoring equipment				
f.	Alarm sounds prevent me from focusing on my professional duties				

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SECTION B; To assess by Nurse related factors that contribute to alarm fatigue among Nurses working at THIKA LEVEL 5 HOSPITAL, Kiambu, Kenya.

		Strongly agree	Agree	Disagree	Strongly disagree
a.	My Level of education empowers me to manage clinical alarms effectively				
b.	The more the Years of experience the lower the level of Alarm fatigue				
c.	Training on clinical alarms management results to reduction of Alarm Fatigue.				
d.	Being Organised at work reduces Alarm fatigue				
e.	My mood and emotional state contributes to alarm fatigue				
f.	When alarms go off repeatedly and continuously I lose my concentration				
g.	Long working hours without a break contribute to Alarm fatigue				
h.	Focused Alarm management skills contributes to reduction of Alarm fatigue				

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SECTION C; To assess Institutional related factors that Contribute to alarm fatigue among Nurses working at THIKA LEVEL 5 HOSPITAL ., Kiambu, Kenya.

	The following lead to Alarm fatigue	Strongly agree	agree	Diagree	Strongly disagree
a.	Low staff patient Ratios				
b.	Lack of training on alarms management				
c.	Complex equipment				
d.	New equipment				
e.	Lack of Support from biomedical teams				
f.	Shift duty (Night shifts)				
g.	Shift duty (Day Shifts)				
h.	Lack of Central stations				
i.	Patient Acuity requiring intense monitoring				
j.	The unit lay out (open icu)				
k.	The unit layout (closed icu)				
l	Lack of unit-specific default parameters and alarm management policies				

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M	Lack of alarm management policies				

BN. On a scale of 1-5 How Would you rate your Institutions Policy on Management of Clinical alarms. 0 (We do not have a policy) 1 (Very Poor) 2 (Poor) 3 (avarage) 4 (Good) 5 (Excellent)

BO. On a scale of 1-5 How would you rate your knowledge in alarm management 1 (Very Poor) 2 (Poor) 3 (average) 4 (Good) 5 (Excellent)

BP. On a scale of 1-5. How would you rate your Ability to manage Alarms. 1 (Very Poor) 2 (Poor) 3 (avarage) 4 (Good) 5 (Excellent)

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SECTION D; To assess Alarm Management strategies utilized by Nurses working at THIKA LEVEL 5 HOSPITAL ., Kiambu Kenya.

35. What strategies do you use to manage alarms

Silence alarms	Adjust alarm limit	Ignore alarms	Asses alarm source

Rate your actions in operating alarms on the critical care devices					
a.	**Alarm Management**	Always	Frequently	Sometimes	Never
b.	I regularly readjust the limits of alarms based on the clinical symptoms				
c.	Pause alarms and cancel the pause				
d.	Silence alarms				
e.	During my shift, I limit the number of alarms by disabling them				
f.	Change alarm volume				
g.	Change alarm limits safely (10-30%)				
h.	Differentiate the source of each alarm (*e.g.*, HR[e] Low alarm is from ECG[f] settings)				
i.	Customize default settings to patient specific				
j.	contact service personnel to correct difficult alarms				
k.	Check alarm settings at the start of every shift, with any change in patient condition and with any change in caregiver				
l.					
m.					
n.	Check alarm settings at the start of every shift, with any change in patient condition and with any change in caregiver				

o.	Use proper oxygen saturation probes and placement				
p.	Provide proper skin preparation for and placement of ECG electrodes				
q.	I go to the patient's bedside immediately I hear alarms				
r.	I have immediate reaction infusion and syringe Pump alarms				
s.	I have immediate reaction to ventilator alarms				
t.	I have immediate reaction to cardiac monitor alarms				
u.	I have immediate reaction To Hemodialysis Machines				

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DIRECTORATE OF GRADUATE STUDIES

MSCN/2019/47868

21st March, 2023

National Commission for Science Technology & Innovation (NACOSTI)
Off Waiyaki Way, Upper Kabete,
P.O Box 30623- 00100
NAIROBI, KENYA

Dear Sir/Madam,

RE: EMMANUEL KEYA – REGISTRATION NO. MSCN/2019/47868

The purpose of this letter is to introduce the above named student who is pursuing **Master of Science in Nursing** in the department of **Nursing Education Leadership Management and Research** in the **School of Nursing.**

The title of the research is"**Determinants of Alarm Fatigue Among Nurses Working in Critical Care Unit, at Thika Level 5 Hospital, Kenya"**

It has been cleared by the University's Ethics Review Committee (Certificate attached) and now has to proceed to the field to collect data between **March, 2023 and May, 2023.**

Any assistance accorded to the student will be highly appreciated.

Thank you.

Mount Kenya University
P.O. Box 342 - 01000, THIKA
Office of the Director
Graduate Studies

Dr. Samuel M. Karanga, Ph.D.
Director, Graduate Studies
Enc.

Main Campus, General Kago Road, P.O. Box 342-01000 Thika.
Tel: 020-2878 000, Cell: +254 709 153 000
Email: info@mku.ac.ke, Web: www.mku.ac.ke
Chartered and ISO 9001 : 2015 Certified Institution.
Unlocking Infinite Possibilities

REF: **MKU/ISERC/2615**

Date: 21 March 2023

TO: **EMMANUEL KEYA**

REG: **MSCN/2019/47868**

Dear Sir/Madam,

RE: DETERMINANTS OF ALARM FATIGUE AMONG NURSES WORKING IN CRITICAL CARE UNIT, AT THIKA LEVEL 5 HOSPITAL, KENYA.

This is to inform you that **Mount Kenya University** has reviewed and approved your above research proposal. Your application approval number is **1688.** The approval period is **21/03/2023 - 20/03/2024.**

This approval is subject to compliance with the following requirements;

i. Only approved documents including informed consents, study instruments, MTA will be used

ii. All changes including amendments, deviations and violations are submitted for review and approval by **Mount Kenya University**

iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to **Mount Kenya University** within 72 hours of notification

iv. Any changes, anticipated or otherwise that may increase the risks or affect the safety or welfare of study participants and others or affect the integrity of the research must be reported to **Mount Kenya University** within 72 hours

v. Clearance for export of biological specimens must be obtained from relevant institutions

vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal

vii. Submission of an executive summary report within 90 days upon completion of the study to **Mount Kenya University**

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://research-portal.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely,

The Chairman
Mount Kenya University
Ethics Review Committee
P.O. Box 342 - 01000, Thika

Dr. Peter G. Kirira
Chairman, Mount Kenya University ISERC

Main Campus, General Kago Road, P.O. Box 342-01000 Thika
Tel: 020-2878 000, Cell: +254 709 153 000

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **249208** Date of Issue: **05/April/2023**

RESEARCH LICENSE

This is to Certify that Mr.. Emmanuel Otieno Keya Odero of Mount Kenya University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Kiambu County on the topic: DETERMINANTS OFALARM FATIGUE AMONG NURSES WORKING AT THIKA LEVEL 5 HOSPITAL, KENYA for the period ending : 05/April/2024.

License No: **NACOSTI/P/23/24432**

249208

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

See overleaf for conditions

COUNTY GOVERNMENT OF KIAMBU
DEPARTMENT OF HEALTH SERVICES

All correspondence should be addressed to HEAD
HRDU – HEALTH DEPARTMENT
Email address: mndiritu@gmail.com
mkwasa@live.com
Tel. Nos: 0721641516
0721974633

HEALTH RESEARCH AND DEVELOPMENT UNIT
P. O. BOX 2344 – 00900
KIAMBU

Ref. No.: KIAMBU/HRDU/23/04/12/RA_KEYA   Date: 12th APR 2023

TO WHOM IT MAY CONCERN

RE: CLEARANCE TO CONDUCT RESEARCH IN KIAMBU COUNTY

Kindly note that we have received a request by Mr. Emmanuel Otieno Keya of Mount Kenya University to carry out research in Kiambu County, the research topic being on **"Determinants Of Alarm Fatigue Among Nurses Working At Thika Level 5 Hospital, Kenya"**

We have duly inspected his documents and found that he has been cleared by NACOSTI to carry out the research for a period ending **5th April 2024.** He thus does not need any further clearance with another regulatory body in order to conduct research within the county of Kiambu.

However, it is incumbent upon the institution where he is carrying out research to ensure that he receives adequate supervision during the process of conducting the research. This note also accords him the duty to provide a feedback on his research to the county at the conclusion of his research.

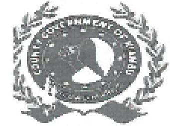
DR. MWANCHA KWASA
COUNTY CLINICAL RESEARCH OFFICER
KIAMBU COUNTY

COUNTY GOVERNMENT OF KIAMBU

DEPARTMENT OF HEALTH SERVICES

Telephone: +254722106797
Email address: thika15hospital@gmail.com

When replying please quote:



THE MEDICAL
SUPERINTENDENT,
P. O. BOX 227 – 01000,
THIKA

Ref: CGK/TL5H/07/03/2023

Date: 31st May, 2023

APPROVAL TO CARRY OUT RESEARCH

PRINCIPAL INVESTIGATOR: EMMANUEL OTIENO KEYA

RE: A STUDY ON DETERMINANTS OF ALARM FATIGUE AMONG NURSES WORKING AT THIKA LEVEL 5 HOSPITAL

Following deliberations by Thika Level 5 Hospital's Training, Research and Ethics Committee (TREC), and subject to provision of all the necessary licenses and ethical approvals, your proposal to carry out the above referenced research, at this facility, has been approved.

This approval is subject to the following mandatory conditions:

1. You shall submit a copy of the abstract or the final report, through the above contact details.
2. Where called upon, you shall be expected to make a feedback presentation to the hospital's Training, Research and Ethics Committee.
3. You shall maintain ethical consideration and the research subjects' confidentiality as outlined in your proposal.
4. Any patient confidential information that you may access during your research should not be used without consent.
5. You shall make payments of applicable research fees to the hospital before commencing research activities.

This letter is valid up to 5th April, 2024.
For any queries feel free to contact the committee chair through the Medical Superintendent's office or Training, Research and Ethics Committee Office.

Thank you and all the best.

SUSAN GATEI
FOR: CHAIRPERSON, TRAINING RESEARCH & ETHICS COMMITTEE,
THIKA LEVEL 5 HOSPITAL

silver silver

DETERMINANTS OF ALARM FATIGUE AMONG NURSES WORKING IN THIKA LEVEL 5 HOSPITAL, KENYA.

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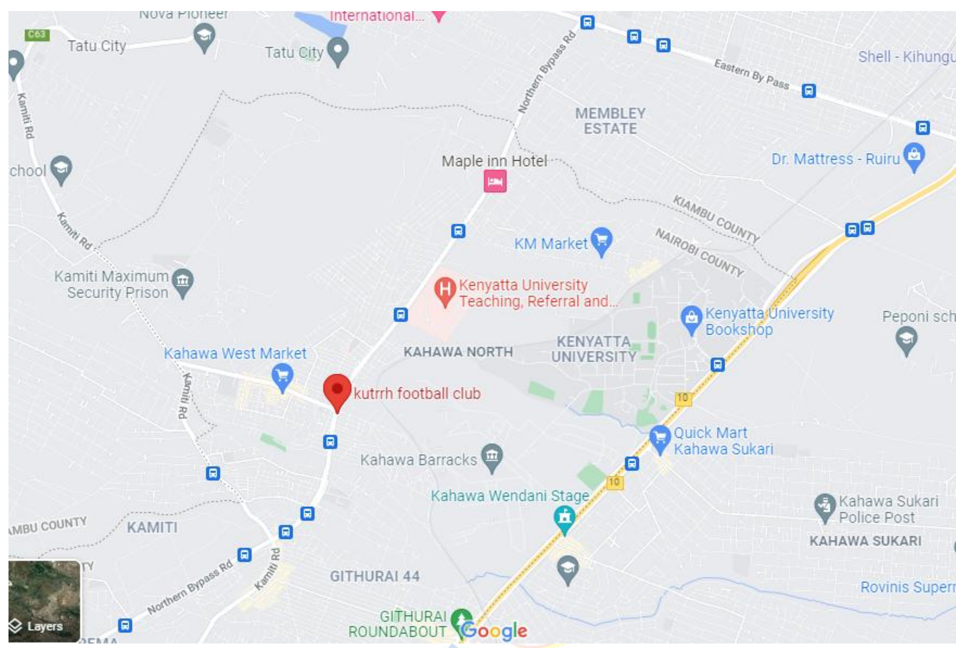
APPENDIX 5 GEOGRAPHICAL LOCATION OF THIKA LEVEL 5 HOSPITAL



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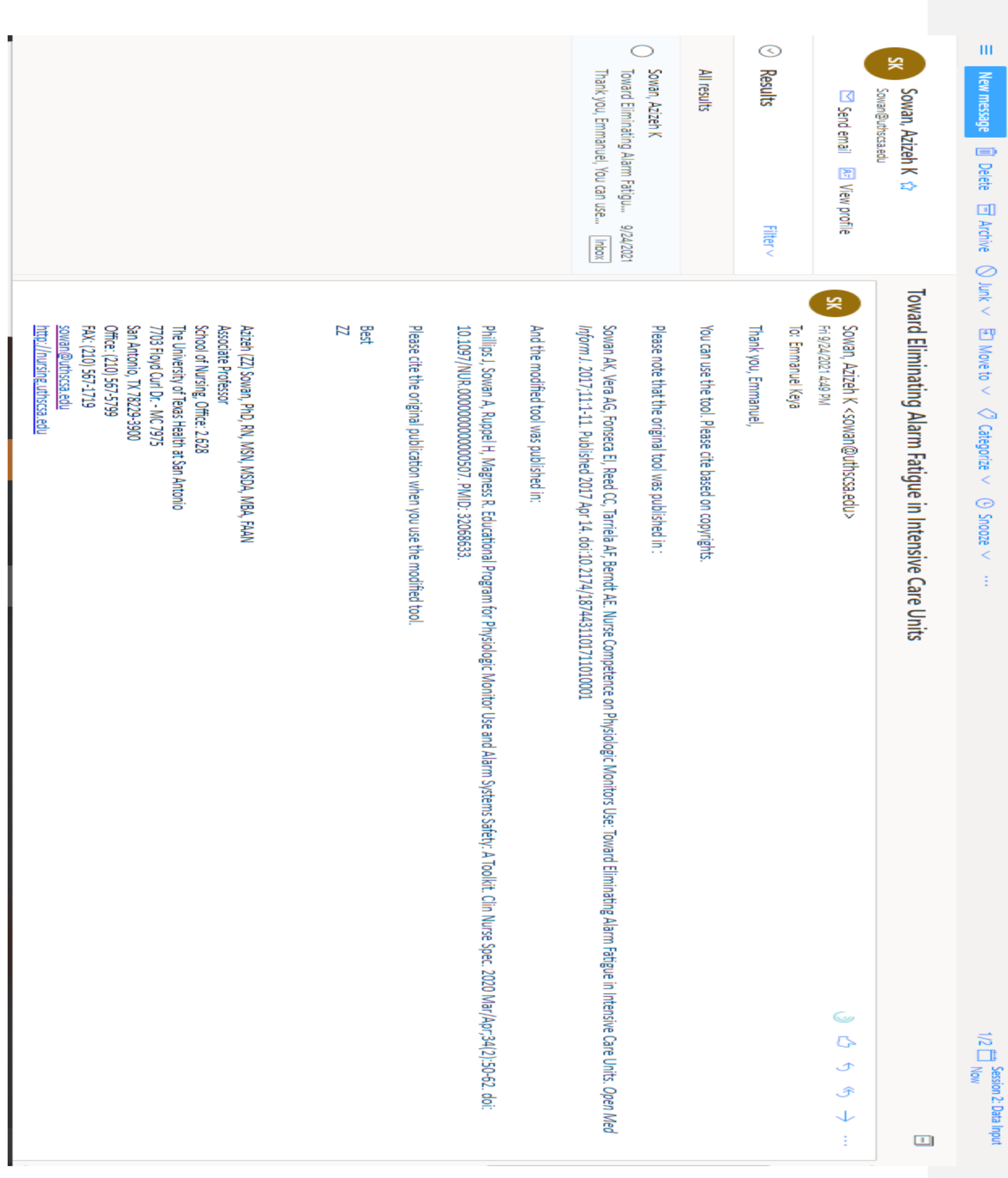
APPENDIX 5: Approval to use the tool from the Author



Toward Eliminating Alarm Fatigue in Intensive Care Units

Sowan, Azizeh K <sowan@uthscsa.edu>
Fri 9/24/2021 4:49 PM
To: Emmanuel Keya

Thank you, Emmanuel,

You can use the tool. Please cite based on copyrights.

Please note that the original tool was published in :

Sowan AK, Vera AG, Fonseca EI, Reed CC, Tarriela AF, Berndt AE. Nurse Competence on Physiologic Monitors Use: Toward Eliminating Alarm Fatigue in Intensive Care Units. *Open Med Inform J*. 2017;11:1-11. Published 2017 Apr 14. doi:10.2174/1874431101711010001

And the modified tool was published in:

Phillips J, Sowan A, Ruppel H, Magness R. Educational Program for Physiologic Monitor Use and Alarm Systems Safety: A Toolkit. Clin Nurse Spec. 2020 Mar/Apr;34(2):50-62. doi: 10.1097/NUR.0000000000000507. PMID: 32068633.

Please cite the original publication when you use the modified tool.

Best

ZZ

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CHAPTER THREE

RESEARCH METHODOLOGY

CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSIONS

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CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

REFERENCES (Must follow APA referencing style version 7)

APPENDICES

Insert the required appendices sequentially (each on its own page)

I) Research tools
II) ERC certificate
III) Introduction letter from MKU

IV) NACOSTI research license
V) Field entry /Research Authorization
VI) Turnitin report (First two (2) pages
VII) Research site map
VIII) Long tables (if any)

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