Arab American University

Faculty of Graduate Studies

Department of Administrative and Financial Sciences

Master Program in Quality Management in Health Institutions

Assessment of Attitude and Competence towards Clinical Alarm Management among Intensive Care Units Nurses in Palestine: A Cross-sectional Quantitative Study

Tariq Nazeh Sadeq Fuqha

20211336

Supervision Committee:

Dr. Yahya Saleh

Dr. Sami Al- Sader

Dr. Atef Al- Remawi

This Thesis Was Submitted in Partial Fulfillment of the Requirements for the Master Degree in Quality Management

Palestine, February/ 2025

Arab American University

Faculty of Graduate Studies

Department of Administrative and Financial Sciences

Master Program in Quality Management in Health Institutions

Thesis Approval

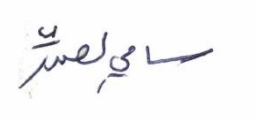
Assessment of Attitude and Competence towards Clinical Alarm Management among Intensive Care Units Nurses in Palestine: A Cross-sectional Quantitative Study

Tariq Nazeh Sadeq Fuqha

20211336

This thesis was defended successfully on 23/02/2025 and approved by:

Thesis Committee Members:

Name	Title	Signature
1. Dr. Yahya Saleh	Main Supervisor	
2. Dr. Sami Al- Sader	Member of Supervision Committee	
3. Dr. Atef Al-Remawi	Member of Supervision Committee	

Palestine, February/ 2025

Declaration

I declare that, except where explicit reference is made to the contribution of others, this thesis is substantially my own work and has not been summitted for any other degree at the Arab American University or any other institution.

Student Name: Tariq Nazeh Sadeq Fuqha

Student ID: 20211336

Signature: 

Date of Submitting the Final Version of the Thesis: 25/06/2025

Dedication

To the beloved memory of my mother, whose unwavering belief in me and insistence on my pursuit of this master's degree were the foundation of this journey. Though fate did not allow her to witness its completion, her encouragement and prayers remained my guiding light. Your absence was a profound loss, but your spirit accompanied me through every step. May you rest in eternal peace.

To my father, my first teacher and lifelong role model, who instilled in me the values of perseverance, hard work, and a love for learning. Your wisdom, support, and steadfast encouragement have been my greatest strength, and every achievement reflects the values you have taught me.

To my dear siblings, whose encouragement and joyful presence have always been a source of inspiration.

To my beloved spouse, whose unwavering faith in me provided the emotional foundation I needed to complete this journey. Your patience and understanding through long study and research nights have been invaluable.

To my extended family, whose kind words, prayers, and presence have uplifted me throughout this endeavor. Your collective encouragement and love are reflected in every milestone I have reached.

This achievement is not mine alone—it belongs to all of you, for your support has been my greatest strength.

With immense gratitude, I dedicate this work to you all.

Tariq Nazeh Sadeq Fuqha

Acknowledgments

First and foremost, I extend my heartfelt gratitude to God, the Almighty, for giving me various blessings, knowledge, and opportunities and finally allowing me to finish the thesis. Furthermore, I would like to convey my gratitude and appreciation to my supervisor, Dr. Yahya Saleh, for his assistance and guidance.

Dr. Saleh provided me with excellent knowledge in the field of research and considerable time assisting me in completing my thesis; with his guidance, support, and mentorship, I was able to progress to this point.

To my late mother, whose love and encouragement remain a source of strength, and to my father, whose unwavering support has guided me throughout—I am forever grateful.

Finally, to everyone who has contributed to this journey in any way, thank you for your kindness, encouragement, and support.

With heartfelt appreciation, I extend my gratitude to you all.

Tariq Nazeh Sadeq Fuqha

Assessment of Attitude and Competence towards Clinical Alarm Management among Intensive Care Units Nurses in Palestine: A Cross-sectional Quantitative Study

Tariq Nazeh Sadeq Fuqha

Supervision Committee:

Dr. Yahya Saleh

Dr. Sami Al- Sader

Dr. Atef Al- Remawi

Abstract

Introduction: Alarm fatigue is characterized by sensory overload and desensitization among ICU nurses due to presence of excessive alarm signals, which can affect the quality of provided care. The current study aimed to investigate levels of attitude and competence among intensive care unit (ICU) nurse towards alarm management in ICU among Palestinian nurses, as well as the most common factors affecting them and their intercorrelation.

Methods: The study adopted a descriptive, cross-sectional, quantitative design on a convenient sample of 243 ICU nurses working at 10 governmental and private hospitals in four cities in West Bank – Palestine, and used a three-part, self-administered questionnaire to assess the attitude and competence levels using Likert-scale, close-ended questions. Data were collected with full commitment to ethical criteria, and were analyzed using SPSS software.

Results: Nurses had a mean age of 28.7 years old, with 64.6% males, 73.3% holding bachelor's degree, and a mean experience of 6.4 years in nursing and 3.9 years in ICU settings. The overall attitude (mean = 68.25%) and competence (mean = 76.55%) were moderate, with significantly higher attitude among nurses not living in camps (p-value = 0.016), and with lower educational degree (p-value = 0.014), while higher competence levels were among younger (p-value = 0.002), less experience nurses (p-value = 0.004), living in urban areas (p-value < 0.001), working in private settings (p-value = 0.025) and in adult and neurosurgery ICU types (p-value = 0.007). Significant correlations were found between all domains and overall scores of attitude and competence scales (p-value < 0.05).

Conclusion: The current study found moderate levels of attitude and competence among Palestinian ICU nurses towards alarm management, reflecting low-to-moderate alarm fatigue levels. Several demographic factors were related to alarm management, with differences compared to previous studies. Nurses are encouraged to participate in continuous education and conduct future, longitudinal studies.

Keywords: alarm, intensive care unit, ICU, attitude, practice.

Table of Contents

List of Tables

List of Figures

List of Appendices

List of Definitions of Abbreviations

Abbreviations	Title
AAUP	Arab American University of Palestine
ANOVA	Analysis of Variance
CanMEDS	Canadian Medical Education Directives for Specialists
CCU	Cardiac/coronary care unit
CEASE	Communication, Electrodes, Appropriateness, Setup and Education bundle
CINAHL	Cumulative Index for Nursing and Allied Health Literature
CS	Compassion satisfaction
ECG	Electrocardiogram
ICU	Intensive care unit
IT	Information technology
NBP	Non-invasive blood pressure
NLM	National Library of Medicine
NNUH	An-Najah National University Hospital
PICU	Pediatric intensive care unit
p-value	Probability value
QI	Quality Improvement
QoL	Quality of life
r	Correlation coefficient
RCT	Randomized controlled trial
SD	Standard deviation
SPSS	Statistical Package for Social Sciences
STS	Secondary traumatic stress
US	United States

Chapter One: Introduction

1.1 Background

In various settings, including the intensive care units (ICUs), improved healthcare efficiency, safety, quality and cost were associated with the advancement of technologies that are used in the health sector, but are also associated with the necessity of nurses, as the most involved in continuous monitoring of the patients, to deal with and respond to monitors and other electro medical devices alarms (Carelli et al., 2022). In addition, as nurses are the most common users of monitoring technology, hospital administrators need to focus on them, and consider the importance of their role, with the necessity to implement training programs to improve alarm management and lower alarm fatigue among them (J. Bi et al., 2020).

The term "alarm fatigue" was used in several studies, which was defined as "*the lack of response due to excessive numbers of alarms resulting in sensory overload and desensitization*", and was considered a national problem in the United States (US), with an estimated prevalence of more than 550 related deaths per year by the year 2010, and more than one third of them were attributed to physiological monitors (Cvach, 2012). It was also defined by Winters et al. (2018) as the "*condition that occurs when a user is desensitized by the presence of excessive alarm signals, many of which are non-actionable or in some cases false, and no or delayed response to the alarm signal occurs and harm to the patient could result*". Focusing on the consequence of desensitization among the nurses, it is mostly related to what is known as "nuisance alarms", which are defined as alarms that happen when the threshold of monitor parameters are set too high, resulting in true but insignificant alarms, and when the caregiver views them as nuisance, s/he may disable, make silence or ignore the alarm, instead of creating a safer environment (Ruskin & Hueske-Kraus, 2015).

During the COVID-19 pandemic, nurses were more exposed to alarms in ICUs, which were mainly caused by the increase of clinical conditions severity, and this situation resulted in higher incidences of alarm fatigue, and was found to be significantly correlated with the level of discomfort due to alarms. Thus, it was concluded by a mixed-method study that showed worsened circumstances of nurses during the pandemic, where more than half of them worked for more than 5 months, and 12.1% needed a psychiatric support (Akturan et al., 2022). Another specific area of nursing care that is highly sensitive to

alarm fatigue is in the pediatric intensive care units (PICU), where increased response time related to desensitization is of the largest patient safety concern within healthcare for pediatric patients, who are mostly more vulnerable to errors and negative consequences of delayed care (Herrera & Wood, 2023).

Quality improvement is an essential part of international and organizational goals, such as the Joint Commission National Patient Safety Goal, which states that quality can be improved in the area of alarm fatigue and the resulted desensitization using several evidence-based steps, like proper skin preparation, electrocardiogram (ECG) electrodes daily changes, customization of alarm parameters and staff education, which were found to decrease the prevalence of false alarms. This area of assessment and interventions are in need to be tested using rigorous clinical studies, in order to determine their ability to reduce alarm burden, without the associated patient safety compromising (Sendelbach & Funk, 2013). The organized training programs that focus on behavioral changes among nurses towards alarms management is found to be associated with less non-actionable alarms, as well as lowering alarm fatigue among ICU nurses, with increased effectiveness in nurses' awareness and behavior of alarm management from the social and psychological aspects, as found by a randomized controlled trial (Jiasi Bi et al., 2020).

Alarm fatigue is a serious issue as it is accompanied by negative consequences related to the professional quality of life (QoL) among the nurses, where a study showed that alarm fatigue is a significant predictor of decreased compassion satisfaction (CS) and increased secondary traumatic stress (STS), while it, with the experience of ICU working and having a second job, were the predictors for burnout, although the study showed that alarm fatigue symptoms are mostly mild (Dehghan et al., 2023). A similar study revealed that ICU nurses who showed a certain level of alarm fatigue were significantly at risk of developing compassion fatigue and had higher risk of burnout (Storm & Chen, 2021). Studies have also shown that there is a lack of current high-quality data about alarm fatigue programs implementation, and therefore, there is a need of supportive research to improve alarm management among nurses (Dee et al., 2022).

Also, patients are prone to consequences of alarm fatigue, which includes increased cardiorespiratory events in cardiovascular surgical ICUs, where alarm fatigue increased the risk of missing critical alarms, resulting in threats on patient safety (Allan et al., 2017). This is also associated with the slower response time among nursing team caused by desensitization, increasing the risk of adverse patient outcomes, including delays in necessary interventions (Harris et al., 2017).

Another area of focus is the role of technology and its advancement in the incidence and pattern of alarm fatigue, which can be considered double-edged, resulting in positive and negative consequences. For example, a study by Cobus and Heuten (2019) found that the use of advanced multimodal wearable alarm systems that include both visual and tactile feedback on the ICU alarms have successfully and significantly increased the response rate and decreased the response time to alarms in ICU, with higher suitability and lower annoyance compared to the conventional acoustic alarm systems, and despite its high cost, it showed that technology can play a positive role in reducing alarm fatigue among ICU nurses. On the other hand, the main source of desensitization to alarms is caused by monitoring devices generating excessive amount of false alarms, which is considered to be caused by the advancement in technologies of alarm devices, and therefore, the overwhelming number of false or nonactionable alarms should be a point of focus, with several information technology (IT)-based solutions that can be proposed, like the provision of software updates that aim to reduce false alarms (Chromik et al., 2022).

The proper standardization of any policy starts from assessing the related problem, and therefore, the current study aims to investigate the attitudes and competence of ICU nurses towards alarm fatigue at selected non-governmental hospitals in West Bank – Palestine, as well as the most common related sociodemographic and professional factors that affect them.

1.2 Problem Statement

Nurses are exposed to a variety of stressors during their work in the Intensive Care Units (ICUs), and monitoring devices alarms are one of the most common types of audible stressors, in which they are subjected to too many of them, their usual workflow is disrupted, and therefore, errors may occur related to omission, inattention or distraction. Also, there is a need for development of more policies, procedures, guidelines and appropriate training of nurses about alarm management to decrease alarm fatigue (Alsuyayfi & Alanazi, 2022). Moreover, reviews showed lack of randomized controlled trials (RCTs) on the effectiveness of training programs on alarm fatigue management on the actual alarm management skills (Dee et al., 2022).

In the topic of alarm fatigue and the nursing involvement, more research is needed, and as the variables related to alarms' audibility and types are still controversial, with not enough number of studies that cover the proper settings of alarms parameters, as well as

the attitudes and competencies of nurses, this topic is under-covered in the Palestinian literature.

The main gap in knowledge related to alarm fatigue area is about the need for standardization across devices, and how nurses are involved in this standardization process, considering them as the most healthcare professionals who deal with them. More specifically, the implementation of modern technologies is needed, with the help of the nurses' role, like the use of wireless technologies, is also needed, resulting in more assessment accuracy and improvement of nurses' attitude and competency, leading to enhanced patient's safety and quality of care.

1.3 Significance of the Study

Assessing the attitude and competence levels of ICU nurses towards clinical alarm management will help in focusing on the nurses' role and their participation in the evidence related to alarm fatigue in several areas, such as the effect of alarms on the staff's accomplishment, their response to alarms, audibility levels that nurses are mostly exposed to, the technologies and techniques that nurses tend to use to reduce false alarms, and how alarm notification systems are involved.

The understanding of the aspects is also necessary because nurses are the frontline responders to alarms and play a crucial role in the mitigation of alarm fatigue and its impact on patient outcomes. Therefore, the necessity of the current study includes trying to provide evidence on how ICU nurses perceive and manage clinical alarms in terms of their effect on nurses' workflow efficiency, cognitive load and stress level, as well as their behaviors towards alarms, including their reaction and prioritization strategies, with the focus on challenges and environmental factors.

The current study also helps in reflecting the nurses' specific attitudes and competencies related to alarm management in the ICU settings of Palestinian hospitals, which would help decision-makers and related stakeholders to provide an evidence-based interventions that increase nurses' participation in the inter-professional teamwork to enhance patients' safety and appropriateness of monitoring (Sendelbach & Funk, 2013). The Palestinian healthcare system faces challenges related to staffing shortages, workload intensity and alarm management protocols may differ hospitals of high-income countries, therefore, the findings of the current study provide valuable insights on the development of targeted educational programs to enhance nurses' alarm management competence, evidence-based

interventions to reduce alarm fatigue and improve response time, as well as strategies to strengthen interprofessional collaboration for better motoring and patient safety practices.

1.4 Study Aim and Objectives

The main aim of the current study is to investigate the quality of care the nurses implement in terms of their response to medical devices alarms and their management in the ICU settings, which is conducted by achieving the following objectives:

1. Investigating the level of attitude and competency towards medical devices alarms and their management among the Palestinian ICU nurses.
2. Determining the most common aspects of medical device alarms that Palestinian nurses in ICU settings are dealing with, in terms of their frequencies and severity.
3. Determining the relationship between Palestinian nurses' demographic and professional factors and their attitude and competency levels towards medical devices alarms.
4. Investigating the correlation between Palestinian ICU nurses' attitude and competency levels towards medical devices alarms.

1.5 Study Questions

The study aims to answer the following questions:

1. What are the levels of attitude and competency towards medical devices alarms and their management among the Palestinian ICU nurses?
2. What are the most common aspects of medical device alarms that Palestinian nurses in ICU settings are dealing with, in terms of their frequencies and severity?
3. Is there a relationship between Palestinian nurses' demographic and professional factors and their attitude and competency levels towards medical devices alarms?
4. Is there a correlation between Palestinian ICU nurses' attitude and competency levels towards medical devices alarms?

1.6 Study Hypotheses

In accordance with the study questions and objectives, the following hypotheses have been formulated:

1. H_1: There is no significant relationship between Palestinian nurses' demographic (age, gender, residency, … etc.) or professional (experience, ICU type, receiving courses,

… etc.) factors and the level of attitude towards medical devices alarms in the ICU settings at a significance level of 0.05.

2. H_2: There is no significant relationship between Palestinian nurses' demographic (age, gender, residency, … etc.) or professional (experience, ICU type, receiving courses, … etc.) factors and the level of competency towards medical devices alarms in the ICU settings at a significance level of 0.05.
3. H_3: There is no significant correlation between Palestinian nurses' attitude and competency levels towards medical devices alarms in the ICU settings at a significance level of 0.05.

1.7 Definition of Terms

1.7.1 Conceptual Definitions

Alarm Fatigue: In the conceptual aspect, it refers to the psychological and physiological responses to excessive auditory and visual stimuli in a clinical environment, leading to reduced attention, impaired judgment, and decreased ability to respond effectively to critical alarms, in which the associated desensitization leads to slower response time and missed alarms, increasing the risk on patient safety (Cvach, 2012; Winters et al., 2018).

Attitude: It refers to the beliefs, feelings and behavioral trends towards the use, perceived importance and willingness to be engaged in proper practices, and includes three main components, which can be applied in the context of alarm fatigue: cognitive (including knowledge, awareness and beliefs about alarms), affective (including the emotions and feelings towards alarms) and behavioral (including the possibility of taking specific actions in response to such alarms), and therefore, attitude of nurses can influence their mental and emotional view which they hold towards alarms in their management (Ajzen, 2001; Albarracin et al., 2005).

Competence: The competence level of ICU nurses related to alarm fatigue can be conceptually defined as the combination of skills, knowledge and abilities that the nurse acquires and implement to manage and response to alarms in an effective way, which is driven by the conceptual definition that involves the technical expertise to accurately operate and interpret alarms, as well as the skills of decision-making and cognition that is required to response to several alarms which are specific to the ICU environment, in addition to the ongoing improvement and development of skills and adaptation to new technologies and protocols (Epstein & Hundert, 2002; Frank et al., 2015).

1.7.2 Operational Definitions

Alarm Fatigue: In the operational side, alarm fatigue refers to the measurable decrease in healthcare providers' (including nurses) rate and accuracy of response to medical alarms in a specific time period, mainly related to overwhelming number of false or nonactionable alarms, and can be quantified in measurement by assessing alarm occurrence frequency, nonactionable alarms' proportion, response time to actionable alarms and missed or ignored alarms' rate, taking into consideration the use of surveys and questionnaires to measure the subjective experience of fatigue, stress or frustration among nurses who are exposed to such alarms (Allan et al., 2017; Lewandowska et al., 2020).

Attitude: In the context of the current study, the attitude of nurses towards alarm fatigue can be operationally defined as the measurable expression of ICU nurses' perspectives and reactions toward alarm systems, which can be assessed using surveys, interviews, or behavioral observations, and includes several metrics, like the score on a Likert scale to assess the agreement with statements about alarm management, the frequency of positive or negative expressions to thoughts during interviews, or observed compliance with alarm management protocols (Fishbein & Ajzen, 2010; Zea et al., 2003).

Competence: The competence level of nurses related to alarm fatigue can be operationally defined as the measurable outcomes and performance of the ICU nurses related to their alarm systems management, including the assessment using practical exams, simulations, observation of their behaviors, and self-reported measures of confidence and proficiency, targeting specific variables related to alarm response speed, the ability to prioritize alarms and correctly adhere to their protocols, and the involvement in related continuous education and training programs (Benner, 1982; Currie et al., 2023; Salifu et al., 2022).

1.8 Conceptual Framework

As the current study focuses on both attitudes and perceived competence levels of the ICU nurses towards alarm fatigue and its management, several theories can be used to implement as a framework to guide the comprehension and data collection related to the current idea. Also, it is recommended to implement evidence-based theories that are related to attitude and competence of nurses, because their duty is sensitive, especially in ICUs.

Therefore, two theories of interest can be adopted, which are the Donabedian's Structure-Process-Outcome Model and Competency-Based Framework. The Donabedian's model can be used to analyze how ICU settings (structure) and the processes related to alarm management play roles in patient outcomes and alarm fatigue, while the competency-based framework can be applied to assess and develop specific competencies among nurses that are essential for improving these outcomes. In more details, the Donabedian's model consists of breaking down the evaluation of healthcare services' three main components, which are the structure, i.e., organizational and physical settings, process, i.e., delivery of care, and outcomes, i.e., the health outcomes of the patient, and it highly fits in the current study because it allows for considering attitudes and competence of nurses, in addition to the organizational context, including the design of alarm system and training programs, and how they contribute to alarm fatigue and its outcomes (Donabedian, 1988; Ghofrani et al., 2024).

Furthermore, the competency-based framework can include the CanMEDS framework, which stands for Canadian Medical Education Directives for Specialists, that was developed by the Royal College of Physicians and Surgeons of Canada, and identifies seven key roles of healthcare professionals that they should fulfill, including medical expert, communication, collaboration, leadership, health advocacy, scholarly and professionalism (Frank et al., 2015). The mentioned roles of healthcare professionals are what make this model suitable to implement in the current study, because of the structured way that can be used to evaluate several competencies of nurses to identify and manage alarms in an effective way in a critical setting like the ICU, from the technical skills to communication and teamwork, as shown in Figure 1.1.

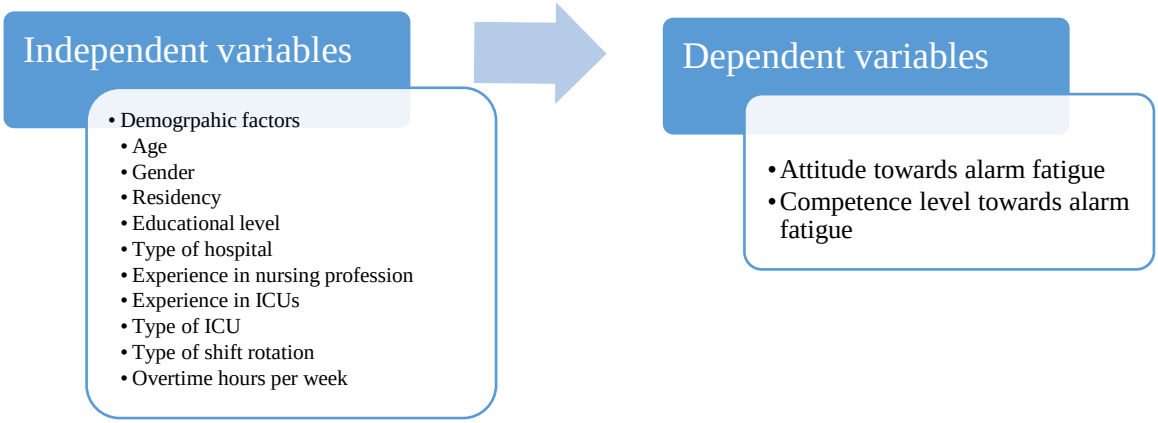


Figure 1.1: Conceptual Framework of the Current Study

In the context of the used tool to measure attitude and competence that was used in the current study, the Donabedian's SPO model provides an essential understanding of how structure (hospital settings, ICU characteristics, training programs), process (alarm management practices and adherence to protocols) and outcomes (attitude and competency levels of ICU nurses toward alarm management) interact to influence alarm fatigue and alarm management in ICU settings, therefore justifying the inclusion of variables to hospital types, shift patterns, ICU experiences and more.

In addition, the CanMEDS framework is reflected in the study tool, because it assesses the ICU nurses' competencies across multiple domains, including software and hardware aspects of alarm management, like admission, discharge, alarm limits, advanced functions and personalized settings of ICU mentoring devices. The inclusion of such domains helps the tool to effectively focus on the multidimensional competence that is required for ICU nurses to properly manage alarms in an efficient way, therefore, this integration supports that this competence assessment aligns with internationally recognized competency-based models for healthcare professionals.

1.9 Thesis Structure

This thesis contains the following chapters:

Chapter 1: Introduction

This chapter introduces the thesis topics, background, problem statement, significance of the study, the purpose of the study, and the specific objectives.

Chapter 2: Literature Review

This chapter includes a general introduction of the literature review approach, then a review of selected peer-reviewed articles that are specific in the field of alarm management and fatigue, focusing on their methodological approaches and main results of each article.

Chapter 3: Methodology

This chapter presents the research methodology. It states the study design, setting, population and sampling, eligibility criteria, data collection tool and process, review process, statistical analysis, and ethical considerations.

Chapter 4: Results

This chapter presents the study findings, and an illustration of the output mentioned there. It includes both descriptive and analytical results applied in accordance with data analysis plan and to achieve the study objectives.

Chapter 5: Discussion & Conclusion

This chapter presents the main study findings and their comparison with previous literature, the study's conclusion, recommendations, and future work.

Chapter Two: Literature Review

2.1 Overview

This chapter is dedicated to reviewing the most recent and related literature of the nurses' attitudes and competence towards alarm fatigue, as well as the most common related sociodemographic and professional factors, including the barriers that nurses face during alarm management. The current review included studies that were extracted from a thorough search in the scientific databases of PubMed (from the National Library of Medicine [NLM]), Cumulative Index to Nursing and Allied Health Literature (CINAHL) and ScienceDirect (from Elsevier) and used the following keywords: alarm, alarm fatigue, intensive care unit, ICU, attitude, practice, management. Most suitable regional and international articles that were published in the recent years in English language were reviewed.

2.2 Nature and Impact of False Alarms and Alarm Fatigue

To take a comprehensive look at the alarm fatigue problem, studies have been conducted to analyze the most common alarms that happen in the ICU settings. Drew et al. (2014) conducted an observational study that to investigate the insights of alarm fatigue problem with physiologic monitor devices among a sample of 461 adult patients, and analysis included a total of more than 2.5 million unique alarms that occurred during the study period that extended for 31 days. Results showed that of the 12,762 annotated arrythmias alarms, 11,251 were false alarms, with around 187 alarms per bed per day. Several causes were investigated to cause false alarms, including persistent atrial fibrillations, inappropriate settings of alarms, as well as alarms that require no needed actions, such as non-persistent PVCs and ventricular tachycardia (found in 93% of them) and brief ST-segment spikes. It is worth noting that most of the alarms, as well as false alarms, are related to the cardiovascular system functioning.

Another study stated that false alarms are the most commonly experienced problem related to alarm fatigue, with significantly higher fatigue level among less experienced and younger nurses, and they reported that inappropriate actions to manage alarm problems, including turning off or muting them, may increase the risks associated with false management on the patients, while negative consequences that happen to nurses

themselves include decreased concentration and increased physical workload (Karahan et al., 2023).

2.3 Interventions to Manage Alarms in the ICU Settings

In the specific area of the interventions that were established and tested to evaluate their efficacy in the alarm management among ICU nurses is the CEASE bundle, which was first introduced by Drew et al. (2004), and explained by the American Association of Critial-Care Nurses (2013). The bundle includes specific areas to focus on in each of the components, like the "communication" domain that focuses on communication with colleagues and the alarm suspension when caring is not creating actionable alarms. Also, the domain of "electrodes" focuses on electrocardiograms (ECG), like daily or when-needed change of electrodes, correct placement, proper skin preparation and application, and the pulse oximeter, like changing sensors when needed and checking skin integrity under it.

In addition, the domain of "appropriate" is considered with the interprofessional collaboration, especially physicians, specifically in terms of monitoring the patient's critical parameters, appropriateness of orders and chosen monitoring parameters, and discontinuing them when no longer necessary. The "setup" domain focused on parameters' customization for each individual based on the institutional policies, like for the default limits for heart rate, blood pressure, respiratory rate and SpO2 measurements, taking into account not changing ventricular tachycardia, ventricular fibrillation or asystole limits, customizing the limits within ±10% pf the baseline, and within 1 hour as patient condition changes. Lastly, the domain of "education" is about educating nursing staff regarding monitoring systems and its alarm communication algorithms (Lewis & Oster, 2019).

As the nurses are the frontline in dealing with such phenomena, interventions related to the improvement of responses to alarms mainly involved nurse-driven, patient-customized interventions, like the bundle of CEASE, which is an evidence-based set of actions that were tested by Lewis and Oster (2019), and stands for Communication, Electrodes (daily changes), Appropriateness (evaluation), Setup alarm parameters (patient customization), and Education (ongoing), which was found to significantly decrease the times of low-priority alarms level 1 and high-priority level 3 alarms, as well as the decrease in the perceived nuisance alarms from 68% to 44% after the implementation of this bundle on a 36-bed ICU.

Lewandowska et al. (2020) conducted a systematic review that included a quantitative assessment of the issues that inhibit the effective management of clinical alarms among ICU nurses, and used weighted average scores to rank them, which were based on the domains of the Health Technology Foundation questionnaire. The results showed that the most burden is related to frequent false alarms, leading to attention and response reduction, followed by difficulties in understanding alarms priority, inadequate staffing to respond to such alarms, difficulties in hearing them, identifying their source, over reliance on alarms to call attention to patients' problems, lack of training and difficulties in properly setting the alarms. On the other hand, Movahedi et al. (2023) highlighted several actions to be taken by ICU nurses to deal with alarm fatigue, including technological and non-technological actions, like identification of alarm cause and take actions in timely manners, as well as the use of personalized alarm settings, and reduce the unnecessary alarms, in addition to self-calmness, effective teamwork and improving ward management and physical environment, and such actions can be referred to smart care for dealing with alarm fatigue among ICU nurses.

It is important to understand how nurses manage the high number of alarms that they face during their care of patients, as well as the interventions that they implement to prevent the adverse effects of them. Therefore, a qualitative study on a sample of 37 nurses in Taiwan (Shih et al., 2022) have derived four main themes that are involved in such issues with alarm management, which included critical care nursing practice that is the cornerstone of these practices and their competences, in addition to the necessity to adopt trajectories of alarm management that are needed to be evidence-based, while taking the impact of alarm management and fatigue on the outcomes of patients and their safety into consideration, and the use of new technologies that include learning alternatives and wireless devices. Barriers related to alarm management were also studied. For example, a descriptive study on a sample of 48 ICU nurses in South Korea (Jeong & Kim, 2023) found that the alarm fatigue level was moderate to high (mean score = 29.1 out of 40), and that the nurses frequently stated issues related to frequent false alarms and staffing inadequacy as the most common challenges and barriers related to alarm management. Such results call for the need to adopt standardized clinical alarm management protocols, which may help with faster, more accurate and more appropriate alarm response in ICU settings.

2.4 Review of Factors Related to Attitudes and Competence of ICU Nurses Towards Alarm Management

Studies focused on the attitudes and competencies of nurses towards alarming, as well as the most common related barriers. A good example is the study of Ramlaul et al. (2021) on a sample of 91 ICU nurses, which showed that majority of the nurses (85.7%) are strongly aware of the purpose of alarming devices, as well as that differentiation in audiovisual displays of alarms depends on their priority (75.8%), with less percentage (52.7% agree) that nuisance alarms may result in lack of response by many nurses, and that they interrupt care (46.2%), occur frequently (53.8%), and reduce trust in serious alarms (35.2%). Also, Higher percentages of nurses disagree that alarms are overwhelming (56.0%), contribute to their stress level (40.7%), and that some of them were not heard or were missed (60.4%). Barriers to effective alarm management were mostly focused on difficulty in setting alarms properly, lack of training, difficulty in hearing them, and difficulties in identifying their sources and priority. Other studies found similar results in terms of the lack of standardization in alarm settings, and that further improvement in nursing management is needed (Petersen & Costanzo, 2017).

An interesting study by Funk et al. (2014) was conducted and compared the attitudes and practices of ICU nurses towards alarms in two separate periods (2005 and 2011), and found that in the overall view of items that were used to ask about alarms, there were no significant differences between the two periods, indicating insignificant improvement in nurses' dealing with alarms, but the significant specific improvement was noticed in the item of frequency of nuisance alarms, while false alarms are still the most common issue addressed by nurses in the ICU settings (Funk et al., 2014). The previous findings are also parallel with the findings of Casey et al. (2018), who stated that 90% of the nurses agreed about the high frequency of non-actionable alarms, and that they are associated with disrupted care (91%), with decreased trust in alarming system and intention to ignore or silence then (81%). The study also found that level of knowledge about alarming system management was low or uncertain among 52% of the nurses, and that 31% of them found policies and procedures of alarm management to be effectively used.

The theory of planned behavior was implemented in a Chinese randomized, single-blind trial by J. Bi et al. (2020) on two groups of 93 ICU nurses, and aimed to investigate the effectiveness of implementing specific alarm management training program on reducing alarm fatigue among ICU nurses, where the interventional group (n = 47) has received a 12-week alarm management training program using the mentioned theory, and targeted

several aspects of alarm fatigue to be measured. Results showed that the alarm fatigue scores were not significantly different between interventional (mean = 27.70) and control groups (mean = 28.26) in the pre-interventional phase, while after implementing the training program, the scores significantly decreased among the interventional group (mean = 20.57), while they did not significantly change among the control group (mean = 28.15). Also, the total number of alarms of the monitor significantly decreased among nurses of the interventional group from a mean of 150.91 to 87.52, while it did not significantly change among control group nurses (from 152.99 to 154.71). While the same pattern applied for the number of nonactionable alarms, where it decreased from a mean of 93.76 to 28.16 among the interventional group compared to 89.93 to 91.43 among control group, the number of true crisis alarms did not significantly improve, where it remained similar in the interventional (from 57.15 to 59.36) and control (from 63.06 to 63.29) group. This trial supports the importance of providing nurses with alarm management training programs, which would be enhanced by an evidence-based theory, as an effective way to improve ICU nurses' critical care training system.

A Polish pilot study that was conducted by Lewandowska et al. (2023) implemented the cross-sectional design on a sample of 400 ICU nurses, who were 88.0% males, 60.0% holding the master's degree, 56.0% are specialized in anesthesiology or intensive care nursing, and 63.0% working in adult ICU, with the aim of investigating the level and predictors of alarm fatigue in the ICU setting. The descriptive results showed that the overall mean alarm fatigue score was 25.8 ± 5.8 out of 44, which equals to 58.6%, which can be considered a moderate level of alarm fatigue, and was not significantly different in the univariate analysis across any of the demographic or professional factors, except for receiving a training program related to the use of monitoring devices available at the ward, whether it was a regular or a one-time training, compared to not having at all. When implementing the regression model, it was found that receiving a regular (B = - 0.21, p-value = 0.04) or one-time (B = -0.17, p-value = 0.03) training program, working at intensive cardiac surveillance unit (B = 0.10, p-value = 0.01, compared to the rest of ICU types), and working either 12-hour or 24-hour shifts (B = 0.11, p-value = 0.01, compared to 8-hour shifts) were considered significant predictors of higher scores of alarm fatigue among ICU nurses. The study concluded the significance of alarm management burden on the ICU nurses who were sampled in their study, with the necessity of increasing the awareness levels among nurses about the consequences of alarm overburdening and fatigue, as well as the importance of identifying alarm fatigue-related factors.

In a descriptive study that was conducted in a Magnet hospital in the USA by Sowan et al. (2017), researchers recruited a total of 30 ICU nurses who were asked to fill in valid scale of 59 items and 2 open-ended questions, which included multiple domains on the competence of physiologic monitors. The nurses were mostly females (83%), with less than 3 years of experience (63%), not receiving a specific training in the last 12 months (83%) and working in neuro (47%) or surgical trauma (37%) ICUs. The nurse's competence was the best at domains of appropriate monitoring (mean = 76.9%), followed by admit, discharge and transfer patient (mean = 74.0%) and alarm management (mean = 72.6%), which were higher than domains of hardware and connectivity (mean = 41.9%) and advanced functions (mean = 39.0%). The analytical results also found no significant differences in domains' scores across all of the studied demographic factors. In the qualitative part of the analysis, nurses asked for more training on the use of monitors, and the necessity of having and being trained on the use of central monitors.

In Palestine, a descriptive, cross-sectional study was conducted by Salameh et al. (2024) on a sample of 187 ICU nurses in northern and central Wet Bank hospitals, and used Alarm Fatigue Scale (AFS) and perceived stress scale (PSS), in order to assess these aspects from the Palestinian perspective. The results of the study revealed that the overall mean score of AFS was 23.36 out of 44, where 37.4% of the nurses were classified as having low alarm fatigue, compared to 33.2% with average classification, which was significantly higher among females (mean = 24.60) compared to males (mean = 22.65, p-value = 0.021), while other factors were not significantly related to alarm fatigue, including age, marital status, experience, educational level, type of ICU, type of work shift or extra hours. The results also showed a significant relationship between alarm fatigue and stress scores, where ICU nurses with high classification of AFS significantly showed higher mean scores of PSS (mean = 19.45) compared to low AFS classification (mean = 15.53, p-value < 0.001), and vice versa, where the nurses with high classification of PSS significantly showed higher scores of AFS (mean = 26.79) compared to nurses with low PSS classification (mean = 21.37, p-value < 0.001). The researcher concluded the importance of addressing alarm fatigue issue among ICU nurses, as it is related to major risk for patient safety, and that educational interventions are needed to be assessed in future research on their impact on ICU nurses' alarm fatigue levels, which may also help in the reduction of their stress levels.

2.5 Effectiveness of Education and Training of ICU Nurses on Alarm Management and Fatigue

The impact and importance of systematic and continuous education on the alarm fatigue is studied in an integrative review by Nyarko et al. (2023) on a total of 13 studies from 2016 to 2021, where most of the included studies have shown the beneficial results in reducing alarms and false alarms numbers. In addition, the studies have shown positive impacts of such educational efforts in enhancing the perception of nurses towards alarm management, which has participated in the reduction of alarm fatigue and increasing their knowledge levels, leading to better practices, indicating a positive correlation between improving ICU nurses' knowledge, enhancing their attitudes and encouraging better practices.

In Saudi Arabia, a study was conducted by Paredath and Al Jarary (2023) on a sample of 85 ICU nurses aiming to investigate the effect of applying alarm fatigue strategies related to their performance, as well as their perceptions of alarm fatigue in ICUs. The nurses were more females (56.5%), between 30 and 35 years old (51.8%), from multiple nationalities, holding bachelor's degree (85.9%), and variant clinical experience in nursing and ICUs. Also, the study included 55.3% of the nurses receiving training and orientation on alarm management. The study found that the highest domains of strategies to effectively manage alarm fatigue are related to education (mean = 4.09), using optimized technology (mean = 3.98), followed by electrodes management (mean = 3.92), setup customized alarms (mean = 3.66) and attitude (mean = 3.60). Specific actions that showed high scores included ideal placement of electrodes, having the idea of responsibility, changing alarm parameters according to patient's specific condition, using a central alarm management staff, and the use of medical equipment competency assessment. As none of the domains were significantly different in their scores across all the demographic factors, the mentioned strategies can be considered to be equally suitable for alarm management, ensuring the use of evidence-based strategies.

2.6 Conclusions and Research Gap

The previous literature review provided a comprehensive understanding of the alarm fatigue nature and impact on nurses who work in the ICUs, as well as the interventions that may be implemented to manage them, and the role of educational training in addressing and dealing with this issue, with sufficient number of studies that support the significant challenge of alarm fatigue, which may lead to sensory overload, reduced

responsiveness and potential risk on patient safety. The importance of evidence-based interventions, like the CEASE bundle and structured training programs, is also addressed in the previous literature review, which showed effectiveness in unnecessary alarm reduction and improvement in nurses' competence towards alarm management.

Moreover, the studies showed that despite the advancements in alarm management protocols, several challenges are present, including difficulties in setting alarms properly, identification of alarm resources, differentiating the priority levels of alarms, and others, highlighting that ICU nurses' attitudes and competencies regarding alarm management have varying levels of awareness and training gaps, and is supported by studies that were conducted regionally and internationally, emphasizing the prevalence of alarm fatigue and its associated factors, like stress levels, workload and staff shortage.

On the other hand, a research gap persists, where several studies have focused on the alarm fatigue prevalence, related factors and consequences, but fewer studies have focused on the impact of structured educational and training programs on the improvement of alarm management and competence, as well as mitigation of fatigue among ICU nurses, especially in the Middle Eastern and Palestinian contexts. In addition, there is a limited research on the long-term impact of such interventions on other outcomes, especially on the patient's level, adding to the scarcity of studies in Palestine and near regions, which have cultural and systemic differences that may play a role in influencing alarm fatigue experience and the management strategies. Therefore, the current study aims to add to the Palestinian research body and focus on addressing the attitudes and competence levels of ICU nurses in governmental and private hospitals towards alarm management, and the most commonly related factors.

Chapter Three: Research Methodology

3.1 Study Design

The current study adopted the descriptive, cross-sectional, quantitative design, in which the researcher aimed to quantitatively determine the attitude and competence levels of the samples ICU nurses in targeted hospitals regarding alarm fatigue and alarm management. Also, the researcher aimed to test several hypotheses related to the investigation of the most common demographic and professional factors that are associated with attitude and competence levels. The chosen study design is suitable for the aim and objectives of the study, as it allows for the measurement of multiple variables at once, as well as the ability to express the results in a comprehensive, quantitative way. This also allowed the researcher to compare the findings of the current study with those of the previous studies that were reviewed in previous literature.

3.2 Site and Setting

The study was conducted in selected governmental and non-governmental hospitals in West Bank – Palestine, involving several cities in the northern provinces of West Bank, namely Ramallah, Nablus, Tulkarem and Jenin, which included a variety of nurses' experiences and educational degrees, as well as their suitability for the intended sample size. The southern provinces were excluded due to the difficulty in mobility and in the expected poor responses of nurses to be surveyed.

3.3 Study Population and Sample

The study population included all ICU nurses who currently work at the selected settings, regardless of age, gender, experience, … etc., while the sample size was calculated using Sample Size Calculator, Raosoft Inc., with a 5% margin of error, a 95% confidence interval and a 50% of response distribution. Based on the total number of nurses who work at the targeted ICUs (approximately 430). Using Steven Thompson formula, the recommended sample size was 204, while the researcher recruited a total of 243 ICU nurses, which was proportionally recruited from each ICU according to the participation in the total population size.

The sampling method was convenient, in which the researcher gathered the data from the nurses who were available at the time of data collection and was chosen due to its time-

and cost-effectiveness (Jager et al., 2017), as well as the inability to follow up the nurses along their shifts. The details related to sampling from the targeted hospitals are shown in the Table 3.1.

Table 3.1: Distribution of Sampled ICU Nurses from the Targeted Hospitals

Hospital's name	**Type**	**Total nurses**	**Sampled nurses**
Ramallah			
Istishari Arab Hospital	Private	54	24
H-Clinic Hospital	Private	45	25
Palestine Medical Complex	Governmental	127	71
Jenin			
Ibn Sina Specialized Hospital	Private	39	23
Al-Razi Hospital	Private	17	12
Martyr Khalil Suleiman	Governmental	49	25
Nablus			
Nablus Specialized Hospital	Private	25	15
Al-Watani Hospital	Governmental	31	18
Rafidia Surgical Hospital	Governmental	28	19
Tulkarem			
Al-Israa' Hospital	Private	16	11
Total		**431**	**243**

3.4 Eligibility Criteria

Nurses who were currently working in a full-time job in the targeted ICUs, regardless of age, gender, residency, educational level, experience level, type of ICU, shift rotation type or number of weekly overtime hours, and agreed to participate in the study were included in data collection and analysis. The targeted ICUs included adult ICU, surgical ICU, cardiac/coronary care units (CCUs), neurosurgery ICUs, pediatric ICUs and neonatal ICUs. Nurses who were in their annual, sick or maternity leaves, working as part-time job or refused to participate in the study were excluded from data collection and analysis.

3.5 Study Variables

Independent variables include demographic data (age, gender, residency and educational level) and professional data (type of hospital, name of the hospital, experience years in

nursing profession and ICUs, type of ICU, type of shifts and number of weekly overtime hours) of the nurses.

Dependent variables include attitude and competence levels of the ICU nurses towards alarm fatigue and management.

3.6 Data Collection Tool and Process

The researcher used an online, self-administered questionnaire (as shown in Appendix A) that was developed based on previous literature, and it consisted of three major parts: demographic and professional data, attitude towards alarm fatigue and management, and competence towards alarm management. Close-ended questions were used because they are easier to answer by the nurses, less time consuming, and are more suitable for quantitative analysis and presentation (Hyman & Sierra, 2016).The first part of the questionnaire consisted of 10 close-ended questions related to the ICU nurses' demographic and professional factors, including age (in complete years), gender (male or female), residency (city, village/town or camp), latest educational level (diploma, bachelor's or higher educations), type of hospital (governmental or non-governmental), experience years in nursing profession and ICUs (in complete years), type of ICU (adult, cardiac, surgical, neurosurgery, pediatric, neonatal or other type), shift type (morning, evening/night or mixed), and the number of weekly overtime hours. For the online form of questionnaire, the name of the hospital was added to easily track the number of recruited nurses from each hospital to help in reaching the proportional recommended sample size from each of them, while it was not used in the final data analysis.

The second part of the questionnaire consisted of the attitude towards alarm fatigue and management part, which included 20 close-ended statements that were rated on a 5-point Likert scale, from 1 (Strongly disagree) to 5 (Strongly agree), in addition to 9 statements related to ranking specific issues related to alarms from 1 (the most important) to 9 (the least important). The attitude part was adopted from the previous literature (Clinical Alarms Task Force, 2007), that was developed by the American College of Clinical Engineering Healthcare Technology Foundation, and originally consisted of 22 items on a 5-point Likert scale, and the same 9 items related to alarm issues. The attitude part was translated to Arabic language by a registered translator, and then the questions were reviewed for their suitability to study population, and after been reviewed by a panel of experts to validate the content, 2 questions were removed. The attitude level was calculated by summing the codes of statements for each nurse and convert it to a score

out of 100%, with higher scores indicating more positive attitude towards alarm-related management and fatigue. The scores were also classified to three categories: Poor (attitude score < 60%), Moderate (attitude score between 60% to less 80%), and High (attitude scores of 80% and higher).

The third part was concerned with measuring the competence level of ICU nurses related to alarm management, reflecting alarm fatigue. The competence part was also adopted from a previous literature (Sowan et al., 2017). It originally consisted of 59 items that were classified to 5 domains (admit, discharge and transfer of patient, hardware and connectivity, alarm management, appropriate monitoring and advanced functions), which are rated on a three-point Likert scale (confident, neutral and not confident), with a fourth option related to never used. The competence tool was also translated to Arabic language by a professional translator, and then was reviewed by the expert panel and suggested several edits to the content and translation of some phrases, which were all taken seriously, with the deletion of 15 items due to repetitive ideas, not suitability with the context of Palestinian ICU practices, and combination of some statements, resulting in the final competence tool to include 44 statements.

The competence level was also calculated by summing the codes of statements for each nurse and convert it to a score out of 100%, with higher scores indicating higher competence towards alarm-related management and fatigue. The scores were also classified to three categories: Poor (competence score < 60%), Moderate (competence score between 60% to less 80%), and High (competence scores of 80% and higher).

The use of a three-level classification of attitude and competence levels facilitates the differentiation of attitudes and competence in a way that can be easily interpreted and compared across different groups or interventions, in addition to its alignment with previous methods in research, where such thresholds often identify meaningful differentiation in nurses' attitudes.

The questionnaire was distributed by the researcher using an online Google Form, which consisted of an informed consent that clarifies the aims of the study, content of the questionnaire, and ensuring the anonymity and confidentiality of the collected data. If the nurse agreed to participate, the form proceeds to the next sections consisting of questionnaire parts. The researcher repeatedly contacted ICU head nurses to remind them to distribute the questionnaire to more nurses as needed to fulfill the recommended sample size, which was based on tracking the number of submitted forms depending on the question related to name of the hospital. The submitted forms were connected to the

researcher's private e-mail to ensure privacy and security of the data, until the start of data analysis.

3.7 Period of the Study

The data collection process was conducted between November 4th and December 31st, 2024, which was a suitable period to recruit the recommended sample.

3.8 Validity and Reliability

For the validation of attitude and competence parts, the translated scales were reviewed by a panel of 5 experts in the field of the study, including 2 faculty doctors, 2 experienced ICU nurses and 1 experienced biomedical engineer. The reviewers were asked to evaluate the content and coverage of the statements, as well as their suitability to the context of ICU practices in Palestine, especially the differences in types and advancement levels of ICU monitoring devices across the Palestinian ICUs. All reviewers provided minor editing recommendations, with the recommendation of deleting some statements, as described above. The reviewed version of the questionnaire was then used in a piloting phase.

For the reliability part, the internal consistency of the attitude and competence scales was tested using Cronbach's alpha test via the data analysis software, with a cut point of 0.7 to consider the scales reliable. The result of Cronbach's alpha for attitude scale was 0.717, indicating an acceptable level of internal consistency, and for the competence scale was 0.942, indicating a high level of internal consistency. These high scores of internal consistency indicate that the scale is reliable, generalizable, and that it can be repeatedly used among similar populations in future research.

The competence scale with a very high Cronbach's alpha score of 0.942 may reflect redundancy, which may indicate that some items are measuring the same aspects, and because the scale was derived from validated tools and cannot be modified at this stage, the results were interpreted within this context, and future research is recommended to consider conducting exploratory or confirmatory factor analysis to assess whether the scale can be refined while validity and reliability of the scale are maintained.

3.9 Piloting

Before the final distribution of the online form, the reviewed questionnaire was distributed to a pilot sample that consisted of 10% of the recommended sample size, who

were asked to fill in the questionnaire and give feedback regarding the content, coverage, suitability and time consumed to fill in the questionnaire. All nurses provided minor comments with positive overall feedback. Edits were conducted accordingly, and the final version of the questionnaire was rebuilt via an online Google Form and distributed to the targeted ICU nurses. It is worth mentioning that the nurses who filled in the piloting questionnaire worked outside the targeted hospitals, and their responses were not included in the final data analysis and interpretation.

3.10 Data Analysis

The data were analyzed using Statistical Package for Social Sciences (SPSS) software version 25.0 on Windows OS. Firstly, the normality of the data was tested using Kolmogorov-Smirnov and Shapiro-Wilk normality tests, and had a p-value of > 0.05, indicating that the data follow the normal distribution curve, resulting in the use of parametric tests. The software was used to analyze the descriptive and analytical results, where descriptive results included frequencies and percentages of ICU nurses' responses to categorical demographic factors and the items/statements and classifications related to their attitude and competence in alarm fatigue and management, in addition to means and standard deviations of scale demographic factors (age and experience in nursing and ICU) and the scores of attitude and competence levels. For the analytical part of analysis, suitable inferential statistics were used to investigate the differences in attitude and competence scores across the categorical demographic factors, including Independent Samples t-test and one-way analysis of variance (ANOVA) for the differences in mean scores across the dichotomous and non-dichotomous demographic factors, respectively. Moreover, Chi-square test was used to test the relationship between nurses' categorical demographic factors and the attitude and competence classification (poor, moderate or high), while Pearson correlation test was used to test the correlation between scale demographic factors and scores of attitude and competence, and between attitude and competence themselves.

The suitable statistics were used to test the study's hypotheses, with a cut point of 0.05 for probability value (p-value) to consider the significance of mean differences, relationships and correlations, based on the rejection of study hypotheses.

3.11 Ethical Considerations

The conduction of the study and the data collection process were consistent with the ethical considerations that are followed by the Arab American University of Palestine (AAUP), in which each nurse received an informed consent at the beginning of Google Form that clarifies the aims of the study, as well as including statements related to ensuring anonymity and confidentiality of the collected data, as the nurses' names or contact information were not collected, with the use of serial numbering instead. Also, the collected data were kept in secured account until the start of data analysis. The informed consent also stated that the data are used for research purposes and by the researcher only, and that the nurse can withdraw from the participation at any time without the need to specify any reason.

It is worth mentioning that one of the challenges that encountered during data collection was the potential for response bias, which was caused by the use of online forms, and may have led to self-selection bias, where nurses with higher interest in the study's topic or better technological access have participated. This was mitigated by the distribution of the link multiple times to the targeted settings in order to reach broader sample, and the inclusion of clear instructions to encourage honest and unbiased responses, in addition to restricting duplicate responses from the same participants.

Chapter Four: Results

4.1 Overview

The following chapter provides the descriptive and analytical results of the current study. the descriptive results include the description of the nurses' demographic data and responses to attitude and competence scales' statements in terms of frequencies and percentages, in addition to the means and standard deviations of scales scores and their categorization. Moreover, the analytical results included the investigation of the relationship between study's independent and dependent variables, as well as the correlations between scale scores, in order to test the study hypotheses.

4.2 Demographic Data Results

Table 2 distributes the demographic and professional factors of the ICU nurses who participated in the current study (N = 243), which shows that the mean age of them was 28.7 ± 5.0 years old, which ranged from 21 to 41 years old. It also showed that around two thirds of the nurses were males (64.6%) compared to 35.4% female nurses, with more than half of them living in rural areas (53.1%), compared to 43.2% in the urban areas and only 3.7% in the refugee camps, while around three fourths of them (73.3%) have the bachelor's degree in nursing, compared to approximately similar percentages of who hold the diploma (15.2%) and higher educations (11.5%) degrees. In terms of the ICU nurses' professional factors, 60.1% of them were working in the governmental sector, with a mean of 6.4 ± 4.5 years of experience in nursing profession, which ranged from 1 to 18 years, compared to a mean of 3.9 ± 3.5 years of experience in the ICU, which ranged from 0 to 15 years. Around half of the ICU nurses worked at adult (general) ICU type (47.3%), compared to 27.6% for cardiac ICUs, and 10.7% in the pediatric ICUs. Lastly, most of the ICU nurses work in the rotational (mixed) shift-way (81.5%), compared to 16.0% who work in the morning shifts only.

Table 4.1: Distribution of nurses' demographic data (N = 243)

Variables	Values	Frequency	Percentage
Age (in complete years)	Mean ± SD	28.7 ± 5.0	
Gender	Male	157	64.6%
	Female	86	35.4%
Residency	City	105	43.2%
	Village/town	129	53.1%
	Refugee camp	9	3.7%
Educational level	Diploma degree	37	15.2%
	Bachelor's degree	178	73.3%
	Higher educations	28	11.5%
Hospital type	Governmental hospital	146	60.1%
	Private hospital	97	39.9%
Experience years in nursing	Mean ± SD	6.4 ± 4.5	
Experience years in ICU	Mean ± SD	3.9 ± 3.5	
Type of ICU	Adult (medical) ICU	115	47.3%
	Adult (surgical) ICU	3	1.2%
	Cardiac ICU	67	27.6%
	Neurosurgery ICU	15	6.2%
	Pediatric ICU	26	10.7%
	Neonatal ICU	17	7.0%
Type of shifts	Morning (A) only	39	16.0%
	Evening and night only	6	2.5%
	Mixed	198	81.5%

SD = Standard deviation, ICU = Intensive Care Unit

4.3 Attitude of Nurses Towards Alarm Fatigue

The ICU nurses who participated in the current study were asked to identify their agreement on a set of statements to assess their attitude towards alarm management in the ICU, in which Table 3 distributed the frequencies and percentages of their responses. The table shows that all nurses either agreed (43.2%) or strongly agreed (56.8%) that the main purpose of clinical alarms is to alert the staff on existing or potentially hazardous patient condition, with a higher agreement level (28.4% agree and 71.6% strongly agree) on the necessity of visual and/or audial differentiation of alarms according to the priority. Moreover, 34.2% of the nurses agreed, and 63.4% strongly agreed, that alarms should

also be distinct based on the parameter source, for example, according to the device, with a high agreement level on the need of alarms to impact multiple senses (49.4% agree and 40.7% strongly agree), including visual, audible and proprioceptive)

Nurses were found to moderately agree (49.4% agree) that nuisance alarms happen frequently, while 41.6% agree that they disrupt the patient's care, and 45.7% agree that they reduce trust in alarms and cause caregivers to turn them off. More than one third of the nurses disagreed (38.7%) that setting up alarm parameters and alerts in the existing devices they use is overly complex, with 44.4% agreeing that the new monitoring systems have solved several problems that were found in the old devices. Almost half of the nurses (45.7%) agree that alarms that are used in their area are adequate to alert the staff of actual or potential changes in patient's condition.

On the other hand, 39.9% of the nurses agreed that there have been alarms that could have been frequently missed, while 60.5% of the nurses agreed that they are sensitive to alarms and respond quickly. Around half of the nurses (46.5%) agree that the monitoring devices that are used in their area produce different audible, visual and proprioceptive types of alarms, so that they can differentiate the alarm sources, with approximately equal percentages of nurses who agreed (34.2%) and disagreed (32.5%) that alarms become confusion when a number of devices are used on the same patient. Moreover, 29.2% of the nurses agree, and 23.5% strongly agree, that environmental background noise interfered with alarm recognition, compared to 56.0% who agreed that the central alarm management is helpful in receiving alarm messages and notification of the appropriate staff.

Other statements also had high agreement levels, including that the integration and communication of alarm devices via wireless technologies is helpful and useful in the alarm management (65.0% agree), and on the use of smart alarm systems to automatically assess parameters change (62.6% agree). Moreover, 51.0% of the nurses agree on the presence of specific policies and procedures to regulate alarms in their facility, with 57.6% agreeing on the need of documentation of appropriate alarm settings for each patient. The nurses were also asked to rank the importance of issues concerning alarms, which showed that the highest priority issues (as indicated by lower mean scores) are frequent false alarms (mean = 4.06 ± 2.60), which lead to reduced attention to alarms, followed by lack of training on alarm systems and their management (mean = 4.09 ± 2.63) and inadequacy of staff to respond to alarms as they occur (mean = 4.19 ± 2.44). The least concerning issues (as indicated by higher mean scores) were over reliance on alarms to call attention to patient problems (mean = 4.85 ± 2.26), followed by difficulties in

identifying the source of the alarms (mean = 4.68 ± 2.56) and understanding the priority of the alarms (mean = 4.68 ± 2.21).

Table 4.2: Distribution of Nurses' Responses to Items of Attitude Towards Clinical Alarm Management (N = 243)

Statement	Mean	Strongly agree		Agree		Neutral		Disagree		Strongly disagree	
		N	%	N	%	N	%	N	%	N	%
1. The purpose of clinical alarms is to alert staff of an existing or potentially hazardous patient condition	**4.568**	138	56.8%	105	43.2%	0	0.0%	0	0.0%	0	0.0%
2. Alarm sounds and/or visual displays should differentiate the priority of alarm	**4.716**	174	71.6%	69	28.4%	0	0.0%	0	0.0%	0	0.0%
3. Alarm sounds and/or visual displays should be distinct based on the parameter or source (e.g. device)	**4.538**	154	63.4%	83	34.2%	6	2.5%	0	0.0%	0	0.0%
4. Alarms should impact multiple senses	**4.269**	99	40.7%	120	49.4%	21	8.6%	0	0.0%	3	1.2%
5. Nuisance alarms occur frequently	**4.065**	69	28.4%	120	49.4%	51	21.0%	3	1.2%	0	0.0%
6. Nuisance alarms disrupt patient care	**3.64**	42	17.3%	101	41.6%	76	31.3%	21	8.6%	3	1.2%
7. Nuisance alarms reduce trust in alarms and cause care givers to turn alarms off at times other than setup or procedural events	**3.892**	66	27.2%	111	45.7%	45	18.5%	15	6.2%	6	2.5%
8. Properly setting alarm parameters and alerts is overly complex in existing devices	**2.678**	3	1.2%	58	23.9%	64	26.3%	94	38.7%	24	9.9%
9. New monitoring systems have solved most of the previous problems we experienced with clinical alarms	**3.724**	39	16.0%	108	44.4%	87	35.8%	9	3.7%	0	0.0%
10. The alarms used on my floor/area of the hospital are adequate to alert staff of potential or actual changes in a patient's condition	**3.729**	51	21.0%	111	45.7%	45	18.5%	36	14.8%	0	0.0%
11. There have been frequent instances where alarms could not be heard and were missed	**3.297**	24	9.9%	97	39.9%	67	27.6%	46	18.9%	9	3.7%
12. The staff is sensitive to alarms and responds quickly	**3.987**	60	24.7%	147	60.5%	21	8.6%	9	3.7%	6	2.5%
13. The medical equipment used on my unit/floor all have distinct outputs (sounds,	**3.958**	72	29.6%	113	46.5%	34	14.0%	24	9.9%	0	0.0%

	repetition rates, visual displays, etc.) that allow differentiation of the source of the alarm											
14.	When a number of devices with alarms are used with a patient, it can be confusing to determine which device is in alarm	**3.265**	33	13.6%	83	34.2%	45	18.5%	79	32.5%	3	1.2%
15.	Environmental background noise has interfered with alarm recognition	**3.523**	57	23.5%	71	29.2%	63	25.9%	46	18.9%	6	2.5%
16.	A central alarm management staff that receives alarm messages and notifies the appropriate staff is helpful	**3.728**	30	12.3%	136	56.0%	58	23.9%	19	7.8%	0	0.0%
17.	Alarm integration and communication systems via pager, cell phone, other wireless device are useful in improving alarms management and response	**3.967**	39	16.0%	158	65.0%	46	18.9%	0	0.0%	0	0.0%
18.	Smart alarms, where multiple parameters, rate of change of parameters, and signal quality, are automatically assessed in their entirety would be effective in improving clinical response to important patient alarms	**3.938**	42	17.3%	152	62.6%	40	16.5%	9	3.7%	0	0.0%
19.	Policies and procedures exist within the facility to regulate alarms and they are followed	**3.396**	24	9.9%	124	51.0%	31	12.8%	52	21.4%	12	4.9%
20.	There is a requirement in your institution to document that the alarms are set and are appropriate for each patient	**3.458**	21	8.6%	140	57.6%	24	9.9%	46	18.9%	12	4.9%

Ranking of issues concerning alarms	**Mean**	**SD**
1. Difficulty in setting alarms properly.	4.44	2.01
2. Difficulty in hearing alarms when they occur.	4.64	2.56
3. Difficulty in identifying the source of an alarm.	4.68	2.21
4. Difficulty in understanding the priority of an alarm	4.68	2.40
5. Frequent false alarms, which lead to reduced attention or	4.06	2.60

response to alarms when they occur.		
6. Inadequate staff to respond to alarms as they occur.	4.19	2.44
7. Over reliance on alarms to call attention to patient problems.	4.85	2.26
8. Noise competition from non-clinical alarms and pages.	4.46	1.94
9. Lack of training on alarm systems.	4.09	2.63

4.4 Competence of Nurses Towards Clinical Alarm Management

The ICU nurses were also asked to state their competence level in specific tasks in the monitoring devices, which were classified to five domains, in which Table 4 distributes their responses to these statements in frequencies and percentages.

The first domain was related to admission, discharge and transfer process on patients, where 51.0% of the nurses were fairly competent, and 42.4% were competent, in the process of patient admission to central and bedside monitors, compared to 62.6% who were fairly competent in the discharge process, and 47.7% who were fairly competent in the patient transfer process between monitors. Also, nurses were approximately equal in being competent (44.0%) and fairly competent (42.4%) in the process of patient information editing, while 63.8% of them were fairly competent in resolving patient information mismatch.

The second domain was related to hardware and connectivity, where 47.3% of the ICU nurses were competent in connecting monitor cables, with 48.6% of them being competent, and 46.5% fairly competent, in identifying monitor's major hardware components and connectors, while 56.4% of them were fairly competent in reporting device malfunctions to service personnel. In addition, 60.1% of the nurses were fairly competent in identifying monitor's battery status from the color displayed on its screen, compared to 53.9% being fairly competent in the process of cleaning, sterilizing and disinfection of monitors and accessories, with an approximately equal percentage of the nurses who are fairly competent in describing the functions of alarms lamps and indicators of the front panel (56.8%).

In the third domain, nurses were asked about statements that are related to alarm management, where 47.7% of nurses were fairly competent and 47.3% were competent in pausing, silencing and cancelling the silence of alarms, with 50.2% of them being fairly competent and 47.3% being competent in differentiating the different types of parameters'

display and the meaning of displayed waves and information. Moreover, 42.4% of the nurses were fairly competent in changing alarm volumes easily, while 45.3% of them were fairly competent in choosing and changing the alarm source, in addition to 56.4% being fairly competent in the safe, easy and appropriate change of alarm limits. Also, 44.0% of the nurses were fairly competent in the differentiation of physiological alarms priority based on the visual and audible indicators, with 45.3% being fairly competent in acknowledging and correcting alarm messages, and more than half of the nurses being fairly competent in differentiating the technical alarms based on visual and audible indicators (52.3%) and customization of default settings to be specific for each patient (51.4%). Also, more than half of the nurses were fairly competent in understanding the monitor's logic behind displaying different types of alarms (52.3%) and knowing when to contact service personnel or troubleshoot the problem (50.2%), while less than half of them were fairly competent in differentiating the latching from non-latching alarms (44.9%).

In the fourth domain, which was related to appropriate monitoring, ICU nurses were found to have more competence, as indicated by higher percentages of competent responses on majority of the statements. For example, 66.3% of the nurses were competent in appropriate placement of electrodes, 67.1% were competent in changing non-invasive blood pressure (NBP) measurement interval, compared to 59.7% being competent in selecting its appropriate measurement mode. Also, 66.3% of the nurses were competent in zeroing pressure transducer, with 54.7% being competent in putting monitor in standby mode and resuming from it, while 56.4% were competent in selecting the appropriate label for monitoring invasive pressure. Almost two thirds of the nurses (67.5%) were competent in selecting optimal SpO2 measurement site, with 65.0% being competent in recognizing elements and purpose of using monitor screen keys. Moreover, 58.4% of the nurses were competent in picking best primary and secondary leads for paced and non-paced patients, with 57.6% being competent in reviewing trended patient data using screen trends, while 53.5% were competent in temporarily disabling and re-enabling the touchscreen of the monitor.

Lastly, the fifth domain was related to advanced functions, which showed that 65.0% of the nurses are competent in viewing hemodynamic, oxygenation and ventilation calculations, compared to 49.8% who are competent in preforming such calculations, and 52.3% being competent in accessing and using the drug calculation from the monitor,

while 48.6% were competent in manually entering data to monitors, and 41.2% are competent in using sepsis protocols and guidelines that are within the monitor.

Table 4.3: Distribution of ICU Nurses' Responses to Statements Related to Their Competence in Alarm Management

Statement	Competent		Fair		Incompetent		Not used	
	N	%	N	%	N	%	N	%
1. Admit, Discharge, and Transfer Patient								
1. Admit patient to central and beside monitors	103	42.4%	124	51.0%	6	2.5%	10	4.1%
2. Discharge patient from central and bedside monitors	82	33.7%	152	62.6%	3	1.2%	6	2.5%
3. Transfer patient from central and bedside monitors	84	34.6%	116	47.7%	33	13.6%	10	4.1%
4. Edit patient information after admission	107	44.0%	103	42.4%	21	8.6%	12	4.9%
5. Resolve patient information mismatch	61	25.1%	155	63.8%	9	3.7%	18	7.4%
2. Hardware and Connectivity								
6. Connect monitor cables	115	47.3%	94	38.7%	28	11.5%	6	2.5%
7. Identify monitors' major hardware components and connectors	118	48.6%	113	46.5%	3	1.2%	9	3.7%
8. Report device malfunctions to service personnel	81	33.3%	137	56.4%	12	4.9%	13	5.3%
9. Identify battery's power status of the monitor from display color	70	28.8%	146	60.1%	15	6.2%	12	4.9%
10. Clean, sterilize and disinfect monitors and monitors accessories	106	43.6%	131	53.9%	3	1.2%	3	1.2%
11. Describe the functions of alarm lamps and front panel color indicators	93	38.3%	138	56.8%	9	3.7%	3	1.2%
3. Alarm Management								
12. Pause and silence alarms and cancel the pause	115	47.3%	116	47.7%	6	2.5%	6	2.5%
13. Know different types of parameters' display and the meaning of waves and information in the display	115	47.3%	122	50.2%	3	1.2%	3	1.2%
14. Change alarm volume easily	92	37.9%	103	42.4%	42	17.3%	6	2.5%
15. Choose and change the source of an alarm appropriately	84	34.6%	110	45.3%	40	16.5%	9	3.7%
16. Change alarm limits safely, easily and appropriately	88	36.2%	137	56.4%	15	6.2%	3	1.2%

17. Identify and differentiate the priority and meaning of all physiologic alarm messages, based on visual and audible alarm indicators	100	41.2%	107	44.0%	36	14.8%	0	0.0%
18. Acknowledge and correct alarm messages appropriately	88	36.2%	110	45.3%	36	14.8%	9	3.7%
19. Identify and differentiate the priority and meaning of technical alarm messages based on visual and audible alarm indicators	87	35.8%	127	52.3%	22	9.1%	7	2.9%
20. Customize default settings to patient specific	97	39.9%	125	51.4%	12	4.9%	9	3.7%
21. Understand the monitor logic behind displaying different types of alarms	91	37.4%	127	52.3%	6	2.5%	19	7.8%
22. Know when you need to contact service personnel to correct technical alarms *vs.* when you need to troubleshoot the problem	75	30.9%	122	50.2%	30	12.3%	16	6.6%
23. Differentiate the behaviors of latching vs. non-latching alarms	91	37.4%	109	44.9%	37	15.2%	6	2.5%
4. Appropriate Monitoring								
24. Place electrodes appropriately	161	66.3%	76	31.3%	6	2.5%	0	0.0%
25. Change the NBP measurement interval	163	67.1%	74	30.5%	3	1.2%	3	1.2%
26. Select the appropriate NBP measurement modes	145	59.7%	95	39.1%	3	1.2%	0	0.0%
27. Store and send the 12-lead ECG to the central monitor	118	48.6%	71	29.2%	24	9.9%	30	12.3%
28. Zero the pressure transducer	161	66.3%	58	23.9%	15	6.2%	9	3.7%
29. Put monitor into Standby mode and resume from Standby monitoring	133	54.7%	91	37.4%	9	3.7%	10	4.1%
30. Select appropriate invasive pressure label for monitoring	137	56.4%	85	35.0%	18	7.4%	3	1.2%
31. Change the size of a waveform	100	41.2%	115	47.3%	18	7.4%	10	4.1%
32. Select optimal SpO2 measurement site	164	67.5%	61	25.1%	12	4.9%	6	2.5%
33. Recognize elements and purpose of using monitors' Screen Keys	158	65.0%	73	30.0%	3	1.2%	9	3.7%
34. Pick best primary and secondary leads for paced and non-paced patients	142	58.4%	61	25.1%	15	6.2%	25	10.3%

35. Navigate the different monitors' screens easily	127	52.3%	107	44.0%	6	2.5%	3	1.2%
36. Freeze and unfreeze waves	93	38.3%	116	47.7%	9	3.7%	25	10.3%
37. Review trended patient data using screen trends	140	57.6%	73	30.0%	9	3.7%	21	8.6%
38. Differentiate/print patient reports available within the monitor	112	46.1%	82	33.7%	25	10.3%	24	9.9%
39. Temporarily disable/re-enable monitor touchscreen operation	130	53.5%	76	31.3%	24	9.9%	13	5.3%
5. Advanced Functions								
40. View hemodynamic, oxygenation, and ventilation calculations	158	65.0%	73	30.0%	3	1.2%	9	3.7%
41. Perform parameters calculations	121	49.8%	76	31.3%	18	7.4%	28	11.5%
42. Access/use the drug calculator from the monitor	127	52.3%	61	25.1%	18	7.4%	37	15.2%
43. Manually enter some data into the monitor	118	48.6%	61	25.1%	24	9.9%	40	16.5%
44. Use sepsis protocol and its guidelines that are within the monitor	100	41.2%	91	37.4%	12	4.9%	40	16.5%

4.5 Attitude and Competence Scores

The scoring of attitude and competence domains was based on summing the scores of individual statements for each nurse, and then convert the summation to a score out of 100% to facilitate the comparisons between them. Table 5 shows the descriptive statistics of the attitude and competence scores, where it shows that the mean score of attitudes towards alarm management was 68.25 ± 5.76 out of 100, ranging from 56 to 88, which indicates an overall moderate level of attitude among the participating nurses.

For the competence, the overall competence score was 76.55 ± 14.04 out of 100, which also indicates an overall moderate competence of the participating nurses towards alarm management. Also, the highest competence among the participating nurses was in the domain of appropriate monitoring (mean = 80.41 ± 15.54), followed by hardware and connectivity (mean = 76.29 ± 17.26), alarm management (mean = 74.12 ± 16.88), patient management (mean = 73.61 ± 19.11) and advanced functions (mean = 73.28 ± 27.67), which indicates that the domain of appropriate monitoring was within the excellent competence level, while the rest of domains were in the moderate competence levels. Figure 1 also shows these results.

Table 4.4: Description of attitude and competence scores towards alarm management among ICU nurses (out of 100%)

Domain	**Mean %**	**SD %**	**Minimum %**	**Maximum %**
Overall attitude	68.25	5.76	56.00	88.00
Competence of patient management	73.61	19.11	0.00	100.00
Competence of hardware and connectivity	76.29	17.26	0.00	100.00
Competence of alarm management	74.12	16.88	25.00	100.00
Competence of appropriate monitoring	80.41	15.54	35.42	100.00
Competence of advanced functions	73.28	27.67	0.00	100.00
Overall competence	76.55	14.04	37.88	100.00

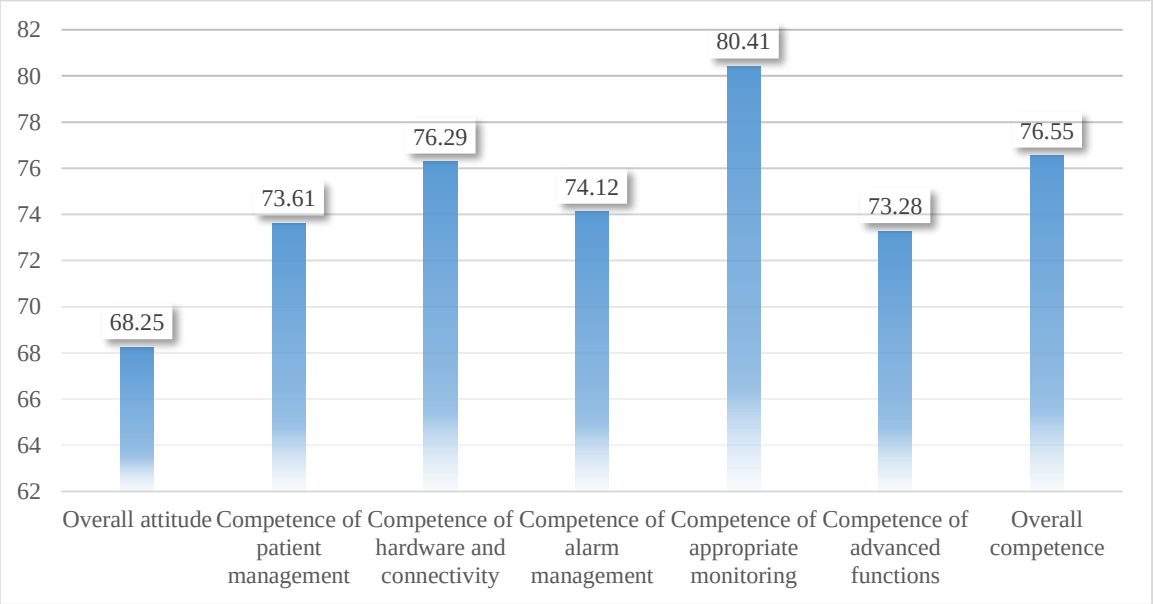


Figure 4.1: Description of Attitude and Competence Scores

The scores were also classified to three-level categories, which are shown in Table 6. The table shows that the majority of ICU nurses (88.5%) have a moderate level of attitude towards alarm management. In addition, around half of the nurses have a moderate level of competence towards alarm management (48.1%), with a less percentage (42.0%) having a high competence level. Specifically, more than half of the nurses (54.7%) have high level of competence in advanced functions, with 47.3% having the same level in the domain of appropriate monitoring, while moderate competence levels were more dominant in domains of hardware and connectivity (59.4%), patient management (48.6%) and alarm management (40.7%). Figure 2 shows the results also.

Table 4.5: Distribution of Attitude and Competence Classifications Among ICU Nurses

Scale	Low		Moderate		High	
	N	%	N	%	N	%
Overall attitude	22	9.1%	215	88.5%	6	2.5%
Competence of patient management	25	10.3%	118	48.6%	100	41.2%
Competence of hardware and connectivity	12	4.9%	144	59.3%	87	35.8%
Competence of alarm management	54	22.2%	99	40.7%	90	37.0%
Competence of appropriate monitoring	27	11.1%	101	41.6%	115	47.3%
Competence of advanced functions	61	25.1%	49	20.2%	133	54.7%
Overall competence	24	9.9%	117	48.1%	102	42.0%

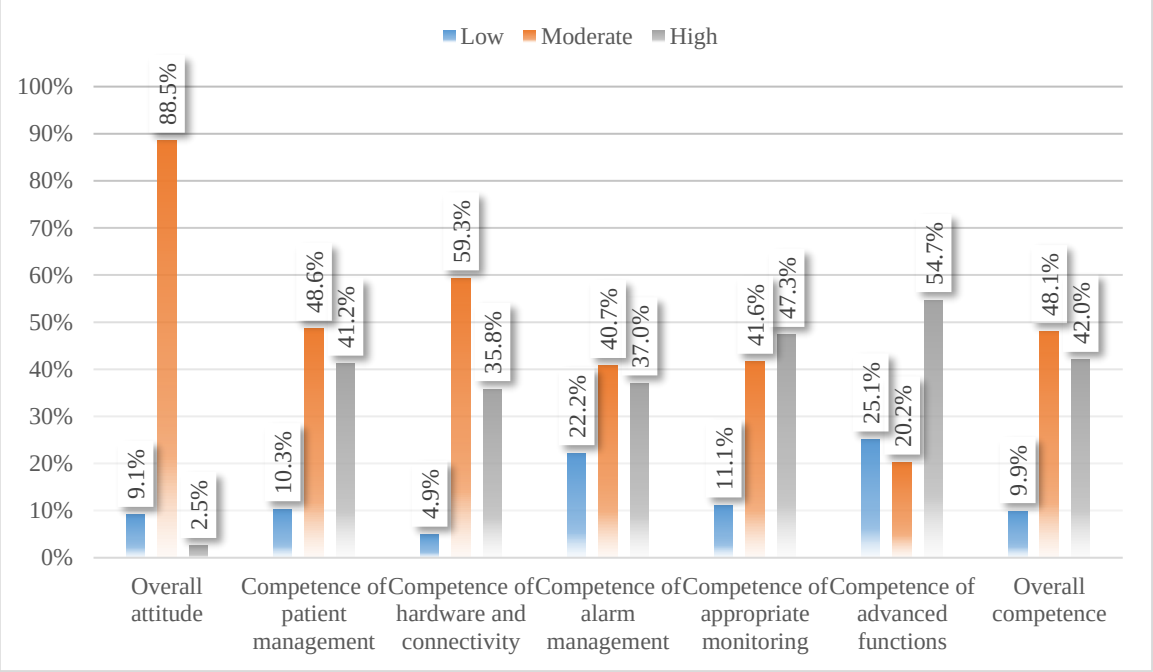


Figure 4.2: Description of Attitude and Competence Classification

4.6 Analytical Results

Analytical results investigate for the relationship between study's independent and dependent variables, as well as the correlations between attitude and competence domains scores, using the appropriate inferential statistics. Table 7 shows the relationship between ICU nurses' demographic factors and the overall attitude scores, which shows that a higher attitude scores were significantly found among nurses who live in cities (mean = 68.17 ± 5.49) and villages (mean = 68.68 ± 6.01) than refugee camps (mean = 63.00 ± 5.47, p-value = 0.016), with higher attitude scores among nurses with diploma degree (mean = 69.03 ± 5.37) compared to who hold bachelor's degree (mean = 68.55 ± 5.04)

and higher educations (mean = 65.32 ± 9.03, p-value = 0.014), which indicates better attitude towards alarm management with lower educational levels. On the other hand, the rest of the demographic and professional factors were insignificantly related to attitude of ICU nurses towards alarm management (p-value > 0.05).

Table 4.6: Differences in Attitude of Alarm Management Across Nurses' Demographic Factors

Variables	**Values**	**Mean attitude**	**SD**	**p-value**
Age	Correlation	r = 0.064		0.318
Gender	Male	68.55	4.09	0.353
	Female	67.70	7.95	
Residency	City	68.17	5.49	0.016
	Village/town	68.68	6.01	
	Refugee camp	63.00	5.47	
Educational level	Diploma degree	69.03	5.37	0.014
	Bachelor's degree	68.55	5.04	
	Higher educations	65.32	9.03	
Hospital type	Governmental	68.51	6.36	0.369
	Private	67.87	4.71	
Experience in nursing	Correlation	r = 0.065		0.315
Experience in ICU	Correlation	r = 0.050		0.438
Type of ICU	Adult (medical) ICU	67.77	5.04	0.518
	Adult (surgical) ICU	66.00	0.00	
	Cardiac ICU	69.33	8.14	
	Neurosurgery ICU	68.00	2.85	
	Pediatric ICU	68.65	3.17	
	Neonatal ICU	67.29	3.95	
Type of shifts	Morning only	69.00	3.25	0.360
	Evening or night	65.50	1.64	
	Mixed	68.19	6.19	

SD = Standard deviation, ICU = Intensive care unit, r = correlation coefficient

Table 4.7 is concerned with the investigation of the relationship between nurses' demographic and professional factors and the overall competence scores, which shows that better competence of nurses towards alarm management is significantly correlated with younger age (r = -0.198, p-value = 0.002), and is found among nurses who live in cities (mean 80.76 ± 13.28), that is higher than who live in villages (mean = 73.55 ±

14.25) and refugee camps (mean = 70.45 ± 4.66, p-value < 0.001). Also, a better competence level was significantly found among nurses who worked in private hospitals (mean = 78.88 ± 11.45) than governmental hospitals (mean = 75.00 ± 15.37, p-value = 0.025), as well as with lower experience in nursing (r = -0.180, p-value = 0.005) and lower experience in ICU (r = -0.192, p-value = 0.004), indicating significantly negative, weak correlation between experience in nursing and ICU and competence in alarm management.

Lastly, a better competence in alarm management was also found in nurses who worked in adult surgical ICUs (mean = 89.39 ± 5.66) and neurosurgery ICUs (mean = 82.73 ± 11.09) compared to others (p-value = 0.007), while the rest of demographic and professional factors were not significantly related to differences in competence levels towards alarm management (p-value > 0.05).

Table 4.7: Differences in Competence of Alarm Management Across Nurses' Demographic Factors

Variables	**Values**	**Mean competence**	**SD**	**p-value**
Age	Correlation	r = -0.198		0.002
Gender	Male	77.10	12.81	0.442
	Female	75.55	16.08	
Residency	City	80.76	13.28	< 0.001
	Village/town	73.55	14.25	
	Refugee camp	70.45	4.66	
Educational level	Diploma degree	78.24	13.37	0.274
	Bachelor's degree	75.70	14.41	
	Higher educations	79.71	12.22	
Hospital type	Governmental	75.00	15.37	0.025
	Private	78.88	11.45	
Experience in nursing	Correlation	r = -0.180		0.005
Experience in ICU	Correlation	r = -0.192		0.004
Type of ICU	Adult (medical) ICU	77.46	11.90	0.007
	Adult (surgical) ICU	89.39	5.66	
	Cardiac ICU	77.25	17.90	
	Neurosurgery ICU	82.73	11.09	
	Pediatric ICU	69.70	13.49	
	Neonatal ICU	70.37	8.25	
Type of shifts	Morning only	78.55	11.76	0.353

	Evening or night	82.20	1.24	
	Mixed	75.98	14.61	

SD = Standard deviation, ICU = Intensive care unit, r = correlation coefficient

Table 4.8 shows the correlations between attitude and competence domains, using Pearson correlation test. The table shows that all domains are significantly inter-correlated. For example, there was a significantly positive correlations between better attitude and moderate competence in patient management ($r = 0.248$, p-value < 0.001), moderate competence in hardware and connectivity ($r = 0.286$, p-value < 0.001), mildly better competence in alarm management ($r = 0.145$, p-value $= 0.024$), moderately better appropriate monitoring ($r = 0.280$, p-value < 0.001), moderately better competence in advanced functions ($r = 0.297$, p-value < 0.001) and moderately better overall competence ($r = 0.313$, p-value < 0.001).

Also, the domains of competence are significantly inter-correlated. For example, the better competence in patient management is significantly correlated with strongly better competence in hardware and connectivity ($r = 0.661$, p-value < 0.001), alarm management ($r = 0.648$, p-value < 0.001), appropriate monitoring ($r = 0.502$, p-value < 0.001), moderately with advanced function ($r = 0.343$, p-value <0.001) and strongly with the overall competence level ($r = 0.757$, p-value < 0.001). In addition, the domain of competence in hardware and connectivity was significantly correlated with competence domains of alarm management ($r = 0.714$, p-value < 0.001), appropriate monitoring ($r = 0.444$, p-value < 0.001), advanced functions ($r = 0.232$, p-value < 0.001) and the overall competence level ($r = 0.807$, p-value < 0.001). The competence in alarm management was also found to have significant positive correlation with appropriate monitoring ($r = 0.530$, p-value < 0.001), advanced functions ($r = 0.204$, p-value < 0.001) and the overall competence level ($r = 0.807$, p-value < 0.001). Lastly, the domains of appropriate monitoring and advanced functions are significantly correlated ($r = 0.646$, p-value < 0.001), while the overall competence level is significantly correlated with both appropriate monitoring ($r = 0.873$, p-value < 0.001) and advanced functions ($r = 0.642$, p-value < 0.001).

Table 4.8: Correlations between Domains of Attitude and Competence Towards Alarm Management Among ICU Nurses

Domain	Attitude		Patient		Hardware		Alarm		Monitoring		Advanced	
	r	p	r	p	r	p	r	p	r	p	r	p
Com. Patient	0.248	<0.001	-	-								
Com. Hardware	0.286	<0.001	0.661	<0.001	-	-						
Com. Alarm	0.145	0.024	0.648	<0.001	0.714	<0.001	-	-				
Com. Monitoring	0.280	<0.001	0.502	<0.001	0.444	<0.001	0.530	<0.001	-	-		
Com. Advanced	0.297	<0.001	0.343	<0.001	0.232	<0.001	0.204	<0.001	0.646	<0.001	-	-
Overall Competence	0.313	<0.001	0.757	<0.001	0.807	<0.001	0.807	<0.001	0.873	<0.001	0.642	<0.001

4.7 Concluding Remarks

The ICU nurses who participated in the current study had a mean age of 28.7 years old, and were more males (64.6%), having bachelor's degree (73.5%) and working more in the governmental sector (60.1%). They had a mean of 6.4 years of experience in nursing, compared to 3.9 years of experience in the ICU setting, mainly in the adult ICU (47.3%) and working in rotating shifts way (81.5%).

The overall attitude score towards alarm management was moderate (mean = 68.25), and an overall moderate competence score (mean = 76.55), with competence in appropriate monitoring (mean = 80.41) having the best competence, and advanced functions (mean = 73.28) having the lowest competence level.

Significantly better attitude levels were found among nurses who live in non-refugee camp areas (p-value = 0.016), which may not reflect the actual significance of difference due noticeable low percentage of participants who live in refugee camps (3.7%), and who have lower educational degree (p-value = 0.014), with significantly better with lower age (r = -0.198, p-value = 0.002), living in cities (p-value < 0.001), working in private sector (p-value = 0.025), having lower experience in nursing profession (r = -0.180, p-value = 0.005) or ICU setting (r = -0.192, p-value = 0.004) and working adult and neurosurgery ICUs (p-value = 0.007).

All domains of attitude and competence were significantly inter-correlated (p-value < 0.05), indicating a positive correlation between better attitude and competence in all domains, and between all of the competence domains and with the overall competence level.

Chapter Five: Discussion, Conclusions and Recommendations

5.1 Overview

The following chapter is concerned with providing a discussion of current study results, where the researcher provides a critical overview of the findings and methodological approaches from the personal point of view, in addition to a comparison between the current and previous studies findings. In addition, the chapter covers the study conclusions, recommendations to improve alarm management among ICU nurses and future research, as well as some limitations that faced the conduction of the current study.

5.2 Discussion of Methodological Approaches and Sample Characteristics

In the current study, the sample consisted of more male (64.6%) than female nurses (35.4%), almost in a ratio of 2:1, and was similar to a previous Palestinian study (Salameh et al., 2024), where the male-to-female percentages was 63.6% vs 33.4%. The presence of more male than female nurses in the ICU settings is interpreted by the gender differences in workplace practices and relationships (Göktepe & Sarıköse, 2022). The current study also recruited a sample of nurses who mainly have bachelor's degree of nursing (73.3%), which is approximate or higher than what is found in previous studies in ICU settings, like J. Bi et al. (2020) with around 70%, Jeong and Kim (2023) with 66%, and Nyarko et al. (2023) with 72%. This indicates an overall consistency of the distribution of ICU nurses' educational levels across different countries. It is also worth noticing that the percentage of ICU nurses who hold higher education degrees, like master's degree in critical care nursing or anesthesia nursing, is increasing in the recent years, due to adoption of master's programs in leading universities that teach nursing profession, like AAUP and NNU, among others. The presence of ICU nurses with higher educational degrees participates in the advancement of critical care that is provided to patients, as it is associated with higher knowledge, as found in the current study, and better practices, which is reflected in previous studies. The percentage of ICU nurses in the current study sample from governmental hospital settings is 60.1%, compared to 39.1% from the private sector, which shows a predominance of governmental healthcare employment. In the Palestinian context, this can be interpreted by a common pattern that is found in other developing and middle-income countries, while most of the governmental healthcare workers may declare that the reason of selecting the

governmental sector is focused on professional security and above-average healthcare insurance (AL-Ghwary et al., 2024; Karnataka, 2021). Also, the governmental hospitals in Palestine tend to have a wider variety and often larger capacity ICUs. In comparison with other studies that were conducted in ICU settings, they also found higher percentages of governmental than private sector ICU nursing workforce. For example, the percentage of nurses recruited from public hospitals reached around 65% in a Tunisian study (Tlili et al., 2020), compared to around 60% in a Saudi study (Ageel & Shbeer, 2022), with 68% in a study in South Asia and Middle East (Sodhi et al., 2023), while a Bulgarian study (Grancharova et al., 2020) found that public hospitals mostly attract older nurses (69.2% are over 49 years old), than private hospitals (52.8% are younger than 40 years old). In comparison, the current study recruited a sample of ICU nurses with a mean age of 28.7 years old, ranging from 21 to 41 years old, which indicates a relatively young nursing workforce in the Palestinian ICU settings.

The implemented design was the cross-sectional, quantitative design, which have several advantages when studying variables as in the current study, including the data collection and resource efficiency in terms of cost and time, especially in comparison with longitudinal designs (Butler et al., 2021; Spector, 2019), and the suitability to the aim of a snapshot exploration of attitude and practices and their comparison across the demographic characteristics of ICU nurses (Ray, 2020). On the other hand, it is limited by the lack of causality, potential of selection and recall bias, and missing dynamic processes of nurses' adaptation to alarm management strategies over time, which are recommended to be conducted in a prospective design, as it helps in gathering useful information on the benefits and results of educational and quality improvement (QI) projects. But, the current study design can be seen as beneficial as it serves as descriptive insights into patient safety and quality improvement, which provides foundational data to guide future interventions, (Ferreira et al., 2021), because of the initial identification of the most common demographic and professional factors that are significantly related to attitude and practice levels towards alarm management, which will help in the proper selection of QI projects in terms of what to be covered and the suitable time of their implementation.

The site and settings of the current study included both governmental and private hospitals of three cities in West Bank – Palestine, which are Tulkarem, Nablus and Ramallah, which reflects a comprehensive representation of healthcare settings that helps in gathering data about alarm management attitudes and practices from various levels of resources and

staffing, as well as covering geographic diversity that reflects variations in socioeconomic, cultural and demographic patient conditions. Also, it helped in taking insights on the differences across these settings, which will also help in recommending specific actions that are more relevant to policymakers, implementing the core of QI projects, including the optimal allocation of resources and workforces according to the current situation of each hospital type.

The use of an online form to collect data had advantages that were also supported by several studies, including being convenient, cost-effective, allowing for quicker data collection, in addition to enhanced reach in resource-limited settings, and allowing participants to have autonomy of participation which increases their engagement and response rate (Oliveri et al., 2021; Putranto, 2019), and in terms of quality and patient safety, using online forms for data collection allows for real-time data for rapid decision-making (Muthusamy et al., 2021), as well as the cost-effectiveness and better resource allocation, especially for large scale studies, and the encouragement of honest responses due to anonymity of the collected data (Menon & Muraleedharan, 2020). Moreover, the use of online forms improves quality control through better data accuracy that is caused by reducing errors associated with manual data entry, which ensures more reliable and accurate data collection for quality benchmarks (Braekman et al., 2020).

5.3 Discussion of Results and Comparison with Previous Literature

The study of Shih et al. (2022) focused on the importance of acquiring the proper level of practice towards alarm management in order to help in the prevention of alarm fatigue and help in delivering the suitable patient care. In the current study, the overall competence level was found to be moderate (mean = 76.55%), with 42.0% of the nurses having high and 48.1% having moderate competence levels, which indicates an above-average level of practice among the participating nurses in the current study. In the Palestinian context, such findings reflect an effective level of practice in handling and responding to alarms in critical care units, which is found in spite of the resource-limited healthcare system in Palestine, like the limited access to advanced medical equipment, high nurse-to-patient ratio, in addition to ongoing economic and political instability. This also reflects the high resilience level that calls for the importance of allocating more resources in nursing continuous education and training programs, which is also important to improve the quality of care and patient outcomes to overcome these systemic challenges.

In the current study, the issues/challenges concerning alarms and alarm management were similarly perceived by the ICU nurses who participated in the current study, which is shown in the mean scores that are approximate (mean scores of priority ranged from 4.06 to 4.85), which reflects that such issues are almost equally perceived by the Palestinian nurses, and that they are all in the same priority levels, which indicates the variety of challenges that face the healthcare system in Palestine, in general, and the alarm management among the nurses in critical care units. In the previous study of Jeong and Kim (2023), the researchers found that the most common related issues were frequent false alarms and inadequate staffing, which were perceived by the nurses in the current study in the first and third top priority issues.

Studies that aimed to investigate the attitude and competence levels of nurses towards alarms and their management have focused on assessing the responses of nurses to specific statements that may reflect different areas of critical care and alarm management, which was also implemented in the current study, where a multiple response statements were used for attitudes (n = 20) and competence (n = 44). The previous study of Ramlaul et al. (2021) stated some specific findings that can be compared with the current study results. For example, 75.8% of the nurses in the previous study are aware of the differentiation of audiovisual alarming based on their priority, while 63.4% and 34.2% of the nurses in the current study strongly agree and agree, respectively, that audiovisual display of the alarms should be distinct based on the parameter or source, with 49.4% who agree and 40.7% who strongly agree that alarms should impact multiple senses, which highlights the high awareness level of nurses in both studies on the importance of alarm consciousness, which also appears in that 60.5% of the nurses in the current study agree that the staff is sensitive to alarms and respond quickly. The previous study also found that 53.8% of the nurses agree that nuisance alarms happen frequently, with 46.2% agreeing on that they interrupt patient care, which is higher than in the current study, where 49.4% agree on frequent happening and 41.6% agree on disrupting patient care. This comparison may reflect a better and quicker response to alarms and better adjustment of alarms limits among the nurses in the current study, so that they do not complain too much of nuisance alarms. This may also reflect a better quality management in the Palestinian settings, which indicates enhanced alarms protocols, focusing on systemic safety measures, variations in quality standards and higher adoption of patient-centered safety culture (Karapas & Bobay, 2019; Sujimongkol et al., 2023).

In the field of quality improvement, the current study found that 51.0% of the nurses agree that there are existing protocols and policies that regulate alarms and that they are followed, while 57.6% agree that there is a requirement to document alarms are set on specific limits for each patient, with 21.4% and 18.9% disagreement level on them, respectively. While the percentage of agreement in higher than disagreement, which may reflect a strength level in existing policies, the disagreement level is not small, which may be related to concerns about inconsistency, where some nurses are not aware or do not apply such protocols, resulting from inadequate of different training or organizational barriers related to resource limitation or high workload, in addition to the need for better communication and engagement levels, which may also impact the patient safety. On the other hand, this can be properly utilized as a room for improvement throughout enhanced training programs, regular audits and feedback, and standardization across units, especially in hospitals with high variety in number and types of ICUs.

The percentage of nurses who agree on the frequency (90%) and disruption (91%) of nuisance alarms is much higher in the study of Casey et al. (2018), which indicates a higher alarm fatigue among the nurses in the previous study, and is reflected in their other finding related to high percentage of decreased trust in alarming system (81%), leading to ignorance or silencing alarms. This phenomenon negatively impacts the quality of care that is provided to patients, because delays or failure to respond to clinical alarms may lead to adverse patient outcomes. Also, increasing the trust in alarm system in the hospital and department levels is and integrative effort that should be taken from continuous education and quality departments, which can be implemented by alarm customization, training and teaching on reduction of false alarms. Building a better safety culture and increasing the nursing engagement and feedback are also important steps in the process of quality improvement.

The importance of training and continuous nursing education appeared in the previous Chinese study (J. Bi et al., 2020) that implemented a planned behavior theory-based training, and resulted in a significant decrease in the scores of alarm fatigue among nurses in the interventional group, as well as the significant decrease in number of reported alarms. Therefore, it is highly recommended to replicate this method in the Palestinian settings, using the interventional study design, and inclusion of multiple setting from different types (e.g., governmental vs. private, different areas of the West Bank, … etc.). Such study designs are also preferred in the field of quality improvement, as they measure the impact of educational sessions and training programs directly, providing a

comparative baseline and outcome analysis, which delivers an evidence on changes in alarm monitoring attitudes and competence, and alarm fatigue, as well as the ability to identify the effective strategies in continuous education, which all play role in the enhancement of patient safety, building continuous improvement culture among the nurses, and encouraging multidisciplinary collaboration, especially with the quality department, which plays an essential role in the foundation of policies and development of protocols.

The current study found an overall moderate attitude and competence levels of alarm management, which can conclude an overall low-to-moderate alarm fatigue levels among the participating nurses, and can be generally considered lower than what has been found in the previous study of Lewandowska et al. (2023), who found a moderate level of alarm fatigue among their sample of ICU nurses (mean = 25.8 out of 44). In their study, they found no significant relationship between any of the demographic factors and alarm fatigue level, except for training. On the opposite, the current study found that better attitudes towards alarm management are among nurses living in non-camp residences and with lower educational levels, in addition to better competences among nurses with younger ages, working in private hospitals, lower experience in nursing profession and ICU, and who work in adult and neurosurgery ICU types. The differences in these relationships can be related to sampling differences between both studies, including sample size (400 vs 243), male-to-female ratio, and the percentage of nurses holding master's degrees (56.0% vs 11.5%). For example, holding higher educational degrees was found to negatively impact the attitude and competence levels on the current study, which may also help interpret the lower alarm fatigue level in the current study compared to previous one. Also, the previous study has 63.0% of their sample working in adult ICU type, compared to 47.3% in the current study. The differences in ICU types can be related to differences in the type of monitoring devices, as well as in the alarm limits and how nurses deal with them, leading to variances in attitude and competence levels.

The differences between ICU types should be taken into account when trying to enhance the quality of patient care and improving patient safety. This should be also based on evidence-based efforts by the policymakers and decision makers in health institutions. For example, standardizing alarm limits and monitoring devices across different ICU types helps in creating availability in care quality, reducing inconsistencies and improving safety, which also emphasizing the role of standardization in minimizing errors and enhancing outcomes, the same as found in practices of medication administration (Otero

et al., 2021). Such standardization doubles the positive impact on patient safety when combined with tailored training programs, including multi-component educational interventions, which helps in improving nurses' adherence to standard precautions (Gomarverdi et al., 2019), as well as with the integration of technological tools, such as AI-based systems, which helps in reducing alarm fatigue throughout providing real-time insights (Ferrara et al., 2024). Lastly, supporting the multidisciplinary collaboration among ICU types is useful in sharing best practices and unifying approaches in alarm management and patient monitoring to the optimal level possible.

To support the idea of the educational and training efforts on the ICU nurses' attitudes and practices towards alarm management, the previous study of Paredath and Al Jarary (2023) concluded no significantly different score changes in domains of education about alarm fatigue across the participated nurses across all of their demographic factors, which indicates that such efforts can result in positive results regardless of the variances in nurses' characteristics, and that benefits from undergoing training and continuous education will reach all nurses. In the field of quality management, such efforts do not necessarily need to be expensive and resource-extensive, because simple and effective approaches of teaching are also beneficial, as in a previous study (Najafi Ghezeljeh et al., 2022) that showed the effectiveness of online methods of teaching in increasing the knowledge, attitude and skills of nurses, regardless of their demographic variations. Several differences in domains scores of alarm management competence were found between the previous study of Sowan et al. (2017) and the current study, and while the domain of patient management, that consists of admitting, transferring and discharging patients was slightly higher (mean = 74.0 vs. 73.61), the domain of appropriate patient monitoring was slightly lower (mean = 76.9 vs 80.41), similar to alarm management (mean = 72.6 vs. 74.12), while others were notably different, including hardware and connectivity (mean = 41.9 vs. 76.29) and advanced functions (mean = 39.0 vs. 73.28). Moreover, the previous study found no significant differences in all of the competence domains across nurses' demographic factors. Both studies used the same competence questionnaire, but the current study found that competence in significantly related to nurses' age, residence, hospital type, experience and type of ICU they are working in. such differences in findings can be related to samples' variations in the previous study, including sample size (N = 30 vs 243), gender variations (female = 83% vs 35.4%), experience and type of ICUs, as well as the coverage of multiple settings in the current study (private and governmental hospitals). Also, the current study used a face-validated

version of the same questionnaire, where some statements were modified or deleted, according to the specific situation in Palestinian hospitals and experts' opinions. The Palestinian nurses in the current study seem to generally address a higher level of competence in specific domains, like hardware and connectivity, and advanced functions, which both are mostly related to more engagement of nurses in monitoring devices, and can be related to differences in job descriptions between both settings. In terms of quality management, there are differences in resource allocation between the USA and Palestine, which is caused by short staffing in Palestine, leading Palestinian nurses to have broader responsibilities in equipment, and calling for a need to have clear role definitions and competency-based training programs.

5.4 General Applications of Alarm Management Attitudes and Practice in Quality Management and Patient Safety

While the current study did not directly investigate for the alarm fatigue levels among the participating nurses, its results can be utilized to reflect a general comprehension of alarm fatigue, as well as the resulting quality of care and patient safety concerns in the ICU settings. For example, previous studies have demonstrated that better attitudes and competence levels in alarm management can indicate, or are significantly correlated with, lower alarm fatigue levels (Jeong & Kim, 2023), and that training designed to enhance alarm management capabilities among the ICU nurses significantly reduces alarm fatigue (J. Bi et al., 2020), highlighting the importance of effective and guided training and continuous education. On the other hand, other studies have found that while proper competence and alarm management are essential in the nursing care, they do not always directly impact or reduce nurses' alarm fatigue, because of the presence of other factors, such as workload and organizational support, highlighting the importance of addressing systemic issues that may affect how competence and attitude levels mitigate alarm fatigue (Bani Hani & Abu Aqoulah, 2024; Lewandowska et al., 2020).

In addition, smart care is a strategy of alarm management and is linked with the quality of provided care and patient safety, which is recommended to be applied in the ICU settings of developing countries, like in Palestine. The key components of this type of care are what supports its application, in addition to its practicality and feasibility. For example, it is based on providing personalized alarm settings, timely actions, reduction of non-actionable alarms, effective teamwork, optimizing care environment and the psychological well-being of the staff. Such components can be implemented in out

settings with the use of available resources, and result in positive impacts on patient safety, through directly reducing alarm fatigue, resulting in faster response time and reduction in desensitization to critical alarms, which minimize the risk of adverse events and enhance patient outcomes (Movahedi et al., 2023). The positive impacts of such strategies are also supported by previous studies that highlighted the role of patient-customized alarm management, data-driven decisions, standardizing of protocols and educational efforts on improving the quality management (Dee et al., 2022; Lewis & Oster, 2019; Paredath & Al Jarary, 2023).

5.5 Conclusions

Nurses' roles in critical care extends beyond providing high-quality care and ensuring patient safety throughout direct nursing actions, but also include ongoing monitoring. Nowadays, monitoring devices have implemented new technologies that require nurses to be up-to-date with their capabilities, and therefore, the current study aimed to acquire a snapshot of the ICU nurses' attitudes and competence of alarm management in Palestine. The study utilized a cross-sectional design on a sample of 243 ICU nurses who worked in selected governmental and private hospitals in West Bank – Palestine, and were asked to fill in a three-part questionnaire, in order to assess their attitude and competence levels and the most common demographic and professional factors that affect these levels. The study sample consisted of ICU nurses with a mean age of 28.7 years old, and a mean experience of 6.4 years in nursing profession and 3.9 years in ICU settings, with 73.3% of them holding the Bachelor's degree, and 60.1% working in governmental hospitals. The overall attitude level of alarm management was moderate (mean = 68.25), which was significantly better among nurses living in non-camp residencies and having lower educational degree. The overall competence level was also moderate (mean = 76.55), which was significantly higher with lower age and experience, private settings and in surgical and neurosurgery ICU types. All domains of alarm management competence were significantly inter-correlated.

Several studies supported the current results, with differences in significance of attitude and competence levels differences across the demographic and professional factors of the nurses, which were mostly related to methodological variations between the reviewed studies. Several recommendations are proposed in order to enhance patient safety and quality of care that is provided to critical patients, in order to improve their outcomes, and to policy makers to support continuous education and tailored training efforts.

5.6 Recommendations

Based on the discussion of current study findings, the researcher suggests the following recommendations:

5.6.1 Recommendations for ICU Nurses

- Participating in continuous education and training sessions that are related to alarm management and alarm fatigue, which also includes the engagement in multidisciplinary collaborations that encourage sharing best practices to improve nurses' alarm responses across ICU settings.
- Adopting smart care practices that utilize personalized alarm settings and focus on reducing non-actionable alarms, which will help in improving response time and minimize fatigue, in addition to improving psychological well-being of nurses to reduce stress.
- Establishing and actively engage in feedback and reporting systems that contribute to the refinement of alarm protocols and systems.
- Developing a sensitivity culture where nurses collaborate to reinforce their responsiveness by encouraging awareness and responsibility in the effective management of alarms.
- Encourage the experienced nurses to engage in mentorship and peer-learning programs to exchange practical insights while also updating their knowledge with the new evidence-based strategies of alarm management, and bridge the gap between years of experience and best practices.

5.6.2 Recommendations for Policymakers and Hospital Administrations

Development and implementation of standardized alarm management protocols across the different types of ICU, which will reduce inconsistencies and improve the quality of care and patient safety.

- Focusing on specific issues that face the Palestinian nurses when allocating resources to be invested in targeted training programs, including high nurse-to-patient ratio and limitations of resources.
- Encouraging the building of quality and safety culture among the nurses, which can be implemented by integrating their feedback into the development of policies, which supports nurses' roles in quality management and improvement.

- Conducting regular and frequent audits that continuously assess current attitudes and competences of nurses towards alarm management, and evaluate efforts of education and training.
- Allocate more resources for the development, implementation and efficacy assessment of training and educational programs for nurses for the aim of improving ICU nurses' attitudes and competence levels towards alarm management, and conduct periodic audits and assessment projects on needs for improvement for such programs.

5.6.3 Recommendations for Future Research

- Conducting interventional studies in the field of quality management and patient safety that would help in assessing the impact of educational and training efforts on the attitude and competence of ICU nurses towards alarm management.
- Including the impact of organizational factors on nurses' attitudes and competence, like workload and resource limitations, as well as differences between ICU types, which will help in identifying actionable interventions to enhance patient care.
- Implementing longitudinal studies in the field of quality management and patient safety on the topic of alarm management and fatigue, including the prospective evaluation of the impact of training and education on such levels over time.

5.7 Research Limitations

The current study was limited by the following points:

- The implementation of a cross-sectional design, which limited the ability to establish causality between demographic factors and alarm management attitudes and practices.
- The reliance on self-reporting data, using a self-administered online questionnaire, which may have introduced information and recall bias, affecting the accuracy of responses.
- The study included private and governmental hospitals from three cities in West Bank – Palestine, which limits the ability to generalize its findings on the overall population of ICU nurses in Palestine. This can be improved in the future research by including a broader coverage of nurses from more settings to enhance the representativeness of the sample.

- Limited inclusion of systemic and other factors, like organizational factors, prior receiving of specific training, … etc.

References

Ageel, M. I., & Shbeer, A. M. (2022). Assessment of the Critical Care Work Environment of Intensive Care Unit Nurses in Saudi Arabia. *Risk Management and Healthcare Policy*, *15*, 2413 - 2420.

Ajzen, I. (2001). Nature and Operation of Attitudes. *Annual Review of Psychology*, *52*(Volume 52, 2001), 27-58. https://doi.org/https://doi.org/10.1146/annurev.psych.52.1.27

Akturan, S., Güner, Y., Tuncel, B., Üçüncüoğlu, M., & Kurt, T. (2022). Evaluation of alarm fatigue of nurses working in the COVID-19 Intensive Care Service: A mixed methods study. *J Clin Nurs*, *31*(17-18), 2654-2662. https://doi.org/10.1111/jocn.16190

AL-Ghwary, A. A., Al-Oweidat, I. A., Al-Qudimat, A. R., Abu Shosha, G. M., Khalifeh, A. H., & Albashtawy, M. (2024). The Impact of Work Environment on Structural Empowerment among Nurses in Governmental Hospitals. *Nursing Reports*, *14*, 482 - 493.

Albarracin, D., Johnson, B., & Zanna, M. (2005). *Handbook of Attitudes*.

Allan, S. H., Doyle, P. A., Sapirstein, A., & Cvach, M. (2017). Data-Driven Implementation of Alarm Reduction Interventions in a Cardiovascular Surgical ICU. *Jt Comm J Qual Patient Saf*, *43*(2), 62-70. https://doi.org/10.1016/j.jcjq.2016.11.004

Alsuyayfi, S., & Alanazi, A. (2022). Impact of clinical alarms on patient safety from nurses' perspective. *Informatics in Medicine Unlocked*, *32*, 101047. https://doi.org/https://doi.org/10.1016/j.imu.2022.101047

American Association of Critial-Care Nurses. (2013). Alarm Management. *Critical Care Nurse*, *33*(5), 83-86.

Bani Hani, S. H., & Abu Aqoulah, E. A. (2024). Relationship Between Alarm Fatigue and Stress Among Acute Care Nurses: A Cross-Sectional Study. *SAGE Open Nursing*, *10*.

Benner, P. (1982). From Novice To Expert. *AJN The American Journal of Nursing*, *82*(3), 402-407. https://journals.lww.com/ajnonline/fulltext/1982/82030/from_novice_to_expert.4.aspx

Bi, J., Yin, X., Li, H., Gao, R., Zhang, Q., Zhong, T., Zan, T., Guan, B., & Li, Z. (2020). Effects of monitor alarm management training on nurses' alarm fatigue: A randomised controlled trial. *J Clin Nurs*, *29*(21-22), 4203-4216. https://doi.org/10.1111/jocn.15452

Bi, J., Yin, X., Li, H., Gao, R., Zhang, Q., Zhong, T., Zan, T., Guan, B., & Li, Z. (2020). Effects of monitor alarm management training on nurses' alarm fatigue: A randomised controlled trial. *Journal of Clinical Nursing*, *29*(21-22), 4203-4216. https://doi.org/https://doi.org/10.1111/jocn.15452

Braekman, E., Demarest, S., Charafeddine, R., Drieskens, S., Berete, F., Gisle, L., Van der Heyden, J., & Van Hal, G. F. (2020). Unit Response and Costs in Web Versus Face-To-Face Data Collection: Comparison of Two Cross-sectional Health Surveys. *Journal of Medical Internet Research*, *24*.

Butler, A., Battista, K., Leatherdale, S. T., Meyer, S. B., Elliott, S. J., & Majowicz, S. E. (2021). A comparison of repeat cross-sectional and longitudinal results from the COMPASS study: design considerations for analysing surveillance data over time. *International Journal of Social Research Methodology*, *25*, 597 - 609.

Carelli, L., Terzoni, S., Destrebecq, A., Formenti, P., Soumahoro, F., Esposito, A., & Ferrara, P. (2022). Alarm fatigue in nurses working in intensive care units: A multicenter study. *Work*, *72*(2), 651-656. https://doi.org/10.3233/wor-210552

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*, *48*, 36-41. https://doi.org/10.1016/j.iccn.2018.05.004

Chromik, J., Klopfenstein, S. A. I., Pfitzner, B., Sinno, Z. C., Arnrich, B., Balzer, F., & Poncette, A. S. (2022). Computational approaches to alleviate alarm fatigue in intensive care medicine: A systematic literature review. *Front Digit Health*, *4*, 843747. https://doi.org/10.3389/fdgth.2022.843747

Clinical Alarms Task Force. (2007). Impact of Clinical Alarms on Patient Safety: A Report From the American College of Clinical Engineering Healthcare Technology Foundation. *Journal of Clinical Engineering*, *32*(1), 22-33. https://journals.lww.com/jcejournal/fulltext/2007/01000/impact_of_clinical_alarms_on_patient_safety__a.24.aspx

Currie, J., Thompson, C., Grootemaat, P., Andersen, P., Finnegan, A., Carter, M., & Halcomb, E. (2023). A scoping review of clinical skill development of preregistration registered nurses in Australia and five other English-speaking countries. *J Clin Nurs*, *32*(1-2), 283-297. https://doi.org/10.1111/jocn.16239

Cvach, M. (2012). Monitor Alarm Fatigue: An Integrative Review. *Biomedical Instrumentation & Technology*, *46*(4), 268-277. https://doi.org/doi:10.2345/0899-8205-46.4.268

Dee, S. A., Tucciarone, J., Plotkin, G., & Mallilo, C. (2022). Determining the Impact of an Alarm Management Program on Alarm Fatigue among ICU and Telemetry RNs: An Evidence Based Research Project. *SAGE Open Nurs*, *8*, 23779608221098713. https://doi.org/10.1177/23779608221098713

Dehghan, M., Mokhtarabadi, S., Rashidi, E., Rahiminejad, E., & Asadi, N. (2023). Correlation between professional quality of life and alarm fatigue symptoms among intensive care unit nurses. *Health Sci Rep*, *6*(10), e1583. https://doi.org/10.1002/hsr2.1583

Donabedian, A. (1988). The Quality of Care: How Can It Be Assessed? *Jama*, *260*(12), 1743-1748. https://doi.org/10.1001/jama.1988.03410120089033

Drew, B. J., Califf, R. M., Funk, M., Kaufman, E. S., Krucoff, M. W., Laks, M. M., Macfarlane, P. W., Sommargren, C., Swiryn, S., & Van Hare, G. F. (2004). Practice standards for electrocardiographic monitoring in hospital settings: an American Heart Association scientific statement from the Councils on Cardiovascular Nursing, Clinical Cardiology, and Cardiovascular Disease in the Young: endorsed by the International Society of Computerized Electrocardiology and the American Association of Critical-Care Nurses. *Circulation*, *110*(17), 2721-2746. https://doi.org/10.1161/01.Cir.0000145144.56673.59

Drew, B. J., Harris, P., Zègre-Hemsey, J. K., Mammone, T., Schindler, D., Salas-Boni, R., Bai, Y., Tinoco, A., Ding, Q., & Hu, X. (2014). Insights into the problem of alarm fatigue with physiologic monitor devices: a comprehensive observational study of consecutive intensive care unit patients. *PLOS ONE*, *9*(10), e110274. https://doi.org/10.1371/journal.pone.0110274

Epstein, R. M., & Hundert, E. M. (2002). Defining and Assessing Professional Competence. *Jama*, *287*(2), 226-235. https://doi.org/10.1001/jama.287.2.226

Ferrara, M., Bertozzi, G., Di Fazio, N., Aquila, I., Di Fazio, A., Maiese, A., Volonnino, G., Frati, P., & La Russa, R. (2024). Risk Management and Patient Safety in the Artificial Intelligence Era: A Systematic Review. *Healthcare*, *12*.

Ferreira, M. B. G., Dos Santos Felix, M. M., de Souza Lopes, R. A., Haas, V. J., Galvão, C. M., & Barbosa, M. H. (2021). Barriers to research utilization influencing patient safety climate: A cross-sectional study. *International journal of nursing practice*, e12959.

Fishbein, M., & Ajzen, I. (2010). *Predicting and changing behavior: The reasoned action approach*. Psychology Press.

Frank, J., Snell, L., & Sherbino, J. (2015). *CanMEDS 2015 Physician Competency Framework*.

Funk, M., Clark, J. T., Bauld, T. J., Ott, J. C., & Coss, P. (2014). Attitudes and Practices Related to Clinical Alarms. *American Journal of Critical Care*, *23*(3), e9-e18. https://doi.org/10.4037/ajcc2014315

Ghofrani, M., Valizadeh, L., Zamanzadeh, V., Ghahramanian, A., Janati, A., & Taleghani, F. (2024). Adapting the Donabedian model in undergraduate nursing education: a modified Delphi study. *BMC Medical Education*, *24*(1), 202. https://doi.org/10.1186/s12909-024-05187-7

Göktepe, N., & Sarıköse, S. (2022). Same Place but Different Experience: A Qualitative Study on Gender and the Nursing Work Environment. *Journal of nursing management*.

Gomarverdi, S., Khatiban, M., Bikmoradi, A., & Soltanian, A. R. (2019). Effects of a multi-component educational intervention on nurses' knowledge and adherence to standard precautions in intensive care units. *Journal of Infection Prevention*, *20*, 83 - 90.

Grancharova, G., Dulgerova, S. t., & Aleksandrova-Yankulovska, S. (2020). Public and private hospitals – different opportunities for nurses (Bulgaria, Pleven, 2016-2018). *European Journal of Public Health*, *30*.

Harris, P. R. E., Zègre-Hemsey, J. K., Schindler, D., Bai, Y., Pelter, M. M., & Hu, X. (2017). Patient characteristics associated with false arrhythmia alarms in intensive care. *Therapeutics and Clinical Risk Management*, *13*, 499 - 513.

Herrera, H., & Wood, D. (2023). Battling Alarm Fatigue in the Pediatric Intensive Care Unit. *Crit Care Nurs Clin North Am*, *35*(3), 347-355. https://doi.org/10.1016/j.cnc.2023.05.003

Hyman, M., & Sierra, J. (2016). Open- versus close-ended survey questions. *NMSU Business Outlook*, *14*.

Jager, J., Putnick, D. L., & Bornstein, M. H. (2017). MORE THAN JUST CONVENIENT: THE SCIENTIFIC MERITS OF HOMOGENEOUS CONVENIENCE SAMPLES. *Monogr Soc Res Child Dev*, *82*(2), 13-30. https://doi.org/10.1111/mono.12296

Jeong, Y. J., & Kim, H. (2023). Critical care nurses' perceptions and practices towards clinical alarms. *Nurs Crit Care*, *28*(1), 101-108. https://doi.org/10.1111/nicc.12751

Karahan, A., Kav, S., Çevik, B., Çıtak, E. A., Uğurlu, Z., & Fulser, B. (2023). Alarm fatigue among nurses working in intensive care and other inpatient clinics. *Work*, *76*(2), 793-801. https://doi.org/10.3233/wor-220466

Karapas, E. T., & Bobay, K. L. (2019). Reducing Cardiac Telemetry Nuisance Alarms Through Evidence-Based Interventions. *Journal of Nursing Care Quality*, *36*, 355 - 360.

Karnataka, T. (2021). Comparative Study to Assess the Job Satisfaction among Nursing Professionals employed in Government and Private Health Care Sectors. *Nursing Journal of India*.

Lewandowska, K., Weisbrot, M., Cieloszyk, A., Mędrzycka-Dąbrowska, W., Krupa, S., & Ozga, D. (2020). Impact of Alarm Fatigue on the Work of Nurses in an Intensive Care Environment-A Systematic Review. *Int J Environ Res Public Health*, *17*(22). https://doi.org/10.3390/ijerph17228409

Lewandowska, K. B., Mędrzycka-Dąbrowska, W., Tomaszek, L., & Wujtewicz, M. (2023). Determining Factors of Alarm Fatigue among Nurses in Intensive Care Units—A Polish Pilot Study. *Journal of Clinical Medicine*, *12*.

Lewis, C. L., & Oster, C. A. (2019). Research Outcomes of Implementing CEASE: An Innovative, Nurse-Driven, Evidence-Based, Patient-Customized Monitoring Bundle to Decrease Alarm Fatigue in the Intensive Care Unit/Step-down Unit. *Dimens Crit Care Nurs*, *38*(3), 160-173. https://doi.org/10.1097/dcc.0000000000000357

Menon, V., & Muraleedharan, A. (2020). Internet-based surveys: relevance, methodological considerations and troubleshooting strategies. *General Psychiatry*, *33*.

Movahedi, A., Sadooghiasl, A., Ahmadi, F., & Vaismoradi, M. (2023). Smart care for dealing with nurses' alarm fatigue in the intensive care unit. *J Nurs Scholarsh*, *55*(4), 825-833. https://doi.org/10.1111/jnu.12870

Muthusamy, R., Padmapriya, V. M., Jaganathasamy, N., Mathiyazhakan, M., Radhakrishnan, K., Durairajan, C., Ramasamy, S., Aridoss, S., Vinod, V., Eapen, A., & Arumugam, E. (2021). A Quick, Deployable, Online Health Survey in Public Health Research: Emerging Horizons of mHealth during Disasters. *Asian Pacific Journal of Health Sciences*.

Najafi Ghezeljeh, T., Samadi Beiram, Z., & Omrani, S. (2022). Effectiveness of Online Patient Safety Education on the Competency of Nurses in Intensive Care Units: A Quasi-experimental Study. *The Iran Journal of Nursing*.

Nyarko, B. A., Nie, H., Yin, Z., Chai, X., & Yue, L. (2023). The effect of educational interventions in managing nurses' alarm fatigue: An integrative review. *J Clin Nurs*, *32*(13-14), 2985-2997. https://doi.org/10.1111/jocn.16479

Oliveri, S., Lanzoni, L., Petrocchi, S., Janssens, R., Schoefs, E., Huys, I., Smith, M. Y., Smith, I. P., Veldwijk, J., de Wit, G. A., & Pravettoni, G. (2021). Opportunities and Challenges of Web-Based and Remotely Administered Surveys for Patient Preference Studies in a Vulnerable Population. *Patient preference and adherence*, *15*, 2509 - 2517.

Otero, M. J., Merino de Cós, P., Aquerreta González, I., Bodí, M., Domingo Chiva, E., Marrero Penichet, S. M., Martín Muñoz, R., & Martin Delgado, M. C. (2021). Assessment of the implementation of safe medication practices in Intensive Medicine Units. *Medicina intensiva*.

Paredath, M. S., & Al Jarary, K. L. (2023). The effect of applying alarm fatigue strategies related to nursing performance. *International Journal of Research in Medical Sciences*.

Petersen, E. M., & Costanzo, C. L. (2017). Assessment of Clinical Alarms Influencing Nurses' Perceptions of Alarm Fatigue. *Dimensions of Critical Care Nursing*, *36*(1), 36-44. https://doi.org/10.1097/dcc.0000000000000220

Putranto, L. S. (2019). The use of an online survey to speed up the data collection process. *IOP Conference Series: Materials Science and Engineering*, *508*.

Ramlaul, A., Chironda, G., & Brysiewicz, P. (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 Afr J Crit Care*, *37*(2). https://doi.org/10.7196/SAJCC.2021.v37i2.469

Ray, J. V. (2020). Cross-Sectional Research Designs in Criminology and Criminal Justice. *Criminology*.

Ruskin, K. J., & Hueske-Kraus, D. (2015). Alarm fatigue: impacts on patient safety. *Curr Opin Anaesthesiol*, *28*(6), 685-690. https://doi.org/10.1097/aco.0000000000000260

Salameh, B., Abdallah, J., Alkubati, S. A., & Albashtawy, M. (2024). Alarm fatigue and perceived stress among critical care nurses in the intensive care units: Palestinian perspectives. *BMC Nursing*, *23*(1), 261. https://doi.org/10.1186/s12912-024-01897-x

Salifu, D. A., Heymans, Y., & Christmals, C. D. (2022). A Simulation-Based Clinical Nursing Education Framework for a Low-Resource Setting: A Multimethod Study. *Healthcare (Basel)*, *10*(9). https://doi.org/10.3390/healthcare10091639

Sendelbach, S., & Funk, M. (2013). Alarm fatigue: a patient safety concern. *AACN Adv Crit Care*, *24*(4), 378-386; quiz 387-378. https://doi.org/10.1097/NCI.0b013e3182a903f9

Shih, Y.-S., Lee, T.-T., & Mills, M. E. (2022). Critical Care Nurses' Perceptions of Clinical Alarm Management on Nursing Practice. *CIN: Computers, Informatics, Nursing*, *40*(6), 389-395. https://doi.org/10.1097/cin.0000000000000886

Sodhi, K., Chanchalani, G., Arya, M., Shrestha, G. S., Chandwani, J., Kumar, M., Kansal, M. G., Ashrafuzzaman, M., Mudalige, A. D., Al Tayar, A., Mansour, B., Saeed, H. M., Hashmi, M., Das, M., Al Shirawi, N. N., Mathias, R. M., Ahmed, W. O., Sharma, A., Agarwal, D. D., & Nasa, P. (2023). Knowledge and awareness of infection control practices among nursing professionals: A cross-sectional survey from South Asia and the Middle East. *World Journal of Critical Care Medicine*, *12*, 176 - 187.

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. *Open Med Inform J*, *11*, 1-11. https://doi.org/10.2174/1874431101711010001

Spector, P. E. (2019). Do Not Cross Me: Optimizing the Use of Cross-Sectional Designs. *Journal of Business and Psychology*, *34*, 125-137.

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

Sujimongkol, C., Daochai, S., Wichakhrueang, S., & Daochai, C. (2023). Meta-analysis on the Prevalence and Impact of False, Nonactionable, and Nuisance Alarms in Critical Care Environments: Informing Evidence-Based Practices for Improving Patient Safety in Alarm Monitoring Systems. *2023 15th Biomedical Engineering International Conference (BMEiCON)*, 1-5.

Tlili, M. A., Aouicha, W., Sahli, J., Zedini, C., Ben Dhiab, M., Chelbi, S., Mtiraoui, A., Said Latiri, H., Ajmi, T., Ben rejeb, M., & Mallouli, M. (2020). A baseline assessment of patient safety culture and its associated factors from the perspective of critical care nurses: Results from 10 hospitals. *Australian critical care : official journal of the Confederation of Australian Critical Care Nurses*.

Winters, B. D., Cvach, M. M., Bonafide, C. P., Hu, X., Konkani, A., O'Connor, M. F., Rothschild, J. M., Selby, N. M., Pelter, M. M., McLean, B., & Kane-Gill, S. L. (2018). Technological Distractions (Part 2): A Summary of Approaches to Manage Clinical Alarms With Intent to Reduce Alarm Fatigue. *Crit Care Med*, *46*(1), 130-137. https://doi.org/10.1097/ccm.0000000000002803

Zea, M. C., Asner-Self, K. K., Birman, D., & Buki, L. P. (2003). The Abbreviated Multidimentional Acculturation Scale: Empirical validation with two Latino/Latina samples. *Cultural Diversity and Ethnic Minority Psychology*, *9*(2), 107-126. https://doi.org/10.1037/1099-9809.9.2.107

Appendices

Appendix A: Study Questionnaire (Arabic version)

القسم الأول: المعلومات الشخصية والمهنية

يرجى الإجابة عن الأسئلة التالية باختيار إجابة واحدة مما يقابلها

السؤال	الإجابات
1. العمر (بالسنوات)	
2. الجنس	1. ذكر
	2. أنثى
3. مكان السكن	1. مدينة
	2. قرية/بلدة
	3. مخيم
4. المستوى التعليمي (لا يشمل ما تدرسه حاليا)	1. دبلوم
	2. بكالوريوس
	3. دراسات عليا
5. نوع المستشفى الذي تعمل به	1. مستشفى حكومي
	2. مستشفى غير حكومي (خاص أو أهلي أو....)
6. عدد سنوات الخبرة في مهنة التمريض	_____ سنة
7. عدد سنوات الخبرة في أقسام العناية المكثفة	_____ سنة
8. نوع العناية المكثفة التي تعمل بها حاليا	1. العناية المكثفة العامة (Adult ICU)
	2. العناية المكثفة الجراحية (Surgical ICU)
	3. العناية المكثفة القلبية (CCU)
	4. العناية المكثفة للأعصاب (Neurosurgery ICU)
	5. العناية المكثفة للأطفال (Pediatric ICU)
	6. العناية المكثفة للخداج (Neonate ICU)
	7. أخرى
9. طبيعة الورديات	1. صباحية فقط (straight A)
	2. مسائية أو ليلية فقط (B or C shifts)

	3. مختلطة (A, B or C shifts)
10.كم عدد الساعات التي تناوبها على الورديات الإضافية تقريبا كل أسبوع؟	_____ ساعة

القسم الثاني: مقياس سلوك ممرضي العناية المكثفة تجاه الإنذارات السريرية

يرجى اختيار الإجابة الأنسب لكل جملة من الآتية مما يقابلها، وعدم ترك جملة بدون إجابة محددة

الجملة	موافق بشدة	موافق	محايد	معارض	معارض بشدة
1. الغرض من إنذارات الرعاية السريرية هو تنبيه الطاقم على حالة المريض الحالية أو المحتملة الخطورة.					
2. يجب أن يتم تمييز أصوات و/أو شكل الإنذارات حسب الأولوية.					
3. يجب أن تكون أصوات و/أو أشكال الإنذارات مختلفة بناءً على المعلمة parameter أو المصدر (مثل الجهاز).					
4. يجب أن تؤثر الإنذارات على حواس متعددة (سمعية، بصرية، حس اللمس، إلخ).					
5. الإنذارات المزعجة تحدث بشكل متكرر.					
6. الإنذارات المزعجة تعطل الرعاية الطبية.					
7. الإنذارات المزعجة تقلل من الثقة في الإنذارات وتجعل مقدمي الرعاية يقومون بإيقاف الإنذارات في أوقات أخرى غير إعداد الجهاز أو أثناء الإجراءات.					
8. ضبط إعدادات الإنذار والتنبيهات صعب للغاية في الأجهزة الحالية.					
9. أنظمة المراقبة الجديدة قد حلت معظم المشاكل السابقة التي واجهناها مع إنذارات الرعاية السريرية.					
10.الإنذارات المستخدمة في طابقي/منطقتي بالمستشفى كافية لتنبيه الطاقم على التغيرات المحتملة أو الفعلية في حالة المريض.					
11.كانت هناك حالات متكررة حيث لم يتم سماع الإنذارات وتم تفويتها.					
12.الطاقم حساس للإنذارات ويستجيب بسرعة.					

13. المعدات الطبية المستخدمة في وحدتي/طابقي لها جميعها مخرجات متميزة (أصوات، معدلات التكرار، عروض بصرية، إلخ) تسمح بتمييز مصدر الإنذار.						
14. عند استخدام عدد من الأجهزة مع إنذارات مع المريض، يمكن أن يكون من الصعب تحديد أي جهاز ينذر.						
15. تتداخل الضوضاء البيئية (بسبب الأصوات المحيطة) مع التعرف على الإنذارات.						
16. أنظمة دمج الإنذارات والتواصل عبر النداء اللاسلكي أو الهاتف الخلوي أو أجهزة لاسلكية أخرى مفيدة في تحسين إدارة الإنذارات والاستجابة لها.						
17. الإنذارات الذكية حيث يتم تقييم معلمات parameters متعددة، ومعدل تغير المعلمات، وجودة الإشارة تلقائيًا بأكملها ستكون فعالة في تقليل الإنذارات الخاطئة.						
18. الإنذارات الذكية حيث يتم تقييم معلمات parameters متعددة، ومعدل تغير المعلمات، وجودة الإشارة تلقائيًا بأكملها ستكون فعالة في تحسين الاستجابة السريرية لإنذارات المرضى المهمة.						
19. توجد سياسات وإجراءات داخل المنشأة لتنظيم الإنذارات، ويتم اتباعها.						
20. يُطلب في مؤسستك توثيق أن الإنذارات مضبوطة ومناسبة لكل مريض.						

يرجى تقييم المشاكل التالية بما يخص الإنذارات، حيث إن 1 = الأعلى أهمية، 9 = الأقل أهمية. يرجى قراءتها جميعا ثم إعادة تقييمها

	1	2	3	4	5	6	7	8	9
1. صعوبة في ضبط الإنذارات بشكل صحيح.									
2. صعوبة في سماع الإنذارات عند حدوثها.									
3. صعوبة في تحديد مصدر الإنذار.									
4. صعوبة في فهم أولوية الإنذار.									
5. إنذارات كاذبة متكررة تؤدي إلى انخفاض الاهتمام أو الاستجابة للإنذارات عند حدوثها.									
6. عدم كفاية الطاقم للاستجابة للإنذارات عند حدوثها.									
7. الاعتماد المفرط على الإنذارات للفت الانتباه إلى مشاكل المرضى.									

8. المنافسة الضوضائية من الإنذارات غير السريرية والنداءات.									
9. نقص التدريب على أنظمة الإنذار.									

القسم الثالث: مقياس كفاءة ممرضي العناية المكثفة تجاه الإنذارات السريرية

يرجى اختيار الإجابة الأنسب لكل جملة من الآتية مما يقابلها، وعدم ترك جملة بجون إجابة محددة

الجملة	كفء	معتدل	غير كفء	لم أستعملها
أولا: إدخال وإخراج ونقل المريض				
1. إخراج المريض من الأجهزة المركزية وأجهزة المراقبة الجانبية				
2. إدخال المريض إلى الأجهزة المركزية وأجهزة المراقبة الجانبية				
3. نقل المريض من الأجهزة المركزية وأجهزة المراقبة الجانبية				
4. تعديل معلومات المريض بعد الإدخال				
5. حل تضارب معلومات المريض				
ثانيا: الأجهزة وتوصيلها				
6. توصيل كابلات المراقب				
7. تحديد الأجزاء الرئيسية لجهاز المراقبة والمكونات والموصلات				
8. الإبلاغ عن أعطال الأجهزة للفنيين				
9. تحديد حالة طاقة البطارية لجهاز المراقبة من لون العرض (أخضر أصفر أو أحمر)				
10. تنظيف وتعقيم وتطهير أجهزة المراقبة وملحقاتها				
11. وصف وظائف أضواء التنبيه حسب مؤشرات وألوان اللوحة الأمامية				
ثالثا: إدارة التنبيهات				
12. إيقاف التنبيهات مؤقتًا وإلغاء الإيقاف				

13.كتم الأصوات التنبيهية				
14.معرفة أنواع مختلفة من عرض المعلمات parameters ومعنى الأمواج والمعلومات في العرض (مثل عدم انتظام ضربات القلب والتنفس)				
15. عرض جميع رسائل التنبيه النشطة بسهولة				
16. تغيير حجم صوت التنبيه بسهولة				
17. اختيار وتغيير مصدر التنبيه بشكل مناسب (مثل مصدر التنبيه للضغط NBP)				
18. تغيير حدود التنبيه alarm limits بأمان وبشكل مناسب				
19. تغيير حدود التنبيهalarm limits بسهولة				
20. تحديد وتمييز الأولوية (من الأعلى أولوية إلى الأقل أولوية) ومعنى جميع رسائل التنبيه الفسيولوجية بناءً على مؤشرات التنبيه البصرية والسمعية				
21. التعرف على رسائل التنبيه وتصحيحها بشكل مناسب				
22. تحديد وتمييز الأولوية ومعنى رسائل التنبيه الفنية (مثل التحقق من المعدات) بناءً على المؤشرات البصرية والسمعية				
23. تخصيص الإعدادات الافتراضية لتكون محددة للمريض				
24. استكشاف الأخطاء وإصلاحها في الرسائل الفنية الشائعة (مثل !!تحقق من معرف المريض)				
25. التخلص من التنبيهات المتكررة عند تغيير الإعدادات الافتراضية				
26. فهم منطق جهاز المراقبة وراء عرض أنواع مختلفة من التنبيهات (مثل تفضيل الجهاز لعرض الأعلى أولوية وعدم عرض الأقل منها أولوية حتى لو حدثت)				
27. معرفة متى تحتاج للاتصال بالفنيين لتصحيح التنبيهات الفنية مقابل متى تحتاج لاستكشاف الأخطاء وإصلاحها				
28. تمديد وقت إيقاف التنبيه مؤقتًا				

29. تمييز سلوكيات التنبيهات الثابتة (التنبيه يتم إيقافه تلقائيًا عندما لا توجد الحالة) مقابل التنبيهات غير الثابتة (تتطلب من الممرض إيقاف التنبيه حتى لو لم تعد الحالة موجودة)				

رابعا: الاستخدام الصحيح لأجهزة المراقبة				
30. وضع الأقطاب الكهربائية electrodes بشكل مناسب				
31. تغيير فاصل قياس ضغط الدم (الوقت بين كل قياس وآخر بشكل تلقائي)				
32. اختيار أوضاع قياس NBP المناسبة (يدوي، تلقائي، تسلسل، فوري)				
33. تخزين وإرسال12-lead ECG إلى جهاز المراقبة المركزي				
34. معايرة جهاز قياس الضغط (zeroing)				
35. وضع جهاز المراقبة في وضع الاستعداد واستئناف المراقبة من وضع الاستعداد				
36. اختيار التسمية المناسبة للضغط للمراقبة (مثل... IBP, ICP, CVP,)				
37. تغيير حجم موجة عرض البيانات (scaling or wave size)				
38. اختيار موقع قياس SpO2 المثالي من الجسم				
39. التعرف على عناصر وغرض استخدام مفاتيح شاشة المراقب: (1) المفاتيح الدائمة الأربعة (كتم الصوت، إيقاف التنبيهات، إعداد القائمة الرئيسية، الشاشة الرئيسية) (2) المفاتيح الذكية و (3) المفاتيح المنبثقة				
40. اختيار القطب المناسب ECG lead لعرضه بين المرضى الذين لديهم جهاز ضبط النبضpacing أو عدمه non-pacing				
41. التنقل بسهولة بين شاشات جهاز المراقبة المختلفة				
42. تعديل سرعة أنواع مختلفة من الموجات				
43. تجميد وإلغاء تجميد الموجات wave freeze				
44. مراجعة بيانات المريض الممتدة باستخدام اتجاهات الشاشة wave trends				

45. تمييز/طباعة التقارير المرضية المتاحة ضمن جهاز المراقبة				
46. تعطيل/إعادة تمكين عمل شاشة اللمس في جهاز المراقبة مؤقتًا				

خامسا: الوظائف المتقدمة				
47. عرض حسابات الديناميكا hemodynamics والأوكسجين والتهوية على الشاشة				
48. أداء حسابات المعايير parameters calculation				
49. الوصول إلى/استخدام حاسبة الأدوية من جهاز المراقبة				
50. إدخال بيانات يدويًا في جهاز المراقبة (مثل نتائج المختبر)				
51. استخدام بروتوكول sepsis وإرشاداته المتاحة في جهاز المراقبة				

شكرا لك أيها الزميل/ـة العزيز/ة على استثمار وقتك الثمين،،،،

Appendix B: Informed Consent (Arabic version)

تقييم السلوك والكفاءة حول إدارة الإنذارات السريرة عند ممرضي وممرضات أقسام العناية المكثفة في فلسطين

عزيزي الممرض / عزيزتي الممرضة

أنا الطالب: طارق فقها من برنامج الماجستير في الإدارة الصحية في الجامعة العربية الأمريكية، أطلب من حضرتك الموافقة على المشاركة في الدراسة التي أقوم بها استكمالا لرسالتي الماجستير، والتي تهدف إلى تقييم السلوك والكفاءة لدى ممرضي العناية المكثفة بمختلف أنواعها حول إدارة الإنذارات السريرية، أو ما يعرف بمصطلح Alarm Fatigue، وكذلك إلى التعرف على أهم العوامل الشخصية والمهنية التي تؤثر على هذه المتغيرات.

تشمل الاستبانة التالية على ثلاثة أقسام رئيسية، وهي:

القسم الأول: المعلومات الشخصية والمهنية

القسم الثاني: تقييم سلوك ممرضي العناية المكثفة تجاه إدارة الإنذارات السريرية

القسم الثالث: تقييم كفاءة الممرض/ة حول إدارة الإنذارات السريرية

وكل الأسئلة هي من نمط close-ended questions وبذلك فهي لن تأخذ من وقتك الكثير.

أود التأكيد هنا أن التعامل مع البيانات التي سيتم جمعها سيكون بمنتهى السرية والموضوعية، حيث أنه لن يتم جمع اسمك أو أي معلومات حساسة، وكذلك سيتم الاحتفاظ بالنسخ الخاصة بالاستبيانات في ظروف مغلقة إلى حيت بدء عملية تحليلها، وكذلك فإن الاستبيانات لن يتم عرضها إلا على الباحث والمشرف، ولأغراض البحث العلمي فقط. أيضا، يمكنك طلب الانسحاب من الدراسة دون الحاجة لإبداء الأسباب.

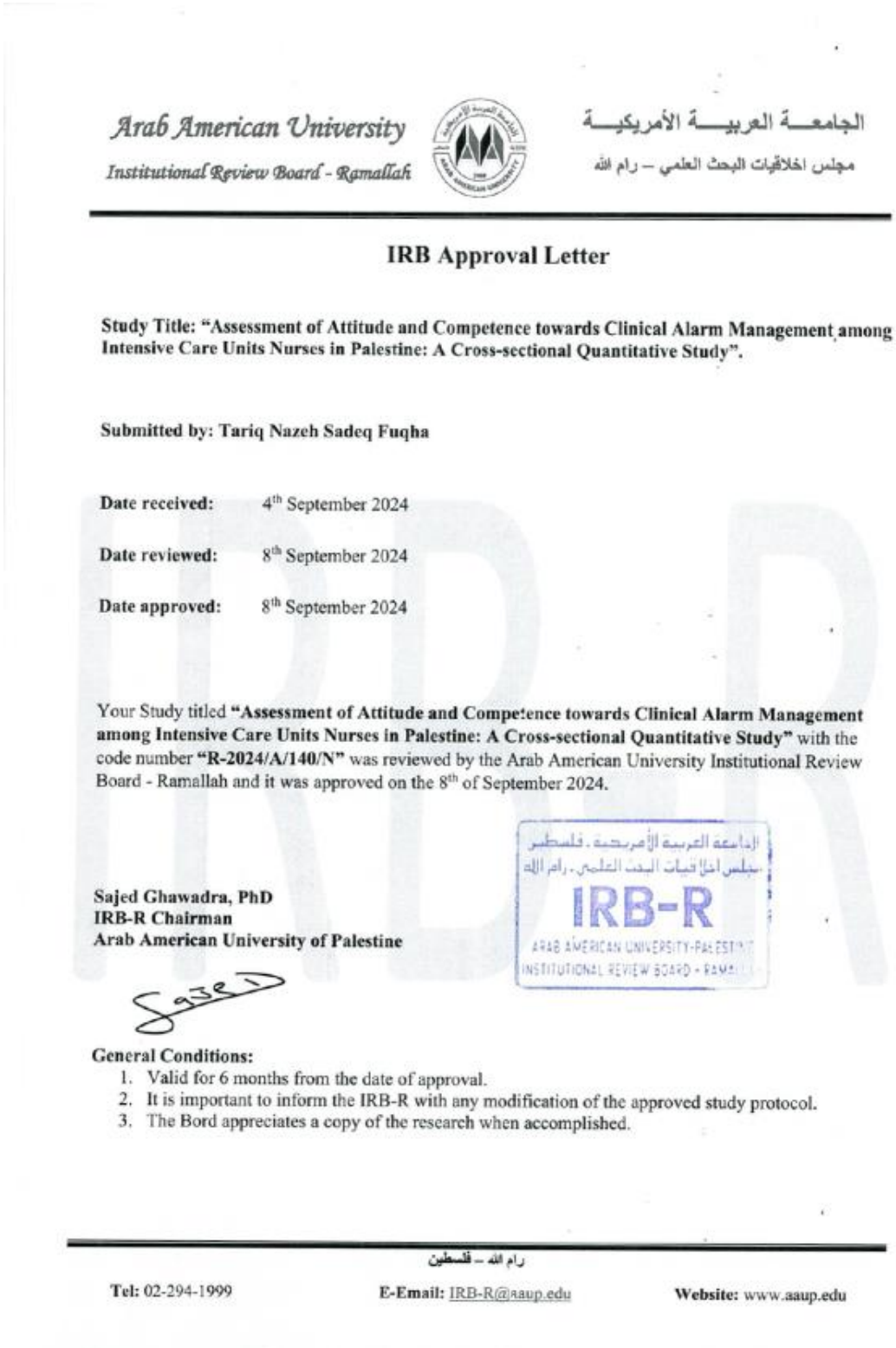
لأي استفسارات أخرى، يرجى التواصل مع الباحث الرئيسي للرسالة،

المهندس: طارق فقها رقم المحمول: 0599750002

تحت إشراف: الدكتور يحيى صالح

التوقيع:_____ التاريخ:_____

Appendix C: Institutional Review Board (IRB) form



Arab American University
Institutional Review Board - Ramallah

الجامعة العربية الأمريكية
مجلس اخلاقيات البحث العلمي – رام الله

IRB Approval Letter

Study Title: "Assessment of Attitude and Competence towards Clinical Alarm Management among Intensive Care Units Nurses in Palestine: A Cross-sectional Quantitative Study".

Submitted by: Tariq Nazeh Sadeq Fuqha

Date received: 4th September 2024

Date reviewed: 8th September 2024

Date approved: 8th September 2024

Your Study titled **"Assessment of Attitude and Competence towards Clinical Alarm Management among Intensive Care Units Nurses in Palestine: A Cross-sectional Quantitative Study"** with the code number **"R-2024/A/140/N"** was reviewed by the Arab American University Institutional Review Board - Ramallah and it was approved on the 8th of September 2024.

الجامعة العربية الأمريكية - فلسطين
مجلس اخلاقيات البحث العلمي - رام الله
IRB-R
ARAB AMERICAN UNIVERSITY-PALESTINE
INSTITUTIONAL REVIEW BOARD - RAMALLAH

Sajed Ghawadra, PhD
IRB-R Chairman
Arab American University of Palestine

General Conditions:

1. Valid for 6 months from the date of approval.
2. It is important to inform the IRB-R with any modification of the approved study protocol.
3. The Bord appreciates a copy of the research when accomplished.

رام الله – فلسطين

Tel: 02-294-1999 **E-Email:** IRB-R@aaup.edu **Website:** www.aaup.edu

Appendix D: Facilitation Letter from Ministry of Health

State of Palestine
Ministry of Health
Education in Health and Scientific Research Unit

دولة فلسطين
وزارة الصحة
وحدة التعليم الصحي
والبحث العلمي

Ref.: ....
Date:.................

الرقم: ع٢٦/٣٠٨٥/٢٠٢٤
التاريخ: ٢٠٢٤/١٢/٨

الأخ مدير عام الادارة العامة للمستشفيات المحترم،،،

ق. أ. المدير التنفيذي لمجمع فلسطين الطبي المحترم،،،

تحية واحتراماً...

الموضــوع: تسهيل مهمة بحث

يرجى تسهيل مهمة الطالب: **طارق نزيه صادق فقها – برنامج ماجستير ادارة الجودة– الجامعة العربية الامريكية**، بعنوان:

"تقييم السلوك والكفاءة حول إدارة الإنذارات السريرية عند ممرضي وممرضات أقسام العناية المكثفة في فلسطين: دراسة مقطعية– كمية"

حيث سيقوم الطالب بجمع معلومات حول موضوع البحث من خلال تعبئة استبانة، وذلك في:

- مجمع فلسطين الطبي–رام الله – مستشفى الشهيد خليل سليمان
- المستشفى الوطني – مستشفى رفيديا الجراحي

مع العلم ان مشرف الدراسة: د. يوسف الميمي.

على ان يتم الالتزام بالمحافظة على اخلاقيات البحث العلمي وسرية المعلومات، وعدم التعرض للمعلومات التعريفية للمشاركين.

على ان يتم تزويد الوزارة بنسخة PDF من نتائج البحث، التعهد بعدم النشر لحين الحصول على موافقة وزارة الصحة.

مع الاحترام...

د. عبد الله القواسمي

رئيس وحدة التعليم الصحي والبحث العلمي

نسخة: عميد كلية الدراسات العليا المحترم/ الجامعة العربية الامريكية

Telfax.:09-2333901 scientificresearch.dep@gmail.com تلفاكس: 09-2333901

تقييم الموقف والكفاءة تجاه إدارة الإنذار الســـريري بين ممرضـــات وحدات العناية المركزة في فلسطين: دراسة كمية مقطعية

طارق نزيه صادق فقهاء

أسماء لجنة الإشراف:

الدكتور يحيى صالح

الدكتور سامي الصدر

الدكتور عاطف الريماوي

ملخص

المقدمة :يتميز إرهاق التنبيهات بفرط التحفيز الحسـي والتعوّد لدى ممرضـي وحدات العناية المركزة بسبب وجود عدد مفرط من إشارات التنبيه، مما قد يؤثر على جودة الرعاية المقدمة. هدفت الدراسة الحالية إلى التحقيق في مستويات السلوكيات والكفاءة لدى ممرضي وحدات العناية المركزة في إدارة التنبيهات في وحدات العناية المركزة بين الممرضـين الفلسـطينيين، بالإضـافة إلى العوامل الأكثر شيوعًا التي تؤثر عليهم وعلاقتها المتبادلة.

المنهجية: اعتمدت الدراسـة تصـميمًا وصـفيًا مقطعيًا كميًا على عينة مكونة من 243 ممرضًـا وممرضة يعملون في وحدات العناية المركزة في 10 مستشفيات حكومية وخاصة في أربع مدن في الضفة الغربية – فلسطين. تم استخدام استبيان ذاتي التعبئة مكون من ثلاثة أجزاء لتقييم مستويات الموقف والكفاءة باسـتخدام أسـئلة مغلقة ومقياس ليكرت. تم جمع البيانات مع الالتزام الكامل بالمعايير الأخلاقية، وتم تحليلها باستخدام برنامج SPSS.

النتائج: بلغ متوسـط أعمار الممرضـين 28.7 عامًا، حيث كان 64.6% منهم ذكورًا، و73.3% يحملون درجة البكالوريوس، وكان متوسـط الخبرة 6.4 سـنوات في التمريض و3.9 سـنوات في وحدات العناية المركزة. كانت مسـتويات السـلوك (متوسـط = 68.25%) والكفاءة (متوسـط =

76.55%) معتدلة، مع وجود مستوى أعلى من السلوك بشكل ملحوظ لدى الممرضين الذين لا يعيشون في المخيمات ($p = 0.016$)، ولدى الحاصلين على درجات تعليمية أقل ($p = 0.014$)بينما لوحظت مستويات أعلى من الكفاءة بين الممرضين الأصغر سنًا ($p = 0.002$)، الأقل خبرة ($p = 0.004$)، الذين يعيشون في المناطق الحضرية ($p < 0.001$)، الذين يعملون في المستشفيات الخاصة ($p = 0.025$)، وفي وحدات العناية المركزة للبالغين وجراحة الأعصاب ($p = 0.007$)وُجدت ارتباطات ذات دلالة إحصائية بين جميع المجالات والدرجات الإجمالية لمقاييس الموقف والكفاءة ($p < 0.05$).

الخلاصة: وجدت الدراسة الحالية مستويات معتدلة من السلوك والكفاءة بين ممرضي وحدات العناية المركزة الفلسطينيين تجاه إدارة التنبيهات، مما يعكس مستويات منخفضة إلى معتدلة من إرهاق التنبيهات. كانت هناك عوامل ديموغرافية مختلفة مرتبطة بإدارة التنبيهات، مع اختلافات مقارنة بالدراسات السابقة. يُشجّع الممرضون على المشاركة في التعليم المستمر وإجراء دراسات مستقبلية طولية.

الكلمات المفتاحية: التنبيه، وحدة العناية المركزة، السلوك، الممارسة، الإدارة.